Attachment 1

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PROTECT MARINE LIFE

Urge NOAA to strengthen its plan to reduce industrial ocean noise.

TAKE ACTION

NATURAL RESOURCES DEFENSE COUNCIL

BUILDING A BETTER FUTURE

Turn Down the Volume on Ocean Noise

The underwater racket caused by human activities is destroying marine life.

A Brief History of Environmental Justice

How communities of color facing the brunt of pollution launched the movement—and where it's headed.

Should You Buy Carbon Offsets?

A practical and philosophical guide to neutralizing your carbon footprint.

9 Tricks That Save Tons of Water

If you follow all of these easy tips, you'll avoid wasting hundreds of gallons a day.

This Ancient Place Is At Risk

Creating Bears Ears National Monument in southeastern Utah would protect some of America's most striking landscape—and its earliest history.

Nontoxic Ways to Protect Your Pet

How to find family-friendly flea and tick products that will provide effective care without skull-and-crossbones ingredients.

Turn Down the Volume on Ocean Noise

The underwater racket caused by human activities is destroying marine life.

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Nontoxic Ways to Protect Your Pet

How to find family-friendly flea and tick products that will provide effective care without skull-and-crossbones ingredients.

VIEW ALL OUR WORK

NRDC creates solutions for lasting environmental change, protecting natural resources in the United States and across the globe.

Climate
Energy
Health
Water
The Wild
Oceans
Food
Communities

PROGRESS

VICTORY

Reducing the Nuclear Threat

Since the 1970s, NRDC has been fighting to protect the earth—and its citizens—from the serious risks that come with nuclear power.

VICTORY

Partnering with the Pentagon

By working with the U.S. Department of Defense, NRDC is mapping the way for renewable energy production near military bases in the West.

NRDC IN ACTION

Fixing the Fashion Industry

The overseas textile mills that make our clothes are incredibly wasteful and polluting. NRDC's Clean by Design program is changing that.

SUPPORT OUR WORK

$35 $50 $100 $500 OTHER DONATE

JOIN US

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Attachment 2

Subject: Fwd: Elephants need their tusks. We don't.
Date: Tuesday, April 7, 2015 at 4:23:26 PM Eastern Daylight Time
From: Auden Shim
To: Shim, Auden

Dear Auden,

Ten years. That's all the time African forest elephants could have left before the global ivory trade wipes these magnificent creatures off the face of the earth.

The Obama Administration pledged to crack down on ivory sales in the U.S. -- and while the President has already taken important steps to restrict ivory imports, new stronger regulations promised months ago have yet to be seen.

NRDC is mobilizing immediately to prevail on President Obama to take swift federal action to help stop this senseless slaughter. Please make an emergency gift to bring forest elephants back from the brink!

Although it's technically illegal to buy and sell ivory from freshly killed elephants, **the sale of older ivory is still perfectly legal in much of the U.S.**

Criminals simply fudge the paperwork, or disguise their ivory as "old." It's that easy -- and they often get away with it.

Help shut down America's shameful ivory market and stop the brutal slaughter of elephants!

Donate now to help NRDC run this powerful full-page newspaper ad in Washington to turn up the heat on the Obama Administration.

DONATE

We need your support to help close these deadly loopholes in our ivory laws and ensure that the Obama Administration follows through on its plan to issue tough regulations on

the sale of ivory.

Meanwhile, one elephant is killed for its tusks *every 20 minutes*. It's unconscionable -- and it must end now.

Your tax-deductible donation will have an immediate impact as we:

- **Run our hard-hitting full-page newspaper ad** in Washington to escalate pressure on the Obama Administration to issue strong rules
- **Sound the alarm in Washington** and rapidly respond to pro-ivory propaganda spread by the NRA and their allies
- **Galvanize overwhelming public support for a nationwide ivory crackdown** that will help end the tragic killing of African elephants

NRDC has already won landmark ivory bans in New Jersey and New York, the biggest ivory market in the U.S. And right now, we're pushing to shut down the second largest ivory market: California.

We're up against groups like the NRA, who are going all out to block an ivory trade ban to protect their ability to hunt elephants for trophies and maintain the collectibles market for expensive guns with ivory inlays.

Please let me know I can count on your generous gift supporting our campaign to save elephants today.

Rhea

Rhea Suh
President, NRDC

The mission of the Natural Resources Defense Council (NRDC) is to safeguard the Earth: its people, its plants and animals, and the natural systems on which all life depends.

Donations to this campaign will be used to save imperiled elephants and defend our environment in the most effective way possible.

We appreciate the opportunity to communicate with you. We are committed to protecting your privacy and will never sell, exchange or rent your email address.

If you would prefer not to receive these action alerts and updates, you can click here to remove yourself from this list. To update your contact information or manage your subscriptions, go to your profile editor.

Attachment 3

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ACT NOW

Whether you want to fight against Big Coal or for struggling species, adding your voice will make a difference.

SEARCH ACTIONS

Tell Swaziland's king to drop his scheme to legalize the rhino horn trade

TAKE ACTION NOW

Help keep the Arctic and the Atlantic coasts permanently off-limits to oil drilling

TAKE ACTION

Urge President Obama to designate Utah's Bears Ears as a national monument

TAKE ACTION

TAKE ACTION

TAKE ACTION

TAKE ACTION

Tell President Obama and the EPA to limit dangerous methane emissions from all—new and old—oil and gas facilities

Join Auntie-Biotic and tell KFC to get its chickens off drugs

Demand Clean Water

Urge Bayer's CEO to stop selling bee-killing pesticides in the United States

TAKE ACTION

Demand climate action by urging your governor to support the Clean Power Plan

TAKE ACTION

Help save monarch butterflies by telling Dow to quit selling the toxic herbicide Enlist Duo

TAKE ACTION

SUPPORT OUR WORK

$35 | $50 | $100 | $500 | OTHER | DONATE

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Enter Email | SUBMIT

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Attachment 4

Email Address Here Subscribe

March 13, 2015

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thisWEEK

THE NEWSLETTER OF THE NATURAL RESOURCES DEFENSE COUNCIL

TOP STORY

Seismic Surveys Harm Whales

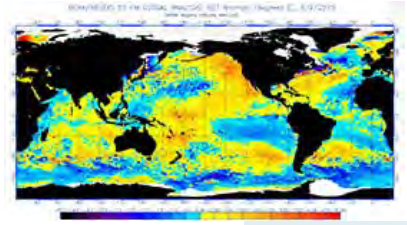
How would you like it if a stick of dynamite exploded in your backyard—every 12 seconds for weeks on end? That's what it's like for whales, dolphins, and other marine mammals when oil companies use underwater air guns to find new deposits. To help protect those animals, 75 ocean scientists urged President Obama in a recent letter to keep the East Coast off-limits to oil exploration. ***Learn More***

LATEST FROM EARTHWIRE

President Obama Sure Doesn't Sound Like a Fan of the Keystone XL Pipeline.

Drought? Climate Change? No Sweat for These Desert-Friendly Cattle.

Ugly Produce Needs Love, Too.



El Niño Finally Showed Up—and It's Not Doing Us Any Favors.

FROM OUR EXECUTIVE DIRECTOR

The West Coast Sets the Standard for Clean, Low-Carbon Fuel

– Peter Lehner –

FROM OUR EXPERTS

Larry Levine
Senior Attorney

Citizens Demand an End to Filthy Urban Waterways

Finding Ways to Protect Wildlife as Wind Energy Ramps Up

Katie Umekubo
Western Renewable
Energy Project Attorney

NRDC IN THE NEWS

Chicago Tribune

Oil Train Derailment Near Chicago Should be a Wake-Up Call

New York Times

Efficiency in the Kitchen Can Reduce Food Waste

NPR's All Things Considered

Monarchs Are Declining at an Alarming Rate

HOW YOU CAN HELP

Don't let polluters poison our water! Tell your senators to defend the Clean Water Act.

ACT NOW

We defend. We protect.

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Photo Credits: Florida Fish & Wildlife Conservation Commission, NOAA Permit #15488/Flickr; Daniel Borman; Ted of Dgar; Lynn Friedman; NOAA

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Environmental Conservation · New York, New York

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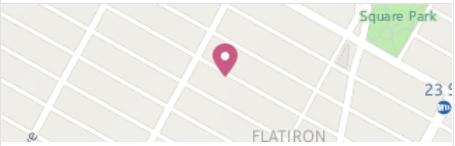

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VIDEOS

NRDC (Natural Resources Defense Council)
4 hrs ·

What's worse, the report reveals that the EPA is also aware that many utilities "game the system," using flawed or questionable testing methods in order to avoid detecting high levels of lead.

That means there could be many more communities violating the laws, exposing residents to dangerous levels of lead. And the public has no idea.

Even Flint, a city with the most notorious case of lead in water discovered, is still not listed as having violated the EPA's lead and copper rule.

5,300 U.S. water systems are in violation of lead rules

18 million Americans live in communities where the water systems are in violation of the law; the EPA knows of the issues and has done very little to stop them.

CNN.COM | BY SARA GANIM, CNN

Like Comment Share

Jennifer Lee, Richard Bargdill, Nancy Klein and 61 others like this. Top Comments

114 shares

Linda Naunapper I believe the EPA and other fed agencies are going thru re-org of sorts, so maybe this is on the change list(?) the recent upgrade of TSCA is a good sign...
2 hrs

Lane Weaver So sad, We live in the largest most corrupt society on this earth
2 · 3 hrs
1 Reply

View 6 more comments

257 22

73 25 33

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Non-Profit Organization

Environmental Conservation in New York, New York

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Demand Clean Power

REVIEWS

3.6 **3.6 of 5 stars**
1.1K reviews

Lauren Taylor
1 I've been a NRDC member and supporter for many years. Your involvement with NRDC Action Fund Board Chair Patricia Bauman... See More
June 1, 2016 ·

NRDC (Natural Resources Defense Council)
7 hrs ·

The amount of electricity generated using solar panels could expand as much as sixfold by 2030.

Solar Power to Grow Sixfold as Sun Becoming Cheapest Resource
The amount of electricity generated using solar panels stands to expand as much as sixfold by 2030.
BLOOMBERG.COM

Like Comment Share

Jenny Mertes, Jessica Nap, Jessica Peck and 369 others like this. Top Comments

92 shares

Bob Byers Is there any ecological impact connected with covering that much land with panels?
4 · 6 hrs
6 Replies · 1 hr

Gabriela Santiago Hernández The earth was not meant to be covered with these panels, I"m sure it will affect negatively the environment in the long run. Every time we mess up with the original design of nature, there's disaster. These panels should be placed only on roof tops. I have a feeling that somehow they'll fry the earth. I hope they know what they're doing!
1 · 58 mins · Edited

View 5 more comments

NRDC (Natural Resources Defense Council)
8 hrs ·

BREAKING: A new NRDC report discovers widespread lead violations in EPA drinking-water records. Our nation's water crisis is affecting 18 million Americans—not just the residents of Flint.

See more of NRDC (Natural Resources Defense Council) by logging into Facebook

Message this Page, learn about upcoming events and more. If you don't have a Facebook account, you can create one to see more of this Page.

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NRDC (Natural Resources Defense Council) Read the report here:
http://on.nrdc.org/290VEEN

What's in Your Water? Flint and Beyond
The Natural Resources Defense Council works to safeguard the earth - its people, its plants and animals, and the natural systems on which all life depends.
NRDC.ORG

7 · 8 hrs

1 Reply

NRDC (Natural Resources Defense Council) Take action:
http://on.nrdc.org/1Y8hxm8

Demand Clean Water for Flint and Across the U.S.
SECURE.NRDCONLINE.ORG

11 · 8 hrs

View 19 more comments

NRDC (Natural Resources Defense Council)
9 hrs ·

Millions of Americans could be drinking contaminated water — and not even know it.

Our Drinking-Water Crisis Goes Far Beyond Flint
Millions of Americans could be drinking contaminated water — and not even know it.
MEDIUM.COM | BY RHEA SUH

Like **Comment** **Share**

Joseph Adams, Jan Smith, Helene Minniti and 75 others like this. Top Comments

82 shares

NRDC (Natural Resources Defense Council) Read our report here:
http://on.nrdc.org/290VEEN

What's in Your Water? Flint and Beyond
The Natural Resources Defense Council works to safeguard the earth - its people, its plants and animals, and the natural systems on which all life depends.
NRDC.ORG

2 · 8 hrs

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1 Reply

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NRDC (Natural Resources Defense Council)
11 hrs ·

BREAKING: 18 million+ Americans got their drinking water from systems with lead violations in 2015, according to a new NRDC report.

This figure may be a “drop in the bucket” due to rigged testing and lax enforcement. "Flint doesn’t even show up as having violations for lead in the EPA’s drinking water tracking data, suggesting that millions more Americans could be at risk of drinking unsafe water but they aren’t even being tracked," said Erik Olson, Health Program Director at NRDC.

What's in Your Water? Flint and Beyond

The Natural Resources Defense Council works to safeguard the earth - its people, its plants and animals, and the natural systems on which all life depends.

NRDC.ORG

Like **Comment** **Share**

MikeJane Winsauer, Rd Cohen, Patricia Woodward and 187 others like this. Top Comments

271 shares

NRDC (Natural Resources Defense Council) Take action: http://on.nrdc.org/1Y8hxm8

Demand Clean Water for Flint and Across the U.S.

SECURE.NRDCONLINE.ORG

4 · 8 hrs

1 Reply

Ray Richardson Everybody in America should have the highest quality water filters free of charge from the government. Take a small fraction of the trillions of dollars spent on defense to wipe out third world countries to pay for it Unfortunately our politicians ar... See More

3 · 4 hrs

View 23 more comments

NRDC (Natural Resources Defense Council)
23 hrs ·

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431

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me (close versus me and infants, anyway). A difference a few years does make!

3 · 23 hrs

1 Reply

Doug Baumgarten I graduated in 86. I remember the early 80s in the Chicagoland the , temperatures below zero for months, the snowbelt reached well into Texas, and the talk was... greenhouse gases were going to cause an ice age!?

1 · 22 hrs

4 Replies · 1 hr

View 17 more comments

NRDC (Natural Resources Defense Council)
Yesterday at 3:30pm ·

California's decision to replace nuclear plant with no-emissions energy is an important milestone, says The New York Times editorial board.

Good News From Diablo Canyon

California's decision to phase nuclear power out for greenhouse-gas-free electricity is an important milestone for the country. New York must be next.

NYTIMES.COM | BY THE EDITORIAL BOARD

Like **Comment** **Share**

Patricia A Hopkins, Lois Wood, Joyce Glynn and 201 others like this. Top Comments

36 shares

Juanita Hepler Cheers!
23 hrs

Robert Cox The first of many. I vote for shooting it into the sun.
23 hrs

View 2 more comments

NRDC (Natural Resources Defense Council)
Yesterday at 2:24pm ·

BREAKING!

"Shifting half of America's electricity to clean energy sources is not only achievable - it's essential. Avoiding the worst effects of climate change demands nothing less. But we must do it the right way, and that means ramping up our reliance on cost-effective renewable wind and solar power, energy efficiency and other 21st Century technologies."
— NRDC president Rhea Suh

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Renee Badertscher I am happy to say that we have a "solar farm" in Lapeer now! Good for GTE Energy!!

19 hrs

View 24 more comments

NRDC (Natural Resources Defense Council)
Yesterday at 12:00pm ·

Berlin's parliament voted Thursday to pull its money out of coal, gas and oil companies.

Berlin Is The Latest City To Pull Out Of Fossil Fuels

Ich bin auch ein Umweltschützer!

HUFFINGTONPOST.COM | BY ALEXANDER CHARLES KAUFMAN

Like **Comment** **Share**

Ann Marshall Smith, Beth Ayoub, Gloria Gomez Ramos and 1,762 others like this. Top Comments

412 shares

Kristine Montamat And the Clinton campaign refuses to do *anything* towards combating climate change-- fracking is okay, a carbon tax is a bad idea. Hey, let future generations figure it out! says the Clinton people on the DNC platform committee. And to think NRDC's PAC endorsed Clinton. Whose side are you really on?

2 · 7 hrs

3 Replies · 1 hr

Ronny Kaye Once again, Europe exposes the US as a primitive society. I use the term society lightly.

19 · Yesterday at 3:09pm

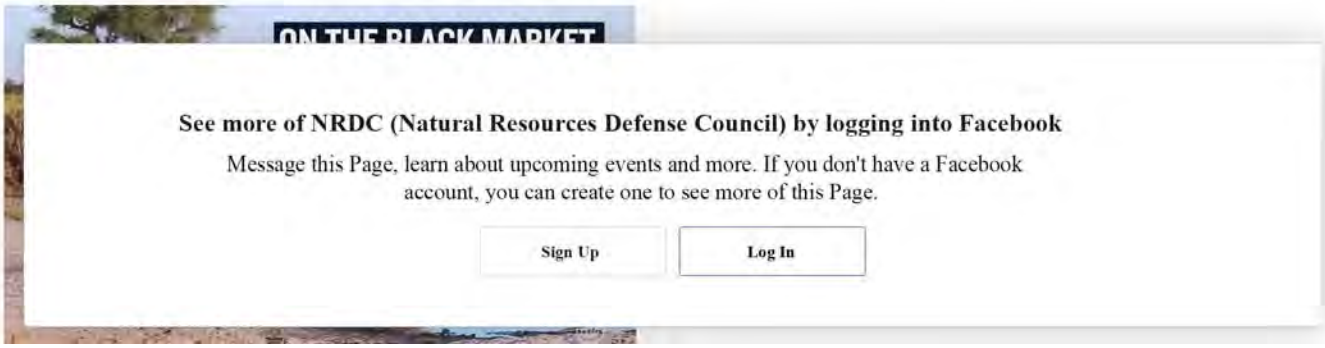
1 Reply

View 23 more comments

NRDC (Natural Resources Defense Council)
Yesterday at 9:00am ·

The government of Swaziland is pushing a dangerous plan to legalize the rhino horn trade. This would likely increase demand for rhino horn and put wild rhinos at even greater risk of extinction. #SaveTheRhino

Take action: http://on.nrdc.org/1rpv1yH



27K Views

Like Comment Share

Gillian Coupland, Amberley Levine, Daniel Burton-Rose and 70 others like this. Top Comments

94 shares

Adrienne Neff Dye their horns pink so that they are not killed for their horns. Other conservation groups are doing it, and it seems to save the animals.

2 · Yesterday at 2:33pm

Lynette Blinne No, this cannot be permitted. These rhinos need to be removed and placed in a sanctuary.

3 · Yesterday at 2:01pm

View 21 more comments

NRDC (Natural Resources Defense Council)
Yesterday at 6:30am ·

Trees are dying at an 'unprecedented' rate due to drought, warmer weather and a bark beetle epidemic, according to the U.S. Department of Agriculture.

66 million dead trees in California could fuel 'catastrophic' wildfires, officials say

Since 2010, an estimated 66 million trees have died in a six-county region of the central and southern Sierra hardest hit by the epidemic.

THEGUARDIAN.COM

Like Comment Share

Stéphanie Grant, Al Hussain, Gail Franklin Johnson and 188 others like this. Top Comments

312 shares

Erin Tubb Wildfires are part of nature. They clear out dead and dying plants and trees to make space for new healthy trees. The ashes provide nutrients to fuel the growth of the new trees. Some species even rely on wildfires to spread. Such as the redwood which has such a hard shell casing on its seeds that it needs the heat of a fire to crack it so the seed can germinate.

9 · Yesterday at 7:54am

6 Replies · 10 hrs

Christine Bryan So The question is how do you save the trees from the Beatles and let them die and Clear them out or let Mother Earth it's course

Yesterday at 10:32am · Edited

View

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Anne Lickman, Bill Blank, Chelsea Roseberry and 135 others like this. Top Comments

166 shares

Cat Lance Always wonder if people realize that the Great Coral Reef is the largest single living organism on the planet. It too is at great risk.
2 · Yesterday at 4:42am

Lynette Blinne Are we saying here that the NOAA cannot turn this around?
1 · Yesterday at 2:44am

1 Reply

View 4 more comments

NRDC (Natural Resources Defense Council)
June 26 at 12:00pm ·

The nation of Swaziland is pushing a risky proposal to legalize the destructive international rhino horn trade.

Tell Swaziland's King Mswati III to drop this disastrous plan:
http://on.nrdc.org/1rpv1yH

Like **Comment**

Zachary Nutland, Lynn Turner, Peg Nation and 1,173 others like this. Top Comments

368 shares

Robin Riley Signed
1 · 18 hrs

Anthea McCarty Signed
1 · Yesterday at 4:42am

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others like this.

99 shares

Michele Rule we all need to have a clean world and clean energy is a start.
June 26 at 4:24pm

Susan Xanthopoulos Exceedingly smarter than the United States aren't they!
1 · June 26 at 4:00pm

View 5 more comments

NRDC (Natural Resources Defense Council) shared their post.
June 26 at 6:05am ·

#ICYMI: On Friday, President Barack Obama and the U.S. Department of the Interior declared the Stonewall Inn in New York City a national monument.

NRDC (Natural Resources Defense Council)
June 24 at 9:43am ·

BREAKING: President Obama and the U.S. Department of the Interior just declared the Stonewall Inn in New York City a national monument. This is the first-ever n...

See More

Announcing the Stonewall National Monument

Like **Comment** **Share**

NRDC (Natural Resources Defense Council)
June 25 at 5:00pm ·

Sweden's new electric highway brings us one step closer to fossil fuel-free transportation.

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Patricia A Hopkins, H Howard Thomson, Sanne Kure-Jensen and 1,973 others like this. Top Comments

808 shares

June Brian McWhorter Check it out on Wikipedia; 49.8% of electrical power is generated by renewable resources and they are closing all fossil fuel plants.

12 · June 26 at 5:46am

3 Replies

Karen Root Toothless article, how the electricity is generated is vital information; they could be powering it with more pollution generation than if it had gasoline engines in the vehicles.

2 · June 26 at 4:41pm

View more comments 2 of 57

NRDC (Natural Resources Defense Council)
June 25 at 12:00pm ·

"It's a tribute to what can be accomplished when we rally together around a common goal. What's more, this plan is a model that can be replicated around the country, where nearly 100 nuclear reactors will retire in the coming decades, and around the world."
- NRDC President Rhea Suh

California's Last Nuclear Power Plant

A plan to replace the state's aging Diablo Canyon reactor with clean energy can be a model for fighting climate change across the country.

MEDIUM.COM | BY RHEA SUH

Like **Comment** **Share**

AgroFusion, Renée Wright, Anne Balderston and 27 others like this. Top Comments

4 shares

Calvin Burgart I hate to say it, but you have this 100% wrong. There will now be more fracking and natural gas burning. Nuclear creates power with zero emissions. Nuclear provides significantly higher availability and is the best base load method of generating constant power.

1 · June 25 at 4:51pm

2 Replies

Martha Welch hope all nuclear plants but do not allow the waste on beach

June 25 at 1:08pm

NRDC (Natural Resources Defense Council)
June 25 at 9:02am ·

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Emil
this.

35 s

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Marilyn B. Saul Seems like only yesterday we were protesting the building of

the Diablo Canyon reactor. Glad it is being decommissioned, finally. And I'm with you, Kent. Last thing the ocean (and our future) needs is an American Fukushima.

2 · June 25 at 10:44am

Kent McMillen I just pray that Diablo Canyon is decommissioned BEFORE an earthqake along the San Andreas fault line!

3 · June 25 at 9:57am

2 Replies

View 2 more comments

NRDC (Natural Resources Defense Council)
June 25 at 6:15am ·

Yellowstone's grizzly bears could lose their vital endangered species protections—and we need your help to save them.

Save Yellowstone's Grizzlies

Yellowstone's iconic grizzly bears are at risk of losing their essential Endangered Species Act protections. Help ensure they have a chance to fully recover. Add your voice now.

SECURE.NRDCONLINE.ORG

Like **Comment** **Share**

Gail Doyle, Eileen Baumgardt, Roberta D'Andrea and 204 others like this. Top Comments

81 shares

Bonny Bellville Changing their status doesn't make sense. They must remain on the endangered species list for them, their vital role in nature and for all generations of people.

1 · June 25 at 6:59am

Cindy R. Ewing People u travel miles to see them but u can't help them, is that the way it works ???

June 25 at 11:27am

3 Replies

View 10 more comments

NRDC (Natural Resources Defense Council)
June 24 at 1:30pm ·

Thousands of cities are uniting to fight human-caused climate change and push for a low-carbon future.

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we had started 40 years ago.

3 · June 24 at 4:57pm

1 Reply

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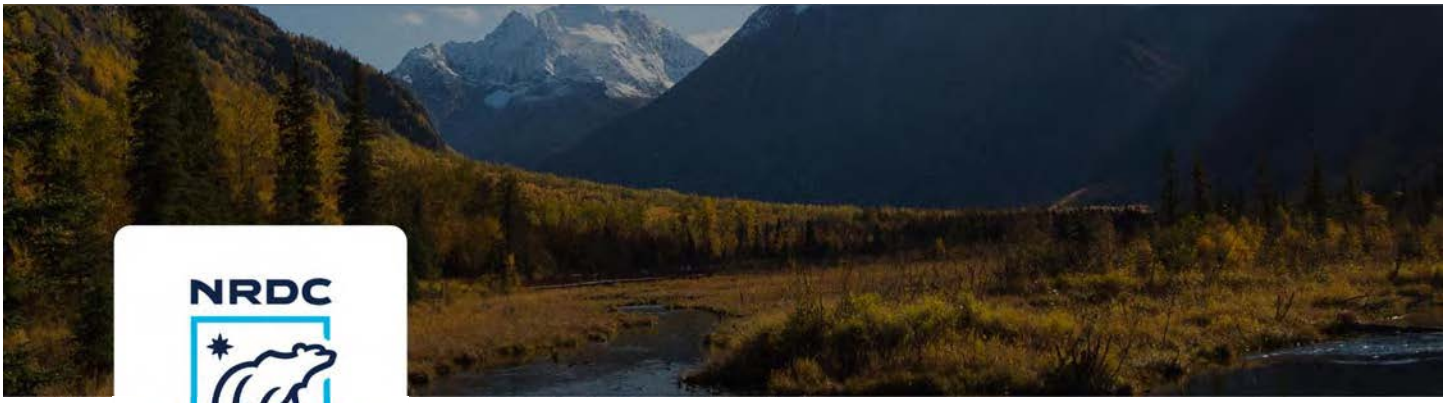

TWEETS 54.7K | FOLLOWING 7,817 | FOLLOWERS 203K | LIKES 627 | LISTS 6 | Follow

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The Earth's Best Defense

Planet Earth
nrdc.org
Joined January 2009

2,190 Photos and videos

Tweets | Tweets & replies | Media

NRDC @NRDC · 12m
Lead is not only a heavy metal—it's a heavy burden on human health and the environment. Read more:

Everything You Need to Know About Lead
Everything You Need to Know About Lead If lead poisoning seems like a story from the past, think again: The toxic metal lingers in communities all over the Unit...
nrdc.org

4 4 •••

NRDC @NRDC · 15m
5,363 communities failed to:

Test for lead
Report lead contamination
Fix corroding pipes

on.nrdc.org/297v6Ck

19 14 •••

NRDC @NRDC · 3h
Help save Yellowstone's iconic grizzly bears! Here's how you can take action:

Attachment 7

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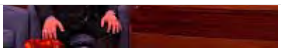
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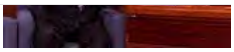
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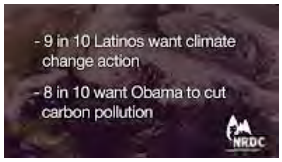

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THE BLOG

Congressional Hearings Should Reflect That Flint Is Not Fixed

03/14/2016 10:39 pm ET | **Updated** Mar 15, 2016

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Henry Henderson
Natural Resources Defense Council Midwest Program Director

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This week the US House Committee on Oversight and Reform is holding two hearings on the mess in Michigan. I expect we will hear more of the same from the folks who created this disaster when they testify in DC: tepid admissions that mistakes were made, lots of finger pointing as well as a steady diet of assertions that things are way better on the ground now and will soon be fixed for all.

Except that they are not...

My colleagues have been in Flint a great deal this year, especially in the recent weeks. Meeting with residents. Meeting with our clients and litigation partners. And talking with the advocates who have been filling the massive left by the city, state and Feds. Make no mistake, for many in Flint, things are no better. The trashed lead pipes are still delivering poisoned water. Access to bottled water and services are very limited and uncertain for some, especially for those with limited means and limited access to transportation.

So when the people who created the mess in Michigan say things are covered, don't buy it.

These are the same folks who ignored concerns from the people of Flint for two years—or belittled their demands for action.

It's the same crew that has been so busy arguing, that they couldn't get around to addressing tests for the bacteria connected with a Legionnaire's Disease outbreak that killed 9 and sickened the better part of 100, and alerting the public to the danger (nearby Wayne State University has had to step in to do the testing).

Things are not fixed in Flint and I am not convinced that they will be as long as the same brain trust is running the show.

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This is why our lawsuit, filed with ACLU of Michigan, Concerned Pastors for Social Action and Flint residents, calls for federal court oversight for the effort to finally get clean water back into town for everyone, and start fixing the water pipes. Chances are, the hearing will leave many thinking the same thing.

Take action to help in Flint: tell Governor Snyder to take quick action to restore clean drinking water, tell your Senators to support aid packages that would rebuild the town's water system and tell the Obama Administration that more needs to be done to get lead out of our water nationally.

A Grey Day in Flint image by jmogs via Flickr

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Marine Policy 47 (2014) 71–75

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Short Communication

The requirement to rebuild US fish stocks: Is it working?

Kimberly Lai Oremus [a,*], Lisa Suatoni [b], Brad Sewell [b]

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ABSTRACT

The Magnuson–Stevens Fishery Conservation and Management Act (MSA) was amended in 1996 to require that overfished stocks be rebuilt in as short a time period as possible, not to exceed 10 years, with limited exceptions. This comment examines the basic but important question of whether the implementation of rebuilding plans under the 1996 amendments has in fact been associated with biomass recovery. Specifically, for each of the 44 stocks examined, this analysis compares the biomass trend before rebuilding plan implementation to the trend after rebuilding plan implementation using a linear trend-break model. The analysis demonstrates a statistically significant positive association between the implementation of rebuilding plans and standardized biomass in 19 of 44 stocks. None of the 44 stocks examined showed a statistically significant negative association. The analysis showed a strong temporal relationship between the implementation of the policy and rebounds in fish stocks.
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1. Introduction

The 1996 passage of the Sustainable Fisheries Act (SFA), which reauthorized and amended the Magnuson–Stevens Fishery Management and Conservation Act (MSA), marked a sea change in the United States' approach to fishery management [1]. In response to a large number of depleted fish stocks in federal waters, particularly in the New England region, a requirement was added to the law that rebuilding plans be developed for overfished stocks [2]. These plans must include time periods for rebuilding that are "as short as possible, … not [to] exceed 10 years except in cases where the biology of the stock of fish, other environmental conditions, or management measures under an international agreement in which the United States participates dictate otherwise [3]".

Since its enactment, the new requirement to expeditiously rebuild depleted fish populations has been a focal point of debate, eliciting both support [4,5] and criticism [6]. However, despite the political attention, there has been little statistical examination of whether the provision is working.

Several prior studies do provide an accounting of progress. The first study, published 7 years after the implementation of the rebuilding requirement, found "disappointing" early results, with only three of 76 overfished stocks successfully rebuilt [7]. A more recent report[1] found mounting successes, with 48% of stocks rebuilt in 2013 [8].

The MSA is up for reauthorization in 2014, and the rebuilding requirements may be among the provisions considered for amendment. Thus, the time is right to evaluate the rebuilding requirement's efficacy. This study is the first to explore whether the implementation of the rebuilding policy is correlated with statistically significant changes in population trends of overfished fish stocks.

2. Materials and methods

This study identified 62 fish stocks designated as overfished by the National Marine Fisheries Service (NMFS) and subjected to rebuilding plans following the SFA's enactment.[2] Of these 62 stocks, 44 were identified for which stock assessment data are sufficient to assess biomass trends since the plan's implementation. To satisfy this criterion, a stock must have been in a rebuilding plan since before 2010 and had at least one stock assessment since the plan's implementation.

[1] This assessment identified 28 of 44 fish stocks as "rebuilding successes", based upon the stocks achieving either their rebuilding targets or at least 50% of their rebuilding targets and at least a 25% increase in abundance since rebuilding plan start.

[2] This excludes 13 internationally managed stocks, which are subject to different rebuilding requirements.

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Biomass and fishing mortality data were compiled from the most recent stock assessments conducted by NMFS. Biomass proxies such as spawning stock biomass were used when they were relied on by the most recent stock assessment. These assessments are utilized by NMFS to evaluate the progress of rebuilding plans and are the best available information. Still, it should be noted that the assessments are limited by how recently they were conducted, the quality of the data sources, and uncertainty in the models used. The present study necessarily excluded more than 200 federally managed fish stocks for which assessments do not exist or are considered out of date by NMFS, and therefore stock status is considered unknown.

For each stock, standardized biomass (biomass or proxy normalized by estimate of biomass at maximum sustainable yield) was analyzed from 1976 (or earliest date available after 1976) to the date the stock was declared rebuilt (or, if the stock has not been rebuilt, the most recent date available). The start date, 1976, was chosen because this is when the MSA was enacted. The MSA significantly changed the fisheries management landscape in the United States, including the creation of a 200-mile conservation zone and the regional fishery management council system.

Since there is no data on overfished stocks that did not receive the policy treatment (and are not listed under the Endangered Species Act), a proper control group does not exist. Following event study literature for testing whether pre-trend growth rates are different from post-trend growth rates [9,10], a continuous linear trend-break model[3] with fishery-level intercepts and slopes was fit to the standardized biomass data using ordinary least squares (Fig. 1). The model assumes similar measurement errors within regions, because of similarities in how fish stocks are assessed and managed within a region by each of the regional fishery management councils. The trend break year was defined using the year of rebuilding plan implementation [8] and its significance was evaluated using *t*-tests. A Bonferroni correction was applied to account for errors from running multiple tests.

3. Results and discussion

This analysis compared the standardized biomass trend for each stock before rebuilding plan implementation to the trend after implementation. In this linear model, 19 of 44 stocks showed statistically significant positive slope changes (trend breaks) in biomass after rebuilding provisions were implemented (Fig. 2). Statistical significance was defined at the 5% level with a Bonferroni correction. None of the 44 stocks showed a statistically significant negative trend break. This allows for the rejection of the null hypothesis that there was no change in biomass trends following rebuilding plan implementation. In other words, there is a strong relationship between the implementation of the rebuilding requirement and rebounds in fish stocks. These results are consistent with observations that stock depletion is reversible when fishing mortality is effectively controlled [11–13].

As a placebo test, the same model was applied to biomass data only from the years prior to rebuilding plan implementation, and then to biomass data only from the years after rebuilding plan implementation. In both cases the trend-break model was run multiple times using randomly chosen trend-break dates. In four of the five tests, none of the 44 stocks examined showed significant trend breaks. In the fifth test, which was performed on post-implementation data using an event date of plus-3 years, six showed significant positive trend-breaks and three negative. Taken as a whole, these checks reinforce the conclusion that the positive relationship between rebuilding plans and biomass recovery is not random.

The regressions in this analysis were run by region rather than by individual fishery because fisheries are managed at the regional level, and because estimating the errors by region compensates for limitations in the data. Not only are the fishery-level time series relatively limited for some stocks, but stock modelers use different modeling techniques and measures of uncertainty are unavailable. However, running the regressions independently by fishery reduces standard errors and would only yield more positive trend breaks,[4] strengthening this study's main findings.

There may be concern as to whether this study's linear model favors stocks with lower biomass variance. Lower variances could result from a natural cause, such as slow-growing stocks or stocks with demersal habitat [14], but they could also be the result of stock assessment scientists smoothing the biomass data with interpolation. However, weighting the trend-break model to favor high-variance stocks using a weighted least-squares regression produced only marginally fewer, positive results.[5] Thus the main study's core finding is not simply the result of artificially low-variance stock assessment-data, and controlling for inter-annual variability would likely yield unchanged or only marginally stronger conclusions.

The results in this study are also consistent with the significant progress in fish stock rebuilding seen in NMFS' reports on the status of stocks [15], while providing an additional lens through which to view and quantify that progress. NMFS generally considers a stock to be rebuilt as soon as its estimated biomass reaches the level that produces maximum sustainable yield (B_{MSY}). This study examined whether there had been a sustained change over time in a stock's biomass trend following rebuilding plan implementation sufficient to produce a statistically significant trend break. There is substantial overlap between the 19 stocks for which this study found significant positive trend breaks and the 21 that have achieved B_{MSY},[6] NMFS' threshold for declaring a stock rebuilt. Of the 19 stocks with significant trend breaks, NMFS has identified 14 as achieving rebuilding targets.

NMFS considers the number of stocks rebuilt so far to be encouraging [15], especially given that rebuilding plans are generally designed to achieve B_{MSY} by a designated target date with 50% probability of success, and many stocks have not yet reached their target dates. Only 17 of the 44 stocks in this study have reached their target dates.

While further study is required to establish causality, this study makes it clear that the fish population rebounds are non-random and linearly correlate with the implementation of rebuilding plans under the Magnuson–Stevens Act. Future research should examine the factors that lead to rebuilding successes, as well as those involved in unsuccessful responses to rebuilding plans. Previous reviews of efforts to rebuild fish stocks worldwide identify numerous primary causes for failures, including insufficient or delayed decreases in fishing mortality, systematic underreporting

[3] $y_{it}=\beta_{0i}+\beta_{1i}t_i+\beta_{2i}(t-t_{0i})I_{(t\geq t0i)}+\varepsilon_{it}$ where y_{it} is the std. biomass for stock $i=1,\ldots,44$ at time $t=1976,\ldots$, time of rebuild or time of most recent stock assessment; t_{0i} is the rebuild implementation date for stock i; ε_{it} is i.i.d. $N(0,\sigma^2_{r(i)})$; and $r(i)$ is the region of stock i.

[4] Running the regressions independently by fishery yielded 29 significant positive trend-breaks and zero negative.

[5] By weighting this study's model using standardized biomass variance by stock, stocks with higher variances are favored, but still found the same stocks had significant trend breaks with the exception of black sea bass, cowcod, monkfish south and haddock Gulf of Maine. Some of these stocks have naturally low biomass variance due to their long generation times and benthic habitat.

[6] Nineteen of these stocks, excluding Gulf of Maine haddock and summer flounder that currently do not have biomass at B_{MSY}, have been formally designated as "rebuilt" by NMFS. However, two additional stocks—Mid-Atlantic tilefish and Southern Georges Bank/Mid-Atlantic red hake—are recognized by NMFS as exceeding their rebuilding targets even though they are not currently designated as rebuilt.

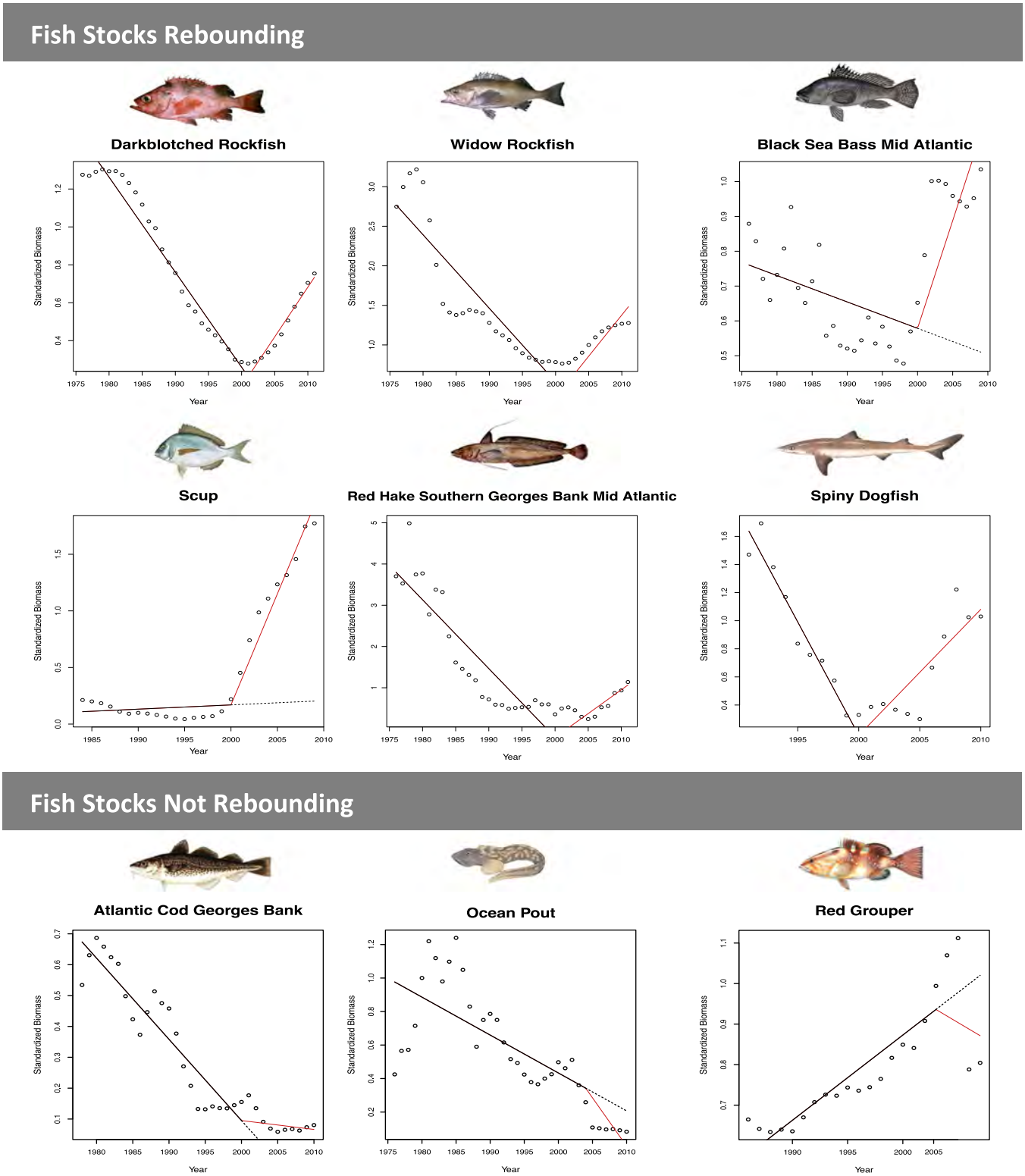

Fig. 1. Each graph plots standardized biomass (open circles) based on NMFS stock assessments. The solid black line represents a linear model of the trend prior to the rebuilding plan. The dotted line represents the hypothetical continuation of that trend. The red line (grey line in print version) is the model. The first two rows show statistically significant, positive trend breaks with policy implementation. The last row shows no statistically significant changes in trend with policy implementation.

of catches, and scientific uncertainty [13]. Less frequently, depensatory mortality and unfavorable climate patterns appear to be important factors in sluggish recovery [13].

This study also underscores the need for improved stock-assessment data in order to better understand the rebuilding requirement's impacts. Monitoring of all 446 federally managed stocks would facilitate comparisons between those in rebuilding plans and those that are not. More frequent and robust stock assessments, timelier reporting of data, and increased understanding of the biology and ecology of each stock would enable

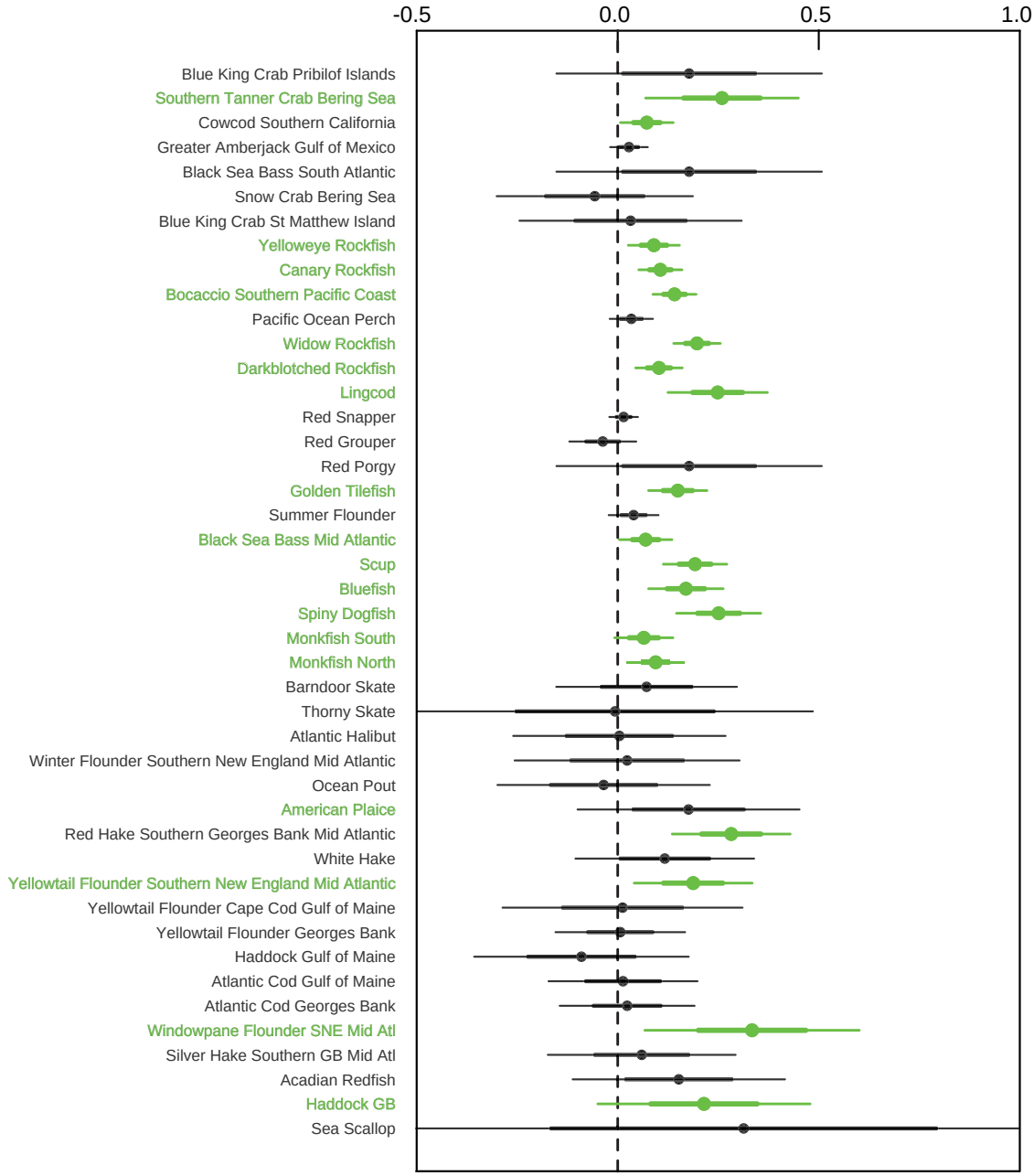

Fig. 2. Trend break coefficient estimates by stock. For each stock, the black dot is the trend-break coefficient, which measures the difference in the slope of the trend and after rebuilding. A coefficient above zero indicates a positive change in the biomass trend, while a coefficient below zero would represent a negative change. The bold and non-bold portions of the line represent one and two standard deviations, respectively.

more nuanced analysis of the relevant population trends. Finally, greater transparency in the stock assessment methodology, including confidence intervals, would aid in developing realistic error terms.

4. Conclusion

This is the first study to rigorously examine an important indicator of the efficacy of the MSA's rebuilding requirements: biomass rebound. Further research will assist in the understanding of the specific causes of biomass recovery, or lack thereof, for each stock. Nevertheless, this study found a strong association between implementation of the rebuilding requirements added to federal law in 1996 and recovery of depleted fish stocks.

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Attachment 12

ISSUE BRIEF

JUNE 2014
IB:14-05-C

The Untapped Potential of California's Water Supply: Efficiency, Reuse, and Stormwater

California is suffering from a third year of drought, with near-record-low reservoirs, mountain snowpack, soil moisture, and river runoff. As a direct result, far less water than usual is available for cities, farms, and natural ecosystems. There are far-reaching effects that will intensify if dry conditions persist. Several response strategies are available that will provide both near-term relief and long-term benefits. This report examines the significant potential contributions available from four priority opportunities: improved efficiency in urban and agricultural water use, reuse and recycling of water, and increased capture of local rain water.

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California is a land of hydrological extremes, from water-rich mountains and redwood forests in the north to some of the driest deserts in North America in the south. It suffers both epic floods and persistent droughts. The existing water infrastructure and management systems reflect these extremes, with massive dams, canals, and pumping stations to store and transfer water, and hundreds of intertwined laws, institutions, and organizations promoting overlapping and sometimes conflicting water interests. The drought could end next year or it could continue, with even greater consequences in the coming years. But even during good years, disputes over water are common and claims of water shortages rampant. Dry years magnify disagreements over allocation, management, and use of California's water resources.

For much of the 20th century, California's water supply strategy has meant building reservoirs and conveyance systems to store and divert surface waters, and drilling groundwater wells to tap our aquifers. Hundreds of billions of federal, state, and local dollars have been invested in these supply options, allowing the state to grow to nearly 40 million people with a $2 trillion economy (LAO, 2013; Hanak et al., 2012). But traditional supply options are tapped out. Rivers are over-allocated even in wet years. There is a dearth of new options for surface reservoirs, and those that exist are expensive, politically controversial, and offer only modest improvements in water supply for a relatively few users. Groundwater is so severely overdrafted that there are growing tensions among neighbors and damage to public roads, structures, and, ironically, water delivery canals from the land subsiding over depleted aquifers.

The good news is that solutions to our water problem exist. They are being implemented to varying degrees around the state with good results, but a lot more can be done. During a drought as severe as the current one, the incentives to work cooperatively and aggressively to implement solutions are even greater. In this report, we examine the opportunities for four cost-effective and technically feasible strategies—urban and agricultural water conservation and efficiency, water reuse, and stormwater capture—to improve the ability of cities, farmers, homeowners, and businesses to cope with drought and address longstanding water challenges in California. We conclude that these strategies can provide 10.8 million to 13.7 million acre-feet per year of water in new supplies and demand reductions, improving the reliability of our current system and reducing the risks of shortages and water conflicts.

NATURE OF THE CHALLENGE: THE "GAP"

California's water system is out of balance. The current water use pattern is unsustainable, and there is a large and growing gap between the water desired and the water made available by nature. Human demands for water in the form of water rights claims, agricultural irrigation, and growing cities and suburbs greatly exceed—even in wet years—volumes that can be sustainably extracted from natural river flows and groundwater aquifers. Major rivers, such as the San Joaquin, have been entirely de-watered. Declines in groundwater levels in some areas due to overpumping of groundwater are measured in hundreds of vertical feet and millions of acre-feet.

Estimates of the overall "gap" are difficult because large volumes of water use are not measured or reported, California's natural water supply varies greatly between wet and dry years, and because water "demand" can be artificially inflated by over-allocation of rivers, inefficient use, price subsidies, the failure to prevent groundwater overdraft, and other hard limits on supply. But there are a wide variety of signs of the gap:

Sacramento-San Joaquin River Delta

The Sacramento-San Joaquin River Delta illustrates the unsustainable gap between how much water we take from our rivers and how much those rivers can provide. The Delta is vitally important to California. It is the primary hub for moving water from north to south. It is home to hundreds of species of birds, fish, and wildlife (DSC, 2013), including two-thirds of the state's salmon and at least half of the Pacific Flyway migratory water birds (USFWS, 2001). It is also a vibrant farming community. But excessive water diversions have contributed to a crisis that threatens the Delta's ability to perform any of these functions. In response to this crisis, in 2009, the State Legislature directed the State Water Resources Control Board (State Board) to determine how much water the Delta would need to fully protect public trust resources in the Delta.[1] For an average weather year, the State Board found that substantially increased flows from the Sacramento and San Joaquin River basins through the Delta into San Francisco Bay are needed to restore and maintain viable populations of fish and wildlife under existing conditions.[2] The Board's findings indicate that we currently divert almost 5 million acre-feet more water in an average year from the Delta than is compatible with a healthy Delta.[3] While these findings were designed to inform future planning decisions without considering other changes to the system or balancing other beneficial uses, the State Board's determination illustrates the yawning gap between our water demands in California and how much our surface waters can supply.

Groundwater Overdraft

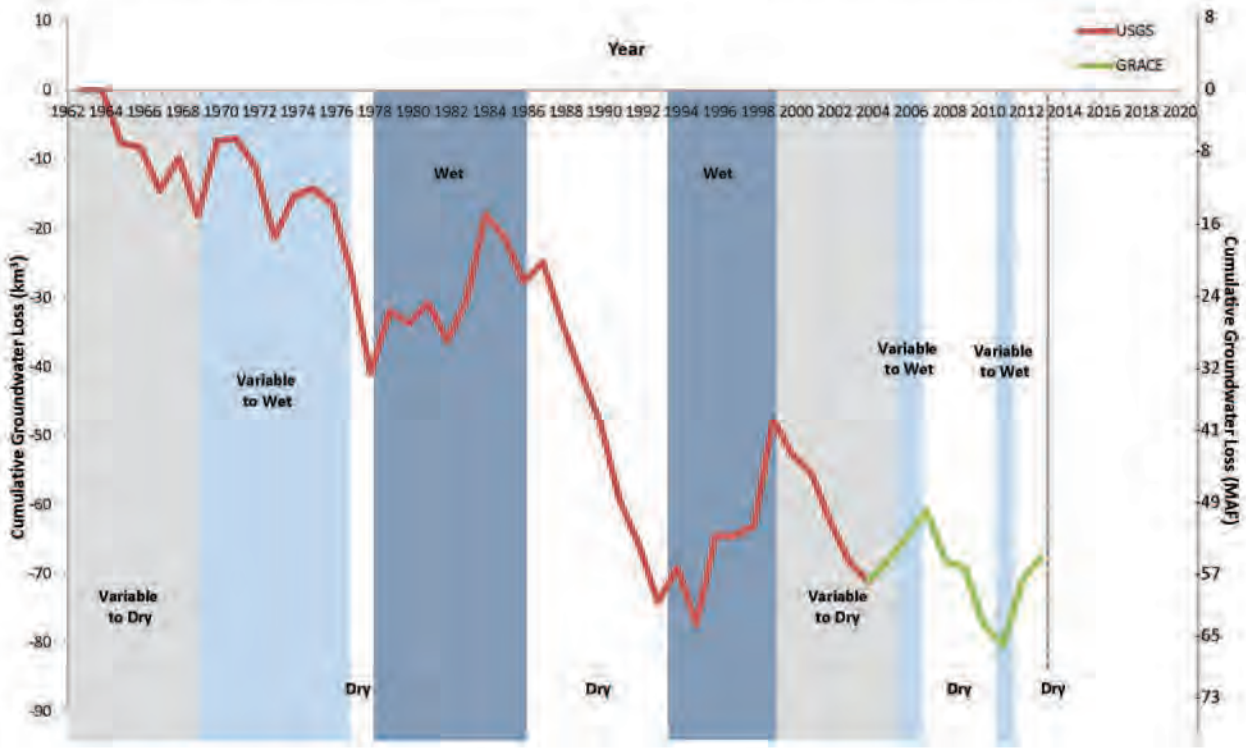
Groundwater is a vital resource for California. In average years, it provides nearly 40 percent of the state's water supply. That number goes up to 45 percent in dry years and close to 60 percent in a drought (DWR, 2014a). Moreover, many small- and medium-sized communities, such as Lodi, are completely dependent on groundwater. A clear indicator of the gap between water supply and water use in California is the extensive and unsustainable overdraft of groundwater, i.e., groundwater extracted beyond the natural recharge rate of the aquifer. Chronic overdraft has led to falling groundwater levels, dry wells, land subsidence, decreased groundwater storage capacity, decreased water quality, and stream depletion (Borchers et al., 2014).

As shown in Figure 1, groundwater levels are declining across major parts of the state. According to the Department of Water Resources (2014a), since spring 2008, groundwater levels have dropped to all-time lows in most areas of the state and especially in the northern portion of the San Francisco Bay hydrologic region, the southern San Joaquin Valley, and the South Lahontan and South Coast hydrologic regions. In many areas of the San Joaquin Valley, recent groundwater levels are more than 100 feet below previous historic lows. While some groundwater recharge occurs in wet years, that recharge is more than offset by pumping in dry and even average years, with over 50 million acre-feet of groundwater having been lost over the last half century (UCCHM, 2014). A comprehensive statewide assessment of groundwater overdraft has not been conducted since 1980, and there are major gaps in groundwater monitoring.[4] DWR has been estimating with considerable uncertainty that overdraft is between 1 million and 2 million acre-feet per year (DWR, 2003).

There are strong indications, however, that groundwater overdraft is worsening. Recent data indicates that the Sacramento and San Joaquin River Basins collectively lost over 16 million acre-feet of groundwater between October 2003 and March 2010, or about 2.5 million acre-feet per year (Famiglietti, 2014). This period captured a moderate drought, and thus we would expect overdraft to be higher than in non-drought periods. But while groundwater levels increased in 2011 and 2012, they did not fully recover to pre-drought levels, resulting in a net loss in groundwater storage at time when California enters a far more severe drought.

The gap between water supply and use from the state's groundwater basins and from the Sacramento-San Joaquin Delta alone exceeds 6 million acre-feet of water per year. We know that this underestimates the gap, as numerous studies have identified considerable unmet environmental flow objectives in other parts of the state (Hayden and Rosekrans, 2004). Moreover, we know that these "gaps" are expected to grow with the increasing challenges posed by population growth and climate change (DWR, 2013a).

Figure 1. Cumulative groundwater loss (in km³ and million acre-feet) for California's Central Valley since 1962



Note: Cumulative groundwater losses (cubic km and million acre-ft) in California's Central Valley since 1962 from USGS and NASA GRACE data. Figure from UCCHM (2014) and extends figure B9 from *Faunt* [2009]. The red line shows data from USGS calibrated groundwater model simulations [Faunt, 2009] from 1962-2003. The green line shows GRACE-based estimates of groundwater storage losses from *Famiglietti* et al. [2011] and updated for UCCHM(2014). Background colors represent periods of drought (white), of variable to dry conditions (grey), of variable to wet conditions (light blue) and wet conditions (blue). Groundwater depletion mostly occurs during drought; and progressive droughts are lowering groundwater storage to unsustainable levels.

Source: UC Center for Hydrologic Modeling (UCCHM), 2014. Water Storage Changes in California's Sacramento and San Joaquin River Basins From GRACE: Preliminary Updated Results for 2003-2013. University of California, Irvine UCCHM Water Advisory #1, February 3, 2014. Available at https://webfiles.uci.edu/jfamigli/Advisory/UCCHM_Water_Advisory_1.pdf.

Figure courtesy of Jay Famiglietti, UCCHM, UC Irvine

OPPORTUNITIES

The good news is that California can fill the gaps between water supply and use with a wide range of strategies that are cost-effective, technically feasible, more resistant to drought than the current system, and compatible with healthy river and groundwater basins. New supply options include greatly expanded water reuse and stormwater capture. Demand-management options include the adoption of more comprehensive efficiency improvements for cities and farms that allow us to continue to provide the goods and services we want, with less water. Efforts in these areas have been underway in California for decades, and laudable progress has been made, but much more can be done.

Efficiency, water reuse, and stormwater capture can provide effective drought responses in the near-term and permanent water-supply reliability benefits for the state. Moreover, by reducing reliance on imported water supplies and groundwater pumping, they can cut energy use and greenhouse emissions, reduce the need to develop costly new water and wastewater infrastructure, and eliminate pollution from stormwater and wastewater discharges. Finally, these strategies can also generate new jobs and provide new business opportunities.

To better understand the extent to which these alternatives could reduce pressure on the state's rivers and groundwater basins, the Pacific Institute, Natural Resources Defense Council, and Professor Robert Wilkinson from the University of California, Santa Barbara undertook a series of assessments of the potential for urban and agricultural water conservation and efficiency, water reuse, and stormwater capture. In particular, we evaluated the technical potential, i.e., the total water supplies and demand reductions that are feasible given current technologies and practices.[5] These measures are already being adopted in California and have been shown to be cost-effective compared to other water supply alternatives (Cooley et al. 2010; DWR, 2013b). The next section provides a short summary of the additional technical potential for each of these strategies.

Improving Agricultural Water-Use Efficiency

Agriculture uses approximately 80 percent of California's developed water supply (DWR, 2014b). As such a large user, it is heavily impacted by the availability and reliability of California's water resources. Moreover, agriculture can play an important role in helping the state achieve a more sustainable water future. California irrigators have already made progress in modernizing irrigation practices, but more can be done to promote long-term sustainable water use and ensure that agricultural communities remain healthy and competitive. Since 2000, several research studies—including two sponsored by the CALFED Bay-Delta Program and a third by the nonprofit Pacific Institute—have shown that there is significant untapped agricultural water-use efficiency potential in California (CALFED, 2000 and 2006; Cooley et al., 2009). Although the studies varied in their geographic scope and in their approach, the researchers came up with remarkably similar numbers, finding that agricultural water use could be reduced by 5.6 million to 6.6 million acre-feet per year, or by about 17 to 22 percent, while maintaining current irrigated acreage and mix of crops. As much as 0.6 million to 2.0 million acre-feet per year represent savings in consumptive use, which can then be allocated to other uses. The rest of the savings reflect reductions in the amount of water taken from rivers, streams, and groundwater, leading to improvements in water quality, instream flow, and energy savings, among other benefits. Additional water savings could be achieved by temporarily or permanently fallowing land or switching crop types, but these options were not evaluated here.

Improving Urban Water-Use Efficiency

Greater urban water conservation and efficiency can reduce unnecessary and excessive demands for water, save energy, reduce water and wastewater treatment costs, and eliminate the need for costly new infrastructure. Between 2001 and 2010, California's urban water use averaged 9.1 million acre-feet per year, accounting for about one-fifth of the state's developed water use (DWR, 2014b). By adopting proven technologies and practices, businesses can improve water-use efficiency by 30 to 60 percent. Residential users can improve home water-use efficiency by 40 to 60 percent by repairing leaks, installing the most efficient appliances and fixtures, and adopting landscape designs with less turf grass and more native and drought tolerant plants. In addition, water utilities can expand their efforts to identify and cut leaks and losses in underground pipes and other components of their distribution systems. Together, these savings could reduce urban water use by 2.9 million to 5.2 million acre-feet per year.

Greater Water Reuse

Water reuse is a reliable, local water supply that reduces vulnerability to droughts and other water-supply constraints. It can also provide economic and environmental benefits by reducing energy use, diversions from rivers and streams, and pollution from wastewater discharges. There is significant opportunity to expand water reuse in California. An estimated 670,000 acre-feet of municipal wastewater is already beneficially reused in the state each year (SWRCB and DWR, 2012). Onsite reuse—including the use of graywater—is also practiced across California, although data are not available to estimate the extent of reuse. We estimate that the water reuse potential in California, beyond current levels, ranges from 1.2 million to 1.8 million acre-feet per year, after taking into account efficiency opportunities. Approximately two-thirds of the reuse potential is in coastal areas where wastewater is discharged into the ocean or into streams that drain into the ocean. In these areas, expanding water reuse can provide both water-supply and water-quality benefits.

Expanding Stormwater Capture and Use

Municipalities used to manage stormwater by channeling it away from developed land and urban centers as quickly as possible. This approach reduces the amount of freshwater available for groundwater recharge and use, and it creates tremendous pollution problems with stormwater discharges to rivers, lakes, and ocean waters. As water resources have become increasingly constrained, there is new interest in capturing stormwater runoff as a sustainable source of supply (CNRA, 2014). In California, there are substantial opportunities to use stormwater beneficially to recharge groundwater supplies or for direct use for non-potable applications. Our assessment indicates that capturing stormwater from paved surfaces and rooftops in urbanized Southern California and the San Francisco Bay Area can increase average annual water supplies by 420,000 to 630,000 acre-feet or more each year, while also reducing both flooding and a leading cause of surface water pollution in the state.

Combined Water Supply and Demand Reductions

Together, these improvements in water conservation and efficiency, water reuse, and stormwater capture can provide 10.8 – 13.7 million acre-feet in new supplies and demand reductions. As shown in Figure 2, these savings can be realized throughout the state. There are, however, important regional differences. In the Central Valley and the Colorado River hydrologic region, for example, the majority of savings are from agriculture, although savings from other strategies are also available. In coastal areas, the majority of savings are in urban areas. Statewide, urban conservation and efficiency combined with water reuse and stormwater capture provide the equivalent in new supplies and demand reductions as agricultural efficiency (Table 1).

Along the coast and in areas that drain into a salt sink, these measures provide water supply and water quality benefits. In inland areas, some portion of the yield of these measures may already be used by a downstream user and thus do not constitute "new" supply. However, even in such locations, the measures described here can improve the reliability of water supplies, leave water instream for use by ecosystems, replace the need for potable water, and reduce pressure on the state's overtaxed rivers and groundwater basins.

Figure 2. Total water supply and demand changes with four drought response strategies, in thousand acre-feet per year, by hydrologic region

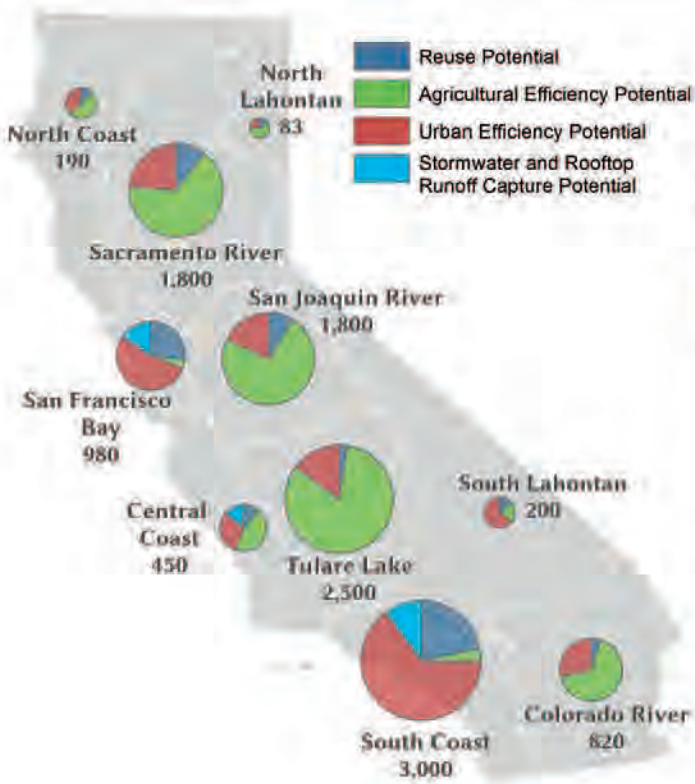


Table 1. Statewide water supply and demand changes with four drought response strategies

Strategy	Water Savings (million acre-feet per year)
Agricultural water conservation and efficiency	5.6 – 6.6
Urban water conservation and efficiency	2.9 – 5.2
Water reuse	1.2 – 1.8
Stormwater capture	0.4 – 0.6

Note: Stormwater capture was only examined in the San Francisco Bay Area and the South Coast. There is additional potential to capture stormwater in other regions of the state, although we did not evaluate that here. The values shown in this figure represent the midpoint of the ranges for each strategy.

CONCLUSIONS

We conclude that there is tremendous untapped potential to improve efficiency and augment supplies in California. Water efficiency, water reuse, and stormwater capture can provide 10.8 million – 13.7 million acre-feet of water in new supplies and demand reductions. These alternatives can provide both effective drought responses in the near-term and permanent water-supply reliability benefits for the state. Additionally, they can reduce energy use and greenhouse emissions, lower environmental impacts, and create new business and employment opportunities. Given the large potential and broad agreement about these strategies, state, federal, and local water agencies should move much more rapidly to implement policies to capture this potential.

California is reaching, and in many cases has exceeded, the physical, economic, ecological, and social limits of traditional supply options. We must expand the way we think about both "supply" and "demand"—away from costly old approaches and toward more sustainable options for expanding supply, including water reuse and stormwater capture, and improving water use efficiency. There is no "silver bullet" solution to our water problems, as all rational observers acknowledge. Instead, we need a diverse portfolio of sustainable solutions. But the need to do many things does not mean we must, or can afford, to do everything. We must do the most effective things first.

Identifying the technical potential to expand non-traditional supply options and increase water-use efficiency savings is just the first step in tackling California's water problems. Equally, if not more, important is adopting policies and developing programs to achieve those savings. A substantial body of law and policy already points the way to a more sustainable future for our state. For example, the California Constitution prohibits the waste of water. Likewise, the Brown Administration's California Water Action Plan supports local water projects that increase regional self-reliance and result in integrated, multi-benefit solutions. Many of these themes are also expressed in policy documents and recommendations from the California Urban Water Conservation Council, the Pacific Institute, the Association of California Water Agencies, the Delta Stewardship Council, the California Council on Science and Technology, the California Water Foundation, and others.

There is broad agreement on the value of improved efficiency, water reuse, and stormwater capture. The challenge is not a lack of knowledge or vision about what to do, but rather the urgent need for more effective implementation of strategies already known to work. Many innovative policymakers around the state have proposed new approaches to promote more widespread implementation of these strategies. We look forward to working with the Governor, agency heads, legislative leaders, water suppliers, and civic and business leaders to follow up with more specific actions for bringing the supply and demand for water in California into a sustainable balance.

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Footnotes

1 Water Code section 85086(c)(1): "For the purpose of informing planning decisions for the Delta Plan and the Bay Delta Conservation Plan, the board shall, pursuant to its public trust obligations, develop new flow criteria for the Delta ecosystem necessary to protect public trust resources."

2 See, e.g., page 5 of SWRCB and California EPA (2010a), recommending the general magnitude and timing of 75 percent of unimpaired Delta outflow from January through June, from approximately 30 percent in drier years to almost 100 percent in wetter years; 75 percent of unimpaired Sacramento River inflow from November through June, from an average of about 50 percent from April through June; and 60 percent of unimpaired San Joaquin River inflow from February through June, from approximately 20 percent in drier years to almost 50 percent in wetter years.

3 SWRCB and California EPA (2010b) at 180, Scenario B (2,258 thousand acre-feet (TAF) north-of-Delta delivery difference + 1,031 TAF south-of-Delta delivery difference = 1,609 TAF Vernalis flow difference = 4,898 TAF).

4 Of California's 515 alluvial groundwater basins, 169 are fully or partially monitored under the CASGEM Program and 40 of the 126 High and Medium priority basins are not monitored under CASGEM. The greatest groundwater monitoring data gaps are in the Sacramento, San Joaquin River, Tulare Lake, Central Coast, and South Lahontan hydrologic regions (DWR 2014a).

5 The technical potential estimated in these analyses is based on current use patterns and does not include population and economic growth, or changes in the total acreage or types of crops grown in the state. Increased population can result in increased demand, and these tools can help offset that growth. We do not examine the economic or market potential of these alternatives.

Authors and Acknowledgements

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Attachment 13

The New York Times | http://nyti.ms/1n9cfIB

Saving Water in California

By THE EDITORIAL BOARD JULY 9, 2014

California is in the third year of its worst drought in decades. But you wouldn't know it by looking at how much water the state's residents and businesses are using. According to a recent state survey, Californians cut the amount of water they used in the first five months of the year by just 5 percent, far short of the 20 percent reduction Gov. Jerry Brown called for in January. In some parts of the state, like the San Diego area, water use has actually increased from 2013.

Without much stronger conservation measures, the state, much of which is arid or semiarid, could face severe water shortages if the drought does not break next year. Los Angeles recently recorded its lowest rainfall for two consecutive years, and climate change will likely make drought a persistent condition, according to the National Climate Assessment report published in May.

Yet, even now, 70 percent of water districts have not imposed reasonable mandatory restrictions on watering lawns and keeping backyard pools filled. The State Water Resources Control Board is to consider placing restrictions on some outdoor water uses like washing paved surfaces at a meeting on July 15.

California's agriculture sector is the largest in the country, and it accounts for about 80 percent of the state's water use. Even a small percentage reduction in the fields could have a sizable effect on total water consumption.

A recent report by the Pacific Institute and the Natural Resources

Defense Council estimates that agricultural water use could be reduced by up to 22 percent if farmers more carefully scheduled the watering of crops based on weather and soil conditions and if they used the drip irrigation systems that deliver water directly to the roots of plants. Some progress has been made. About 38 percent of California farmland was irrigated by more efficient systems in 2010, up from 15 percent in 1991. But far too many farmers still irrigate by flooding their fields.

In terms of urban conservation, the report shows that homes and businesses could reduce water use by up to 60 percent by using it more efficiently, recycling and reusing water and capturing more rainwater. Some efficiency improvements are simple and could be done quickly, like installing water meters at all homes and businesses. Currently, about 250,000 water-utility customers, most of them in the Central Valley, have no meters and are charged a flat monthly fee regardless of how much water they use — a practice that invites waste.

Other changes will take longer to carry out but could have a big impact. For instance, Santa Cruz's municipal water utility imposes water "budgeting" under which it determines how much water each home needs based on where it is and the number of people in the household. Customers who use more than their budgeted amount must pay higher rates for extra water used. This approach has helped Santa Cruz cut water use by about 30 percent since 1987.

Other government programs have been effective, too, and deserve broader adoption. The Los Angeles Department of Water and Power last month began paying people $3 for every square foot of grass they replace with landscaping that requires little or no water under a "cash in your lawn" program, up from $2 previously; residents can claim up to $6,000 under that program. The department says it has paid to have 8 million square feet of lawn removed since the program started in 2009.

Finally, state officials need to act with a much greater urgency. Earlier this year, the State Legislature set aside nearly $700 million for emergency drought relief, but 90 percent of that money has yet to be spent. Mr.

Brown's administration should think a lot bigger than emergency aid aimed at a single drought. The state must focus on longer-term policies that encourage people to alter their lifestyles and businesses to change how they operate.

Meet The New York Times's Editorial Board »

A version of this editorial appears in print on July 10, 2014, on page A26 of the New York edition with the headline: Saving Water in California.

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Attachment 14

Wave of phony charges over new clean water safeguards

Getty Images

By Peter Lehner - 06/17/14 06:31 PM EDT

Beat me with the truth, the saying goes, don't torture me with lies.

Officials at the Environmental Protection Agency and the U.S. Army Corps of Engineers must be longing for a little slap of truth these days, after being pummeled with misstatements, wild exaggerations and, yes, untruths about their latest proposal to keep our tap water clean and our rivers, lakes and beaches safe for swimming and fishing.

The proposed action is a long overdue clarification of which streams and wetlands are protected by the Clean Water Act.

After considerable scientific study, the EPA came to the unassailable conclusion that because small, intermittent streams and nearby wetlands feed into larger lakes and rivers that people use for drinking water, fishing and recreation, those waters should also be protected from pollution. And the EPA and the Corps produced some common-sense protections to cover those streams and wetlands.

Almost immediately, opponents started making extreme statements about "government overreach," "the biggest government land grab ever," and "an end to farming as you know it," even though the change simply restores protections to waters that long had been covered.

You'd never know from this overheated rhetoric that the proposal would leave fewer waters protected than was the case under President Reagan or that many tributary streams had been protected against pollution by federal law since William McKinley was president in 1899.

Much of this over-the-top criticism has come from oft-cited polluters, like the mining industry. Yet, some of the most strident charges have come from agribusiness interests. One writer declared, "The 370-page rule may as well be written in farmers' blood." The irony is that, thanks to numerous exemptions in the law and the regulations, agriculture is actually the least regulated of any sector. But no doubt some polluters are happy to see the powerful farm lobby, well, carrying water for them.

The comment period for the new proposal will close in October, but some in Congress aren't waiting. They're already offering legislation to block the initiative, riding this flood of misinformation. So let's part the waters of myth and get down to the truth.

• Claim: The American Farm Bureau Federation tweets that the proposal "gives the fed gov control over all farming and land use."

• Truth: The clean water safeguards explicitly exempt irrigated areas, farm ponds and dozens of other agricultural practices. They also reduce coverage of "ditches," a favorite Farm Bureau talking point.

• Claim: The Farm Bureau says certain permitting exemptions for agriculture apply only to land that has been continually farmed since 1977.

• Truth: This is simply wrong. There is no 1977 trigger date for the exemptions, and they are available to anyone engaged in "normal farming," which allows for crop rotations, fallow fields and other practices that may vary over time.

• Claim: The Farm Bureau alleges that under this initiative "nearly every drop of water that falls will be regulated by the federal government."

• Truth: The Clean Water Act clearly applies only to "waters," not all water. That doesn't change with these new safeguards. The law doesn't regulate, and never has, the mere use of water, but instead simply makes it illegal to pollute certain bodies of water without proper safeguards.

• Claim: The agencies are evading court rulings and congressional intent.

• Truth: The clean water proposal restores protections consistent with two Supreme Court decisions, in 2001 and 2006, that called into question just which waters are covered by the Clean Water Act of 1972 but authorized the agencies to protect waters when the science supports it. For nearly 30 years prior, throughout the Nixon, Reagan and Bush I eras, these small streams and wetlands, which feed into drinking water systems serving 117 million Americans, were protected, as Congress intended.

More examples abound. But clearly the truth wouldn't frighten anyone, so the opposition isn't sticking to it. The facts are too prosaic: The agencies relied on a large body of scientific studies to propose a modest, common-sense rule that would restore protections to many waters that existed for nearly three decades.

More facts: Small and seasonal streams and wetlands filter pollutants, protect against flooding, and serve as habitat for fish and wildlife. A single acre of wetland can store 1 million to 1.5 million gallons of flood water. This initiative is backed by conservationists, hunters, fishers, people of faith, business leaders and even the National Farmers Union, a family-farm group, which calls it "ag-friendly."

Congress should not succumb to the hype. Let the EPA and the Corps do their jobs protecting the safety of America's waters.

Lehner is executive director of the Natural Resources Defense Council, an international environmental advocacy organization based in New York City.

TAGS: Clean Water Act, Water law in the United States, United States Environmental Protection Agency, Wetland

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Attachment 15

Op-Ed Don't buy the smear of the EPA

New regulations on carbon emissions proposed by the Obama administration have reportedly angered politicians on both sides of the aisle in energy-producing states such as Kentucky and West Virginia. (Luke Sharrett / Getty Images)

By FRANCES BEINECKE

JUNE 3, 2014, 5:51 PM

The nation's worst polluters and their allies have launched a propaganda campaign to convince you that the Environmental Protection Agency's new carbon pollution standards are nothing more than a backdoor energy tax that will kill jobs and cost you money.

That campaign is a lie. And what's at stake is too important to let the lie stand, or even start.

Right now, there are no limits on the amount of carbon pollution that coal-fueled electric plants can pour into the air. Zero limits on the worst pollution in America, pollution that increases the risk of asthma, heart disease and lung cancer. Pollution that is the leading cause of climate change.

For the polluters, the carbon pollution loophole has been one of the most lucrative giveaways in America. So it's not surprising that the EPA proposal would start them howling. The thing is, what

they're saying isn't true.

Take the radio ads from the National Mining Assn. claiming that home electric bills will "nearly double" if "extreme new power plant regulations take effect."

In fact, the proposal calls for a 30% cut in pollution, which would at most create small, short-term changes in electricity prices of the sort the power sector already deals with. EPA chief Gina McCarthy compared the potential increases for families with the price of a gallon of milk a month. And those costs would be dwarfed by huge benefits in job creation and health savings, worth more than $90 billion, according to the EPA.

Even before the official EPA announcement, the opposition was lining up with a range of astonishing falsehoods. The folks at the U.S. Chamber of Commerce said the plan they hadn't seen yet could cost $50 billion and kill 224,000 jobs (they have since said they're reexamining their numbers). GOP Sen. Michael B. Enzi of Wyoming, the nation's largest coal-producing state, said Saturday that the Obama administration "set out to kill coal and its 800,000 jobs."

The truth? When these pollution cuts take effect, coal will still provide 31% of American electricity, down from 37% today — hardly a death blow.

And those 800,000 jobs? The National Mining Assn. itself counts just 90,000 coal miners in the whole country. Double that for the workers transporting it and working in coal-fired plants, and the figure is still far short of Enzi's numbers and short of the Chamber of Commerce jobs-at-risk numbers. Most of these coal jobs will remain. Moreover, hundreds of thousands of new, clean energy jobs will be created. Last year alone, investments in clean energy created more than 78,000 jobs, according to Environmental Entrepreneurs, a business group.

Among the toothless charges being made, my personal favorite is the claim that the EPA proposals represent "an illegal use of executive power," as Sen. Rand Paul (R-Ky.) called it. The facts? The Supreme Court has twice (in 2007 and 2011) ruled that the EPA has the responsibility under the Clean Air Act to control air pollution that "endangers public health or welfare," and that this responsibility applies to carbon pollution and other heat-trapping pollutants.

The new EPA standards are a first step in the work that must be done to slow, stop and eventually reverse the climate chaos that is contributing to life-threatening heat waves, dangerous storms, rising seas and more. The EPA has proposed flexible, state-by-state limits that would enable states to invest in creative and locally appropriate solutions to curb dangerous pollution while providing dependable and inexpensive power to their citizens.

California is already proving that an approach like the EPA's can work. Thanks to the state's climate and clean energy plan, millions of Californians received a "climate credit" of $30 to $40

on their electricity bills this April (and residents can expect those credits biannually from here on out). What's more, California's emissions per capita have dropped 17% since 1990.

So when the coal and oil industry titans and their allies try to tell you the EPA carbon rules will kill jobs or send your electric bills soaring, tell them you don't buy their lies.

Tell them you want to leave our children and grandchildren a healthy, livable world, and that you're not willing to give the worst polluters in America a free pass anymore.

Frances Beinecke is president of the Natural Resources Defense Council.

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Attachment 16

< Conservationists Call For Quiet: The Ocean Is Too Loud!

July 28, 2013 4:29 PM ET

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JACKI LYDEN, HOST:

If you're just joining us, it's WEEKENDS on ALL THING CONSIDERED from NPR News. I'm Jacki Lyden.

We're about to embark on a tour of nature in a variety of forms. First, take a listen to this.

(SOUNDBITE OF HUMPBACK WHALE)

LYDEN: You're listening to a humpback whale talking. Though we don't quite know what he's saying, we do know that it's important for whales and other sea creatures to be able to talk to each other in the ocean. But humans are making that conversation nearly impossible, according to Michael Jasny, the director of the Marine Mammal Protection Project for the Natural Resources Defense Council. He says we have to quiet down.

MICHAEL JASNY: There's an old English science fiction story in which the people of the world wake up one morning to find that they're all blind. That's what we're doing to whales and other animals in the sea. We haven't blinded them completely, but we've diminished their sight. We've made it much harder for them to live in their world. And it's not just in a few places. It's almost everywhere.

LYDEN: The noise of a cruise ship completely drowns out the sound of this small clan of whales conversing in a matter of seconds.

JASNY: Sound in the ocean travels incredibly well, so that time was when a blue whale calling off of Massachusetts could be heard by other blue whales straight across the Atlantic. Now, unfortunately, that's changed. Since the advent of the propeller engine 150 years

ago, the noise that we have been putting into the sea has grown and grown. Just about everything that humans do in the water makes noise - when we ship good from country to country, when we explore for oil and gas and minerals, when the military trains with explosives or intense sonar systems. And this noise travels.

What's happened over the last 150 years is that we have created a kind of smog in the seas. And this is a particularly virulent form of smog. It affects every aspect of the lives of whales and dolphins and other creatures. Noise causes animals to abandon their habitat, to go silent, to stop foraging, to forage poorly, to go deaf and, in some cases, to die. It affects every aspect of their survival and their ability to reproduce.

LYDEN: One of the biggest culprits for under the sea noise is the way we prospect for oil and gas offshore.

(SOUNDBITE OF HIGH-VOLUME AIR GUN)

LYDEN: Companies use arrays of high-volume air guns that are so loud you can see the water rise and fall when the guns go off.

JASNY: It's an incredible thing to imagine thinking about someone setting off a sound like dynamite in your neighborhood again and again and again, every 10 to 12 seconds, for weeks and months. This is what we are forcing whales and dolphins and fish to live with.

(SOUNDBITE OF HIGH-VOLUME AIR GUN)

LYDEN: That's Michael Jasny, director of the Marine Mammal Protection Project for the Natural Resources Defense Council. His conservation group and others like it recently settled a lawsuit with several oil and gas companies that requires the industry to take steps that will reduce the noise around whales' and dolphins' habitat and use less invasive forms of exploration.

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Attachment 17

NATURAL RESOURCES DEFENSE COUNCIL

Testimony of David D. Doniger
Policy Director and Senior Attorney, Climate and Clean Air Program
Natural Resources Defense Council

Hearing on the American Energy Initiative: A Focus on EPA's Greenhouse Gas Regulations

Subcommittee on Energy and Power
Committee on Energy and Commerce
House of Representatives
June 19, 2012

Summary

- Nearly 2 million Americans – more than double the previous record – have already raised their voices in comments to support EPA's proposed carbon pollution standard for power plants. More than 60 percent of Americans support EPA's setting carbon pollution standards according to a recent bipartisan poll conducted for the American Lung Association.

- Carbon pollution is imposing staggering health and environmental costs, including by contributing to more severe heat waves and worsened smog pollution and by fueling increasingly extreme weather that takes lives and causes billions of dollars in property damage each year. June 2011-May 2012 was the warmest 12-month stretch ever in the U.S.

- Two Supreme Court decision, *Massachusetts v. EPA* and *American Electric Power v. Connecticut*, confirm that it is EPA's job under the Clean Air Act as Congress enacted it to protect the American people from carbon pollution from both cars and power plants.

- By proposing standards for new power plants under Section 111(b) of the Clean Air Act, EPA is simply following the law and the science. Power plants are the largest U.S. source of greenhouse gases: 2.3 billion metric tons per year of CO_2 emissions, approximately 40 percent of the U.S. total.

- NRDC supports EPA's decision to establish a single category including all new plants, however fueled, that perform the same function of base-load and intermediate-load power generation. Owners and operators have the flexibility to choose among these technologies when building new plants to serve this function.

- The proposed new source standard recognizes that the market has already turned away from building new conventional coal plants due low-cost natural gas, strong growth in wind and solar power, big opportunities to improve energy efficiency, and even the potential for nuclear power. Analysts from government, the power industry, and the financial world all forecast that we will meet electricity needs over the next two decades without constructing new coal-fired plants.

- Thus, despite all the rhetoric and scape-goating, this standard will impose no additional costs on the industry or on electricity rate-payers and will have no adverse impact on jobs.

- NRDC agrees that CCS-equipped coal-fired plants are technically feasible today and can meet the proposed standard. NRDC supports proposed provisions to facilitate construction of CCS-equipped plants. NRDC has long supported well-designed legislative measures to accelerate the deployment of CCS, including tens of billions of dollars of support that would have been provided to power companies for adopting CCS under the climate and energy legislation considered in the last Congress.

- EPA needs to move forward to start the joint Federal-state process of cutting the 2.3 billion tons of dangerous carbon pollution from the existing fleet of power plants under Section 111(d). It is just plain false to claim that existing coal plants will be required to meet the new plant standard. The criteria and procedures for new and existing plants are different. EPA and the states must set existing source standards that are achievable and affordable. NRDC believes significant, cost-effective reductions can and should be made within that legal framework.

Thank you Chairman Whitfield and Ranking Member Rush for the opportunity to testify on behalf of the Natural Resources Defense Council about the Environmental Protection Agency's proposed carbon pollution standard for new electric power plants, and related actions to carry out the agency's responsibilities under the Clean Air Act to address the pollution that drives dangerous climate change. Founded in 1970, NRDC is a national nonprofit environmental organization of scientist, lawyers, and environmental specialists with more than 1.3 million members and online activists, served from offices in New York, Washington, Chicago, San Francisco, Los Angeles, and Beijing. I am policy director of NRDC's Climate and Clean Air Program, and our principal lawyer on climate change matters. I have been with NRDC twice, from 1978 through 1992 and from 2001 to the present. In the 1990's I served as director of climate change policy in the EPA Office of Air and Radiation.

Although the period for public comment has not yet finished, already nearly two million citizens across this country – more than double the previous record number in the EPA's history – have raised their voices in comments to support action under the Clean Air Act to curb the dangerous carbon pollution from our fleet of power plants.

This record outpouring should come as no surprise, since public polling consistently shows the American people supports the Environmental Protection Agency's doing its job, under the laws that Congress enacted, to protect their health and their future. For example, 60 percent of the American people support EPA's setting standards for carbon dioxide pollution, even after hearing the arguments against that many of you are making today, according to the most recent bipartisan poll conducted for the American Lung Association.[1]

Americans in record numbers are concerned, because scientists tell us that carbon pollution is imposing, and will continue to impose, staggering health and environmental costs. The health consequences include contributing to more severe heat waves and worsened smog pollution, which

[1] http://www.prnewswire.com/news-releases/american-lung-association-bipartisan-poll-shows-strong-public-support-for-lifesaving-clean-air-act-116319864.html.

trigger more asthma attacks and other life-threatening illnesses. Carbon pollution is driving climate change that is fueling increasingly extreme weather, including more extreme heat, more extreme precipitation, devastating tropical storms, rising sea levels and more severe coastal flooding, and many other threats to life, limb, and property.[2] Americans had extraordinary personal experiences with extreme weather last year. Across the country, 2011 gave us 3,251 broken monthly weather records -- so many extreme events that NRDC created an online map tool to track them and the destruction they caused.[3] 2012 is off to another record-smashing start: March 2012 was the hottest March in the contiguous US since record-keeping began back in 1895.[4] May 2012 marked the end of the warmest 12-month stretch ever in the US.[5]

Looking back over the past decade, case studies of six extreme weather events – heat waves, wildfires, floods, smog episodes, hurricanes, and disease outbreaks – yielded health-related costs of more than $14 billion.[6] A new study by the Rocky Mountain Climate Organization and NRDC shows that the number of extreme rainstorms – storms dumping more than three inches of rain in a day – has doubled over the last 50 years in eight Midwestern states, causing huge flooding losses.[7]

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[2] IPCC, 2012: Summary for Policymakers. In: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 3-21.

[3] NRDC's *Extreme Weather Map 2011* website is available at: www.nrdc.org/extremeweather and on NRDC's *Climate Change Threatens Health* webpages at: www.nrdc.org/climatemaps. Data for the map was taken from the National Oceanic and Atmospheric Administration-National Climatic Data Center (NOAA-NCDC); the methods used to develop the map are described at: http://www.nrdc.org/health/extremeweather/methods.asp (updated Feb. 2012).

[4] NOAA-NCDC (2012) website at: http://www.ncdc.noaa.gov/temp-and-precip/time-series/index.php?parameter=tmp&month=3&year=2012&filter=1&state=110&div=0 ("Contiguous U.S. Temperature: March 1895-2012").

[5] NOAA-NCDC (2012), http://www.ncdc.noaa.gov/sotc/national/2012/5 .

[6] Knowlton, *et al.*, "Six Climate Change–Related Events In The United States Accounted For About $14 Billion In Lost Lives And Health Costs," *Health Affairs*, **30**:11, pp. 2167-76 (Nov. 2011). *See also* NRDC, "Health and Climate Change: Accounting for Costs," Nov. 2011, http://www.nrdc.org/health/accountingforcosts/files/accountingcosts.pdf (attached for the record).

[7] Rocky Mountain Climate Organization & NRDC, "Double Trouble: More Midwestern Extreme Storms," May, 2012, http://www.rockymountainclimate.org/images/DoubledTroubleHigh.pdf.

The Supreme Court's landmark 2007 ruling in *Massachusetts v. EPA*[8] confirmed that greenhouse gases, just like any other chemicals released into the air, are "air pollutants" under the Clean Air Act. The Court held that EPA must make a science-based determination whether these pollutants may reasonably be anticipated to endanger public health or welfare, and if so, that EPA must set standards to their emissions under the Clean Air Act. EPA made that endangerment finding in 2009, based on a mountain of scientific evidence that demonstrates that carbon dioxide and other heat-trapping pollutants are already harming, and will continue to harm, the health and well-being of our families, our children, and our communities. You have heard about EPA's other initial steps – the clean vehicle standards and permitting requirements for the biggest new industrial facilities – from Daniel Weiss of the Center for American Progress on the first panel. I will concentrate on the carbon pollution standard proposed in April for new power plants.

The Supreme Court spoke a second time specifically addressing power plants, in June 2011 in *American Electric Power v. Connecticut*,[9] confirming that it is EPA's job to protect the American people from power plants' dangerous carbon emissions by setting standards under Section 111 of the Clean Air Act. The "new source performance standard" that EPA has proposed for new power plants under Section 111(b) is a critical step towards providing that protection.

Power plants have long topped the list of categories of industrial stationary sources that contribute significantly to air pollution that endangers public health and welfare. Fossil fuel-fired power plants are responsible for more than 2.3 billion metric tons per year of CO_2 emissions, approximately 40 percent of total U.S. CO_2, and more than a third of all U.S. greenhouse gas emissions. American power plants account for nearly 10 percent of *global* CO_2 emissions. By any standard, power plants contribute significantly to dangerous greenhouse gas air pollution. By proposing standards for new power plants under Section 111(b) of the Clean Air Act, EPA is simply following the law and the science. Its proposal

[8] 549 U.S. 497 (2007).
[9] 131 S.Ct. 2527 (2011).

to set the first national limits on carbon pollution from new power plant, which applies only to new plants, not existing or modified ones, is long overdue.

NRDC supports EPA's determination to establish a single category that includes both natural gas-fired generating units and coal-fired generating units. As EPA has found, these units perform the same function of base-load and intermediate-load power generation, and prospective owners and operators have the flexibility to choose among these technologies when building new plants to serve this function. Consequently, NRDC also supports setting a single emissions-rate standard applicable to all new plants in the category. EPA has proposed 1000 lbs/MWh standard and a range of levels around this mark. NRDC supports setting the new source standard somewhat below 1000 lbs/MWh because modern new natural gas combined cycle plants can meet such levels at no additional cost. New coal-fired plants equipped with carbon capture and storage technology (CCS) can also meet that level, especially with the 30-year averaging provisions that EPA has proposed.

There is no truth to claims that grouping all new plants that perform the same function – whether natural gas- or coal-fired – in the same category under the proposed new source standard is a "de facto ban" on constructing new coal-fired plants, nor to claims that the standard will cause lost jobs and higher utility bills. These are phony arguments. The proposed new source standard actually will impose <u>no additional costs</u> on the industry or on electricity rate-payers and will have <u>no adverse impact on jobs</u>.

The reason is that market realities have already driven decisions on new power plants away from building new conventional coal plants. As Brookings senior economist Peter Wilcoxen explained in April: "To put it simply: the life-cycle costs of coal-fired power are considerably higher than gas-fired power. This is not a theoretical matter: over the last decade, the electric power sector has responded by adding more than about 200 gigawatts of gas-fired capacity and about 2 gigawatts of coal. The US now has considerably more gas-fired capacity than coal-fired capacity and low gas prices will accelerate

that trend even without the EPA decision." He continued: "Finally, because it only rules out an expensive option that wouldn't have been used anyway, the EPA rule will have no significant effect on electricity prices."[10]

Analysts from government departments, the power industry, and the financial world all agree in forecasting that the nation will meet its electricity needs over the next two decades without constructing new coal-fired plants.[11] Power companies simply aren't planning to build new coal plants due to the availability of low-cost natural gas, strong growth in wind and solar power, big opportunities to improve energy efficiency, and even the potential for nuclear power. For example, the country's largest current CO2 emitter, American Electric Power, stated that the proposed rule "doesn't cause immediate concern" for the company. "We don't have any plans to build new coal plants," said AEP spokesperson Melissa McHenry in March. She continued, "Any additional generational plants we'd build for the next generation will be natural gas."[12] And Jim Rogers, CEO of Duke Energy, operating in the Carolinas, Indiana, Kentucky, and Ohio, told the National Journal in February: "We're not going to build any coal plants in any event. You're going to choose to build gas plants every time, regardless of what the rule is."[13]

These market forecasts are robust. EPA's sensitivity analyses in the Regulatory Impact Analysis show that power companies will not choose to construct any new conventional coal-fired plants before 2030 even if natural gas becomes *4-5 times more costly than it is today* <u>*and*</u> *power demand increases faster than expected*.[14]

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[10] http://mediamatters.org/research/201204020012.

[11] See sources cited by Lashof, "Financial Analysts, Private Economists, and Government Forecasters All Agree: Market Realities, Not EPA, Driving New Power Plants Away from Coal," April 2012, http://switchboard.nrdc.org/blogs/dlashof/financial_analysts_private_eco.html.

[12] National Journal, Government Executive (Mar. 27, 2012), http://www.govexec.com/oversight/2012/03/first-major-climate-regs-obama-epa-sure-stir-political-debate/41580/

[13] National Journal, Need to Know: Energy (Feb. 2, 2012).

[14] EPA Regulatory Impact Analysis for the Proposed Standards of Performance for Greenhouse Gas Emissions for New Stationary Sources: Electric Utility Generating Units, Chapter 5 (March 2012), http://epa.gov/carbonpollutionstandard/pdfs/20120327proposalRIA.pdf.

The proposed new source standard reinforces what most power company executives and investors already understand – that carbon pollution and climate change are serious concerns, and that if and when underlying market economics support a comeback for new coal-fired power plants, they will need to be designed with CCS.

The nation's utilities also have huge money-saving opportunities to shift investments to energy efficiency, which is cheaper than power from either coal or gas-fired plants. By doing so they will create hundreds of thousands of jobs, since it takes a lot more people to upgrade homes, offices, and factories with better insulation and lighting, high performance heating and cooling systems, and more efficient appliances and equipment. Between 2007 and 2011, American electric efficiency budgets more than doubled, from $2.7 billion to $6.8 billion, but they have only scratched the surface of the cost-effective efficiency resource that is available to us.[15] According to McKinsey & Co., we could save $1.2 trillion on our national energy bill while creating almost 1 million jobs if we captured all of this resource.[16]

NRDC supports provisions EPA has proposed to facilitate construction of coal-fired plants equipped with CCS. NRDC agrees that CCS-equipped plants are technically feasible today and can be built – and are being built today[17] – even under current market conditions with subsidies provided under federal law. Further, NRDC agrees with EPA's assessment that further experience with CCS can bring costs down. I will also note that NRDC has long supported well-designed legislative measures to accelerate the deployment of CCS, including tens of billions of dollars of support that would have been provided to power companies for adopting CCS under the climate and energy legislation considered in the last Congress.

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[15] Consortium for Energy Efficiency, "Energy Efficiency Picture Emerges," http://www.cee1.org/ee-pe/2011AIR.php3.

[16] McKinsey & Co. , "Electric Power and Natural Gas, Unlocking Energy Efficiency in the U.S. Economy," 6 and 118, McKinseyGlobal Energy and Materials, July 2009, http://www.mckinsey.com/client_service/electric_power_and_natural_gas/latest_thinking/unlocking_energy_efficiency_in_the_us_economy.

[17] For example, Mississippi Power Company's Kemper County Plant Ratcliffe is now under construction and will capture and sequester 65 percent of its carbon dioxide emissions.

As already mentioned, EPA's proposed standards apply to new plants only, not existing or modified ones. Despite some rather clear statutory language to the contrary, EPA has even proposed to treat as existing plants a set of so-called "transitional" coal-fired plants that have permits but not commenced construction yet, provided they do so within a year. Like dozens of other proposals for new coal-fired capacity that have been abandoned because of market realities over the past years, many of these plants probably will not go forward because they lack financing and can't meet other, non-Clean Air Act legal requirements. Indeed, at least one of the transitional plants has already been dropped. Tenaska, which had proposed a coal-fired plant for southern Illinois has dropped it in favor of a new natural gas plant. Further, the majority owner of the proposed Holcomb 2 project, Tri-State Generation and Transmission, Inc., has published and filed with the Colorado Public Utilities Commission a final Electric Resource Plan stating that it has no need for any new coal-fired power until at least 2027. Tri-State's extensive resource planning modeling demonstrated that future demand could be met with a combination of cleaner alternatives, such as demand side management and renewable generation resources.[18] When questioned, Tri-State has advised the press that it planned to delay construction of Holcomb 2.

Going forward, EPA also needs to issue standards and guidelines under Section 111(d) of the Clean Air Act to start the joint Federal-state process of cutting the 2.3 billion tons of dangerous carbon pollution from the existing fleet of power plants. Another false claim you will hear is doing so will wipe out existing coal plants by requiring them to meet the same standard that EPA has proposed for new plants. But this is not what the Act requires. The criteria and procedures under Sections 111(b) and 111(d) are different, and under the statute EPA and the states share the job of setting performance standards for existing sources. EPA and the states have a legal obligation to set standards that are

[18] Integrated Resource Plan / Electric Resource Plan for Tri-State Generation and Transmission Associate, Inc., Submitted to Western Area Power Authority, Colorado Public Utilities Commission (Nov. 2010). Tri-State Generation and Transmission Associate, Inc., Resource Planning Presentation (June 10, 2010).

achievable and affordable. Within that legal framework, NRDC believes significant, cost-effective reductions in the heat-trapping CO_2 from existing power plants can and must be made, and EPA must begin that process forthwith.

In conclusion, the proposed carbon pollution standard for new power plants is another important step that EPA has taken under President Obama to clean up and modernize the nation's two most polluting sectors – the power plants that provide our electricity, and the motor vehicles that move us around. When the second round of carbon pollution and fuel economy standards for new cars and light trucks are finalized later this summer, they will cut carbon pollution in half and double miles per gallon, saving car-owners thousands of dollars at the pump and dramatically cutting our oil dependence. Because of these standards, and the ones set for heavy duty trucks, America's oil use is finally falling, and is expected to continue falling as far as the eye can see, even as oil production grows.

Scientists and the public agree overwhelmly that it is time to start protecting our families and the planet from the clear harm carbon pollution is causing. We owe it to our children to act now. Denial won't change the facts about carbon. It won't keep rising seas from eroding coastal property, just like it won't stop the wind from carrying pollution from one state to the next, mercury from being a brain poison, or soot from lodging in our lungs. Cleaning up pollution shouldn't be about politics. It's about fulfilling the promise to our families and our children that we will protect their health and their future from dangerous air pollution.

Attachment 18

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LOS ANGELES, July 29, 2009

Pollution Still a Hazard to U.S. Beaches

Report: Water Seriously Polluted, Jeopardizing Swimmers' Health; Beach Closings Top 20,000 for 4th Straight Year

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A new report shows that the dirtiest beaches

(CBS/AP) *Last updated at 6:53 p.m. EDT*

A report on water quality at U.S. beaches shows a 10 percent decrease in closing or advisory days last year compared to 2007, but indicates pollution remains serious.

The Natural Resources Defense Council says in Wednesday's report that there were 20,341 days on which ocean, bay and Great Lakes beaches were closed or were the subject of health advisories.

That's the fourth year in a row that the number has topped 20,000.

"Pollution from dirty stormwater runoff and sewage

in the U.S. are predominantly in the Northeast and Florida. The main pollutant is dirty runoff following storms. Kelly Wallace reports.

(CBS/AP)

overflows continues to make its way to our beaches. This not only makes swimmers sick - it hurts coastal economies," said Nancy Stoner, NRDC Water Program Co-Director.

Click here to read the full report

Rain plays a big role in flushing pollutants into the oceans, but last year it was relatively dry in California, Hawaii and from Delaware to the southeastern states and the Gulf of Mexico.

The NRDC also says some of the overall decline was due to decreased funding for monitoring.

Five-Star Beaches include:

Gulf Shores Public Beach (Alabama),
Laguna Beach-Main Beach, Bolsa Chica State Beach, Newport Beach (California)
Ocean City (Maryland),
Park Point - Community Club Beach in Duluth (Minnesota)
Hampton Beach State Park in Rockingham County (New Hampshire)

One-Star Beaches include:

Zach's Bay at Jones Beach State Park in Wantagh (New York)
Ocean Beach Park in New London (Connecticut)
Venice Public Beach (Florida)
Central Beach in Point Pleasant (New Jersey)

Wetter than usual conditions increased closings and advisories in the Great Lakes, New England and the New York-New Jersey region.

"Nobody wants their trip to the beach to send them to the bathroom or, worse, the emergency room," said Stoner. "It is vitally important to remember that if it has recently rained - or you see or smell a pipe discharging onto the beach - keep your head above water or avoid swimming altogether."

Swimming in contaminated water causes hundreds of thousands of cases yearly of skin rash, pink eye and gastrointestinal diseases, reports **CBS News correspondent Kelly Wallace**

"What we saw this year is that we are not doing any better at addressing the sources of beach water pollution," Stoner told **Wallace**. "There were 7 percent of the samples that violated public health standards nationwide. That's the same thing we saw last year and the year before."

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Attachment 19

Program

World Business Summit on Climate Change
Shaping the sustainable economy
Copenhagen, 24-26 May 2009

A Monday Morning Initiative

Sunday 24 May Highlighting critical issues.

09:30- **REGISTRATION**

12:30-13:30 **LUNCH**

13:30-14:00
Plenary hall

OPENING CEREMONY (DOORS WILL CLOSE AT 13.29)
Welcome to the World Business Summit on Climate Change.
Opening address by
Ban Ki-moon, *Secretary-General, United Nations*

H.M.Q. Margrethe II of Denmark and H.R.H. The Prince Consort

Tim Flannery, *Scientist and Author; Chairman of the Copenhagen Climate Council*
Erik Rasmussen, *Chief Executive Officer, Monday Morning; Founder of the Copenhagen Climate Council*

H.M.Q. Margrethe II of Denmark and H.R.H. the Prince Consort will oversee the opening. Due to protocol reasons H.M.Q. and H.R.H. must be the last persons to enter the plenary hall. We kindly ask all participants to be seated well in advance.

14:00-14:25

KEYNOTE ADDRESS
Al Gore, *former US Vice President*
Introduced by
Lise Kingo, *Executive Vice President and Chief of Staffs, Novo Nordisk*

14:25-16:00
Plenary hall

SHAPING THE NEW GREEN ECONOMY
Interactive debate
The international community is facing the twin challenges of dealing with the most serious global economic crisis in decades and negotiating an ambitious agreement on climate change. How can these two challenges be turned into opportunity? What policies, incentives and investments will most effectively stimulate low-carbon growth? What are the pathways to a sustainable, global economy?
Indra Nooyi, *Chairwoman and Chief Executive Officer, PepsiCo*
Fu Chengyu, *Chief Executive Officer, China National Offshore Oil Corporation*
Philippe Joubert, *President, Alstom Power*
Lars G. Josefsson, *President and Chief Executive Officer, Vattenfall*
Walter B. Kielholz, *Chairman, Swiss Re*
Alan Salzman, *Chief Executive Officer, Vantage Point Venture Partners*
Ditlev Engel, *Chief Executive Officer, Vestas*
Masamitsu Sakurai, *Chairman, Ricoh*
Carl-Henric Svanberg, *Chief Executive Officer, Ericsson*
Girish S. Paranjpe, *Joint-Chief Executive Officer, Wipro*
Sultan Al Jaber, *Chief Executive Officer, Masdar*
Li Zhengmao, *Executive Board Member, China Mobile*
Moderated by
Geoff Cutmore, Anchor, CNBC

16:00-16:30 **BREAK**

16:30-16:45
Plenary hall

SPECIAL ADDRESS
Dr. R. K. Pachauri, *Director General, TERI; Chairman, Intergovernmental Panel on Climate Change*
In conversation with
Katherine Richardson, *Vice Dean, University of Copenhagen*

16:45-17:00
Plenary hall

SPECIAL SESSION: AVIATION
Despite progressively more efficient operations, emissions attributable to international aviation represent 2% of the global total and continue to rise. Absent a global framework, regional measures are being implemented that display promise but also raise concerns related to fairness and evasion. Can 2009 deliver on the promise of a global framework to address aviation emissions?
Giovanni Bisignani, *Chief Executive Officer, IATA*
Moderated by
Adam Aston, *Energy and Environment Editor, BusinessWeek*

17:00-18:00
Plenary hall

GETTING TO COPENHAGEN
Panel discussion
We are at a critical juncture, just six months before political leaders will gather at the UN Climate Change Conference (COP15) in Copenhagen to negotiate an ambitious agreement on climate change. What are the critical challenges and stumbling blocks on the road to Copenhagen? How can the business community support the policy process leading up to COP15 – and beyond?
Connie Hedegaard, *Minister of Climate and Energy, Denmark*
Xie Zhenhua, *Vice Chairman, National Development and Reform Commission, China*
Marthinus van Schalkwyk, *Minister of Environmental Affairs and Tourism, South Africa*
Erik Solheim, *Minister of the Environment and International Development, Norway*
Moderated by
Orville Schell, *Director, Center on U.S.-China Relations, Asia Society*

18:00-18:30

TRANSPORTATION TO RECEPTION

18:30-20:00

RECEPTION AT THE COPENHAGEN CITY HALL
Hosted by the City of Copenhagen
Klaus Bondam, *Deputy Mayor, City of Copenhagen*

INTERACTIVE DEBATE. Featuring key government officials, Chief Executive Officers, opinion leaders and experts interactive debates are engaging and dynamic sessions that involve all participants in discussing the broad issues on the Summit agenda and how to implement sustainable solutions.

WORKING GROUP. Guided by a skilled facilitator, working groups are designed to ensure the highest level of interaction between participants, with a view to sharing experiences, debating lessons learned and creating collaborative solutions to complex problems.

KEYNOTE AND SPECIAL ADDRESS. These short interventions provide a fresh perspective and a personal view on climate change from distinguished individuals.

PANEL DISCUSSION. These sessions are high-level panel discussions in plenary, where heads of state, Chief Executive Officers and other thought leaders high-light critical issues and new insights to inform the Summit.

Monday 25 May Showcasing innovative solutions.

07:00- **REGISTRATION**

08:30-09:40
Plenary hall

INNOVATIVE BUSINESS PERSPECTIVES ON THE CLIMATE CHALLENGE
Panel discussion
Meeting the climate challenge will require innovative approaches from businesses of all sectors and geographies. How can we engage partners, suppliers and consumers in developing and implementing new solutions? How can we involve some of the world's least privileged people in creating sustainable change?
Adam Werbach, *Chief Executive Officer, Saatchi & Saatchi S*
Sir Martin Sorrell, *Chief Executive Officer, WPP*
Paul Polman, *Chief Executive Officer, Unilever*
Jacqueline Novogratz, *Chief Executive Officer, Acumen Fund*
Harish Hande, *Co-founder and Managing Director, SELCO Solar Light*
Moderated by
Rick Duke, *Director, Center for Market Innovation, Natural Resources Defense Council*

09:40-10:00
Plenary hall

KEYNOTE ADDRESS
José Manuel Barroso, *President, European Commission*
Introduced by
Anders Eldrup, *Chief Executive Officer and President, DONG Energy*

10:00-10:30 **BREAK**

10:30-12:30

WORKING GROUPS IN PARALLEL #1
The morning sessions will showcase solutions and experiences, presented by CEOs of leading global companies. The following topics will be addressed in working groups:
Technology push, ***Aud. 12***
Technology collaboration, ***Room BV1***
Financing the transition to a low-carbon economy, ***Room BV5***
Energy efficiency, ***Aud. 11***
Carbon market, ***Room 18 + 19***
Forestry and sustainable land use, ***Room 21***
Adapting to the effects of climate change, ***Room 20***
Measurement and progress, ***Room 17***
Value chain, ***Aud. 10***

12:30-14:00 **LUNCH**

14:00-15:45

WORKING GROUPS IN PARALLEL #2

The afternoon sessions will address policy incentives and public-private partnerships. What will it take to achieve rapid scaling-up of best practices? How can business and governments work together to make the transition to a low-carbon, sustainable economy? The following topics will be addressed in working groups:

Technology push, *Aud. 12*
Technology collaboration, *Room BV1*
Financing the transition to a low-carbon economy, *Room BV5*
Energy efficiency, *Aud. 11*
Carbon markets, *Room 18 + 19*
Forestry and sustainable land use, *Room 21*
Adapting to the effects of climate change, *Room 20*
Value chain, *Aud. 10*

15:45-16:15

BREAK

16:15-17:40
Plenary hall

RAPID TRANSFORMATION TO A LOW-CARBON ECONOMY: WHAT WILL IT TAKE?

Panel discussion

The entrepreneurial drive of business coupled with policies to facilitate large-scale investment in clean technologies and infrastructure can ensure rapid transformation to a low-carbon economy. But what mechanisms, policy instruments, metrics and new structures will be required to accelerate transformation?

Tony Hayward, *Group Chief Executive, BP*
Björn Stigson, *President, World Business Council for Sustainable Development*
Alan Salzman, *Chief Executive Officer, Vantage Point Venture Partners*
Frank Appel, *Chief Executive Officer, Deutsche Post*
Samuel A. DiPiazza, Jr., *Chief Executive Officer, PricewaterhouseCoopers*
Rob Morrison, *Chairman, CLSA Asia-Pacific Markets*
Steve J. Lennon, *Managing Director, Eskom*
Lise Kingo, *Executive Vice President and Chief of Staffs, Novo Nordisk*
Moderated by
Steve Howard, *Chief Executive Officer, The Climate Group*
With reflections from
Lord Michael Jay, *Globe International Advisory Board member*

17:40-18:00
Plenary hall

SPECIAL ADDRESS

Cate Blanchett, *Artistic Co-Director, Sydney Theatre Company*
Introduced by
Tim Flannery, *Chairman, Copenhagen Climate Council*

18:00-18:30

TRANSPORTATION TO DINNER

18:30-23:00

OFFICIAL DINNER AT THE DANISH NATIONAL ARTGALLERY

Tuesday 26 May Presenting a business vision.

07:30- **REGISTRATION**

09:00-10:40
Plenary hall

BUSINESS ACTION ON CLIMATE CHANGE AND THE NEW POLICY FRAMEWORK
Interactive debate
This session will present and discuss a shared business vision for a new global framework for tackling climate change – and a fundamental shift that has the potential to mark the beginning of the next industrial revolution. What is required to achieve green, sustainable growth? How can business take forward the outcomes and recommendations of the Summit to secure an ambitious agreement at COP15?
Anders Eldrup, *Chief Executive Officer and President, DONG Energy*
Shai Agassi, *Founder and Chief Executive Officer, Better Place*
Samuel A. DiPiazza, Jr., *Chief Executive Officer, PricewaterhouseCoopers*
James E. Rogers, *Chairman, President and Chief Executive Officer, Duke Energy*
David Blood, *Senior Partner, Generation Investment Management*
Sir Crispin Tickell, *Director, James Martin Institute for Science and Civilization, Oxford University*
Moderated by
Nik Gowing

10:40-11:00
Plenary hall

SPECIAL SESSION: MARITIME
The shipping industry transports more than 90% of the world's trade and is responsible for nearly 4% of its greenhouse gas emissions. These emissions are projected to grow by 30% by 2020, and currently fall outside any international treaty. What action is the sector taking to address climate change?
Nils Smedegaard Andersen, *Group Chief Executive Officer, A. P. Møller – Mærsk*
Andreas Chrysostomou, *Chairman, Marine Environment Protection Committee, IMO*
Moderated by
James Kanter, *Reporter, International Herald Tribune*

11:00-11:45 **BREAK**

11:45-13:00
Plenary hall

ENGAGING THE WIDER PUBLIC: THE ROLE OF COMMUNICATION IN CLIMATE CHANGE
Panel discussion
Global awareness of the threat of climate change pales in comparison to the number of people that will be directly affected by its impacts. Until this gap is bridged, visionary action by business and political leaders will continue to be difficult. But the message is hard to get across, and there is a need for innovation in communication. How can communicators advance the dialogue, raise awareness and spur meaningful climate action?

13:00-14:00
Plenary hall

CLOSING: TAKING THE RECOMMENDATIONS FORWARD
The result of the Summit – The Copenhagen Call – will be presented to the Danish Government, who will take the recommendations forward. How can business be a strong ally to politicians in tackling the climate challenge, in Copenhagen and beyond?
Lars Løkke Rasmussen, *Prime Minister of Denmark*
Tim Flannery, *Chairman, Copenhagen Climate Council*
Li Xiaolin, *Chairwoman and Chief Executive Officer, China Power International Development*
Yvo de Boer, *Executive Secretary, UNFCCC*
Moderated by
John Harwood, *Chief Washington Correspondent, CNBC*

14:00-15:30 **LUNCH**

Working group 01

Technology push
Room 12

CHAIR:
Tony Hayward, *Group Chief Executive, BP*

FACILITATOR:
Dan Kammen, *Co-Director, Berkeley Institute for the Environment*

SPEAKERS:
Lars G. Josefsson, *President and Chief Executive Officer, Vattenfall*
Prasad Menon, *Managing Director, Tata Power*
Mikael Lilius, *Senior Advisor, Fortum*
Graeme Sweeney, *Executive Vice President, Future Fuels and C02, Royal Dutch Shell; Chairman, European Technology Platform for Zero Emission Fossil Fuel Power Plants (ETP-ZEP)*
Sir David King, *Director of the Smith School of Enterprise and the Environment, University of Oxford*
Christopher Bunting, *Secretary General, International Risk Governance Council*

The commercialization of new low-carbon technologies will be crucial to the sustained reduction of greenhouse gas emissions. The real challenge is pushing these technologies down the learning curve, reducing costs and facilitating commercial-scale deployment. Many potentially relevant technologies exist, and policy makers should avoid 'picking winners' and develop a portfolio strategy for supporting commercialization.

What is important is a solid understanding of where some of the most important technological tools lie on the learning curve and their potential to displace emissions and reach commercially competitive costs. This session will examine several important technology options, discuss progress to date and prospects with regard to deployment at scale. Among the technologies in focus will be next generation biofuels, electric cars, and carbon capture and storage. Speakers will discuss the practical work being undertaken in these areas.

The session will then discuss the types of policy support most appropriate to moving each technology to the next stage on the learning curve and closer to commercialization.

This session is organized by the 3C initiative.

Working group 02

Technology diffusion and collaboration
Room BV1

CHAIR:

Björn Stigson, *President, World Business Council for Sustainable Development*

SPEAKERS:

Ditlev Engel, *President and Chief Executive Officer, Vestas Wind Systems*

James E. Rogers, *Chairman, President and Chief Executive Officer, Duke Energy*

Luis Neves, *Vice President Corporate Responsibility, Deutsche Telekom*

Jukka Uosukainen, *Director General, International Affairs Unit, Ministry of Environment, Finland; former Chair of the UNFCCC Expert Group on Technology Transfer*

DISCUSSION LEADERS:

Gerd Leipold, *Executive Director of Greenpeace International*

Joan MacNaughton, *Senior Vice President, Power and Environmental Policies, Alstom Power*

Christian Kornevall, *Director, Energy Efficiency in Buildings Project, World Business Council for Sustainable Development*

This workshop will bring the business perspective on keys to the successful deployment of low-carbon technology to the UNFCCC process. These discussions will provide an overview of business strategies on technology diffusion and center on the following issues: What are the necessary steps to achieve a low-carbon economy in the next ten years? What barriers to the deployment of clean technologies need to be overcome? Why is technology collaboration so important in our competitive world?

The morning session will be driven by global business leaders from the utilities, renewables manufacturing, and information and communications technology sectors as well as experts on technology transfer under the UNFCCC. They will walk through the challenges, priorities and potential to deploy low-carbon technologies in the short term, and will recommend key elements to be included in the Copenhagen agreement to ensure the development of pathways towards a low-carbon economy.

These pathways will require large changes in power generation, mobility, buildings, and industry and consumer choices. The afternoon session will continue with an interactive roundtable discussion on those four areas, driven by recognized leaders with vast experience within the UNFCCC process. Each of these areas faces distinct challenges when it comes to fully deploying established technologies and each necessitates specific policy responses. Discussion in this session will focus on identifying the main barriers for technology deployment and policy recommendations based on successful collaborative experiences in the private sector.

This session is organized by the World Business Council for Sustainable Development

Working group 03

Financing the transition to a low-carbon economy

Room BV5

CHAIR:

Alan Salzman, *Chief Executive officer, Vantage Point Venture Partners*

FACILITATOR:

Dominic Waughray, *Senior Director, Head of Environmental Initiatives, World Economic Forum*

DISCUSSION LEADERS:

Anne Kelly, *Senior Vice President, Director for Corporate and Policy Programs, Ceres*

David Blood, *Managing Partner, Generation Investment Management*

Jacqueline Cramer, *Minister of Environment, Netherlands*

James Cameron, *Vice Chairman, Climate Change Capital*

Jon Williams, *Partner, Sustainability and Climate Change, PricewaterhouseCoopers*

Rob Lake, *Head of Sustainability, APG Asset Management; IIGCC and P8 group of pension funds*

Shilpa Patel, *Chief, Climate Change, Environment and Social Development Department, International Finance Corporation*

Nick Robins, *Head of Climate Change Centre, HSBC*

Experts agree that addressing the challenge of climate change will involve a radical mobilization of finance. A report prepared by the World Economic Forum and New Energy Finance in January 2009 estimates an average annual investment of over $500 billion is required from now through 2030 in renewable energy and energy efficiency technologies alone. In the context of the current economic situation whereby debt and equity financing for all but the most risk-free investments has dried up, developing and developed countries alike are faced with fast-growing public sector deficits and amid a global slowdown in capital flow.

Public spending will have to be prioritized. But public finance is clearly not available on the scale required to tackle the problem alone. Prior to the credit crunch, the volume of private investment directed towards clean energy projects were growing quickly; the challenge for 2009 will be to sustain this scale-up in clean energy investment in the midst of a global economic downturn.

This working group will discuss innovative mechanisms to leverage the finance that is required across different regions and economic sectors. A particular issue for consideration will be how best to link the economic recovery and climate agendas.

This session is organized by the World Economic Forum´s Climate Change Initiative.

Working group 04

Energy efficiency
Room 11

CHAIR:
Dr. Frank Appel, *Chief Executive Officer, Deutsche Post DHL*

FACILITATOR:
Peter Head, *Director, Arup*

SPEAKERS:
Nicky Gavron, *Assembly Member, Greater London Authority*
Peder Holk Nielsen, *Executive Vice President, Novozymes*
Jim Leape, *Director General, WWF International*
Kunihiko Shimada, *Principal International Negotiator, Ministry of the Environment, Japan*
David Rosenberg, *Chief Executive Officer, Hycrete*
Senator Tim Wirth, *President, United Nations Foundation*
Werner Schnappauf, *Director General, BDI*
Stefan Denig, *Vice President, Head of Corporate Communications, Siemens*

Increasing energy efficiency has long been considered a big win for the three priorities of economic growth, environmental sustainability, and energy security. Some studies suggest that the payback from improved efficiency could cover most if not all of the expected cost of other emissions reductions efforts. Myriad economically beneficial opportunities have been identified at both corporate and societal levels, yet mobilizing resources towards these activities remains elusive.

It is not for lack of effort. Numerous policy and best practice initiatives have been implemented over the years to try to overcome market imperfections and incentive issues associated with inefficient energy use in buildings, white goods, transportation, and even heavy industry. Yet the impact remains small, and action tends to be dominated by entrepreneurial initiatives not designed to scale.

This session will address the challenge of commercializing the energy efficiency opportunity at scale. Looking at the sectors with the most efficiency improvement potential (urban infrastructure/buildings, white goods/consumer products, transportation, and possibly heavy industry), the session will look at the technological approaches, business strategies, and policy initiatives that offer the most promise of achieving large-scale efficiency improvements by engaging commercial actors.

This session is organized by the 3C initiative.

Working group 05

Carbon markets
Room 18/19

CHAIR:

Samuel A. DiPiazza, Jr., *Chief Executive Officer, PricewaterhouseCoopers International*

FACILITATORS:

Henry Derwent, *President and Chief Executive Officer, International Emissions Trading Association*

Abyd Karmali, *Global Head of Carbon Markets, Bank of America Merrill Lynch*

RAPPORTEUR:

Mark Kenber, *Policy Director, The Climate Group*

SPEAKERS:

Jos Delbeke, *Deputy Director-General for the Environment, European Commission*

Mahesh Babu, *Chief Executive Officer, IL&FS Eco-Smart*

Ian Marchant, *Chief Executive Officer, Scottish and Southern Energy*

James E. Rogers, *Chairman, President and Chief Executive Officer, Duke Energy*

Zhengrong Shi, *Chief Executive Officer, Suntech Power*

Caio Koch-Weser, *Vice Chairman, Deutsche Bank Group*

Tracy Wolstencroft, *Managing Director, Goldman Sachs*

The focus of these discussions will be to understand and communicate, from a business perspective, the strengths and weaknesses of current carbon markets as a tool for incentivizing cost-effective emission reductions and the adoption of low-carbon technologies and, on this basis, to make recommendations on the reform and global scale-up of carbon markets in future international policy.

The morning session will focus on experiences with carbon markets to date, both their successes and shortcomings, with a view to taking forward key lessons with regard to emissions reductions, technology development and transfer, competitiveness impacts and cost reductions. The markets to be considered include the EU ETS and other national/regional trading schemes, the Kyoto flexible mechanisms (CDM and JI) and the emerging voluntary carbon market.

Afternoon discussions will build on the conclusions from the morning and begin with provocative proposals on possible roles and strategic developments for the carbon market in future international climate policy. Key elements of the discussions will include: how carbon markets can best drive the deployment of low carbon technologies; whether and how national and regional trading schemes should be linked to create a more unified global carbon market and the mechanisms for doing so; the future of the project-based mechanisms and the role of programmatic and sectoral approaches; necessary institutional frameworks; and the interaction between carbon markets and other policy instruments.

This session is organized by The Climate Group with the International Emissions Trading Association and the Carbon Markets and Investors Association

Working group 06

Forestry and terrestrial carbon
Room 21

CHAIR:
Rob Morrison, *Chairman, CLSA Asia-Pacific Markets*

FACILITATOR:
John Elkington, *Founding Partner and Director, Volans*

RAPPORTEUR:
Tim Flannery, *Chairman, Copenhagen Climate Council*

SPEAKERS:
Achim Steiner, *Executive Director, United Nations Environment Programme*
Audun Rosland, *Senior Advisor on Climate Change, Norwegian Pollution Control Authority*
Gavin Neath, *Senior Vice President, Unilever*
Helmy Abouleish, *Vice Chairman and Managing Director, Sekem Group*
James Griffiths, *Co-Leader, The Forests Dialogue; Managing Director, World Business Council for sustainable Development*
Jens Riese, *Senior Partner, McKinsey & Company*
Ralph Ashton, *Convenor and Chair, Terrestrial Carbon Group*
Stefan Reichenbach, *Global Head, Environmental Markets, Thomson Reuters*
Thomas Lovejoy, *President, Heinz Center for Science, Economics, and the Environment*
Marc D. Stuart, *Founder, Director of New Business Development, EcoSecurities*

This working session will address the sequestration capacity of natural ecosystems as well as policy, market-based and private sector approaches to maximize their use in a long-term global climate change agreement.

The world's terrestrial landscapes contain an estimated 2,300 Gt of carbon stored in vegetation and land. The release of greenhouse gases from these landscapes - particularly from land clearing of tropical forests and degradation of agricultural soils - is contributing an estimated 20% of global emissions. The scale and diversity of terrestrial carbon opportunities make it a vital and cost effective means of reducing greenhouse gas emissions; indeed, it is difficult to envision a policy scenario that reduces emissions on the scale required without comprehensively including forestry and agriculture.

The scale of the challenge, however, is well beyond the means of the public sector. What is the current state of the science, the potential of policy and the best strategy to mobilize the private sector? Do the challenges posed by terrestrial carbon lend themselves to market based solutions? If so, how do we deal with issues of permanence, leakage, monitoring, transparency and carbon property rights, all of which are fundamental to successfully working markets? This session will highlight emerging scientific findings and discuss the various spheres and approaches that demonstrate the most potential for bilateral and multilateral processes. It will consider actions being undertaken by private sector firms, and discuss holistic market-based approaches that not only reduce carbon but measurably contribute to sustainable development.

This session is organized by the Copenhagen Climate Council.

Working group 07

Adapting to climate change through strategic planning and collaboration

Room 20

CHAIR:

Steve J. Lennon, *Managing Director, Eskom*

FACILITATORS:

Laurent Corbier, *Vice President Sustainable Development and Continuous Improvement, Areva*

Wendy Poulton, *General Manager, Sustainability and Innovation, Eskom*

SPEAKERS:

Andrew Brandler, *Chief Executive Officer, CLP Holdings*

Jeremy Hobbs, *Executive Director, Oxfam International*

Jan Dell, *Vice President, Energy and Chemicals, CH2MHill*

Claude Nahon, *Senior Vice President, Sustainable Development and Environment, EDF Group*

David Bresch, *Director, Head Sustainability and Emerging Risk Management, Swiss Re*

Youssef Nassef, *Manager, Adaptation, UNFCCC Secretariat*

Mr Mirza Shawkat Ali, *Deputy Director, Bangladesh Department of Environment*

Hendro Sangkoyo, *Delegation of Indonesia*

Saleem Huq, *Senior Fellow, Climate Change, International Institute for Environment and Development*

David Stevenson, *Director Policy, Planning and Strategy, United Nations World Food Program*

Alan Miller, *Principal Climate Change Specialist, International Finance Corporation*

It is now acknowledged that even if greenhouse gas emissions are successfully reduced through mitigation actions, some climate change impacts will be unavoidable. Adaptation to a changing climate is therefore necessary as temperatures will continue to rise, bringing both short- and longer-term impacts.

These impacts will vary across different business sectors in different geographies. Business stakeholders will also be affected in different ways. From a business perspective, climate change is likely to affect the location, design, operation of infrastructure, and marketing of products and services. From a human perspective, climate change will have socioeconomic implications for workforces and markets.

Business must therefore not only adapt its own operations, but can play a role in working with government and civil society to prepare for and avoid the worst climate impacts. This will require a holistic and long-term planning perspective, encompassing different levels of activity (including international, national, and local) and engaging different stakeholders. An international climate change framework is an important stimulus to drive change at the national and local levels and business experience and input can be shared at every step.

This session will therefore focus on direct business experience in adapting to climate change. Drawing from these experiences, we will highlight policy recommendations to the international energy and climate debate to support the scaling-up of global adaptation actions.

This session is organized by the World Business Council for Sustainable Development.

Working group 08

Measuring and communicating progress
Room 17

CHAIR:

Lise Kingo, *Executive Vice President and Chief of Staffs, Novo Nordisk*

FACILITATOR:

Lord Michael Hastings of Scarisbrick, *Global Head of Citizenship and Diversity, KPMG International*

SPEAKERS:

Paul Dickinson, *Chief Executive Officer, Carbon Disclosure Project*

Marcel Jeucken, *Head of Responsible Investment, PGGM; Principle of Responsible Investment Board designate*

Robert Bailis, *Professor, Yale University*

Lu Youqing, *Vice President, China Aluminum Corporation (Chinalco)*

Mats Forsberg, *Chief Executive Officer, Bring CityMail*

Jeff Seabright, *Vice President, Environment and Water Resources, The Coca-Cola Company*

The Bali Action Plan calls for mitigation activities that can be measured, reported and verified (MRV). That actions can be quantified will be essential for the integrity of a post-2012 climate agreement more robust and ambitious than the Kyoto Protocol. The quantification of greenhouse gases outputs must become as timely and reliable as the statistics for employment, trade or financial flows.

Many companies are gaining experience in non-financial reporting. Whether for compliance with a carbon cap-and-trade scheme or for voluntary disclosure in the Carbon Disclosure Project and the UN Global Compact Communication on Progress, thousands of companies have started to monitor, review and publish their carbon or greenhouse gases emissions. Cities and other organizations with climate strategies are also adopting similar practices.

This workshop will propose a qualitative assessment of current reporting experiences and will aim to make specific recommendations towards a universal reporting standard. It will consider how to report actual emissions as well as assess the progress of policies, technology development and other mitigation actions that factor into UNFCCC discussions. It will further discuss barriers and opportunities to improve reporting practices towards the requirements of a robust international MRV framework.

This session is organized by the UN Global Compact.

Working group 09

Value chain
Room 10

CHAIR:
Paul Polman, *Chief Executive Officer, Unilever*

FACILITATOR:
Aron Cramer, *President and Chief Executive Officer, Business for Social Responsibility*

SPEAKERS:
Per Falholt, *Executive Vice President, Research and Development, Novozymes*
Peter Graf, *Chief Sustainability Officer, SAP*
Marckus Reckling, *Executive Vice President, Corporate Development, Deutsche Post*
Søren Stig Nielsen, *Senior Director, Health, Saftery, Security and Environment, MaerskLine*

The networked nature of business operations means that effective action to reduce climate impacts will require working through the dense value chains upon which all companies – and consumers – rely. Through the lens of corporate strategy and operations, the challenge of achieving consistent measurement frameworks, supply chain partnerships, and enabling public policy frameworks, this workshop will examine the role that value chains can play in addressing climate change.

This two-part discussion will enable participants to understand current contexts; hear about existing innovations; identify current barriers, and develop a roadmap for action. The morning will feature brief presentations from companies actively looking at value chain approaches to climate, followed by breakout group discussions that will look at four distinct "building blocks" of a comprehensive approach that both reduces impacts and looks at innovative solutions.

The afternoon will discuss and gather highlights from breakout group deliberations to develop a set of recommended steps for business and government to guide the creation of frameworks to shape sustainable value chains, from natural resource sourcing to product use and end-of-life considerations.

This session is organized by Business for Social Responsibility.

Copenhagen Climate Council Secretariat

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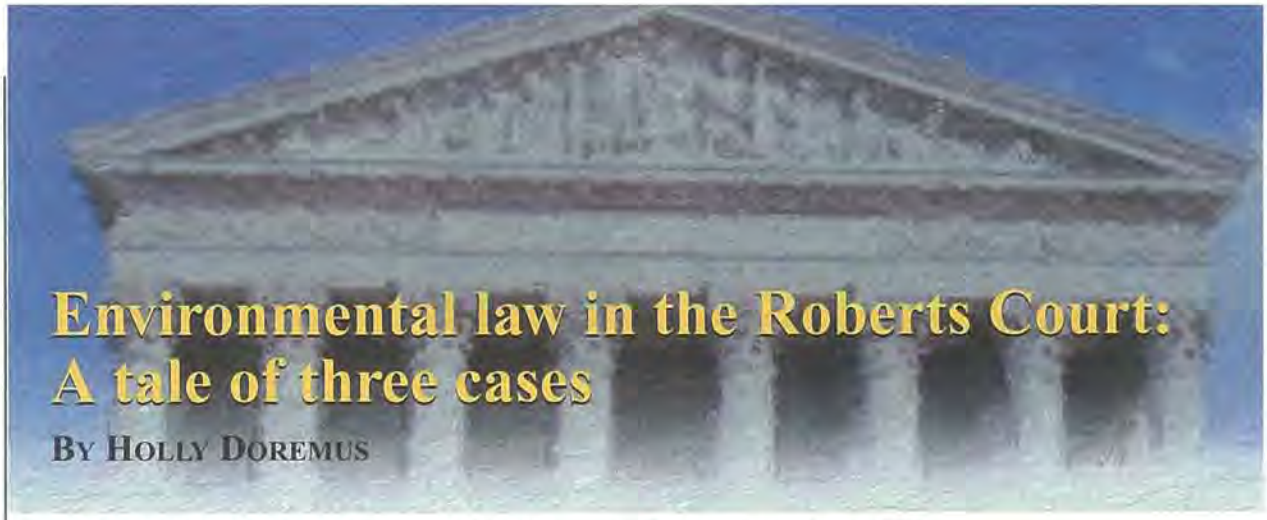
TRENDS
ABA SECTION OF ENVIRONMENT, ENERGY, AND RESOURCES NEWSLETTER



Environmental law in the Roberts Court: A tale of three cases

By Holly Doremus

So far, the Roberts Court looks much like the Rehnquist Court on environmental issues: bitterly divided. Four justices, including Chief Justice Roberts and Justice Alito, are suspicious of environmental regulation and of opening the federal courts to citizen suits. Four predictably support environmental regulation, at least where Congress has clearly called for it, and take a more expansive view of the role of the courts. Justice Kennedy alone holds the center. The Roberts Court's three most important environmental decisions so far—*Rapanos v. United States*, 126 S. Ct. 2208 (2006); *Massachusetts v. EPA*, 127 S. Ct. 1438 (2007); and *National Association of Home Builders v. Defenders of Wildlife*, 127 S. Ct. 2518 (2007)—illustrate the deep divisions in the Court. In each case, Justice Kennedy's vote was decisive, and in each case it produced a different result: a cryptic 4–1–4 split in *Rapanos*, a 5–4 win for environmental interests in *Massachusetts*, and a contrasting 5–4 victory for developers in *Home Builders*.

Rapanos v. United States

In 2001, the Court ruled 5–4 that the Clean Water Act (CWA) does not cover isolated waters whose only connection to commerce is use by migratory birds. *Solid Waste Agency of Northern Cook County v. U.S. Army Corps of Engineers*, 531 U.S. 159 (2001) (*SWANCC*). *SWANCC* provided few clues to the location of the outer boundary of federal regulatory authority. Distinguishing *United States v. Riverside Bayview Homes*, 474 U.S. 121 (1985), the *SWANCC* Court noted "the significant nexus" between adjacent wetlands and navigable waters but did not explain what constitutes a "significant nexus" or whether one was required to support CWA jurisdiction.

Five years later in *Rapanos*, the Court again considered the reach of the CWA. Justices Scalia, Thomas, Roberts, and Alito excluded ephemeral or intermittently flowing streams, limiting jurisdiction to "relatively permanent, standing or continuously flowing bodies of water" and "wetlands with a continuous surface connection" to such waterbodies. 126 S. Ct. at 2225. On the other side, the four *SWANCC* dissenters read the CWA to cover navigable waters, their tributaries (ephemeral or not), and wetlands adjacent to either. Justice Kennedy joined neither camp, instead offering his own test: wetlands may be regulated under the CWA only if they have a "significant nexus" to navigable waters.

Massachusetts v. EPA

In 1999, a coalition of environmental groups petitioned the Environmental Protection Agency (EPA) to regulate greenhouse gas emissions from new cars. Several years later, EPA denied the petition, asserting that it lacked the authority to address climate change under the Clean Air Act, and even if it had that authority it would decline to exercise it. A number of states joined the environmental groups to challenge that decision. A panel of the D.C. Circuit upheld EPA. The Court granted certiorari at the request of the states and environmental groups, something it has rarely done, and reversed 5–4.

Writing for the majority, Justice Stevens concluded that Massachusetts had standing because it was faced with the concrete injury of inundation of its coastal lands, U.S. automobile emissions were contributing meaningfully to that threat, and reduction of those emissions would at least slow global warming. On the merits, Justice Stevens went on to hold that EPA has the authority and duty to regulate carbon dioxide emissions from new automobiles if those emissions may endanger public health or welfare and that it cannot decline to exercise that authority for policy reasons unrelated to the endangerment question. Justice Kennedy joined the majority opinion, which relied heavily in its standing discussion on his concurrence in *Lujan v. Defenders of Wildlife*, 504 U.S. 555 (1992).

Chief Justice Roberts, joined by Justices Scalia, Thomas, and Alito, dissented on both standing and the merits in two separate opinions. On standing, the Chief Justice derisively referred to the majority's standing analysis as an "utterly manipulable" standard that would not provide any effective limits. 127 S. Ct. at 1471. Justice Scalia wrote the dissent on the merits, agreeing with EPA that it lacked authority to regulate carbon emissions or at least had discretion to put off deciding whether those emissions endanger human health or welfare.

National Association of Home Builders v. Defenders of Wildlife

This case examined the relationship between the Endangered Species Act (ESA) and the CWA. The CWA provides that EPA "shall" transfer permitting authority on the request of a state unless it finds that the state does not meet nine enumerated requirements designed to insure compliance with

Continued on page 12

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Is there a "proper level" of compliance with environmental laws?

By Michael E. Wall

How much compliance with environmental laws is enough? Whether society should tolerate a certain level of illegal environmental conduct as a necessary result of productive economic activity is debatable. The answer to that question has profound ramifications for how, and how vigorously, we enforce the nation's environmental laws. Yet little reliable data on the extent of noncompliance is available to inform this discussion.

For example, even in California, a state that often leads the nation in setting progressive environmental standards, the public cannot easily discern how often those standards are violated or how state and local officials respond when illegal conduct occurs. Basic statistics on environmental enforcement activity in California—statistics that at a federal level can be found on the U.S. Environmental Protection Agency's (EPA's) Web site—are not consistently and publicly available at the state level. And data that have been available are often incomplete, inconsistent, or inaccurate. Filling this data gap is essential to ensuring that environmental laws are effectively implemented and consistently obeyed.

A review by the Natural Resources Defense Council of compliance information in state and federal agency databases indicates that patterns of illegal activity under California environmental laws vary considerably across programs and around the state. On annual average in recent years, (1) one in twenty facilities that manages hazardous waste was identified as having violated hazardous waste laws (2000–04); (2) almost one in ten California facilities permitted to discharge pollution to water was known to have violated water pollution laws (2000–04); (3) more than one in ten drinking water suppliers was recorded as violating drinking water program requirements (2001–05); (4) one in seven major stationary air pollution sources was identified as breaking one or more air pollution laws (2001–05); and (5) about one in five agricultural pesticide use inspections identified illegal conduct (FY2003/2004–FY2005/2006).

The limitations on these data must be weighed before drawing any definitive conclusions from them. First, these figures include only those violations known to and recorded by state and federal agencies in the databases they made available for this analysis. The rates of noncompliance would increase if these figures included actual violations that went undetected and violations known to local agencies but never reported to the state or EPA. Second, these figures do not reflect trends in the most recent years because data from those years were not publicly available at the time of analysis; therefore, these figures may not fully reflect any results of a recent California Environmental Protection Agency enforcement initiative. Third, these data do not indicate how many violations (one, a few, or many) or what type of violations (demonstrable risk or not) were committed by each wrongdoer.

Despite these limitations, the agency compliance data consistently revealed one puzzling fact: the extent of known illegal activity varied strikingly across different parts of the state. For example, (1) In 2005, the average number of wastewater violations committed statewide for each wastewater permit in violation was about nine. However, that average was less than three in some regional offices and more than forty in another; (2) During the period from 2001 to 2005, the rate of recorded violations by large drinking water systems varied among districts, from no known noncompliance at all to more than 60 percent of facilities with one or more violations; (3) In 2005, just 3 percent of permitted wastewater facilities within the jurisdiction of one regional water board were found to have violated a water pollution discharge permit. In another region, 39 percent of such facilities were found to have committed such violations; (4) The proportion of agricultural pesticide use inspections that resulted in a finding of violation was 4 percent in one county and 76 percent in another during the three year period from FY 2003/2004 to FY 2005/2006; and (5) The average percentage of workplace safety inspections that identified a violation during 2001 to 2005 varied among regions, from as low as 14 percent in one district office to as high as 76 percent in another.

Whether higher rates of known illegal activity in some regions reflect more lax enforcement or more vigilant detection is unclear. What these data suggest, however, is that not all parts of the state have received the benefits of environmental protection equally. High levels of variability in known noncompliance raise the prospect of either uneven compliance or uneven enforcement that should be fully investigated as California works to improve its environmental enforcement program. Regardless of what level of illegal activity one views as tolerable, the puzzlingly pattern of noncompliance revealed here cannot easily be reconciled with any obvious policy goal.

Michael E. Wall *is senior attorney with the Natural Resources Defense Council. The views expressed in this column are his own and may not necessarily reflect those of NRDC.*

Attachment 21

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Attachment 22

NRDC REPORT

APRIL 2014
R:14-03-A

Generally Recognized as Secret: Chemicals Added to Food in the United States

AUTHORS:

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Natural Resources Defense Council

EXECUTIVE SUMMARY

When President Eisenhower signed the Food Additives Amendment of 1958, he established a regulatory program intended to restore public confidence that chemicals[a] added to foods are safe. In the intervening 56 years, the basic structure of the law has changed little. However, the regulatory programs the U.S. Food and Drug Administration (FDA) established to implement the law have fallen behind over time as the agency strived to keep up with the explosion in the number and variety of chemicals in food, and to manage its huge workload with limited resources.

The 1958 law exempted from the formal, extended FDA approval process common food ingredients like vinegar and vegetable oil that are "generally recognized as safe" (GRAS). It may have appeared reasonable at the time, but that exemption has been stretched into a loophole that has swallowed the law. The exemption allows manufacturers to make safety determinations that the uses of their newest chemicals in food are safe without notifying the FDA. The agency's attempts to limit these undisclosed GRAS determinations by asking industry to voluntarily inform the FDA about their chemicals are insufficient to ensure the safety of our food in today's global marketplace with a complex food supply. Furthermore, no other developed country in the world has a system like GRAS to provide oversight of food ingredients.

Because of the apparent frequency with which companies make GRAS safety determinations without telling the FDA, NRDC undertook a study to better understand companies' rationale for not participating in the agency's volutnary notification program. First, we built a list of companies and the chemicals they market. Then we reviewed public records, company websites, and trade journals to identify additives that appear to be marketed in the U.S. pursuant to an undisclosed GRAS determination, i.e. without notification to the FDA.

All told, we were able to identify 275 chemicals[a] from 56 companies that appear to be marketed for use in food based on undisclosed GRAS safety determinations. This is likely the tip of the iceberg—we previously published in an industry journal an estimate that there have been 1,000 such secret GRAS determinations.[1] For each chemical we identified in this study, we did not find evidence that FDA had cleared them.

In addition, using the Freedom of Information Act (FOIA), we obtained from the FDA copies of communications between the agency and companies who voluntarily sought agency review of their GRAS determinations. We found this glimpse into the review process shows that often the agency has had serious concerns about the safety of certain chemicals, and that companies sometimes make safety decisions with little understanding of the law or the science. As discussed later, companies found their chemicals safe for use in food despite potentially serious allergic reactions, interactions with common drugs, or proposed uses much greater than company-established safe doses.

On those occasions when the FDA is asked to review a GRAS determination, the agency rejects or triggers withdrawal of about one in five notices. Moreover, the public has even less information about the many substances with GRAS determinations that are never submitted to the agency in the first place—and which may pose a much greater danger. It is often virtually impossible for the public to find out about the safety—or in many cases even the existence—of these chemicals in our food.

"Generally Recognized as SECRET" rather than "Generally Recognized as SAFE" is a better name for the GRAS loophole that has allowed manufacturers to sanction the use of hundreds of chemicals in food that Americans eat every day.

a We use the term "chemicals" to apply to the products sold by additive manufacturers. They may be individual substances or mixtures of substances. They are sometimes referred to as substances, additives, or ingredients, which, in reality, are all chemicals or mixtures of them. They may be extracted from natural products or synthesized from other chemicals.

"We cannot require anything, as this is a voluntary program and we don't want to frighten anyone away. Having said that, we would typical [sic] tell any notifier that their submission would have to address the total dietary exposure from new and current uses, [h]ow else could you conclude that the uses were safe, without a notion of what total exposure is[?]"[2]

FDA reviewer of GRAS determination submitted by manufacturer

NRDC believes that "Generally Recognized as SECRET" rather than "Generally Recognized as SAFE" is a better name for the GRAS loophole. A chemical additive cannot be "generally recognized as safe" if its identity, chemical composition, and safety determination are not publicly disclosed. If the FDA does not know the identity of these chemicals and does not have documentation showing that they are safe to use in food, it cannot do its job.

In an increasingly global marketplace where many additives and foods are imported into the United States, this loophole presents an unsettling situation that undermines public confidence in the safety of food and calls into question whether the FDA is performing its duty to protect public health.

The problem is rooted in a law adopted in 1958 when Dwight Eisenhower was president and Elvis was drafted. It is time for the FDA and Congress to fix the problems. In the meantime, consumers need to demand that their grocery stores and their favorite brands sell only those food products with ingredients that the FDA has found to be safe.

GRAS: HOW THE LOOPHOLE SWALLOWED THE LAW

Over the last five years, there have been many news stories about unsafe foods that have sickened people. There have been a few reports of acute health problems related to chemicals added to foods, such as energy drinks containing a mixture of caffeine and alcohol, or rice with excessive amounts of the vitamin niacin. But chemicals added to food are more likely to be associated with health problems that may appear after years of frequent food and beverage consumption. These problems are often chronic in nature. The FDA is unlikely to detect an adverse health effect (short of immediate serious injury) unless companies notify it about the chemical and its use in food.

That is why Congress required that a chemical's intentional use in food be determined to be safe prior to its entering the marketplace.[3] In 1958 President Eisenhower signed the Food Additives Amendment to the Federal Food Drug and Cosmetic Act to address these concerns.[4] The law presumed that a chemical intentionally added to food was potentially unsafe and required that no chemical be used without a "reasonable certainty in the minds of competent scientists that the substance is not harmful under the intended conditions of use."[5] Congress required food companies to file a "food additive petition" as the primary means by which to get an FDA approval of a chemical's use in food. If the agency did propose to approve the chemical, it would inform the public and request comments before adopting a regulation allowing the use.[6] The system was designed at a time when an estimated 800 chemical additives were in use, far fewer than the more than 10,000 allowed today.[7,8]

"The next day, [notifier] called and asked whether [notifier] would have an option to withdraw the notice rather than receive a letter that the notice did not provide a basis for a GRAS determination. I replied that this was an option. On September 4, [notifier] asked whether [notifier] could still sell its [name] product if it withdrew its GRAS notice. Consistent with my response to her earlier question about marketing [name], I said yes."[9]

FDA officer summarizing telephone conversations with manufacturer regarding its GRAS notice review

Determining that a chemical's use in food is and remains safe typically involves significant professional judgment. Rarely are these decisions clear cut; there is no bright line. So who decides is critical. Congress concluded that the FDA would make all safety decisions, except in the most obvious situations in which a chemical's use in food was "generally recognized as safe." This is known as the GRAS exemption. Examples include such common food ingredients as oil and vinegar. When a chemical's use was determined to be GRAS, the FDA did not need to adopt a regulation specifically allowing its use, and the formal public notice and comment rulemaking process was not required.[10] In other words, the

chemical didn't need premarket approval by the agency, and manufacturers could use it without delay. To qualify as GRAS, a chemical's safety had to be generally recognized by knowledgeable scientists, as borne out by published safety studies unless commonly and safely used before 1958.[11]

However, the FDA and the food industry interpreted the law as allowing manufacturers to determine that a chemical's use in food was safe without notifying the agency.[12] As a result, the identity of the chemical and the foods in which it was being used could be unknown to the public and the agency. Since 1958, an estimated 1,000 chemicals have been determined as GRAS by manufacturers and have been used in food without any approval or review by the FDA.[13] The exemption has become a loophole that has swallowed the law.

THE FDA'S ATTEMPTS TO LIMIT UNDISCLOSED INDUSTRY SAFETY DECISIONS

Recognizing the problem of undisclosed safety decisions, the FDA adopted regulations in 1972 inviting manufacturers to voluntarily submit "GRAS affirmation petitions" in a rulemaking process that was similar to the one for food additive petitions, but without statutory deadlines for action.[14] Companies sought FDA's approval, it appears, because their product would be more widely accepted by food manufacturers.

By the early 1990s, confronted with limited resources and an increasingly complicated and time-consuming formal rulemaking process, the FDA faced an overwhelming backlog of unresolved reviews.[15] In response, the agency proposed a rule in 1997 to replace the 1972 GRAS petition process with a less formal review process that did not involve adopting regulations for specific chemicals.[16] The next year, the FDA began accepting voluntary notifications from the companies that summarized the safety evidence and issuing decision letters.[17] In some cases, these decision letters are often cited by the companies as evidence of FDA clearance, although the agency maintains that the letters are informal and do not constitute approval. This process, however, largely cuts the public and outside experts out of meaningful participation in decision making. The proposed rule has never been finalized despite its wide use by industry and the FDA.[18] Since 2000, almost all new chemicals have passed through the loophole rather than being subjected to the food additive petition process established by Congress in 1958.

In 2010, the Government Accountability Office (GAO), the nonpartisan investigative arm of Congress, scrutinized the agency's GRAS program and found serious shortcomings. It concluded that "FDA's oversight process does not help ensure the safety of all new GRAS determinations" and that "FDA is not systematically ensuring the continued safety of current GRAS substances."[19]

Given these concerns, NRDC sought to identify examples of chemicals marketed pursuant to undisclosed GRAS safety determinations, procure such safety determinations from companies, and examine why companies choose to forgo even the voluntary FDA notification process.

CLAIMING GENERAL RECOGNITION WHILE AVOIDING DISCLOSURE

As mentioned above, some 1,000 chemicals have been determined by manufacturers to be safe for use in food without FDA review or approval. Some of them, like artificial *trans* fat, were self-certified by industry as safe ingredients decades ago and are well known.

NRDC's investigation focused on newer, less known chemicals marketed as GRAS for use in food in the United States since 1997. We looked at situations in which:

- the manufacturer opted to rely on an undisclosed GRAS determination, without using the FDA's voluntary notification process;
- the manufacturer notified the FDA, and the agency subsequently rejected the company's GRAS notice;
- the manufacturer notified the FDA but subsequently withdrew its notice from FDA review. (We will discuss the problems with withdrawal of notices later.)

Our investigation began with a list of companies and chemicals from three sources:

- the little-known (outside of the food additives industry) web-based "GRAS Self-Determination Inventory Database," compiled by a consulting firm that makes GRAS safety determinations for industry;[20]
- consultants who provided company names based on their experience at food industry trade shows;
- withdrawn or rejected notices in FDA's GRAS Notice Inventory.[21]

Overall, we identified 398 chemicals marketed by 163 companies that appear to be marketed in the U.S. based on GRAS determinations not reviewed by FDA.[b]

For each chemical, we sought a copy of the written documentation of the GRAS safety determination required by FDA's regulations (21 CFR §170.30), which companies must have completed before marketing a product as GRAS. This documentation must provide the chemical composition of the substance, describe how it is made, estimate how much people are likely to consume (exposure), and describe what is known about the chemical's potential hazards. Unless a chemical was commonly and safely used before 1958, the key studies evaluating the hazards ordinarily must be published, preferably in a peer review journal but the FDA does not exclude publication on a company's website. While identifying a key study is helpful, it is not a substitute for providing the full safety determination.

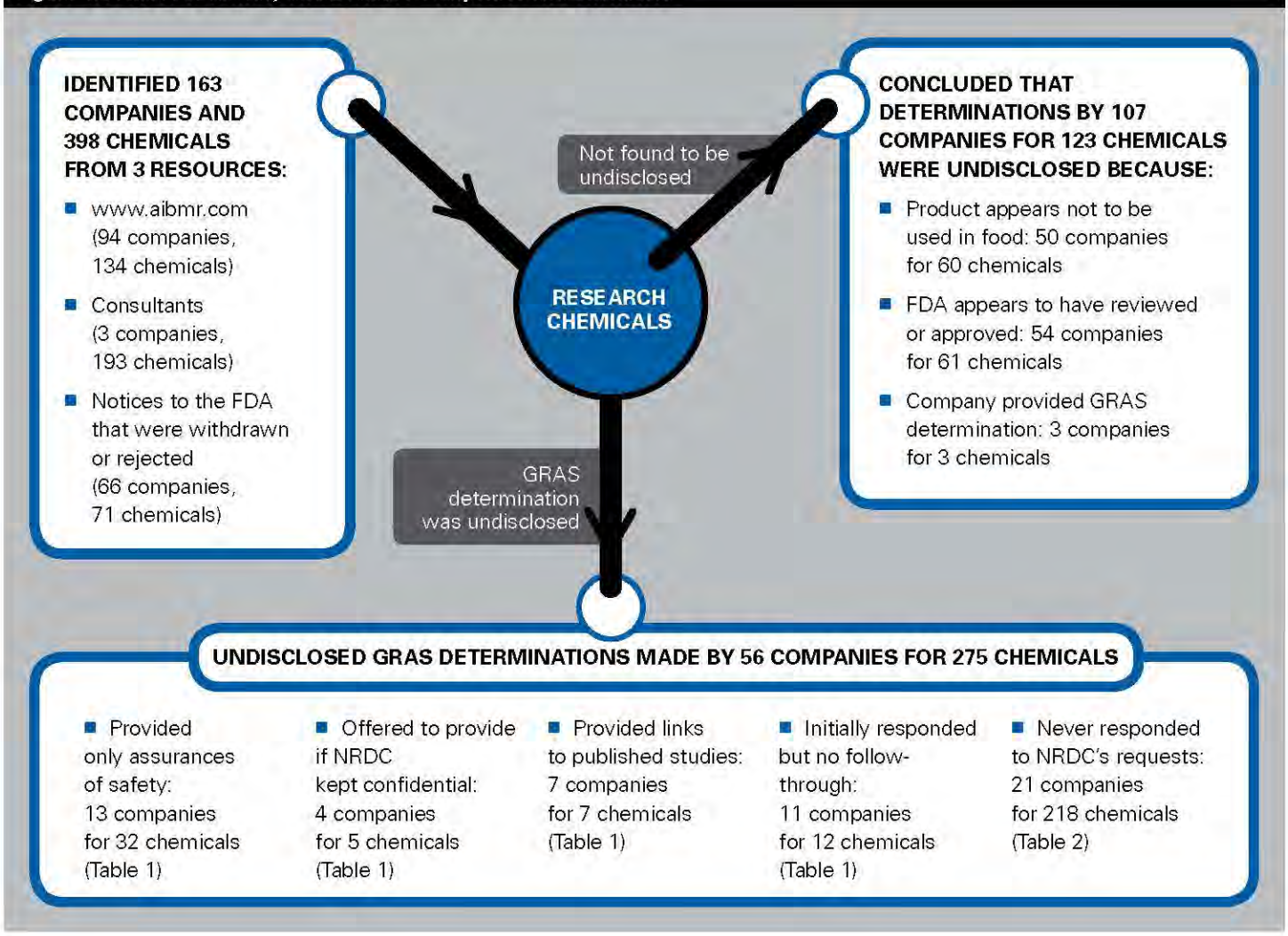
Where a company appeared to be marketing a chemical for use in the United States as GRAS without final FDA review, NRDC contacted the company to request a copy of the undisclosed safety determination. If the company declined or did not respond to our request, we classified the GRAS determination as "undisclosed". Also, if the company did not provide us with a revised GRAS determination that addressed the FDA's concerns after the agency rejected the company's notice, or if the company withdrew its notice before the agency made a final decision, we considered the GRAS determination to be undisclosed.

"GENERALLY RECOGNIZED AS SECRET"

All told, 56 companies appear to rely on undisclosed GRAS safety determinations for 275 chemicals (Figure 1):

- 35 companies selling 57 chemicals responded to our inquiries, but did not provide their GRAS safety determination (Table 1).
- 21 companies selling 218 chemicals did not respond to our repeated inquiries (Table 2).

Figure 1: Process to Identify and Evaluate Companies and Chemicals



b Where chemicals had similar names but different manufacturers, we treated them as separate chemicals.

Table 1: Companies with undisclosed GRAS determinations that responded to NRDC						
Company	**Country**	**No. of Chemicals**	**Declined Requests**	**Only if Confidential**	**Only Gave Studies**	**No Follow-up**
Albion	USA	2	Yes	Yes		
Aloecorp	Korea	1				Yes
BASF	Germany	2				Yes
BioCell Technology	USA	1	Yes			
Bioriginal	Canada	1	Yes	Yes	Yes	
ChromaDex	USA	1				Yes
Cyvex Nutrition	USA	3	Yes			
DSM	Netherlands	8	Yes			
Embria Health Sciences	USA	1	Yes			
ESM Technologies	USA	1	Yes		Yes	
Frutarom Health	Israel	1				Yes
Genosa	Spain	1	Yes			
GTC Nutrition	USA	1				Yes
HG&H Pharmaceuticals (Pty) Ltd.	South Africa	1	Yes			
House Wellness Foods	Japan	1	Yes			
InterHealth Nutraceuticals	USA	4	Yes			
Ixoreal Biomed	India	1				Yes
Jungbunzlauer	Switzerland	1	Yes			
Kaneka	Japan	1	Yes		Yes	
Kemin	USA	1	Yes			
Lonza	Switzerland	1				Yes
Merck Eprova AG	Germany	1	Yes		Yes	
NattoPharma	Norway	1				Yes
NuLiv Science	USA	1	Yes		Yes	
NutraGenesis	USA	4	Yes			
P.L. Thomas	USA	1				Yes
PhenoFarm	Italy	1				Yes
RIBUS	USA	1	Yes			
Sabinsa Corporation	USA	5	Yes			
SoluBlend Technologies	USA	1	Yes	Yes		
Stepan	Netherlands	1	Yes			
Trace Minerals Research	USA	1	Yes		Yes	
TSI Health Sciences	USA	1	Yes	Yes		
Unibar	USA	1				Yes
Verdure Sciences Trim	USA	1	Yes		Yes	
Totals	**35 companies**	**57**	**24**	**4**	**7**	**11**

The 35 companies that responded but did not provide us with their GRAS determinations fit into the following four categories:

- 13 companies provided us only with assurances that their chemicals were safe and complied with the law.
- 4 companies were willing to share the documentation only if NRDC signed a confidentiality agreement, which we declined to do.
- 7 companies declined to provide the GRAS determination but identified a published toxicology study that supported their analysis without providing the additional information such as exposure calculations and product composition needed to evaluate the safety.
- 11 companies acknowledged the inquiry but did not follow through.

The remaining 107 companies selling 123 chemicals fell into three general categories:

- 50 companies did not appear to market their chemicals for use in food in the United States.[c]
- 54 companies that withdrew notices to the FDA later submitted revised notices and received a final review by the agency confirming product safety.
- 3 companies provided NRDC with a copy of their GRAS determination without requiring confidentiality.

Figure 2 summarizes our findings. Of the 163 companies we reviewed, 56, or 34 percent, appear to rely on undisclosed GRAS determinations.

UNDISCLOSED SAFETY DETERMINATIONS: NOT JUST U.S. COMPANIES

As stated earlier, no other developed country in the world has a system like GRAS for food ingredients.[22] On the basis of each company's website and communications, NRDC identified the home country of the 56 companies with undisclosed GRAS determinations. See Tables 1 and 2. Figure 3 provides the results by region.

Fifty-six percent of the companies are from the United States, and 44 percent are based outside the country. This distribution is similar to what one might see at a typical food expo.

WHY DID COMPANIES FORGO FDA REVIEW?

About 20 companies provided explanations for why they decided not to submit a voluntary notification to the FDA. These can be distilled into the following categories:

- **Concerns about too much FDA transparency.** The most common concern was the FDA's routine posting of GRAS safety determinations to its website. These companies said they were worried that easy access to information about product composition and the manufacturing process would enable competitors to develop identical or similar chemicals and would simplify the competition's own GRAS determinations.
- **Concerns about FDA delays.** Several companies claimed they did not want to wait for the FDA to make a decision, even though the agency explicitly allows the use and marketing of a chemical while a review is under way.

> *"In other words, if a panel of experts reviews data that are not publicly available and subsequently renders an opinion regarding safety, even if the experts are well-recognized, the opinion does not meet the general recognition of safety for GRAS ingredients because the data were not publicly available."*[23]
>
> FDA reviewer of GRAS notice

c Either these chemicals appear to be used only in dietary supplements and not food, or we could not find an active website for the company or the chemical, or the chemicals appear to be marketed only overseas.

- **Desire to keep investment low.** Submitting a GRAS determination to FDA typically means additional work whether by company employees or a consultant doing the analysis. The agency asks many questions that must be answered. Often there are meetings with the agency. We found that almost all of the chemicals NRDC reviewed were also ingredients in dietary supplements and served no essential purpose in food other than to attract consumers' attention. Several companies indicated that a GRAS determination sometimes is done in connection with a test of the food market for a chemical previously used only as a dietary supplement ingredient, thus minimizing the investment in an unproven market by opting out of the FDA review process.
- **Wish to avoid new dietary ingredient review:** The Dietary Supplement Health and Education Act of 1994 (DSHEA) requires manufacturers to notify FDA about dietary ingredients that either were not on the market before 1994 or whose use in food is not GRAS. Several dietary supplement manufacturers appear to be making a GRAS determination to avoid having to notify the FDA under both DSHEA and the Food Additives Amendment of 1958.
- **Misunderstanding of the law:** Some companies apparently did not understand the requirements for a GRAS determination. It appears that they did not realize that the determination must be written, that safety information must be drawn from published scientific studies, or that "generally recognized as safe" means more than obtaining the opinion an employee or consultant. Others apparently believed that an independent panel of experts was required even though the FDA states that no panel is needed.[24] Finally, some companies appeared not to understand the difference between an efficacy study, which determines whether a chemical is effective in addressing a health problem, and a toxicology study, which evaluates whether a chemical may cause harm. The scope of most efficacy studies falls far short of an adequate toxicology study.

Figure 2: Undisclosed vs. Resolved GRAS Determinations

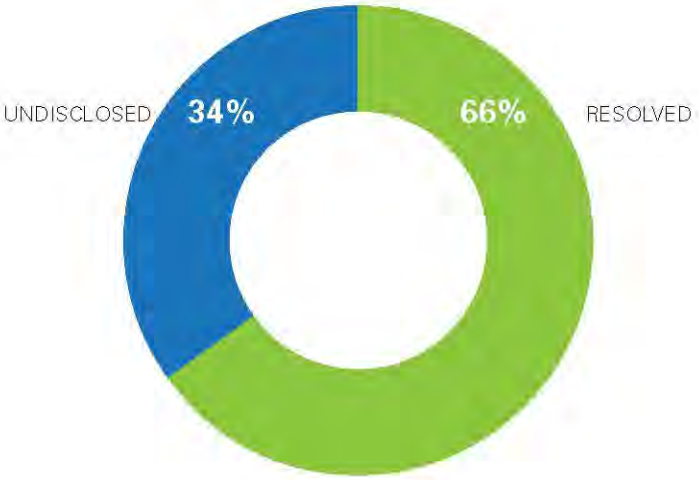
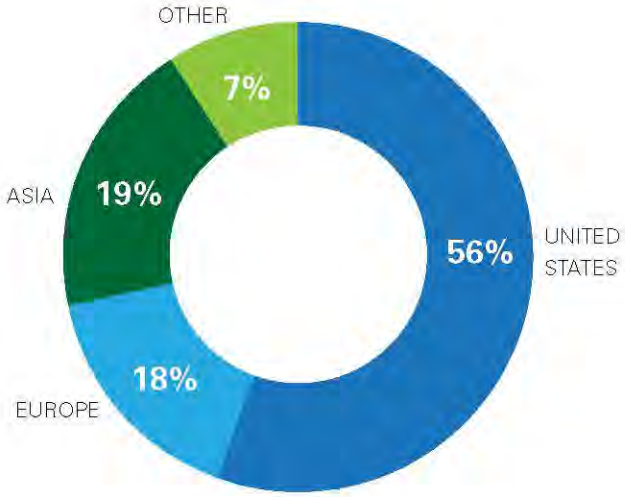


Figure 3: Undisclosed GRAS Determinations by Company's Region



FDA REVIEWS OF NOTICES REVEALED TROUBLING RISKS

As described earlier, companies may voluntarily submit GRAS notices (which contain the GRAS safety determination) to FDA seeking the agency's agreement with their safety determination, and when they do, the agency posts these notices on its website. We reviewed the quality of the industry's notices and identified three, still under review by the FDA as of September 2013 (listed as "pending" on the FDA site), that appeared to be poorly done. They were GRN No. 466 for polyglycerol polyricinoleic acid by McCormick and Co., GRN No. 471 for annatto seed extract by DeltaGold, and GRN No. 474 for Bioperine by Sabinsa Corp.[25,26,27] All three had the same weaknesses: limited toxicology data, poor or inadequate exposure assessment, and lack of consideration of children's exposures. For each we submitted to the FDA detailed comments on the shortcomings of the safety determinations.[28] See www.nrdc.org/food/safety-loophole-for-chemicals-in-food.asp.

If the FDA rejects a GRAS notice, it explains its safety concerns in a letter to the company and publishes the letter on the agency's website. But when a company withdraws a notice and asks FDA to stop further review, the agency issues a letter confirming the withdrawal without publicly explaining any of the concerns that could have prompted the withdrawal. The withdrawal does not prevent the company from continuing to market the product for use in food.

Between 1998 and the end of February 2014, the FDA rejected 17 out of 466 notices submitted to the agency; another 32 are still pending. During that time, 80 notices were withdrawn by the companies. For notices no longer pending, one out of five were either withdrawn or rejected.[29]

After analyzing the poor quality of notices and the number of withdrawn notices, NRDC filed a FOIA request for communications between the FDA and manufacturers for 20 GRAS notifications. We chose notices for chemicals whose use in food we were able to document through a commercial database[30] that provides product information for more than 200,000 food products; and the notices were submitted throughout the length of the program, starting in 1998. Sixteen of these notices were withdrawn, several of them multiple times. Although interested primarily in understanding what concerns raised by FDA prompted manufacturers to ask the agency to stop reviewing the notices, we also included two notices that the agency rejected and two that FDA accepted as sufficient, issuing what is known as a "no questions" letter. To see the FDA's FOIA response, go to www.nrdc.org/food/safety-loophole-for-chemicals-in-food.asp.

The FOIA documents reveal that the FDA does carefully review the notifications and asks tough questions. The agency's reviews often raise serious safety concerns or reveal that the company's scientific analysis is flawed or inconsistent with the law. Often the FDA tells the company that it will reject a notice if it is not voluntarily withdrawn. If rejected, food manufacturers would be more reluctant to buy the product since FDA posts its rejection letter and its reasoning on its website.

The following are examples of four withdrawn GRAS notices and our summary of the back-and-forth communications between the FDA and manufacturers. Despite the safety concerns, these chemicals have been listed as an ingredient in some food products:

Epigallocatechin-3-gallate (EGCG):

A Japanese company declared this chemical to be GRAS for use in beverages including teas, sport drinks, and juices, despite evidence it may cause leukemia in fetuses based on studies using newborn and adult human cells grown on a dish.[31] Moreover, the company did not address a short-term study on rats showing it affected the thyroid, testis, spleen, pituitary, liver, and gastrointestinal tract. The notice did not explain potentially dangerous interactions with sodium nitrite, a common preservative, or with acetaminophen (the active ingredient in Tylenol® and many other over the counter pain-killers).[32] The company withdrew the notice, resubmitted it, but withdrew that one as well.[33] In response to our inquiries, the company assured us it was not marketing the product in the United States. However, two other companies, DSM and Kemin, appear to market chemicals high in EGCG in the United States pursuant to undisclosed GRAS determinations (Table 1). We identified more than 25 food products with EGCG as a named ingredient.

Gamma-amino butyric acid (GABA):

A Japanese company declared this neurotransmitter to be GRAS for use in beverages, chewing gum, coffee, tea, and candy.[34] It did so despite having estimated exposure well in excess of what the company considered safe, relying on unpublished safety studies, providing the specifications in Japanese, and failing to consider existing exposures.[35] The company told NRDC that it withdrew the notice "from a business perspective" and was selling the product in the United States only as an ingredient in a dietary supplement. It also indicated that it would not use the chemical in food without an FDA final review. We identified five food products with GABA as a named ingredient. These products included bottled tea and nutrition bars.

Sweet lupin protein, fiber, and flour:

An Australian firm declared these chemicals to be GRAS for use in baked goods, dairy products, gelatin, meats, and candy, despite concerns that the chemicals would cause allergic reactions in those with peanut allergies.[36] The FDA noted that a warning label for sweet lupin would be insufficient to alert consumers who suffered from peanut allergies.[37] The company did not respond to our inquiries and we could not find evidence that the company was marketing the product in the U.S. However, sweet lupin was a listed ingredient in more than 20 food products, none of which appear to bear any warning to those allergic to peanuts.

Theobromine:

A U.S. firm declared it to be GRAS for use in bread, cereal, beverages, chewing gum, tea, soy milk, gelatin, candy, and yogurt and fruit smoothies, despite having an estimated consumption rate more than five times the safe consumption level reported by the company's consultant.[38] In addition, the manufacturer did not provide convincing explanations for the testicular degeneration in rats and rabbits and delayed bone formation in rats that were seen in animal studies of theobromine.[39] The FDA was especially concerned that the product would be used in baby food.[40] The company did not respond to our inquiries. Although we don't know the provider, theobromine was a named ingredient in more than 20 food products, including isotonic waters, nutrition bars, and diet foods. Fortunately, from what we could tell, none appeared in baby food.

The evidence from these FOIA responses makes it clear: the FDA's review adds value, and many companies' GRAS safety determinations are seriously flawed. The agency should make its concerns publicly available when companies withdraw their notices. Chemicals that, at least in some instances, prompted the FDA to raise safety concerns are used as ingredients in our food supply, and consumers are unprotected from their health effects.

Table 2: Companies with undisclosed GRAS determinations that did not respond to NRDC*

Company	Country	No. of Chemicals
ADM	USA	1
AHD International	USA	1
Ametis JSC	Russia	1
Applied Food Sciences	USA	2
CBC Group	USA	1
Davos Life Sciences	Singapore	1
FutureCeuticals	USA	1
Gencor Pacific	USA	1
Hamari Chemicals	Japan	1
Hanzhong TRG Biotech	China	32
Horizon Science	USA	1
Kyowa Hakko	USA	2
Laurus Labs	India	1
Naturex	Canada	4
Nexira	France	1
NutraMax	China	154
Oxis International	USA	1
Skyherb	China	7
Terry Laboratories	USA	1
Triarco Industries	USA	2
Ventria Bioscience	USA	2
Totals	21 companies	218 chemicals

*In each case, we confirmed that we had either a: 1) confirmation from the company's website that the webform was accepted; or 2) valid email address from website because we did not get a notice from the company's email server that the email had bounced or was not deliverable.

MANY GRAS CHEMICALS BEGAN AS DIETARY SUPPLEMENT INGREDIENTS

Most of the GRAS chemicals NRDC examined were primarily marketed as "active" ingredients in dietary supplements. The availability of the GRAS loophole allows for the expansion of the market for such into conventional foods with claims that they made food "better for you." The chemicals were often extracts of plants or highly purified or synthetic versions of the biologically active chemicals in those extracts, such as antioxidants, which were purported to have possible health benefits.

Since the Dietary Supplement Health and Education Act of 1994[41], when Congress created separate, less rigorous safety standards for dietary supplements under DSHEA, there has been an explosion of these products. Ingredients allowed in dietary supplements are not necessarily safe when used in conventional food.

A product may be a natural extract or a highly purified version of one, but that does not necessarily mean it is safe. In 2014, the FDA recognized the safety threat when it issued guidance regarding substances added to foods, including beverages and dietary supplements.[42] The agency stated:

> *"We have seen a growth in the marketplace of beverages and other conventional foods that contain novel substances, such as added botanical ingredients or their extracts. Some of these substances have not previously been used in conventional foods and may be unapproved food additives. Other substances that have been present in the food supply for many years are now being added to beverages and other conventional foods at levels in excess of their traditional use levels, or in new beverages or other conventional foods. This trend raises questions regarding whether these new uses are unapproved food additive uses."*[43]

It is likely that had the FDA reviewed the undisclosed GRAS determinations, it would have found some to be unapproved food additives.

THE SYSTEM IS BROKEN AND PLAGUED WITH CONFLICTS OF INTEREST

When the FDA reviewed GRAS determinations made by manufacturers, the agency found flaws with one in five, based on the number of notices rejected or withdrawn prior to a final decision.[44] These notices presumably were those in which the manufacturer's had the most confidence, since the manufacturers voluntarily submitted them for agency scrutiny.

Food manufacturers are ultimately responsible for the safety of the food they make. However, in today's highly competitive global marketplace, there are strong economic incentives to minimize expenditures, which may lead to insufficiently-justified decisions. Our understanding of the health effects of many of the more than 10,000 chemicals allowed in food is far from complete, and as the number grows over time, concerns grow as well. For example, some manufacturers still consider *trans* fats to be GRAS despite the FDA's concluding that it causes eight deaths a day in the United States and that if it were banned from food, our country would realize more than $117 billion in health benefits including reduced healthcare costs over 20 years.[45]

Here is another issue of serious concern. For years, companies have used their own employees or hired consultants to evaluate their chemicals' safety and then relied on such undisclosed safety determinations to market their products for use in food. This raises serious conflict-of-interest concerns because a company's financial benefit from selling a particular product can bias its employees' or contractors' judgment.[46] The lack of independent review in GRAS determinations compromises the integrity of the process and calls into question whether it can effectively ensure the safety of the food supply.[47]

The FDA has acknowledged that a company's potential legal liability and its interest in protecting its brand are insufficient to ensure that food is safe.[48] In 2013 the agency said, "Because the demand for many manufactured or processed foods may not be sufficiently affected by safety considerations, incentives to invest in safety measures from farm to fork is diminished. Consequently, the market may not provide the incentives necessary for optimal food safety."[49]

"Even in cases where consumers are aware that their illness was contracted from a specific food," the FDA explained, "it is often difficult to determine who is ultimately responsible for their illness, since the particular source of contamination is not known in many circumstances."[50] It concluded that "it is unlikely that the existence of brands in the food sector creates the optimal level of safety for society."[51]

As the Institute of Medicine explained in the context of medical safety, conflicts of interest can result in bad decisions.[52] Similarly, undisclosed safety determinations affecting the food that Americans eat may be undermining public health. Without FDA and public scrutiny—as Congress intended that there be—we cannot be confident in the safety of chemicals added to food.

CONCLUSIONS

A chemical additive cannot be "generally recognized as safe" if its identity, chemical composition, and safety determination are not publicly disclosed. Congress never intended that almost all new food chemicals would pass through the GRAS loophole without formal agency review and approval. The law places responsibility on FDA to ensure that food additive petitions are submitted for additives without general recognition of safety and to ensure that manufacturers' GRAS determinations are properly made. If the FDA does not know the identity of these chemicals and does not have documentation showing that their uses in food are safe, it cannot not do its job.

In an increasingly global marketplace where many additives and foods are imported into the United States, this loophole presents an unsettling situation that undermines public confidence in the safety of food and calls into question whether the FDA is performing its duty to protect public health. Until conflicts of interest are minimized and safety decisions are subject to mandatory FDA review, the safety of chemicals in food will depend largely on the integrity and competence of food manufacturers. That is not in the public's best interest, because manufacturers have a financial incentive that may bias their judgment about an additive's safety.

When consumers buy dietary supplements, they make a choice to consume chemicals that the FDA has not reviewed for safety. Indeed, under the law, consumers must be told that FDA has not reviewed the health claims made for ingredients in dietary supplements. As a result, dietary supplements carry labels disclosing that they have not been reviewed for safety by the FDA. However, when buying food, consumers can't make informed choices because they don't know which ones contain reviewed chemicals or which contain substances not reviewed by the FDA for safety. There are no warning labels. There is no disclosure. As a consequence, they may unknowingly be putting their health at risk. The current processes allowing this to occur should be addressed and changed to better protect the health of the American public.

NRDC'S RECOMMENDATIONS

The problems identified in this report are rooted in a law adopted more than a half century ago. Ultimately, Congress needs to fix these problems. Until it does, the FDA should implement the recommendations made by the GAO in 2010 including strictly limiting conflicts of interests and requiring that the FDA be informed of GRAS determinations so it can confirm that the chemical's use in food is generally recognized as safe. The agency should also make its concerns with all notices it reviews, even those that are withdrawn, publicly available.

In the meantime, consumers should demand that their grocery stores and their favorite brands sell only food products with ingredients that the FDA has found safe, and call on the FDA and Congress to make the necessary changes to better ensure that food consumed in the U.S. is safe.

ENDNOTES

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3 21 U.S.C. § 321(s) and § 348.

4 Pub. L. No. 85-929, 72 Stat. 1784 (1958).

5 21 C.F.R. § 170.3(i).

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7 Degnan, p. 22.

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11 21 C.F.R. § 170.30. Neltner, "Navigating," p. 347.

12 Ibid.

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24 Kahl, p. 5.

25 FDA, GRAS Notice Inventory, GRN No. 466. www.accessdata.fda.gov/scripts/fdcc/?set=GRASNotices. The FDA issued a "no questions" letter before the NRDC submitted its comments.

26 Ibid, GRN No. 471. It was pending as of February 28, 2014.

27 Ibid, GRN No. 474. It was withdrawn before the NRDC submitted its comments.

28 NRDC, Comments on GRN No. 466, 2013, www.nrdc.org/food/files/chemicals-in-food-GRN-466.pdf and NRDC, Comments on GRN No. 471, 2013, www.nrdc.org/food/files/chemicals-in-food-GRN-471.pdf and NRDC, Comments on GRN No. 474, 2013, www.nrdc.org/food/files/chemicals-in-food-GRN-474.pdf.

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30 See www.gladson.com. March 15, 2013 version

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Attachment 23

Federal Eye

Are secret, dangerous ingredients in your food?

By Kimberly Kindy April 7

Food

(Susan Biddle/Washington Post file photo)

manufacturers are routinely exploiting a “legal loophole” that allows them to use new chemicals in their products, based on their own safety studies, without ever notifying the Food and Drug Administration, according to a new report by an environmental and consumer advocacy group.

Natural Resources Defense Council identified 56 companies that were marketing products using 275 chemicals that the company’s hired experts decided met federal safety standards, known as Generally Recognized as Safe (GRAS). However, the science behind those safety findings and the use of the chemicals was disclosed to the FDA in only six instances. The New York-based NRDC called its report “Generally Recognized as Secret” and said the lack of transparency with the GRAS process is a public health threat.

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“If you don’t know when (an additive) is being used, how can you determine if it’s safe?” said Thomas Neltner, a chemical engineer and co-author of the study that was presented Monday at a Grocery Manufacturers Association’s Science Forum at Washington.

In a prepared statement, the GMA defended the GRAS process, saying, “It is a very thorough and comprehensive process that has, under the current law provided FDA with authority to challenge the improper marketing of an ingredient as GRAS, and if necessary, act to remove products containing that ingredient from the food supply.”

The FDA said that although the law allows for food manufacturers to make their own safety determinations, the agency “encourages companies to consult with the agency when developing new ingredients.” Ultimately, the FDA said, manufacturers “are responsible for ensuring that their food products are safe and lawful.”

NRDC said that Food Additives Amendment of 1958 was enacted, the GRAS process was meant to apply to innocuous additives like vinegar. Instead, it is commonly used for chemicals that are potentially dangerous and have never before been in the American food supply. For example, until recently, artificial transfats were considered GRAS but the

FDA has now deemed them dangerous, saying they cause as many as 7,000 deaths from heart disease each year.

The organization said its findings are “likely the tip of the iceberg,” since the scientific work and GRAS determinations are not publicly disclosed and therefore difficult to track down. The organization spent more than a year reviewing trade journals and talking to food additive consultants to identify the 56 companies that frequently make their own safety determinations.

The FDA’s food additive process allows companies to take several paths to determine the safety of new chemicals or other ingredients.

The most transparent and rigorous path involves companies submitting a food additive petition – along with the science behind why they think the ingredient is safe — to the FDA in an effort to gain formal approval from the agency. Companies use the FDA approvals to promote the safety of their products.

The other, non-public path that NRDC examined allows companies to determine GRAS status on their own without notifying the FDA.

A third path allows companies to voluntarily submit their own GRAS determinations for FDA review and

sign off, but they may withdraw the petition if the agency is worried about the safety of the additive. The agency announces the withdrawal but does not disclose whether it had safety concerns. The company may then go ahead and use its own GRAS determination to use the additive in products anyway. The NRDC found that one in every five GRAS petitions were either rejected by the FDA or the company voluntarily withdrew their petition.

NRDC's report also calls on the FDA to petition Congress for a new law that would require manufacturers to submit their safety determinations to the agency for review and approval. The council said it is encouraging consumers to "demand" that their grocery stores and their favorite brands sell only food products with ingredients that the FDA has found to be safe.

At Monday's event, the Grocery Manufacturers Association also announced a new food additive research center it has helped create at Michigan State University, which will be called the Center for Research on Ingredient Safety (CRIS). GMA's chief science officer, Leon Bruner, said the center will operate independent of the association and will review the safety of ingredients, train future food toxicologists and serve as an "independent and credible source" for the public, news organizations and the industry.

Kimberly Kindy is a government accountability reporter at The Washington Post.

Attachment 24

JANUARY 2014
IB:14-01-B

Playing Chicken with Antibiotics:
Previously Undisclosed FDA Documents Show Antibiotic Feed Additives Don't Meet the Agency's Own Safety Standards

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SUMMARY

Between 2001 and 2010, the United States Food and Drug Administration (FDA) quietly reviewed the safety of 30 penicillin and tetracycline antibiotic[i] feed additives[ii] approved for "nontherapeutic use" in livestock and poultry.[iii] Nontherapeutic use refers to using antibiotics for growth promotion or to prevent disease in typically crowded, often unsanitary conditions.[1] NRDC obtained the previously undisclosed review documents from the FDA as a result of a Freedom of Information Act (FOIA) request to the agency and subsequent litigation made necessary by FDA's failure to provide any of the requested documents.

FDA's scientific reviewers' findings show that *none* of these products would likely be approvable as new additives for nontherapeutic livestock use if submitted today, under current FDA guidelines. Eighteen of the 30 reviewed feed additives were deemed to pose a "high risk" of exposing humans to antibiotic-resistant bacteria through the food supply, based on the information available. The remainder lacked adequate data for the reviewers to make any determination and their safety remains unproven. In addition, FDA concluded in their review that at least 26 of the reviewed feed additives do not satisfy even the safety standards set by FDA in 1973.

To our knowledge, FDA has taken no action since the reviews to revoke approvals for any of these antibiotic feed additives (although two were voluntarily withdrawn by the drug manufacturer). The FDA does not disclose sales of specific animal drug products, and we have no information about the quantities of these specific antibiotic additives that were sold for livestock use or administered to food animals. However, we found evidence suggesting that at least nine of these additives are being marketed today, and all but the two voluntarily withdrawn additives remain approved for use today.

The significance of these findings extends far beyond the 30 antibiotic feed additives reviewed. FDA data indicate that the types of antibiotics in the reviewed additives—tetracyclines and penicillins—together make up nearly half of all the antibiotics used in animal agriculture. Other feed additives with these same antibiotics, including generics, that are approved for similar uses would likely pose a similar risk of promoting antibiotic resistance. This risk was recognized by FDA in 1977 when it proposed to withdraw approvals for animal feed additives containing penicillin and most tetracyclines.[2]

Furthermore, the use of tetracyclines and penicillins in animal feed is part of a larger problem of antibiotic overuse. Approximately 70 percent of all sales of medically important antibiotics in the United States are for livestock use.[3] Scientists have demonstrated that nontherapeutic use of antibiotics to raise livestock promotes drug-resistant bacteria that can migrate from livestock facilities and threaten public health. These bacteria can spread resistant traits to other bacteria, and some of these shared traits also can confer resistance to antibiotics used primarily in human medicine.[4]

Unfortunately, the FDA's failure to act on its own findings about the 30 reviewed antibiotic feed additives is part of a larger pattern of delay and inaction in tackling livestock drug use that goes back four decades. A recent voluntary policy adopted by FDA, "Guidance #213," recognizes the problem, but lacks meaningful requirements and seems unlikely to curb uses of the antibiotics reviewed here or any of the other problematic uses (for a number of reasons discussed further below). It is time for decisive action to help protect the public from the threat of antibiotic resistance. The FDA should:

1. Complete the decades-delayed process for withdrawing approval of penicillin and tetracyclines in animal feed, strictly limiting their use to treating sick animals and, in rare circumstances, to controlling disease outbreaks.
2. Initiate the process for withdrawing approval for all other classes of medically important antibiotics approved for nontherapeutic livestock use that are not shown to be safe.

In the face of the FDA's continued inaction, Congress, food industry leaders, and consumers should step in to demand change. Congress should insist on real regulation of livestock antibiotic use as outlined in the Preservation of Antibiotics for Medical Treatment Act (PAMTA) in the House of Representatives[5] and the Preventing Antibiotic Resistance Act (PARA) in the Senate.[6] In the meantime, large food companies and consumers can reduce livestock antibiotic use by choosing meat and poultry supplied by producers that promote antibiotic stewardship in the livestock and poultry industry.

i Here we use "antibiotic" to refer to all antibacterial agents, including both synthetic antibacterials and those produced from a natural source. For convenience, and based on common usage, we use "antibiotic" throughout.

ii For convenience, "antibiotic feed additives" refers throughout to drug products added to both feed and water.

iii Hereafter, for ease of use, "livestock and poultry" is referred to only as "livestock." Similarly, "livestock facilities" refers to both livestock and poultry facilities.

A BRIEF OVERVIEW OF ANTIBIOTICS, RESISTANCE, AND LIVESTOCK USE

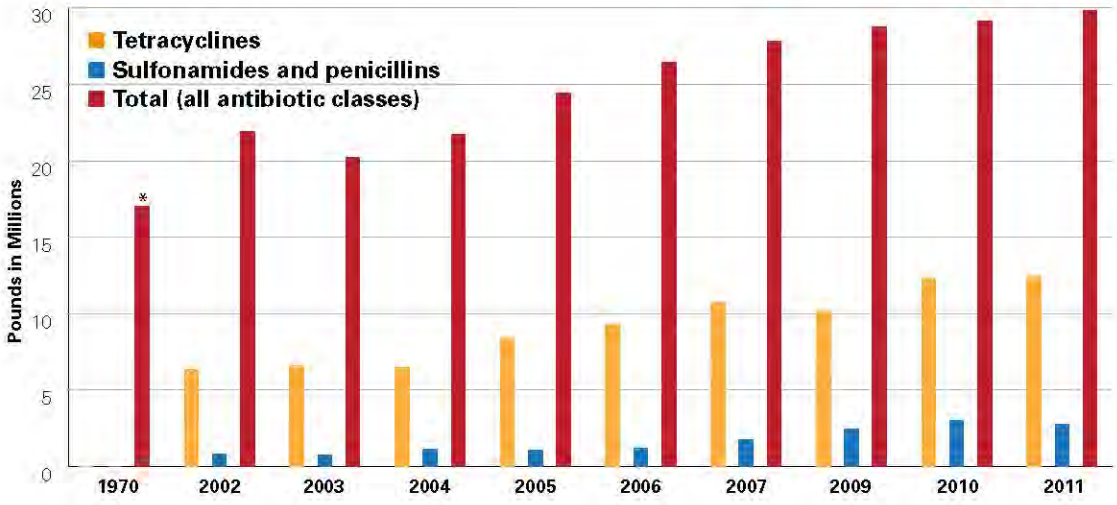
Antibiotics are the miracle drugs of the past century; they transformed medical care by turning infections that often proved fatal or required amputation into easy-to-treat illnesses.[7] Yet overuse and misuse of these medicines in both humans and food animals is causing rising rates of antibiotic resistance. The World Health Organization (WHO) and the Centers for Disease Control and Prevention (CDC) have repeatedly highlighted the risk of an impending post-antibiotic era due to growing resistance and have called for action, including the curtailment of inappropriate uses in livestock.[8]

In a report on Antibiotic Resistance Threats in the United States, 2013, the CDC says that "[i]n most cases, antibiotic-resistant infections require prolonged and/or costlier treatments, extend hospital stays, necessitate additional doctor visits and healthcare use, and result in greater disability and death compared with infections that are easily treatable with antibiotics."[9] The agency also warns that declining effectiveness of antibiotics will undermine "many life-saving and life-improving" procedures and treatments, such as "joint replacements, organ transplants, cancer therapy, and treatment of chronic diseases such as diabetes, asthma, [and] rheumatoid arthritis."[10]

As U.S. production of meat and poultry products has grown, U.S. livestock farms have become larger, leading to more confinement and crowding and also to greater risk of disease among the animals.[11] After the FDA approved the use of antibiotics in livestock feed in 1951, producers began relying on nontherapeutic use of antibiotics to speed animal growth and to prevent disease.[12] Studies by both livestock scientists and advocacy groups, while they have data gaps, suggest that the majority of all antibiotic use in U.S. livestock is for these nontherapeutic purposes, rather than for the treatment of sick animals.[13]

Using antibiotics at low doses for extended periods of time in crowded livestock facilities can lead to more drug-resistant bacteria that can outcompete other bacteria, and escape livestock facilities to threaten human health.[14] A large chorus of scientists, health experts, and government agencies warns that the overuse and misuse of antibiotics in livestock production is contributing to the expanding public health crisis of antibiotic resistance, depleting the physician's arsenal of antibiotics effective for treating infections in people. In its recent report, CDC notes that "much of antibiotic use in animals is unnecessary and inappropriate and makes everyone less safe"[15] and emphasizes that antibiotic overuse in both human medicine and livestock production is contributing to the problem of resistance.[16] The report notes that antibiotic resistance is associated with at least 2 million illnesses and 23,000 deaths each year[17] and shows that as newer antibiotics become less effective, older antibiotics may matter more.[18]

Figure 1: Estimated use of tetracyclines and penicillins/sulfonamides from 1970 to 2011 in livestock production.



Numbers for 1970 and 2002-2011 are based on estimates from the FDA and quantities sold domestically as reported by AHI and to the FDA. Penicillin and sulfonamides were reported together.

* No estimate of penicillin and tetracycline use is available for 1970.

(Total=all antibiotic classes.)

Source: Data for graph compiled from several sources. Animal Health Institute, http://www.ahi.org/archives/2008/11/2007-antibiotics-sales/; The Poultry Site, http://www.thepoultrysite.com/poultrynews/7985/antibiotic-use-in-us-animals-rises-in-2004; Food and Drug Administration "Summary Report on Antimicrobial Sold for Food Producing Animals-2009," http://www.fda.gov/downloads/ForIndustry/UserFees/AnimalDrugUserFeeActADUFA/UCM231851.pdf; Food and Drug Administration, "Summary Report on Antimicrobial Sold for Food Producing Animals-2010," http://www.fda.gov/downloads/ForIndustry/UserFees/AnimalDrugUserFeeActADUFA/ucm277657.pdf; Food and Drug Administration, "Summary Report on Antimicrobial Sold for Food Producing Animals-2011," http://www.fda.gov/downloads/ForIndustry/UserFees/AnimalDrugUserFeeActADUFA/UCM338170.pdf; Food and Drug Administration, "Statement of Gregory J. Ahart, Director, Human Resources Division before the House Committee on Interstate and Foreign Commerce on Food and Drug Administration's Regulation of Antibiotics Used in Animal Feeds," http://www.gao.gov/assets/100/98536.pdf

PENICILLINS AND TETRACYCLINES: USE IN ANIMAL FEED AND FOR HUMAN HEALTH

The reviewed antibiotic additives—penicillins and tetracyclines—are also important for treating human disease. In the U.S. in 2011, penicillins accounted for 44 percent of the total antibiotics sold for human medicine, and tetracyclines accounted for 3.5 percent.[19] The World Health Organization lists penicillins as critically important for human medicine and lists tetracyclines as highly important.[20] The FDA itself recognizes both as highly important, even under its limited criteria whereby antibiotics are designated "critically important" only if the drugs are used to treat gut pathogens that cause foodborne illness.[21] A partial listing of continuing medical uses of these drugs is provided in Table 1, below.[22] Unfortunately, penicillins and tetracyclines are no longer effective in fighting some infections because of increased resistance, decreasing options for treatment.[23]

Table 1: Overview of common medical conditions treated with penicillins and tetracyclines

Antibiotic Class	Antibiotic	Common Uses in Human Medicine[24]
Penicillins	Penicillin G	Syphilis Bacterial meningitis
	Ampicillin	Bacterial meningitis Leptospirosis Complicated UTI (kidney complication)
Tetracyclines	Tetracycline	Eye infection Early stages of syphilis Ehrlichiosis (spread by ticks and fleas)
	Doxycycline*	Chlamydia Gonorrhea Bronchitis Tularemia Lyme Disease

*Specific antibiotic not used in livestock, but cross resistance between antibiotic used in livestock and this antibiotic has been observed.[25]

At the same time, tetracyclines and penicillins are among the most commonly used antibiotics in livestock production in the U.S. In 2011, 42 percent of antibiotics used in animals were tetracyclines and 6.5 percent were penicillins (Figure 1).[26]

ANTIBIOTIC-RESISTANT BACTERIA CAN ESCAPE LIVESTOCK FACILITIES TO THREATEN PUBLIC HEALTH

A rich body of scientific literature, reinforced by the latest CDC report on emerging antibiotic resistance, shows that antibiotic-resistant bacteria bred in livestock facilities can make their way off the farm in a number of ways. People who work with livestock or in meat production/processing can carry the resistant bacteria into their communities.[27] Resistant bacteria can travel from the farm in air or water, can wind up in the soil when manure is applied to crops, which in turn can end up on fruits and vegetables, and can be found in meat on retail shelves.[28] Even insects and rats can carry antibiotic-resistant bacteria from farms to surrounding communities.[29] There is mounting evidence that antibiotic-resistant bacteria that originate in livestock are reaching our communities and homes.[30]

Researchers have also demonstrated that the overuse and misuse of one antibiotic can actually lead to bacterial resistance to other antibiotics. This means that nontherapeutic use of penicillins and tetracyclines in animal feed can compromise the effectiveness of other medically important antibiotics that were not used in livestock facilities.[31] This occurs through mechanisms described by scientists as "cross resistance" or "co-resistance."[32] (See box on antibiotic resistance).

Antibiotic resistance: How antibiotic use increases the population of resistant bacteria

Mutation and multiplication

Bacteria multiply rapidly. Each time this happens, there is a small chance that a gene in a bacterium will mutate in a way that makes it resistant to a particular antibiotic.

While new resistance genes can and do arise, bacterial resistance and associated genes have long existed, although usually in very low numbers.[33] Using an antibiotic, for instance, for growth promotion and disease prevention purposes, allows resistant bacteria that can withstand the antibiotic to survive and multiply. This creates many new bacteria that carry the same resistance gene, while bacterial populations susceptible to antibiotics die off, and ultimately increases the overall population of antibiotic-resistant bacteria.[34]

Gene sharing and multiplication

Bacteria that are resistant to antibiotics can, in some cases, pass a resistance gene or 'trait' on to other bacteria, essentially "teaching" them how to endure an antibiotic. One or more resistance genes can be passed from one bacterium to another. This means that a bacterium can become resistant to an antibiotic it was never exposed to. This can even occur between different types of bacteria.[35] This gene-sharing can occur in any environment, including on the farm; in air, water, and soil; and in the community, including in the animal and human gut.[36]

Cross resistance: A resistance trait that confers resistance to multiple antibiotics

Sometimes a bacterium's ability to resist one antibiotic enables it to resist other antibiotics as well, even those it was not exposed to. In simple terms, a bacterium can figure out, and/or share with a neighbor, a way to fend off antibiotics that are similar in structure or mechanism. Resistance to drugs both within a class of antibiotics or across multiple classes of antibiotics can be shared in this way. For example, as indicated in Table 1, bacteria that are resistant to oxytetracycline can also be resistant to Doxycycline, another tetracycline used only in human medicine.[37]

Resistance traits that are shared can also confer resistance to drugs across antibiotic classes. A prime example of such a trait is the presence of antibiotic "pumps" in the bacteria. These literally pump out antibiotics from bacterial cells, and thereby make bacteria resistant.[38] Some of these pumps are very versatile and can pump out practically all classes of antibiotics currently used in medicine.[39] When this trait is transferred from one bacterium to another, the recipient bacterium can now withstand any antibiotic that the pump works on.

Co-resistance: Clusters of resistance traits that confer multidrug resistance

The ability of bacteria to move around and share genes also enables them to accumulate a cluster of resistant genes or traits in a single transferrable unit.[40] In one extreme case, ten resistance genes to eight different classes of antibiotics were found in such a unit.[41] This can lead to an increase in multidrug resistance in the population when even one of these antibiotics is used, resulting in the selection of bacteria that have received the cluster from their neighbors. For years the USDA, FDA, and CDC have been testing for several known clusters of resistant genes, such as the resistance (and transferable) unit ACSSuT (resistance to ampicillin, chloramphenicol, streptomycin, sulfonamides, and tetracycline), and such clusters are often detected.[42] The problem of co-resistant bacteria is well known in both livestock production and human medicine.

MAIN FINDINGS OF THE FDA REVIEW

NRDC obtained copies of the FDA review documents following litigation over a Freedom of Information Act (FOIA) request.[43] The documents tell a story of FDA's continuing inaction on antibiotic use in livestock even after the agency's own re-examination of 30 livestock antibiotic feed additives, some of which have been allowed for livestock use since the 1950s,[44] showed that these approved antibiotics have not been shown to be safe.[45] (For further details on the documents, see Appendix.) Starting in 2001 and concluding in 2010, FDA scientists, with expertise in fields such as veterinary medicine and microbiology, reviewed livestock antibiotic feed additives containing penicillin and/or tetracyclines.[46] The review was triggered by legislation in 2001 that set aside money for the FDA to work on antibiotics,[47] and was discontinued in 2010 for unknown reasons.[48]

The FDA scientists reviewed the livestock feed additives, listed by NADA (New Animal Drug Application) number in Appendix I, according to two sets of criteria: safety regulations adopted by FDA in 1973 and FDA's 2003 guidelines for evaluating the safety of new animal antibiotic drugs (see sidebar).

The findings of the FDA review are troubling. Of the 30 reviewed antibiotic feed additives, 26 have never met the safety criteria established by FDA in 1973.[49] The 1973 safety requirements mandated that drug manufacturers submit scientific studies that addressed several criteria, including evidence that establishes that the nontherapeutic use of the antibiotics in animal feed did not promote resistance to antibiotics used in human medicine (see sidebar).[50] In addition to the 26, three other antibiotic additives were found not to have met the 1973 safety requirements (and thus were not proven to be safe), although the requirements may not have applied.[51] Of the 30 reviewed feed additives, only one was found by FDA (in 1986) to meet the 1973 safety standards; however it was found to have failed the agency's standard for efficacy.[52] It too remains approved for use.

Furthermore, when these previously approved antibiotic feed additives were evaluated against the FDA's 2003 antimicrobial safety guidelines (Guidance #152) for the evaluation of a new animal drug,[53] the agency found that 18 of the 30 antibiotic feed additives posed a high risk of exposing humans to antibiotic-resistant bacteria through the food chain. While FDA did not have sufficient data to conduct a comprehensive risk assessment for any of the 30 additives, it did have enough information to conduct an abbreviated risk assessment for these 18 additives, which varied in the level of detail in the assessment. In all of these cases, FDA concluded that, based on the information available, these were "high risk" uses. For the remaining 12 additives, the drug manufacturers had not provided sufficient evidence for FDA to even determine the level of risk for human health posed by the additives, let alone to determine that the additives are safe as used (see Figure 1). Thus, none of the 30 reviewed feed additives could likely be approved in their current forms today.

Guidance #152 calls for the characterization of safety through the assessment of hazard (or level of risk) before approval of all new animal drugs. This allows the FDA to set the right restrictions for use of the drug in order to manage risk: under Guidance #152, high-risk drugs could only be approved for treatment of individual animals for short periods of time (less than 21 days).[54] Yet, the existing approvals for these 18 "high-risk" feed additives would allow much wider use. They are approved for over-the-counter use for long periods of time with no restriction on the number of animals to which they are administered. Thus, they could not be approved in their current forms today. The other 12 feed additives could not be approved today unless their safety was established[55] and FDA concluded that it did not even have sufficient information to estimate risk (see Appendix I).

The FDA has not withdrawn approvals for any of the reviewed antibiotic feed additives, even though the agency is required to do so when a drug is not proven to be safe.[56] FDA did send letters to "sponsors" (sponsoring company) in 2004 for six of these antibiotic feed additives deemed "high risk," requesting information to address concerns that the additives might promote antibiotic resistance (see Appendix III). The FDA records do not show that any of the sponsors provided additional studies that addressed the FDA's concerns (see Appendix III). Nor do the documents show that FDA took any further action.[57]

The FDA does not disclose sales of specific animal drug products, and we have no information about the quantities of these specific antibiotic additives that were sold for livestock use or administered to food animals. However, we found evidence suggesting that at least nine of these feed additives are being marketed today (see Appendix II), and all but two apparently voluntarily withdrawn additives remain approved for use today.[58]

FDA's Criteria for Evaluating the Safety of Approved Feed Additives

1973 Criteria (21 C.F.R. § 558.15)[59]

Beginning in 1973, the FDA required the submission of data to establish the safety of antibiotic use in animals for nontherapeutic purposes (growth promotion and disease prevention). Required submissions include studies demonstrating that the antibiotics feed additive does not promote resistance to antibiotics used in human medicine or increase *Salmonella* shedding in fecal matter when used in animal feed for growth promotion and disease prevention, as recommended by an FDA task force in 1972.

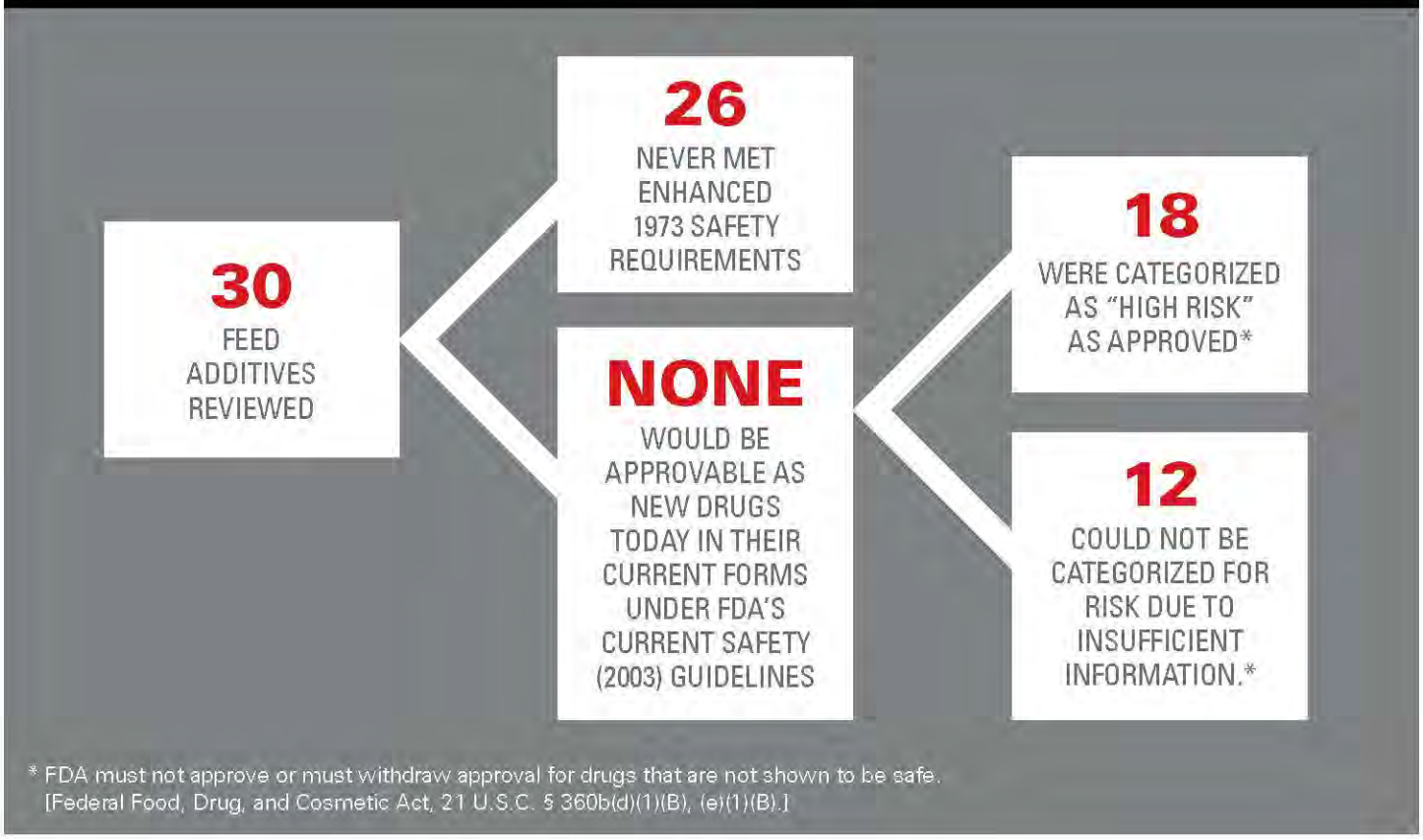
2003 Criteria (Guidance for Industry #152)[60]

The FDA's 2003 Guidance criteria evaluate antibiotic use on the basis of three parameters:

1. Risk that the antibiotic(s) added to feed will result in the emergence or selection of resistant bacteria in the animal being fed.
2. Likelihood of human exposure to a foodborne bacterium of human health concern.
3. Risk of adverse human health consequences if exposure occurs. This focuses primarily on the importance of the antibiotic class for human medicine and whether its effectiveness might be compromised.

The three factors above are combined to create a risk estimation of high, medium, and low. The criteria then describe allowed conditions of use for each of the different levels of risk such as restrictions on number of animals that can be treated at a time.

FDA Review of Approved Nontherapeutic Antibiotic Animal Feed Additives



* FDA must not approve or must withdraw approval for drugs that are not shown to be safe. [Federal Food, Drug, and Cosmetic Act, 21 U.S.C. § 360b(d)(1)(B), (e)(1)(B).]

Example of FDA Inaction: Antibiotic Feed Additives That Continue to Be Sold Without Being Shown to Be Safe

CASE 1: Pennchlor SP 250/500: An antibiotic feed additive that made it to market without demonstrating safety relating to antimicrobial resistance.

The sponsor proposed but never submitted studies to address the 1973 safety criteria.[61] FDA's review does not mention any other studies that proved safety regarding the risk of antimicrobial resistance.[62] FDA sent a letter to the sponsor in 2004 because it concluded that the feed additive likely posed a "high risk" for promoting resistance in bacteria of human health concern and requested additional safety information.[63] Notably, FDA's letter focused only on growth promotion claims for the feed additive, even though prevention claims were approved for exactly the same kind of use that FDA had found not to have met safety criteria in the growth promotion context.[64,65,66] Both claims were approved with exactly the same restrictions (or lack thereof) on doses, dosage durations, and number of animals that can be treated.[67] There is nothing in the FDA documents that shows that the sponsor provided any new studies that addressed FDA's concerns.[68] FDA does not appear to have taken any action to withdraw approval even for the growth promotion claims it raised in its letter.[69] Today, Pennchlor SP250 continues to be marketed and is used in swine feeds.[70]

CASE 2: Penicillin G Procaine 50/100: An antibiotic feed additive that failed to meet safety criteria and is still marketed today.

In 1997, the FDA asked the sponsor to voluntarily withdraw this antibiotic additive due to increased concern from public officials and members of the health care community regarding the emergence of antimicrobial resistance.[71] In the same letter, the FDA stated that the product failed to meet antimicrobial-resistance safety criteria.[72] In its review, FDA noted increased microbial resistance was observed when the antibiotic feed additive was administered in feed to animals.[73] The sponsor apparently disputed this finding[74], yet the FDA documents do not contain any other studies to address the safety issue.[75] FDA sent another letter to the sponsor in 2004 laying out its concerns about resistance.[76] The record does not show that the sponsor submitted any new studies.[77] FDA never required the sponsor to take the antibiotic feed additive off the market, and it is still sold as a growth promoter in feed.[78]

Summary: Two medically important antibiotics in use in feed additives that have not been proven to be safe

Feed Additive name	Case I: Pennchlor SP 250/ Pennchlor SP 500	Case II: Penicillin G Procaine 50/100
NADA number	138-934	046-666
Antibiotic class in product	Penicillin, tetracycline, sulfonamides	Penicillin
Currently marketed by:	Pennfield Oil Co.[i]	Zoetis, Inc.[ii]
Approved for use in:	Swine	Non-laying chickens, turkeys, pheasants, and quail
Disease treatment and prevention:	Yes	No
Growth promotion:	Yes	Yes

i Pennfield Oil Co. is a large global animal health company. This company is not the original sponsoring company for the antibiotic feed additive.
ii Zoetis, a former business unit of Pfizer, is a large global animal health company. This company is not the original sponsoring company for the antibiotic feed additive.

HISTORY OF FDA INACTION

The failure to follow up on the recent review of antibiotic feed additives containing penicillin and/or tetracyclines is just the latest example of the FDA's inaction in the face of mounting evidence of public health threats stemming from the overuse and misuse of antibiotics in livestock. This inertia goes back four decades. In 1970, the FDA convened a task force of scientists from multiple agencies, including the National Institutes of Health, the U.S. Department of Agriculture, and the CDC, as well as from universities and industry. The task force found that the use of nontherapeutic antibiotics could threaten human health due to the likely rise of antibiotic resistance.[79]

Similar findings in the Swann Report, a 1969 report issued by the British government that inspired the creation of the FDA task force, had spurred Europe into action, leading to the removal of penicillin and tetracycline as growth promoters in animal feed in several European countries.[80] The European Union has since banned the use of all antibiotic growth promoters in animal feed, and Denmark has gone further to disallow prophylactic uses.[81]

Following the findings of the FDA task force, FDA adopted the 1973 regulations requiring drug manufacturers to prove the safety of using antibiotics in animal feed.[82] When drug manufacturers failed to establish safety pursuant to the 1973 regulations, in 1977, the FDA found that the use of penicillin and tetracyclines in animal feed was not shown to be safe and proposed to withdraw approval for those uses.[83] But the agency never followed through to complete the process. In 2012, NRDC sued to force the agency to act and won two court orders, including a directive to begin cancellation proceedings for penicillin and tetracyclines in animal feed.[84] The FDA then appealed. A decision is pending.

In 2003, the agency put out nonbinding guidelines (Guidance #152) that the agency follows in evaluating applications for new approvals of antibiotics for livestock use.[85] The 2003 guidelines were designed to increase the safety of new livestock drugs by reducing the likelihood that they would contribute to the development and spread of antibiotic-resistant bacteria via food. However, the 2003 guidelines do not apply to drugs that were previously approved, i.e., most of the antibiotics being used in livestock today.[86]

Since then, the agency has recently approved more voluntary guidelines (Guidance #213)—non-binding recommendations—to guide the use and marketing of previously approved livestock antibiotics.[87] A critical loophole is that while FDA's proposed guidelines would encourage drug manufacturers to discontinue selling drugs to speed up animal growth ("growth promotion"), it does not discourage the continuation of very similar or even identical uses as long as the intent is to prevent disease ("disease prevention"), even in cases where the animals are not sick and the use is driven by the anticipated effects of crowded and unsanitary conditions often found on livestock facilities. According to the FDA, "disease prevention involves the administration of an antimicrobial drug to animals, none of which are exhibiting clinical signs of disease, in a situation where disease is likely to occur if the drug is not administered."[88] Because many drugs are approved for both growth promotion and disease prevention uses,[89] most current uses can continue under a different label.

Action to Protect Public Health

The FDA should immediately move to end nontherapeutic uses of the reviewed penicillins and tetracyclines and should limit uses of these medicines to treat sick animals or, in rare cases, to control disease outbreaks. The drug manufacturers of these antibiotic feed additives have failed for four decades to prove that they are safe for human health, as they were required to by law.[90] And FDA has failed to withdraw approval for these drugs in that time, in spite of the drug manufacturers' failure to prove the safety of their products.

As described above, the public health risks found by the FDA's review of 30 antibiotic feed additives are an indicator of a larger threat. The nontherapeutic livestock use of other penicillins and tetracyclines—and, indeed, any other medically important antibiotics—poses a risk of breeding resistant bacteria and contributing to the spread of antibiotic resistance. The FDA should therefore move swiftly to take the necessary steps to eliminate all nontherapeutic uses of all classes of medically important antibiotics in livestock production. FDA should also require improved reporting on livestock antibiotics, including reporting by users of these antibiotics, to enable the agency to track progress in meeting this goal.

Congress must act

If the FDA fails to take action, then Congress should step in to ensure that these essential medicines continue to be effective for humans for as long as possible. It should pass the Preventing Antibiotic Resistance Act and the Preservation of Antibiotics for Medical Treatment Act, both of which would phase out the nontherapeutic use of medically important antibiotics in animal feed.

Food companies and consumers should not wait for federal policy reform

While federal policymakers continue to delay, consumers and business leaders can make progress in promoting antibiotic stewardship in the livestock industry. Consumers should purchase animal products labeled "Certified Organic" or "No Antibiotics Administered" when they can. Food companies with large purchasing power should specify antibiotic stewardship requirements for producers who supply them. While many livestock producers have innovative production systems that are not reliant on nontherapeutic antibiotic use, others must now acknowledge the risks of these practices and transition their operations away from antibiotic dependency.

METHODS

EVALUATION OF DOCUMENTS:

Four volumes of the FDA review were received and the volumes included short and long versions of product reviews of penicillin and tetracycline feed additives. The FDA review was carried out from 2001 to 2010 by the Microbial Food Safety Team (HFV 157) in the Office of New Animal Drug Evaluation. Each review (Microbiologist's review) included a brief summary, a review of the administrative record, and conclusions. Specifically, a review of the administrative record included assessment of 21 C.F.R. § 558.15 (1973 safety and efficacy criteria) information, and assessment of the administrative record using Guidance for the Industry (GFI) #152. Extra documentation was provided that pertained to studies addressing 21 CFR 558.15, email correspondence related to the review team, correspondence between the sponsor and the Center for Veterinary Medicine (CVM), as well as background literature and related presentations or posters. Information presented in Appendix I is based on the short and long versions of the product reviews by the Microbial Food Safety Team including summarized 21 CFR 558.15 information, summarized correspondence and conclusions made by the FDA review team.

EVIDENCE OF MARKETING:

NADA numbers were entered into the Animal Drugs @ FDA (database of Approved Animal Drug Products, http://www.fda.gov/AnimalVeterinary/Products/ApprovedAnimalDrugProducts/). The current sponsor was identified and a search was performed for any evidence of current marketing (including product inserts, MSDS sheets, summary information, etc.) In addition, a search was performed using either the NADA number or the proprietary name and evidence of inclusion in any current or recent catalogs was included as evidence. In one case evidence was found of a generic product based on an identified NADA in the FDA review. The Feed Additive Compendium contained names of several products listed in Appendix I. Because NADA numbers are not associated with those products in the Compendium and many products have similar names, results from the Feed Additive Compendium are not included in Appendix II.

EVIDENCE OF WITHDRAWAL:

NADA numbers were entered into the Animal Drugs @ FDA (database of Approved Animal Drug Products, http://www.fda.gov/AnimalVeterinary/Products/ApprovedAnimalDrugProducts/). NADA numbers were cross referenced to the FDA Green Book (Section 6: Voluntary Withdrawals and monthly updates to Jan. 2014, The current status of the drug was assessed and in cases of withdrawal by the sponsor, such a status was noted.

APPENDIX I

Compilation of FDA scientists' review of 30 penicillin and tetracycline feed additives regarding 1973 criteria and Guidance #152.

Name of product	Volume of FDA Review	NADA Number	Met 1973 Safety Criteria	1973 Safety Criteria Citation	Risk Estimation (Guidance 152)	Risk Citation	Additional Information
Terramycin Animal Formula, Soluble Powder	Vol. I	008-622[#i]	Not met	FDA001732	High risk**[i]	FDA001739	May not be applicable to 1973 criteria, Animal Drugs @FDA
Terramycin Type A medicated Articles	Vol. I	008-804	Met (in 1986)	FDA002102/ FDA002105/ FDA002110	Not enough information	FDA002114	
Aureomix Granular 500	Vol. II	035-688	Not met	See below	High risk**	FDA002145-002147	
(see above), Aureo S 700, Aureomycin	Vol. II	035-688, 035-805, 048-761	Not met	FDA002333	High risk**	FDA002325-002333	
Aureomix S 700 G	Vol. II	041-649	Not met	FDA003898	High risk	FDA003898	
Aureomix S 700 B	Vol. II	041-653	Not met	FDA003908-003910	Not enough information	FDA003910	
Penicillin 100/Penicillin G Procaine 50	Vol. II	046-666	Not met	FDA004026/FDA004029	High risk**	FDA004024-004027	
Pencillin G Procaine 50%	Vol. II	046-668	Not met	FDA004320-004322, FDA004324	High risk**	FDA004326-004330	
Chlormax products, Micro CTC 100	Vol. II	046-699	Not met	FDA004453-004454	High risk**	FDA004459	
Chlorachel 50, Pfichlor products	Vol. II	049-287	Not met	FDA0044486	High risk**	FDA004469-004476	
Rainbrook Broiler Premix No. 1	Vol. II	049-462	Not met	FDA004494	High risk**	FDA004491-004493	Withdrawn, Green book/Animal Drugs@ FDA

APPENDIX I

Name of product	Volume of FDA Review	NADA Number	Met 1973 Safety Criteria	1973 Safety Criteria Citation	Risk Estimation (Guidance 152)	Risk Citation	Additional Information
Aureomycin Soluble Powder	Vol. II	055-020#	Not met	FDA004521	Not enough information	FDA004522	May not be applicable to 1973 criteria, Animal Drugs @FDA
Penicillin G Potassium	Vol. II	055-060*	N/A	FDA004532	High risk	FDA004533-004536	1973 criteria not applicable FDA004533
Tetracycline Soluble Powder	Vol. III	065-496#	Not met	FDA007239	High risk**	FDA004619-004623	May not be applicable to 1973 criteria, Animal Drugs @FDA
ChlorMax SP products, Chlorachel 250	Vol. III	091-668	Not met	FDA004730	High risk**	FDA004724-04730	
CLTC 100 MR, CLTC 70	Vol. III	092-287	Not met	FDA004766	Not enough information	FDA004774	
OXTC products, Terramycin products	Vol. III	095-143	Not met	FDA004811	Not enough information	FDA004811-FDA004812	
Pfichlor 100S Milk Replacer	Vol. III	100-901	Not met	FDA004818	High risk	FDA004819	
Terramycin Premix	Vol. III	103-758	Not met	FDA004838	Not enough information	FDA004839	Withdrawn,[3] Animal Drugs@FDA
Pennchlor SP 250/ Pennchlor SP 500	Vol. III	138-934	Not met	FDA004849-004850, FDA004872	High risk**	FDA004872-004876	
Oxytetracycline products, Pennox products	Vol. III	138-938	Not met	FDA004898	Not enough information	FD004899-4902	
CSP 250/CSP 500	Vol. III	039-077	Not met	FDA006977	High risk**	FDA006973-006977	

APPENDIX I

Name of product	Volume of FDA Review	NADA Number	Met 1973 Safety Criteria	1973 Safety Criteria Citation	Risk Estimation (Guidance 152)	Risk Citation	Additional Information
Chloratet 100, Chloratet 90	Vol. III	048-480	Not met	FDA007160	High risk	FDA007160	
CLTC products	Vol. III	092-286	Not met	FDA007259	Not enough information	FDA007259	
Aureomix S 700-A, Aureomix S 700-D, Aureomix S 700-E, , Aureomix S 700-F, Aureomix S 700-H	Vol. III	041-647 041-648 041-650 041-651 041-654	Not met	FDA007294	Not enough information	FDA007294	
Quratermaster Dry Cow Treatment	Vol. III	055-028*	N/A	FDA007729	High risk**	FDA007729-007738	1973 criteria not applicable (Vol. III FDA007723)
Aureomix S 700-C 2	Vol. IV	041-652	Not met	FDA009391	High Risk	FDA009391	

APPENDIX II

EVIDENCE OF MARKETING

1. Pennchlor SP 250 (NADA 138-934) – evidence of marketing through a feed company

"Pennchlor SP 250 – Product Description," Feed Products and Company South, http://www.feedproducts.net/products/pennchlor-SP-250.htm, accessed November 25, 2013.

"Pennchlor SP-250- Specifications," Feed Products and Company South, http://www.feedproducts.net/documents/PennchlorSP250.pdf, accessed November 24, 2013.

2. Aureomix 500 (NADA 035-688) – evidence of marketing through an animal pharmaceutical company

"Product inserts – Aureomix 500," Zoetis, https://online.zoetis.com/US/EN/contact/product_information/Pages/ProductInserts.aspx, accessed November 25, 2013.

"Material Safety Data Sheet," Zoetis, https://online.zoetis.com/US/EN/MSDS_PI/PI/Aureomix_500.pdf, accessed November 25, 2013.

3. Penicillin 100 (NADA 046-666) – evidence of marketing through an animal pharmaceutical company

"Product inserts – Penicillin 100," Zoetis, https://online.zoetis.com/US/EN/contact/product_information/Pages/ProductInserts.aspx, accessed November 26, 2013.

"Material Safety Data Sheet," Zoetis, https://online.zoetis.com/US/EN/MSDS_PI/PI/Penicillin_100.pdf, accessed November 25, 2013.

4. Chloratet (NADA 048-480) – evidence of marketing through a supplier company

"PALS feed additives and medication products catalog" PALS USA, http://palsusa.com/files/PALSMedCatalog.pdf, last accessed November 21, 2013.

5. Terramycin (NADA 008-622) – evidence of marketing of the generic (ANADA 200-026) based on this NADA by a supplier company

"Supplemental Abbreviated New Animal Drug Application" Food and Drug Administration, http://www.fda.gov/downloads/AnimalVeterinary/Products/ApprovedAnimalDrugProducts/FOIADrugSummaries/ucm061570.pdf, last accessed on November 24, 2013.

"Terramycin 343-soluble powder" Revival Animal Health, http://www.revivalanimal.com/Terramycin-343-Soluble-Powder-Generic.html, last accessed on November 25, 2013.

6. Aureomycin NADA (48-761) – evidence of marketing by an animal pharmaceutical company

"Product insert - Aureomycin 50, 90, 100 Granular," Zoetis, https://online.zoetis.com/US/EN/contact/product_information/Pages/ProductInserts.aspx, accessed November 25, 2013.

"Material Safety Data Sheet," Zoetis, https://online.zoetis.com/US/EN/MSDS_PI/PI/Aureomycin_50_90_100_Granular-swine.pdf, accessed November 25, 2013.

7. Pennox 100MR (NADA 138-938) – Evidence of marketing by a supplier

"Pennox 100MR – Product Description," Feed Products and Company South, http://www.feedproducts.net/products/pennox-100-MR.htm, accessed November 25, 2013.

"Pennox 100MR- Specifications," Feed Products and Company South, last modified October 2010, http://www.feedproducts.net/documents/Pennox100MR.pdf, accessed November 24, 2013.

8. CLTC (NADA 92-287) – Evidence of marketing by a supplier and by inclusion in a USDA risk management program

"CLTC-100 MR" Animart Dairy and Livestock solutions, http://www.animart.com/store/cltc-100-mr-50lb-drum/, accessed November 24, 2013.

"CLTC 100MR" Food Animal Residue Avoidance Databank, http://www.farad.org/vetgram/ProductInfo.asp?byNada=092-287, accessed November 24, 2013.

9. Chlormax (NADA 46-669) – Evidence of marketing by an animal pharmaceutical company

"Product inserts – Chlormax," Zoetishttps://online.zoetis.com/US/EN/contact/product_information/Pages/ProductInserts.aspx, accessed November 25, 2013.

"Material Safety Data Sheet," Zoetis, https://online.zoetis.com/US/EN/PublishingImages/Poultry%20Literature%20Library/US-EN/ChlorMax_Product_Profile_ZP130030_EN_Zoetis.pdf, accessed November 25, 2013.

Note: All products above are also listed by brand name in Feed Additive Compendium.

APPENDIX III

Selection of correspondence between Center for Veterinary Medicine and sponsors on FDA review conclusions.

NADA 046-666

Excerpt from letter sent to sponsor: "The administrative record does not contain sufficient information to alleviate the Center [for Veterinary Medicine]'s concern about the use of your product and its possible role in the emergence and dissemination of antimicrobial resistance."
Food and Drug Administration, Letter from FDA to Sponsor of NADA 046-666, May 26, 2004, Vol. III: FDA007516.

Excerpt from sponsor response: "[W]e wish to advise CVM of our strongly held view that these products, with the current claims, remain safe and effective.... The amendment to the FY 2001 appropriation directed a review of previous approvals. It did not alter the standards applicable to withdrawing approval to allow withdrawal based on nonscientifically based precautionary grounds. We believe the agency should be able to separate the justifiable concerns related to the development of antibiotic resistant human pathogens and discern that [the sponsor's] subtherapeutic penicillins are not the source of, or even a measurable contributor to, this public health issue."
Food and Drug Administration, Letter from Sponsor (of NADA 046-666, 035-688 039-077, and 091-668) to FDA, October 22, 2004, Vol. III: FDA008180-2.[iv] *Note: The sponsoring company sent the same letter as a response to FDA's letters regarding four separate NADAs.*

NADA 046-668

Excerpt from letter sent to sponsor: "The administrative record does not contain sufficient information to alleviate the Center [for Veterinary Medicine]'s concern about the use of your product and its possible role in the emergence and dissemination of antimicrobial resistance."
Food and Drug Administration, Letter from FDA to Sponsor of NADA 046-668, received May 26, 2004, Vol. III: FDA007518.

Excerpt from the sponsor response: "[The sponsor] has been unable to make a decision on how to proceed on this issue. Although [Center for Veterinary Medicine] did supply us with a copy of the presentation given at the meeting, very little information was presented on the hazard characterization. In addition, it would be helpful for us to see a more complete description of the risk assessment so that we can determine what additional data may be collected/supplied to help support a more thorough evaluation."
Food and Drug Administration, Letter from Sponsor (of NADA 046-668) to FDA, November 15, 2004, Vol. III: FDA008950.

NADAs 035-688, 039-077, 091-668

Excerpt from letter sent to sponsor: "The administrative record does not contain sufficient information to alleviate the Center [for Veterinary Medicine]'s concern about the use of your product and its possible role in the emergence and dissemination of antimicrobial resistance."
Food and Drug Administration, Letter from FDA to Sponsor of NADA 035-688, 039-077, and 091-668, May 26, 2004, Vol. III: FDA007522.

Excerpt from sponsor response: ... We wish to advise CVM of our strongly held view that these products, with the current claims, remain safe and effective... The amendment to the FY 2001 appropriation directed a review of previous approvals. It did not alter the standards applicable to withdrawing approval to allow withdrawal based on nonscientifically based precautionary grounds. We believe the agency should be able to separate the justifiable concerns related to the development of antibiotic resistant human pathogens and discern that [the sponsor's] subtherapeutic penicillins are not the source of, or even a measurable contributor to, this public health issue."
Food and Drug Administration, Letter from Sponsor (of NADA 046-666, 035-688 039-077, and 091-668) to FDA, October 22, 2004, Vol. III: FDA008180-2.[iv]

NADA 138-934

Excerpt from letter sent to sponsor: "The administrative record does not contain sufficient information to alleviate the Center [for Veterinary Medicine]'s concern about the use of your product and its possible role in the emergence and dissemination of antimicrobial resistance."
Food and Drug Administration, Letter from FDA to Sponsor of NADA 138-934, May 26, 2004, Vol. III: FDA007526.

Excerpt of FDA's summary of the sponsor's response: "The firm submitted a letter dated July 31, 2006 stating that they would remove the 'growth promotion and increased feed efficiency' indication from their label, as long as the other firms with the same product and indication did so as well...The firms also submitted (January 4, 2005) the results of a literature search... Specific information to address the data gaps in the microbial food safety assessment was not retrieved by the search terms used by the firm."
Food and Drug Administration, Microbial Food Safety Team (HFV-157), Brown Amendment Review of NADA 138-934, Vol. III: FDA004849-50

Endnotes

1 As noted, we use the term "nontherapeutic use" to refer to the use of antibiotics to speed up animal growth and prevent diseases. Antibiotics are typically administered for these purposes to large groups of animals for extended periods of time. We use "therapeutic" use to mean the use of antibiotics to treat sick animals or to control disease outbreaks in rare circumstances. FDA regulations refer to growth promotion and disease prevention uses as "subtherapeutic." 21 C.F.R. § 558.15.

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43 FDA did not respond to the FOIA request until NRDC filed a lawsuit; subsequently a settlement was reached and documents were made available.

44 *Natural Resources Defense Council v. United States Food and Drug Administration*, 884 F.Supp.2d 127, 131-32 (S.D.N.Y. 2012) (hereinafter "*NRDC v. FDA*").

45 FDA also reviewed two antibiotics products that were not approved for use *in animal feed or water*, and determined that they are "high risk" under the 2003 guidelines discussed further below. The antibiotic products are approved for intramammary application to dairy cows (NADA 055-028), and for treatment use (NADA 055-060). They were not required to meet the 1973 safety requirements, which focused on the safety of antibiotic feed additives. FDA examined the topical antibiotic because it was approved for preventive use, but it is not clear why FDA reviewed the antibiotic product approved for treatment. It remains unclear if and how safety for human health was established for these two antibiotic products; Food and Drug Administration, Microbiologist's Review of NADA 055-028, Vol. III, FDA007723-7739; Food and Drug Administration, Microbiologist's Review of NADA 055-060, Vol. II, FDA004531-4537.

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49 Appendix I, Column 4, shows which antibiotics failed to meet the 1973 criteria.

50 *NRDC v. FDA*, 884 F.Supp.2d at 133.

51 Three antibiotic products (NADA 065-496, 055-020, and 008-622) are additives approved for administration to animals for fewer than 14 days and the 1973 criteria may not apply. "In the past, FDA has referred to "subtherapeutic" uses at various times to include: (1) 'Increased rate of gain, disease prevention, etc.' (Ref. 7); (2) 'any use of an antibacterial drug continuously in feed for longer than 14 days' (Ref. 23); and (3) 'lower levels than therapeutic levels needed to cure disease.' (Refs. 1 and 2)." Withdrawal of NOOH; Penicillin and Tetracycline Used in Animal Feed, 76 Fed. Reg. 79697, 79700 (Dec. 22, 2011). See Appendix I, Column 4 and 8, show which antibiotics failed to meet the 1973 criteria and if the 1973 criteria were applicable.

52 *See* Food and Drug Administration, Microbiologist's Review of NADA 008-804, Vol. I, FDA002097, FDA002114. The approved NADA covers several versions of the same feed additive, a Terramycin Animal Mix.

53 See Appendix I, column 5.

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62 *Id.*

63 *See* Appendix III, NADA 138-934, Excerpt from FDA letter sent to sponsor.

64 *See* Approved usages for NADA 134-938, Vol. III, FDA004847-48; 21 C.F.R. § 558.145.

65 *See* Food and Drug Administration, Microbiologist's Review of NADA 134-938, at 24-25, Vol. III, FDA004876-77.

66 FDA's current statements on the issue of preventive claims, in non-binding policy documents such as Guidance #213, explain that FDA does not consider prevention uses to be subtherapeutic anymore, contradicting its own binding regulations, 21 C.F.R. § 558.15, despite the fact that the claims may overlap in the use allowed.

67 *See* Approved usages for NADA 134-938, Vol. III, FDA004847-48; 21 C.F.R. § 558.145.

68 *See* Appendix III, NADA 138-934, Excerpt from FDA's summary of the sponsor's response; *see also* Food and Drug Administration documents concerning NADA 134-938, Vol. III, FDA004846-4885.

69 *See* Food and Drug Administration documents concerning NADA 134-938, Vol. III, FDA004846-4885.

70 *See* Appendix II.

71 "From CVM to the sponsor... The letter indicates that considerable concern is being expressed by public health officials and representatives of the human health care community regarding the emergence of antimicrobial resistance. Attention is being drawn to the use of antimicrobials in animals as a source of the increasing resistance... The sponsor is asked to voluntarily withdraw their product." Food and Drug Administration, Microbiologist's Review of NADA 046-666, Part I: Review of Administrative Record, Vol. II, FDA003974.

72 "From CVM to the sponsor... The letter also states that the products subject to this NADA were determined to be effective for increasing rate of growth and improving feed efficiency under the DESI review, the products failed to meet antimicrobial resistance criteria established under 21 CFR 558.15 and as a result... were proposed for withdrawal via an NOOH published in 1977." Food and Drug Administration, Microbiologist's Review of NADA 046-666, Part I: Review of Administrative Record, Vol. II, FDA003974.

73 "It is interesting to note that although the sponsor makes the following statement in the body of their report, 'Among the non-infected groups, there were significantly more ampicillin, chloramphenicol, nitrofurantoin and kanamycin resistant *E. coli* in the treated group than in the control group,' this does not appear in the conclusions section of their report." Food and Drug Administration, Microbiologist's Review of NADA 046-666, Review of Data Pertaining to 558.15, Vol. II, FDA004019; *see* Letter from FDA to Sponsor of NADA 046-666, May 26, 2004, Vol. III, FDA007515 (noting that CVM concluded that "there were still questions about the observed increases in resistant *Salmonella* and *E. coli*").

74 "From sponsor: 'We are of course, aware of the renewed controversy over the use of certain antibacterials in animals; however, we continue to believe that when their safety is called into question, new animal drug approvals should only be withdrawn when there is sound scientific evidence for so doing. Mere speculation and theory should not be a basis for withdrawal of approval.'" Food and Drug Administration, Microbiologist's Review of NADA 046-666, Part I: Review of Administrative Record, Vol. II, FDA003974.

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Method and Appendices endnotes

i For all of the antibiotic feed additives listed in this appendix, FDA did not have sufficient data to conduct a thorough risk assessment. However, for 18 antibiotic feed additives, it had sufficient information to carry out an abbreviated risk assessment. Even for these 18 additives, the assessment was more thorough for some additives than for others. "High risk" indicates that FDA scientists conducted a basic risk assessment. "High risk**" indicates that FDA conducted a more detailed assessment considering release, exposure, and consequence. See the following for example: Food and Drug Administration, Assessment of the Administrative Record using Guidance for Industry #152 – NADA 091-668, Vol. III, FDA004724-4730. For the other 12 additives, FDA concluded that it simply did not have sufficient information to be able to make any determination about risk. These additives are thus not shown to be safe.

ii *Two antibiotic products (NADA 055-060 and NADA 055-028) are not included in the 30 antibiotic feed additives discussed in the main text. #Three antibiotic products (NADA 065-496, 055-020, and 008-622) are additives approved for administration to animals for fewer than 14 days as indicated in Animal Drugs @ FDA database and the 1973 criteria may not be applicable. (See main text for further information). Animal Drugs @ FDA database, http://www.accessdata.fda.gov/scripts/animaldrugsatfda/

iii Please note that the FDA database at AnimalDrugs@FDA (http://www.accessdata.fda.gov/scripts/animaldrugsatfda/) lists NADA 103-758 as voluntarily withdrawn; however, the official "Green Book" does not.

iv Note that the same sponsor is associated with NADAs 046-666, 035-688, 039-077, and 091-668. The sponsor sent only one letter in response to FDA's concerns and comments on all four NADAs.

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Drug critic slams FDA over antibiotic oversight in meat production

Mon, Jan 27 2014

By P.J. Huffstutter and Brian Grow

(Reuters) - The United States Food and Drug Administration allowed 18 animal drugs to stay on the market even after an agency review found the drugs posed a "high risk" of exposing humans to antibiotic-resistant bacteria through food supply, according to a study released Monday by the Natural Resources Defense Council.

The study by the NRDC, a non-governmental group that criticizes the widespread use of drugs in the meat industry, is the latest salvo in the national debate over the long-standing practice of antibiotic use in meat production. Agribusinesses say animal drugs help increase production and keep prices low for U.S. consumers, while consumer advocates and some scientists raise concerns over antibiotic-resistant bacteria.

The FDA stirred the debate late last year when it unveiled guidelines for drug makers and agricultural companies to voluntarily phase out antibiotic use as a growth enhancer in livestock. The agency said those guidelines were an effort to stem the surge in human resistance to certain antibiotics.

But the NRDC's study found the FDA took no action to remove 30 antibiotic-based livestock feed products from the market even after federal investigators determined many of those antibiotics fell short of current regulatory standards for protecting human health.

NRDC studied a review conducted by the FDA from 2001 to 2010 that focused on 30 penicillin and tetracycline-based antibiotic feed additives. The drugs had been approved by regulators to be used specifically for growth promotion of livestock and poultry - essentially to produce more meat to sell.

The FDA, in a statement, said it began a review of older, approved penicillin and tetracycline products in 2001, and issued letters to companies who made the products asking for additional safety data.

"Based on its review of this and other information, the Agency chose to employ a strategy that would more broadly address the concerns about the production use of medically important antimicrobials in food-producing animals," the FDA said.

Some academics specializing in antibiotic resistance criticized the NRDC's study, saying that the findings do not reflect current regulatory standards because some of the drugs have been withdrawn from the market.

They also say that the study assessed FDA safety guidelines that have been replaced with more stringent standards.

Dr. Randall Singer, associate professor of epidemiology at the University of Minnesota, told Reuters that drug makers and the U.S. livestock industry are phasing out antibiotics used principally for growth promotion.

"We have been telling (both of) them for years to be prepared for the elimination of growth promotion and feed efficiency labeling because you cannot make that change overnight," said Singer, who reviewed the NRDC report for Reuters.

The NRDC, which reviewed more than 3,000 pages of documents through a federal Freedom of Information Act request, said it found evidence to suggest nine of the drugs are still on the market and used by livestock producers. Reuters was not able to independently verify that detail immediately.

One of the drugs still on the market is animal health company Zoetis Inc's Penicillin G Procaine 50/100, which is fed to poultry in part to aid in weight gain.

The NRDC says the FDA twice laid out its concerns to that drug maker that the product failed to meet safety regulations. The unnamed original sponsor of the drug apparently disputed the regulators' findings, according to excerpts from a 1997 letter sent to the FDA and included in documents obtained by the NRDC.

A spokeswoman for Zoetis, a unit of Pfizer Inc that owns the drug today, said the company already is working to phase out use of the drug for growth promotion as part of the new FDA guidelines and is planning to relabel the drug for more limited purposes.

Once companies remove farm-production uses of their antibiotics from drug labels, it would become illegal for those drugs to be used for those purposes, Deputy FDA Commissioner Michael Taylor told reporters recently. Although the program is meant to be voluntary, Taylor said the FDA would be able to take regulatory action against companies that fail to comply.

In its statement on Monday, the FDA said it is "confident that its current strategy to protect the effectiveness of medically important antimicrobials, including penicillins and tetracyclines, is the most efficient and effective way to change the use of these products in animal agriculture."

NRDC attorney Avinash Kar, one of the study's authors, said the group's findings raise questions about whether regulators will be effective in enforcing the new guidelines.

"The FDA's failure to act on its own findings about the 30 reviewed antibiotic feed additives is part of a larger pattern of delay and inaction in tackling livestock drug use that goes back four decades," Kar told Reuters.

(Reporting By P.J. Huffstutter in Chicago and Brian Grow in Atlanta; Editing by David Greising, Amanda Kwan and Kenneth Maxwell)

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Attachment 26

April 2010

Still Poisoning the Well

Atrazine Continues to Contaminate Surface Water and Drinking Water in the United States

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THE EARTH'S BEST DEFENSE

About NRDC

The Natural Resources Defense Council (NRDC) is a national nonprofit environmental organization with more than 1.3 million members and online activists. Since 1970, our lawyers, scientists, and other environmental specialists have worked to protect the world's natural resources, public health, and the environment. NRDC has offices in New York City, Washington, D.C., Los Angeles, San Francisco, Chicago, Montana, and Beijing. Visit us at www.nrdc.org.

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Executive Summary

Watersheds and drinking water systems across the nation remain at risk for contamination from the endocrine-disrupting pesticide atrazine. An herbicide linked to harm to wildlife and humans, atrazine is the most commonly detected pesticide in U.S. waters. Although banned in the European Union in 2004, atrazine is still one of the most widely used pesticides in the United States.

In our 2009 report, *Poisoning the Well*, NRDC obtained and analyzed results of surface water and drinking water monitoring data for atrazine and found pervasive contamination of watersheds and drinking water systems across the Midwest and Southern United States. This new report summarizes scientific information that has emerged since the publication of our initial report. Findings based upon updated monitoring data on the presence of atrazine in surface water and drinking water draw attention to the continuing problem of atrazine contamination and the insufficient efforts by the EPA to protect human health and the environment.

Pervasive Contamination of Watersheds and Drinking Water Continues

Watersheds

Our analysis of the atrazine monitoring data taken from twenty watersheds between 2007 and 2008 confirms that surfaces waters in the Midwestern United States continue to be pervasively contaminated with atrazine.

- All twenty watersheds showed detectable levels of atrazine, and sixteen had average concentrations above 1 part per billion (ppb)—the level that has been shown to harm plants and wildlife.
- Eighteen of the monitored watersheds were intermittently severely contaminated with at least one sample above 20 ppb. Nine had a peak concentration above 50 ppb, and three watersheds had peak maximum concentrations exceeding 100 ppb.
- The Big Blue River watershed in Nebraska had the highest maximum concentration of any watershed tested—147.65 ppb, detected in May 2008.

Drinking Water

NRDC also analyzed atrazine monitoring data taken between 2005 and 2008 from drinking water systems located all across the United States. Our analysis paints an equally disturbing picture about drinking water contamination.

- 80 percent of the raw water (untreated) and finished water (ready for consumption) samples taken in 153 drinking water systems contained atrazine.

Atrazine has been detected in watersheds and drinking water systems across the Midwest and Southern United States. View maps of atrazine contamination online at **www.nrdc.org/health/atrazine/**

- Of the 153 drinking water systems monitored, 100 systems had peak maximum concentrations of atrazine in their raw water that exceeded 3 ppb. Two-thirds of these 100 systems also had peak maximum concentrations of atrazine that exceeded 3 ppb in the finished water.
- Six water systems had high enough atrazine levels to exceed the EPA drinking water standard of 3 ppb.

These results represent only a sampling of public water systems in the United States. Thousands more drinking water systems may be unknowingly contaminated with atrazine, since the federal government only requires monitoring four times a year—compared to the more frequent weekly and bi-weekly monitoring data that we analyzed here. As such, the full extent of atrazine contamination of watersheds and drinking water systems across the United States is unknown.

Harm from Atrazine Exposure is Well Documented

The dangers associated with atrazine use have been well documented, and scientific data continue to emerge that further bolster the health concerns associated with atrazine exposure. The pesticide is an endocrine disruptor, impairs the immune system, and is associated with birth defects. The adverse effects of exposure to atrazine are particularly harmful during critical periods of development. And in the presence of other pesticides, atrazine works synergistically to increase the toxic effects stemming from expose to the harmful chemicals.

Current Regulations Do Not Adequately Protect Human Health

Two statutes principally govern the regulation of atrazine. Under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), the EPA allows atrazine use both in agriculture (such as on corn, sorghum, and sugarcane) and at home (such as on lawns). Under the Safe Drinking Water Act, the EPA regulates the amount of atrazine that is allowed in drinking water. Specifically, only 3 ppb of atrazine (calculated based on a running annual average) is permitted in finished drinking water. NRDC believes a running annual average approach for drinking water is inadequate to protect human health, because even one-time exposures to developmental toxins like atrazine during critical periods of development may cause harm.

Our analysis of the data reinforces the fact that the monitoring schedule, set by the drinking water regulations, fails to guard against high spikes in atrazine levels or even ensure that the EPA's annual average limit on atrazine contamination is not being exceeded. Because public water systems are only required to take one to four samples per year, they are likely to miss a lot of the high spikes that we found. This means both that the EPA is ignoring high spikes of atrazine in drinking water and that the running annual average of atrazine in a system may actually be higher than suggested by four samples. Even short-duration exposures to atrazine should be regulated by the EPA.

Atrazine Use Imposes High Costs on Drinking Water Systems

Several studies have concluded that atrazine use provides only minimal benefits to crop production. On the other hand, the cost of treating drinking water for atrazine can add high costs to municipalities that have to install expensive treatment technology to remove the contaminant. Small systems located around agricultural areas where atrazine is frequently used may be particularly vulnerable to contamination problems and must spend a significant portion of their budgets to protect their customers from atrazine exposure. Water systems spend tens of thousands of dollars per year to maintain treatment systems that remove contaminants such as atrazine.

Recommendations for Reducing Atrazine Contamination

NRDC called for the phase-out of atrazine because of its harm to wildlife and potentially to people and because it has minimal or no benefits for crop production. Programs to improve water monitoring and encourage farmers to reduce their atrazine use are important next steps for addressing the problem of atrazine contamination while the EPA helps farmers transition away from the use of this pesticide altogether. NRDC recommends the following steps be taken to reduce atrazine contamination in U.S. waters

and minimize its impacts on human health and the environment:

1. The United States should phase out the use of atrazine.
NRDC strongly recommends that atrazine be phased out of all uses in the United States, including home gardens and golf courses. Evidence of atrazine's toxic effects on sensitive wildlife species and its potential risk to human health is abundant. The monitoring data show that high contamination levels in the Midwestern and Southern United States are pervasive. There is little compelling evidence that atrazine is needed by farmers.

2. Farmers should take immediate interim steps to reduce their atrazine use.
Farmers should take immediate steps to reduce their use of atrazine, including increasing reliance on a variety of non-chemical techniques for weed control. These include crop rotation, the use of winter cover crops, alternating rows of different crops, and mechanical weed control methods. Additionally, timing fertilizer applications to coincide with periods of greatest nutrient uptake by crops can avoid unnecessary fertilizer use that would fuel weed growth.

3. The EPA should monitor all vulnerable watersheds and require all future monitoring plans to identify worst case scenarios.
The EPA should broaden the monitoring program to assess all watersheds identified as vulnerable. The monitoring data in this update represent less than 2 percent of all the watersheds that are at highest risk from atrazine contamination. Future monitoring plans should be designed to identify the worst case scenarios occurring in vulnerable watersheds and in public water systems. More frequent sampling and sampling after big rainstorms and after fields have been treated with atrazine is necessary to assess the impacts of atrazine use on waterways. Such monitoring would provide a much more realistic view of the actual severity of the atrazine problem.

4. The EPA should publish monitoring results for each watershed and public water system sampled.
Monitoring results on the watersheds and the public water systems that were sampled under the two different monitoring programs were first made available to NRDC through Freedom of Information Act (FOIA) requests and litigation. People who live downstream of atrazine-treated fields have a right to know about high levels of atrazine contamination in their watersheds or drinking water systems. A publicly available website posting sampling data as it is analyzed and that regularly reports spikes of atrazine contamination would be an important step in the right direction, providing accessible information to the public. An interactive map of the data used in *Poisoning the Well* on NRDC's website allows users to see both watershed and drinking water data closest to their homes in graphical form.[1] This format is an example of what the EPA could do.

5. The public should use home water filtration systems and demand transparency of information from their water utilities.
NRDC recommends that consumers concerned about atrazine contamination in their water use a simple and economical household water filter, such as one that fits on the tap. Consumers should make sure that the filter they choose is certified by NSF International to meet American National Standards Institute (ANSI) Standard 53 for atrazine. A list of NSF/ANSI53-certified drinking water filters is available at www.nsf.org/certified/dwtu.

CHAPTER 1

A Fresh Look at the Harmful Effects of Atrazine

In our original 2009 report, *Poisoning the Well: How the EPA is Ignoring Atrazine Contamination in Surface and Drinking Water in the Central United States,* NRDC described the well-documented problems caused by exposure to atrazine, including hormone-disruption and immune system impairment in animals, and potentially in humans. Additional studies have since been published that further strengthen our conclusion that atrazine is harmful to wildlife and should not be in our waterways or drinking water. In this update, NRDC reviews new scientific studies that provide further evidence of the harmful effects of atrazine exposure to people and wildlife.

Atrazine Harms the Hormone System

At least four scientific studies published in late 2009 offer significant new laboratory evidence that atrazine interferes with normal hormone function, including reduced sperm production, reduced steroid production, and insulin resistance. One study reported an increase in male steroid hormones associated with a single-dose of atrazine in male rats.[1] In another study, male rats that ate atrazine-laced feed had significantly less sperm than rats not fed atrazine, even after only one or two weeks of eating the contaminated feed.[2] Importantly, the damaging effect on sperm production was dose-dependent; the more atrazine the rats ate, the lower their sperm count. While a dose-response relationship does not prove the existence of a causal relationship, its presence increases the scientific confidence that the outcome (in this case, hormone effects) is caused by the treatment (atrazine).

A third study documented a dose-dependent decrease in male hormone levels in the testicles of rats that ate atrazine-contaminated feed.[3] A fourth study reported effects of atrazine on a different hormone system leading to insulin-resistance and obesity after lab rats drank atrazine-laced water daily for five months.[4]

Adding to these findings, in early 2010, well-known frog expert Dr. Tyrone Hayes published a startling study. He reported that 10 percent of male frogs that were born and raised in water contaminated with only 2.5 ppb atrazine (less than the federal allowable standard for drinking water of 3 ppb) grew up with female sex characteristics, including reduced levels of male testosterone, reduced sperm levels, and eggs in their testes.[5] Even more disturbing, these atrazine-feminized males showed female mating behavior, attracted normal males, mated with them, and

produced viable larvae that grew into male frogs. Although scientists employed by Syngenta (the manufacturer of atrazine) have strongly criticized the study,[6, 7] Hayes' findings are in general agreement with other reports in the scientific literature and cannot be discounted.

A 2010 article published by University of South Florida researchers analyzed the findings of more than 125 independently published research studies of atrazine effects on freshwater fish and amphibians.[8] Their meta-analysis found that many of the studies reported the same health outcomes, even though the studies were in several wildlife species and used different research methods.[9] In particular, atrazine affected the hormone systems of freshwater fish and amphibian species in most studies, including effects such as altered time of metamorphosis (delayed in some studies and accelerated in other studies), impaired sperm production, and abnormal gonadal development. The consistent finding of endocrine disruption effects of atrazine across diverse species and in different independent studies strengthens the conclusions of each experiment and increases the scientific confidence that the findings are generally true.

Atrazine Harms the Immune System

In addition to the hormone effects identified in the meta-analysis mentioned above, the review paper by Rohr and McCoy also reported that atrazine caused impaired immune function and increased infection rates in aquatic wildlife living in atrazine-contaminated water.[10]

Furthermore, atrazine has been shown to act synergistically with other chemicals to increase their toxic effects by impairing the immune system. In a 2009 study, when tiger salamander larvae were raised for two weeks in water containing atrazine (20 or 200 ppb) or the pesticide chlorpyrifos (2, 20, or 200 ppb), no increase in deaths was observed.[11] However, when the larvae were exposed to the combination of atrazine and chlorpyrifos together, there was a significant increase in larval deaths from increased viral infection and disease. This study suggests that the two chemicals acting together can harm immune function more than either one alone. This finding is significant both because it is common for several pesticides to be found in waterbodies together and because many pesticide products, including atrazine, are packaged and sold as pesticide mixtures.

Atrazine May Increase Risk of Poor Birth Outcomes

New evidence links atrazine to poor birth outcomes in people. A 2009 study found a significant correlation between prenatal atrazine exposure and reduced body weight at birth.[12] The authors reviewed the birth records of more than 24,000 babies born in Indiana and localized each birth to the particular community water system where the mother lived. Their analysis showed that the mothers with the highest concentrations of atrazine in their tap water (above 0.7 ppb) for the duration of the pregnancy had a higher risk of having a baby with a low birth weight than those mothers with lower exposures (below 0.3 ppb). Low birth weight is associated with increased risk of infant illness and some diseases, such as cardiovascular disease and diabetes.[13]

Another 2009 study analyzed more than 30 million births across the United States and reported an increased risk of birth defects associated with mothers who became pregnant between April and July, when pesticides in waterways are at their highest levels.[14] The authors reported that among the pesticides monitored in the waterways, the risk was most closely associated with atrazine contamination. While this study did not measure drinking water levels specifically, the fact that the risk is highest when conception is timed with peak pesticide contamination in rivers and streams raises red flags. In 2007, a study found a significant association between atrazine water contamination levels and birth defects in the gut wall of newborn babies in Indiana.[15] In fact, this study found that the rate of this particular birth defect is higher in Indiana than the rate across the country. Although there are many water contaminants other than pesticides, such as pharmaceutical waste, that are likely to cause reproductive harm in Indiana and elsewhere, these other contaminants would not necessarily be expected to show the seasonal peaks that are found with agricultural use of pesticides.

These studies suggest that, in people, atrazine exposure during pregnancy may contribute to a higher risk of adverse birth outcomes when considered along with genetic factors and other environmental contaminants.

Farmers and Workers May Be Exposed To Unsafe Levels

A recent study of Iowa farmers reported finding atrazine metabolites in the urine of farmers who had recently applied atrazine, proving that they had been dosed with the pesticide.[16] Previous scientific studies have linked atrazine urine levels in farm workers and rural men to reproductive effects such as low sperm count and reduced sperm motility.[17, 18, 19] Interestingly, the Iowa study reported that the amount of pesticide in the urine was related to the amount applied to the field. As such, significantly reducing the amount of atrazine applied (or phasing out its use altogether) would presumably provide an immediate positive effect for farmers by reducing the contamination of their bodies.

CHAPTER 2

Revisiting the Problem of Atrazine Contamination

In *Poisoning the Well* NRDC analyzed surface water data collected between 2004 and 2006 and drinking water data collected in 2003 and 2004 from watersheds and water systems across the Midwestern and Southern United States pursuant to a U.S. Environmental Protection Agency (EPA) mandate. Unfortunately, little has changed in the way atrazine is regulated and overdue changes in how the government monitors for atrazine contamination and attempts to protect public health have not yet occurred.

NRDC's Original Analysis Showed Contamination of Watersheds and Drinking Water

NRDC's original report found that the surface waters of the Midwestern and Southern United States suffer from pervasive contamination with atrazine.[1] In fact, all 40 watersheds tested showed detectable levels of atrazine, and 25 had average concentrations above 1 ppb, the concentration at which the primary production of aquatic non-vascular plants (such as algae) is reduced. We determined that the watersheds with the 10 highest peak concentrations of atrazine were in Indiana, Missouri, and Nebraska. We also noted that some watersheds had at least one sample of very high atrazine levels (ranging from 50 ppb to more than 200 ppb).

Our previous analysis of drinking water data also revealed high levels of atrazine contamination in the drinking water in some public water systems.[2] More than 90 percent of the samples taken in 139 water systems had measurable levels of atrazine in both 2003 and 2004. Fifty-four water systems had a one-time peak atrazine concentration above 3 ppb.

Poisoning the Well revealed that while water systems could claim to be in compliance with the 3 ppb annual average limit for atrazine in drinking water under the Safe Drinking Water Act when calculated using a running annual average, more frequent monitoring showed that some systems actually exceeded the federal standard. In fact, three of the systems analyzed had running annual averages that exceeded 3 ppb. The EPA only requires systems to take between one and four samples per year to determine whether they comply with the standard. As a result, high spikes of atrazine that last for a few weeks can easily be missed. Another problem with the EPA's reliance on a running annual average is that it allows high spikes of atrazine in spring or summer to be offset by low or zero detections in the fall and winter. This update to last year's report reconfirms the danger posed by the unabated and

widespread atrazine contamination of surface and drinking water in the United States and the EPA's continued reliance on running annual averages that are based upon too few samples each year.

Action Undertaken by the EPA Remains Inadequate

In its 2006 final re-registration decision for atrazine, the EPA acknowledged concerns about human exposure to atrazine. The EPA classified the chemical as a Restricted Use Pesticide because of its hazard to ground and surface water.[3] As a result, atrazine can only be applied by a pesticide professional; however, there is an exception for lawn care, turf, and conifer trees, allowing homeowners to apply it themselves. According to the EPA's own assessment, this exception may, nonetheless, lead to unsafe exposures that exceed its "level of concern" for homeowners who apply the products to their lawns.[4] The EPA also expressed concern that children who play on atrazine-treated lawns are also at risk for potentially unsafe exposures.[5]

The EPA found that workers, including farmers, who mix, load, and apply pesticides, like atrazine, also risk unsafe exposures. It found that exposures can result from accidental spills and splashes onto the skin or clothing, or inhalation of fumes and small droplets when the chemical is being applied to the field. It noted that exposure can even occur when those applying the chemicals follow all the label requirements for using protective clothing and equipment.[6]

The EPA also acknowledged concerns about the adverse effects that atrazine can have on wildlife. After washing from the field into streams and rivers with rainfall, atrazine kills algae and other beneficial aquatic plants that provide food, shelter, and oxygen for aquatic animals. The EPA has found, for example, that the effects of atrazine on aquatic ecosystems "may be severe due to the loss of up to 60 to 95 percent of the vegetative cover, which provides habitat to conceal young fish and aquatic invertebrates from predators."[7] The EPA assessment goes on to note that "numerous studies have described the ability of atrazine to inhibit photosynthesis, change community structure," and kill aquatic plants at concentrations between 20 and 500 ppm.[8]

The EPA's conclusions likely underestimate the true extent of the problem. As part of ongoing consultations under the federal Endangered Species Act, both the U.S. Fish and Wildlife Service and the National Marine Fisheries Service have concluded that atrazine concentrations below these levels are likely to have negative effects on aquatic plant communities, which have negative effects on threatened and endangered species.[9]

Moreover, the approved agricultural application rates for atrazine are likely to result in adverse effects to many endangered species. For example, the EPA determined that an application rate of 1.1 or 1.2 pounds of atrazine per acre on corn or sorghum fields is unsafe (that is, it exceeds the EPA's acute toxicity level of concern) for some endangered aquatic invertebrates, endangered aquatic vascular plants, and endangered small herbivore mammals.[10] Yet, the maximum legal application rate is four pounds of atrazine per acre for sugarcane, and two pounds per acre for corn and sorghum. Even if typical use rates for these crops were half of the maximum legal rate, they would still lead to unsafe exposures for many plants and aquatic animals.

CHAPTER 3

Atrazine Contamination Continues to be a Widespread Problem

Poisoning the Well was based on our analysis of data collected by the atrazine manufacturer Syngenta in selected watersheds under the Ecological Watershed Monitoring Program and from drinking water systems under the Atrazine Monitoring Program. The EPA had required Syngenta to collect these data rather than issue a rulemaking to reduce the use of atrazine. Findings in our 2009 report were based on watershed data collected between 2004 and 2006 and drinking water data collected between 2003 and 2004.[1]

For this update, we analyzed the Ecological Watershed Monitoring Program data collected by Syngenta between 2007 and 2008 from 20 watersheds in Illinois, Indiana, Missouri, Nebraska and Ohio. Data was collected from early spring through the summer or fall.[2] Watersheds were chosen for monitoring in these two years based on earlier monitoring results obtained from 2004 to 2006 that showed elevated levels of atrazine approaching or exceeding the EPA's level of concern.[3] Some additional watersheds were chosen within or near those watersheds with high atrazine levels.

We also analyzed the Atrazine Monitoring Program drinking water data collected from 2005 to 2008.[4] During this period, Syngenta collected more than 35,000 water samples taken from 153 public water systems in 12 states. The water systems are located in California (2), Florida (4), Illinois (30), Indiana (13), Iowa (9), Kansas (31), Kentucky (4), Louisiana (4), Missouri (20), North Carolina (3), Ohio (22) and Texas (11). Testing was concentrated in the Midwest, where atrazine use is most common. Both raw water (untreated) and finished water (water ready for human consumption) were tested.[5]

Our updated analysis shows continuing pervasive contamination—at levels of concern—of both watersheds and drinking water that remains consistent with our original findings.

Watersheds Are Still Pervasively Contaminated with Atrazine

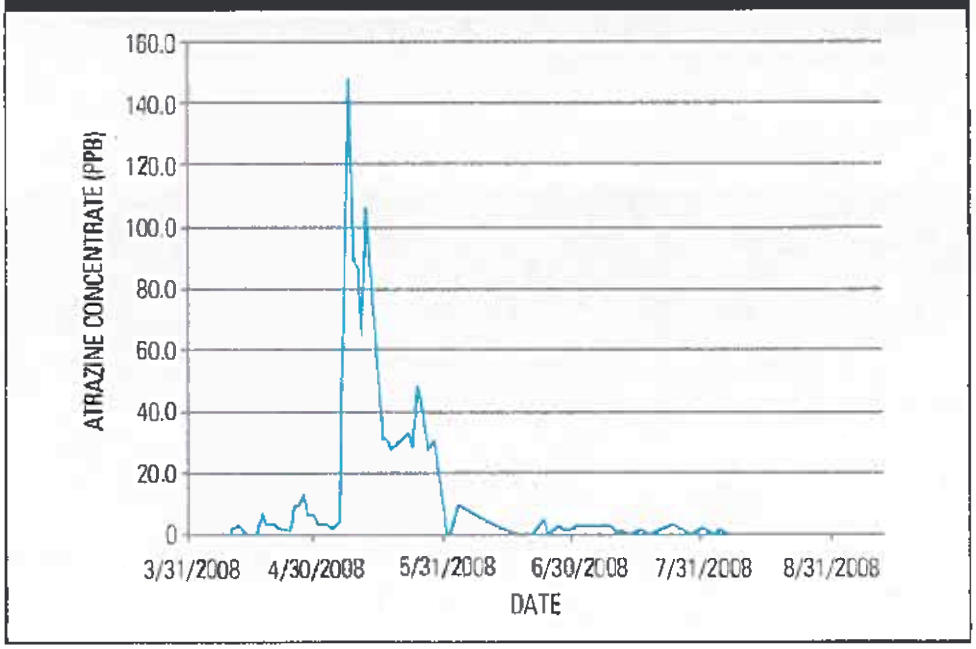
Many of the watersheds monitored showed high atrazine spikes well in excess of levels that are harmful to plants and wildlife. High atrazine concentration spikes were found to be widespread: 18 watersheds

had atrazine spikes above 20 ppb, and nine had spikes of 50 ppb or more (see Table 1 for the monitoring results from all twenty watersheds). The Big Blue River watershed (in upper Gage County, Nebraska) showed the highest maximum peak concentration of atrazine with 147.65 ppb in May 2008. More alarmingly, this high peak concentration lasted twelve days during which atrazine concentrations ranged from 27.92 ppb to 147.65 ppb (see Figure 1).

Table 1: Atrazine concentrations in all 20 monitored watersheds, 2007 – 2008

Watershed	Sampling Year	Number of samples	Atrazine Concentration (ppb)	
			Max.	Annual Avg.
Spring Creek, IL	2007	124	3.25 (6/2/07)	0.36
Iroquois River, IL	2007	139	12.69 (4/26/07)	0.84
Horse Creek, IL	2007	105	42.77 (5/16/2007)	2.41
Vermilion River, North Fork, IN	2007	101	12.15 (4/25/2007)	0.43
Little Pigeon Creek, IN	2007	88	2.95 (8/4/2007)	0.33
	2008	174	27.12 (5/3/2008)	1.10
Little Pigeon Creek, subwatershed, IN	2007	61	1.44 (4/27/2007)	0.30
	2008	155	15.10 (5/3/2008)	1.11
South Fabius River, MO	2007	102	91.60 (6/2/2007)	5.02
	2008	47	62.75 (6/3/2008)	2.03
South Fabius River, MO upstream	2008	192	78.20 (6/3/2008)	1.98
Youngs Creek, MO	2007	120	16.18 (4/26/2007)	2.33
	2008	225	56.60 (5/26/2008)	2.73
Seebers Branch, South Fabius River, MO	2007	124	65.73 (4/26/2007)	2.05
	2008	220	144.69 (5/12/2008)	4.20
Main South Fabius River, MO	2007	121	42.97 (5/4/2007)	2.00
	2008	219	33.60 (6/3/2008)	1.43
Long Branch, MO	2007	126	21.08 (4/26/2007)	3.18
	2008	225	37.83 (6/9/2008)	2.02
Long Branch, MO, main	2008	207	36.23 (5/25/2008)	2.80
Big Blue River, Upper Gage, NE	2008	173	147.65 (5/8/2008)	9.12
Big Blue River, Upper Gage, NE; adjacent site	2008	184	116.03 (5/7/2008)	8.45
Muddy Creek, NE	2008	175	67.81 (5/30/2008)	2.49
Big Blue River, Lower Gage, NE	2008	200	82.80 (5/22/2008)	2.07
Big Blue River, Lower Gage, NE; adjacent site	2008	188	32.90 (5/24/2008)	2.32
Lower Muddy Creek, NE	2008	153	50.00 (5/30/2008)	2.25
Licking River, North Fork, OH	2007	128	9.90 (5/16/2007)	0.62

Figure 1. Atrazine concentrations in the Big Blue River watershed (upper Gage County, Nebraska), March – August 2008



However, the Big Blue River was not alone; other watersheds had lengthy spikes as well. The Seeber Branch of the South Fabius River in Missouri had a 13-day spike with concentrations ranging from 5 ppb to 144.69 ppb between May 11 and May 23, 2008. Youngs Creek, also in Missouri, had an 8-day spike in May 2008 with concentrations ranging from 9.85 ppb to 56.60 ppb.

Some atrazine was detected in the sampled streams in all watersheds, with annual average atrazine concentrations ranging from 0.3 ppb in a sub-watershed of Little Pigeon Creek in Indiana to 9.12 ppb in the Big Blue River watershed in upper Gage County, Nebraska. Sixteen of the 20 watersheds had annual average concentrations above 1 ppb, the level at which primary production in aquatic non-vascular plants is reduced and which is likely to cause adverse effects on the ecosystems in and around these streams.[6]

Atrazine Contamination of Drinking Water Continues to be a Problem

Our analysis of the updated drinking water data from the Atrazine Monitoring Program again showed that a surprising amount of drinking water is contaminated with atrazine. Based on more than 35,000 samples, we found that atrazine was detected in 80 percent of the samples.

For samples of raw water, 100 water systems had maximum peak concentrations of atrazine above 3 ppb. For samples of finished water, 67 water systems had concentrations of atrazine above 3 ppb. In Piqua City Public Water System in Ohio, there was a maximum peak concentration of atrazine in the raw water of 84.80 ppb and in the finished water of 59.57 ppb. While another Ohio system, Mt. Orab Village Public Water System, had a higher raw water reading, Piqua had by far the highest maximum peak concentration of atrazine in finished water.

More startling, six systems had atrazine concentrations that exceeded the EPA drinking water standard, which is based on a running annual average:

Wayaconda, Missouri; Piqua City Public Water System, Ohio; Versailles Water Works, Indiana; Evansville, Illinois; Blanchester Village, Ohio; and Beloit Water Department, Kansas..[7] Of those six systems, two had also exceeded the drinking water standard in 2003 - 2004 (Versailles Water Works, Indiana and Evansville, Illinois), demonstrating continuing problems with atrazine contamination. Table 2 shows the water systems with running annual averages above 3 ppb in either the raw or the finished water.

As we found in our analysis of the 2003 and 2004 monitoring data, some utilities are effectively treating the atrazine in their water, while others are not. For example, in the Mt. Orab water system in Brown County, Ohio, there was 227 ppb of atrazine in the raw water on May 23, 2006. Due to a history of high levels of atrazine in Sterling Run Creek (the source water), Mt. Orab tests the water from the creek before pumping it into its reservoirs to avoid water with a high atrazine content. As a result of this testing and the installation of activated carbon filters, the atrazine concentration in the finished water has remained low – below 0.3 ppb.[10] When on May 23, 2006 the 227 ppb spike was detected in the raw water, the finished water had no detectable atrazine.

Other water systems also are successfully reducing high levels of atrazine in their water. For example, the Nashville water system in Washington County, Illinois uses powdered activated carbon to remove atrazine.[11] The monitoring data show that Nashville's raw water has had high levels of atrazine over the years, but atrazine levels in the system's finished water have remained below 1 ppb (see Figure 2).

Table 2. Water systems with annual running averages of atrazine above 3 ppb in raw or finished water, 2005 – 2008

Name of monitoring site	State	County	Population Served[8, 9]	Highest running annual average (ppb)	
				Raw Water	Finished Water
Mt. Orab Village Public Water System	Ohio	Brown	3,565	19.59	0.12
Wyaconda	Missouri	Clark	385	11.24	4.05
Piqua City Public Water System	Ohio	Miami	20,883	7.09	3.11
Versailles Water Works*	Indiana	Ripley	1,784	5.24	4.83
Nashville Water Plant	Illinois	Washington	3,320	4.79	0.15
Mt. Olive Water Works	Illinois	Macoupin	2,150	4.45	2.59
Clermont Co. Water	Ohio	Clermont	101,402	4.15	1.15
Evansville*	Illinois	Randolph	740	4.08	4.44
Kaskaskia Water District	Illinois	St. Clair	12,586	4.08	1.29
Blanchester Village	Ohio	Clinton	4,500	3.95	6.67
Wayne City	Illinois	Wayne	1,370	3.70	0.66
Carthage Public Utilities	Illinois	Hancock	2,725	3.64	0.84
Winterset Water Treatment Plant	Iowa	Madison	4,768	3.40	0.56
McClure Water Treatment Plant	Ohio	Henry	850	3.23	2.74
Coulterville Water Treatment Plant	Illinois	Randolph	1,300	3.02	1.09
Beloit Water Department	Kansas	Mitchell	3,639	2.21	3.48

*This system also had a running annual average above 3 ppb in 2003 or 2004.

Figure 2. Atrazine concentration in raw and finished water, Nashville water system (Illinois), 2005 – 2008

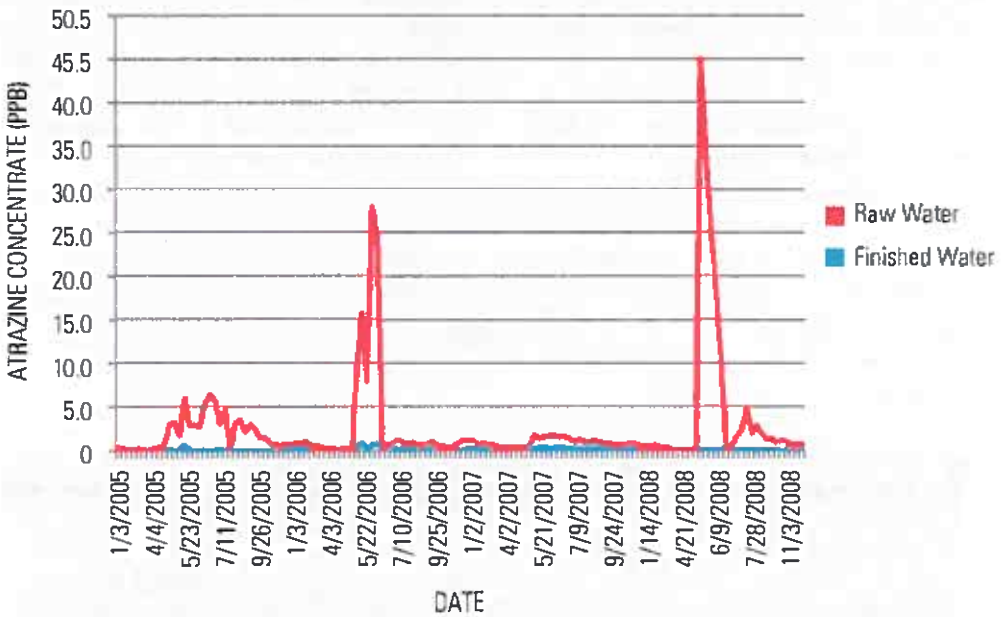


Figure 3. Atrazine concentration in raw and finished water, Blanchester water system (Ohio), 2005 – 2008

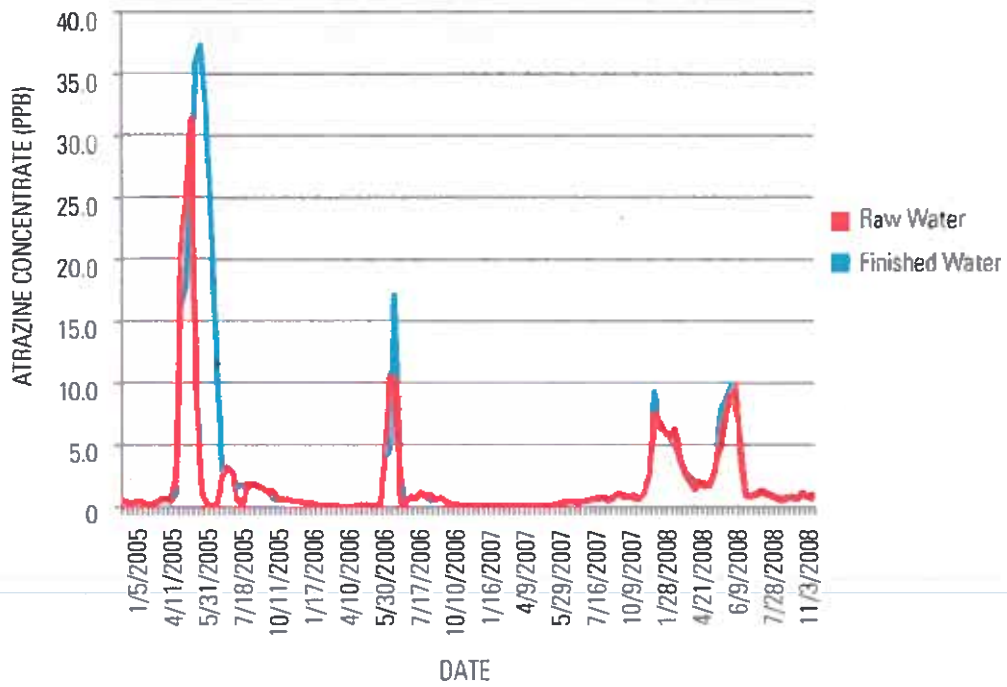


Table 3. Water systems with the highest peak atrazine concentration in raw water

Public water system	State	Date	Maximum Atrazine Concentration (ppb)		Concentration of next sample in raw water (ppb)*	Number of weeks that concentration exceeded 3 ppb
			Raw water	Finished water		
Mt. Orab Village Public Water System	Ohio	5/23/2006	227.00	0.00	65.6	2 weeks
Piqua City Public Water System	Ohio	4/25/2005	84.80	59.57	35.29	12 weeks
Kaskaskia Water District	Illinois	4/25/2005	57.98	14.73	13.32	6 weeks
Baxter Springs Water Treatment Plant	Kansas	4/25/2005	56.74	4.60	5.55	1 week
Nashville Water Plant	Illinois	5/12/2008	44.92	0.07	34.0	4 weeks
Mc Clure Water Treatment Plant	Ohio	6/3/2008	42.89	33.83	13.26	4 weeks
Monroeville Village	Ohio	6/23/2008	37.28	0.03	5.58	1 week
Coulterville Water Treatment Plant	Illinois	6/9/2008	35.50	1.88	0.83	2 weeks prior to peak
Thibodeaux Water Works	Louisiana	5/31/2005	34.75	11.25	0.38	—
Mt. Olive Water Works	Illinois	6/9/2008	33.40	16.47	16.54	10 weeks

* All readings taken 7 days after the peak, except Mt. Orab which was taken 8 days later.

Unfortunately, not all systems have such effective treatments for atrazine. For example, the concentration of atrazine in the raw water and the finished water very closely mirrored one another in the water system in Blanchester, Ohio (see Figure 3). Four years of sampling data indicate that overall the system is not effectively treating for atrazine.

It is also interesting to note that some systems had running annual average concentrations in finished water that were higher than the concentrations in raw water (such as the Blanchester water system). This result may be due to the fact that samples of raw water are taken at different times than samples of finished water, so that high spikes in raw water are not detected, which further underscores that more frequent testing would catch high peak concentrations that may otherwise be missed.

To see the sampling results for all drinking water systems monitored between 2005 and 2008, see the Appendix.

High Peak Concentrations of Atrazine Endanger Human Health

High, seasonal peak concentrations of atrazine are just as important—if not more so—than the annual average level. Exposure to high levels of hormone-disrupting chemicals such as atrazine during key windows of development are associated with permanent developmental and reproductive effects.[12, 13, 14] Therefore, atrazine spikes in the finished water of public water systems—such as the spikes shown on Table 4—are a public health concern, especially to vulnerable populations, such as fetuses, infants, and children.

Table 4. Water systems with the highest peak atrazine concentration in finished water

Public water system	State	Date	Maximum atrazine concentration in finished water (ppb)	Next reading	Number of weeks that concentration exceeded 3 ppb
Piqua City Public Water System	Ohio	4/25/2005	59.57	27.09	1 week
Beloit Water Department	Kansas	5/27/2008	41.61	9.72	1 week
Blanchester Village Public Water System	Ohio	6/6/2005	37.30	31.90	3 weeks
Mc Clure Water Treatment Plant	Ohio	6/3/2008	33.83	11.95	3 weeks
Versailles Water Works	Indiana	5/23/2005	30.48	28.95	7 weeks
Flora Water Treatment Plant	Illinois	5/23/2005	30.48	6.67	1 week
Evansville	Illinois	5/2/2005	25.75	9.57	4 weeks
Logansport Municipal Utility	Indiana	6/2/2008	20.94	6.90	1 week
Caney Water Treatment	Kansas	4/10/2006	19.90	3.24	1 week
Delaware Water Plant	Ohio	5/2/2005	19.33	5.40	1 week

As noted earlier, high peak concentrations of atrazine in the finished water are not necessarily detected by the "routine" monitoring required by the EPA to show compliance with drinking water regulations. As a result, some systems that are shown to comply with the federal standard may actually have annual concentrations of atrazine that exceed the limit. For example, in both 2005 and 2006, the state of Ohio reported no violations of the federal drinking water standard for atrazine; however, based on the more frequent monitoring under the Atrazine Monitoring Program, two different systems in Ohio had running annual average concentrations of atrazine that exceeded 3 ppb.[15] Therefore, showing compliance with the federal standard does not necessarily indicate that a drinking water system provides water that has an annual average concentration below 3 ppb.

Continued Atrazine Use Brings High Economic Costs

As discussed in our 2009 report, atrazine use brings little economic benefit to farmers. A study by the U.S. Department of Agriculture suggests that if atrazine were banned in the United States, the loss of corn yields would be only about 1.19 percent, while corn acreage would be reduced by only 2.35 percent.[16,17] An analysis by Tufts University economist Dr. Frank Ackerman of three other studies that estimated higher corn losses found them to be limited by serious methodological problems.[18] Additionally, Ackerman found that despite a ban on the use of atrazine in Italy and Germany (both corn-producing nations) since 1991, neither country has recorded any significant economic effects. Indeed, there was "no sign of [corn] yields dropping in Germany or Italy after 1991, relative to the U.S. yield—as would be the case if atrazine were essential" and "[f]ar from showing any slowdown after 1991, both Italy and (especially) Germany show faster growth in harvested areas after banning atrazine than before." Based on this analysis, Ackerman concluded that if "the yield impact is on the order of 1%, as USDA estimated, or close to zero, as suggested by the newer evidence discussed here, then the economic consequences [of phasing out atrazine] become minimal."[19]

The cost of reducing the negative impacts stemming from atrazine use, however, is not trivial. Installing additional water treatment systems and taking other measures to reduce atrazine contamination could overwhelm the already overtaxed resources of cities, towns, and utilities charged with providing safe and clean water to the public. Water systems facing elevated levels of atrazine may need to install granulated

activated carbon (GAC) filters to reduce levels of this pesticide, which can be a large expense. For example, the Mt. Orab water system in Ohio produces 372,000 gallons of drinking water per day for about 3,600 people. It has experienced the highest atrazine spikes in its source water among those systems analyzed in this report. To treat this water, Mt. Orab spends $50,000 per year just on carbon replacement for its GAC filters; that figure does not include the cost of purchasing the system or performing other needed maintenance.[20] This level of expense may be expected for any system dealing with atrazine contamination. The small systems taking water from areas surrounded by agricultural lands on which atrazine is used may be most vulnerable to the contamination and be faced with paying these high costs.

CHAPTER 4

Recommendations for Curbing Atrazine Contamination

The contamination of watersheds and drinking water with atrazine around the United States continues to be a problem. Exceedingly high levels are still being detected, levels which are likely having significant effects on wildlife populations and potentially adverse health effects on humans. The few benefits of using atrazine combined with the high cost of treating atrazine-contaminated water further reinforces NRDC's original recommendations.

Recommendation #1: The U.S. EPA Should Phase Out the Use of Atrazine

Atrazine is not agriculturally necessary and does not produce economic benefits that justify its ecological and human health risks. In 2006, the EPA chose not to prohibit the use of atrazine, opting instead to require more monitoring. The results are in, and they show that atrazine contamination of drinking water sources is pervasive and occurs at concentrations that many affected water systems are unable to reduce to safe levels. In early 2010, the EPA began reexamining the data on atrazine. The EPA should take the next logical step to protect public health by removing atrazine from store shelves and curbing its release into our soil and waterways.

Recommendation #2: Farmers Should Be Encouraged to Take Interim Steps to Reduce Their Atrazine Use

Farmers often choose to use atrazine and other pesticides not because they are more effective than other farming methods, but because they are familiar and cheap. Fortunately, there are concrete steps that many farmers are already taking to reduce their use of atrazine and other pesticides. Some farmers are reporting to us that they routinely use only half the amount of atrazine that the label allows, and it is just as effective. Encouraging farmers to follow these leaders and reduce atrazine application rates, especially by using targeted spraying or by applying atrazine in a narrow band in crop rows, is both effective and a money-saver.[1] Other sustainable practices, such as applying atrazine after the corn has emerged, could reduce runoff by half.[2]

Using Integrated Pest Management (IPM) approaches for weed management relies on weed prevention, field monitoring, and the use of effective lower risk control methods. Farmers set an action threshold—the point at which the number of weeds reaches a level that indicates that control is necessary. Control methods are utilized only when the action threshold is exceeded. Controls could include mechanical and natural methods of weed control, and

low-risk pesticides. Conventional pesticides are used only as a last resort.[3] IPM techniques may include:

- **Cover Crops:** Winter cover crops are a prevention strategy that can greatly reduce weed growth by competing with weeds for light, water, and nutrients, and protect soil from erosion. Legumes used as cover crops can also increase nitrogen in the soil.[4]
- **Mechanical Weed Control Methods:** Rotary hoes can be used after weed seeds have germinated, but before the weeds emerge, to significantly reduce weed growth; cultivators can remove emergent weeds before they become established.[5]
- **Delayed Fertilizer Application:** Delaying application of half of the fertilizer used on corn crops until after the ears emerge can deprive weeds of nutrients during key periods of growth, while ensuring that these nutrients are available to the crop when it is best able to absorb them.[6,7]
- **Intercrops:** Alternating rows of different crops helps reduce weeds and results in higher crop yields.[8]
- **Crop Rotation:** Weed density and pesticide use can be reduced substantially by shifting from a two-year corn/soy rotation, typical of Midwestern agriculture, to a multispecies three- or four-year rotation that adds species such as alfalfa and oat.[9, 10]

Recommendation #3: The EPA Should Monitor All Vulnerable Watersheds and Require All Future Monitoring Plans to Identify Worst Case Scenarios

Although the EPA identified 1,172 watersheds that are at highest risk from atrazine contamination, the monitoring data set included samples from only twenty watersheds. Any future monitoring plans should be designed to identify the worst case scenarios occurring in vulnerable watersheds and in public water systems. Monitoring programs should be designed to increase the chances of detecting contamination if it exists. This would include requiring samples to be taken within a certain time after big rainstorms and after fields have been treated with atrazine, which would increase the likelihood of determining the severity of the atrazine problem.

Recommendation #4: The EPA Should Publish Timely Monitoring Results for Each Watershed and Public Water System Sampled Online in a User-Friendly Format

Monitoring results on the watersheds and the public water systems that were sampled under the two different monitoring programs were first made available to NRDC through Freedom of Information Act requests and through litigation by NRDC. However, the public has a right to know if there is an atrazine problem which they must treat, especially people who live downstream of atrazine-treated fields and who may have sensitive individuals—such as pregnant women and infants—in their households. A publicly available website with a searchable database posting sampling data as they are analyzed, or even regular reports about spikes of atrazine contamination, similar to the interactive map produced by NRDC,[11] would make this information more accessible to the public than the EPA's current method of posting large data files in an EPA docket. Furthermore, the data should be presented comprehensively, rather than just in summary form. For example, drinking water systems that have been monitored must be identified by name, along with the monitoring results.

Recommendation #5: The Public Should Use Home Water Filtration Systems and Demand Transparency of Information from Their Water Utilities

NRDC recommends that consumers who are concerned about atrazine in their drinking water use a water filter certified by NSF International to meet NSF/American National Standards Institute (ANSI) Standard 53 for atrazine reduction. This standard includes some faucet-mounted charcoal filters. While filters that meet this certification do not always eliminate atrazine entirely, certified filters earning the NSF certification are able to reduce atrazine levels in drinking water from 9 ppb of atrazine to 3 ppb.[12]

Appendix: Still Poisoning the Well

Presented here are all the results from our analysis of the Atrazine Monitoring Program broken down by state. Samples of raw and finished water were taken from each system throughout the monitoring period and analyzed for atrazine concentration. We have reported on the highest annual running average calculated for each system in both the raw water and the finished water. We have also calculated the highest concentration of atrazine detected throughout the monitoring period in both the raw water and the finished water.

Because it is based on a running annual average, high peak concentrations of atrazine may not result in a violation of the federal standard if the remainder of the year had low or no detections of atrazine.

Atrazine concentrations in public water systems, 2005 - 2008

Name of monitoring site[1]	State	Population served[2]	Maximum atrazine concentration (ppb)		Years sampled	Number of sampling dates
			Raw Water	Finished Water		
Stockton East	CA	50	0.025	0.025	2007	27
Stockton East New Melones Reservoir	CA	50	0.025	0.025	2007	14
Sumner Hills	CA	N/A	0.025	0.025	2007	29
Belle Glade	FL	N/A	1.22	1.31	2007	38
Lee County	FL	224,840	0.98	0.09	2007	37
Peace River	FL	3,301	0.12	0.05	2007	38
Punta Gorda	FL	29,561	0.34	0.27	2007	37
Centerville Municipal Water Works	IA	5,924	2.18	49	2005 - 2006	49
Chariton Municipal Water Works	IA	4,573	5.23	1.75	2005 - 2008	132
Creston (12 Mile Lake)	IA	7,597	2.93	—	2005; 2008	20
Creston (3 Mile Lake and Finished)	IA	7,597	3.8	3.49	2005 - 2008	133
Lamoni Municipal Utilities	IA	2,554	4.79	1.7	2005 - 2006	65
Leon Water Works	IA	1,983	2.02	1.02	2005 - 2006	65
Montezuma Municipal Water	IA	1,457	3.11	0.59	2005 - 2008	138
Osceola Municipal Water Works	IA	4,659	5.82	1.54	2005 - 2008	130
Rathbun Regional Water Association	IA	27,300	1.37	1.2	2005 - 2006	65
Winterset Water Treatment Plant	IA	4,768	28.25	4.93	2005 - 2008	136
Aqua Illinois, Inc.	IL	38,000	9.11	6.81	2005 - 2008	137
Ashland	IL	1,361	1.72	1.3	2005 - 2008	133
Carlinville Water Works	IL	5,685	10.66	5.1	2005 - 2008	128

1 Systems reported concentrations from different water sources separately, so some systems may be listed more than once here.
2 Source: U.S. EPA. Safe Drinking Water Information System (SDWIS). Available at http://www.epa.gov/enviro/html/sdwis/sdwis_ov.html.

Name of monitoring site[1]	State	Population served[2]	Maximum atrazine concentration (ppb)		Years sampled	Number of sampling dates
			Raw Water	Finished Water		
Carthage Public Utilities	IL	2,725	10.23	2.27	2005 - 2006	64
Centralia Water Treatment Plant	IL	14,274	9.39	6.4	2005 - 2008	138
Coulterville Water Treatment Plant	IL	1,300	35.5	2.64	2005 - 2008	137
Evansville	IL	740	29.37	25.75	2005 - 2008	129
Farina Water Treatment Plant	IL	600	4.21	3.48	2005 - 2008	142
Flora Water Treatment Plant	IL	5,675	27.4	30.48	2005 - 2008	130
Gillespie Water Treatment Plant	IL	3,646	14.3	2.78	2005 - 2008	136
Greenfield Water Treatment Plant	IL	1,200	0.77	0.63	2005 - 2006	64
Highland Water Treatment Plant	IL	9,000	1.47	0.5	2005 - 2006	64
Hillsboro	IL	5,759	3.98	2.98	2007 - 2008	76
Hillsboro, Glen Shoals	IL	5,759	4.6	2.8	2005 - 2006	50
Hillsboro, Lake	IL	5,759	0.2	0.13	2006	1
Holiday Shores Sanitary District	IL	3,387	1.21	1.27	2005 - 2006	65
Kaskaskia Water District	IL	N/A	57.98	14.73	2005 - 2008	135
Kinkaid Area Water System	IL	N/A	1.95	1.79	2005 - 2008	135
Mattoon	IL	19,000	2.74	3.04	2007 - 2008	57
Mt. Olive Water Works	IL	2,150	8.61	4.59	2007	35
Mt.Olive, New Lake	IL	2,150	0.84	—	2005	4
Mt.Olive, Old Lake & Finished	IL	2,150	33.4	16.47	2005 - 06; 2008	102
Nashville Water Plant	IL	3,320	44.92	0.77	2005 - 2008	136
New Berlin	IL	1,050	0.93	0.91	2005 - 2008	110
Otter Lake Water Commission	IL	1,251	3.78	2.68	2005 - 2006	63
Palmyra-Modesto Water Commission	IL	70	2.38	1.24	2005 - 2006	65
Paris	IL	9,077	26.1	6.75	2005 - 2008	130
Patoka (East Reservoir & Mid-Process Finished)	IL	731	3.62	1.34	2006	18
Patoka (North Fork Kaskaskia & Finished)	IL	731	14.87	1.24	2006	18
Patoka (West Reservoir & Purchased Finished)	IL	731	4.88	0.81	2006	17
Pittsfield Water Treatment Plant	IL	4,250	2.98	0.24	2005 - 2006	64
Salem WTP	IL	9,000	6.69	3.81	2005 - 2006	65
Springfield City Water Light and Power	IL	128,439	1.16	1.16	2005 - 2006	65
Vermont Water Treatment Plant	IL	800	10.72	2.44	2005 - 2008	137

1 Systems reported concentrations from different water sources separately, so some systems may be listed more than once here.
2 Source: U.S. EPA. Safe Drinking Water Information System [SDWIS]. Available at: http://www.epa.gov/enviro/html/sdwis/sdwis_ov.html.

Name of monitoring site[1]	State	Population served[2]	Maximum atrazine concentration (ppb)		Years sampled	Number of sampling dates
			Raw Water	Finished Water		
Waverly	IL	1,346	9.33	6.79	2005 - 2008	120
Wayne City (Skillet Fork Creek)	IL	1,370	20.6	1.66	2005 - 2008	133
Batesville Water Treatment Plant	IN	5,856	6.24	2.86	2005 - 2008	136
Bedford Water Department	IN	14,000	28.07	8.37	2005 - 2008	136
Fort Wayne (Three River Filtration Plant)	IN	250,000	6.14	4.06	2005 - 2008	129
Indianapolis (Eagle Creek Water Treatment Plant)	IN	781,896	6.87	4.86	2005 - 2006	68
Jasper Municipal Water	IN	12,500	3.01	2.48	2005 - 2008	136
Lake Santee	IN	N/A	15.97	10.54	2005 - 2006	70
Logansport Special Purpose	IN	12,861	27.45	20.94	2005 - 2008	136
Mitchell	IN	4,800	21.06	18.07	2005 - 2008	122
North Vernon	IN	6,500	9.96	8.34	2007 - 2008	49
Stucker Fork Water Treatment Plant	IN	14,000	20.5	10.3	2005 - 2008	144
Versailles Water Works	IN	1,784	29.3	30.48	2005 - 2008	126
Westport Water Company	IN	1,600	1.97	2.66	2005 - 2008	128
Winslow Water Works	IN	881	13.7	13	2005 - 2008	133
Altoona	KS	474	9.79	12.9	2005 - 2008	130
Atchison	KS	10,154	6.78	9.48	2005 - 2008	134
Baxter Springs	KS	4,600	56.74	13.41	2005 - 2008	131
Beloit Water Department	KS	3,639	31.88	31.13	2005 - 2007	103
Burlington City Water Works	KS	2,721	5.1	4.34	2005 - 2008	133
Caney	KS	1,994	8.48	19.9	2005 - 2008	122
Carbondale	KS	1,440	6.28	2.05	2005 - 2008	132
Chanute	KS	8,887	5.43	6.51	2006 - 2008	89
Chetopa	KS	1,234	5.74	6.65	2007 - 2008	41
Ellsworth RWD #1	KS	2,626	4.86	3.71	2005 - 2008	131
Emporia	KS	26,456	4.1	1.64	2005 - 2008	136
Erie	KS	1,167	8.54	9.18	2005 - 2008	134
Franklin County Rural Water District #6	KS	2,400	5.91	5.59	2005 - 2008	134
Harveyville	KS	252	0.89	1.17	2006 - 2008	42
Kansas City Board of Public Utilities	KS	164,462	2.53	2.54	2005 - 2008	135
LaCygne	KS	1,155	4.53	3.77	2006 - 2008	88
Linn Valley Lakes POA	KS	146	0.84	0.80	2005 - 2008	82

1 Systems reported concentrations from different water sources separately, so some systems may be listed more than once here.
2 Source: U.S. EPA. Safe Drinking Water Information System (SDWIS). Available at: http://www.epa.gov/enviro/html/sdwis/sdwis_ov.html

Name of monitoring site[1]	State	Population served[2]	Maximum atrazine concentration (ppb)		Years sampled	Number of sampling dates
			Raw Water	Finished Water		
Miami Co. Rural Water District #2	KS	8,631	2.97	2.13	2005 - 2008	133
Milford	KS	444	2.74	2.73	2005 - 2008	138
Mitchell Co. Rural Water District #2	KS	1,291	2.86	2.86	2005 - 2008	131
Olathe (Composite of Collector Wells)	KS	111,334	2.06	--	2005 - 2008	126
Olathe (Kansas River and Finished)	KS	111,334	3.45	3.23	2005 - 2008	132
Olathe (WTP1)	KS	111,334	5.1	0.97	2005	17
Osage Co. Rural Water District #3	KS	900	16.18	8.79	2005 - 2008	131
Osawatomie	KS	4,616	15.43	14.5	2005 - 2008	135
Paola	KS	5,292	2.17	2.12	2005 - 2008	135
Public Wholesale WSD #12	KS	N/A	2.35	1.66	2005 - 2008	135
Public Wholesale WSD #5	KS	N/A	4.53	4.3	2005 - 2008	132
Richmond	KS	514	15.85	13.36	2005 - 2008	116
Salina	KS	46,140	2.42	0.86	2007 - 2008	53
St. Paul	KS	657	8.6	9.77	2005 - 2008	130
Topeka Water Treatment Plant	KS	121,946	6.52	6.13	2005 - 2008	134
Valley Falls	KS	1,209	8.22	7.04	2005 - 2007	137
Leitchfield Water Works	KY	9,309	4.8	2.6	2005 - 2008	127
Livermore Green River	KY	2,168	2.48	--	2006 - 2007	25
Livermore Rough River & Finished	KY	2,168	5.18	5.2	2006 - 2007	57
Marion, Lake George & Finished	KY	3,033	1.12	0.48	2005 - 2008	133
Marion, Old City Lake	KY	3,033	1.69	0.025	2005 - 2008	120 (only 1 for finished water)
Webster Co. Water District	KY	4,386	4.74	4.95	2005 - 2008	137
E. Jefferson Water Works District #1	LA	308,362	1.9	2.38	2005 - 2008	171
Iberville Water District #3	LA	9,072	13.88	16.13	2005 - 2008	178
LaFourche Water Dist. #1	LA	78,760	6.71	9.11	2005 - 2008	177
Thibodeaux Water Works	LA	15,810	34.75	11.25	2005 - 2008	177
Bucklin Water Department	MO	524	1.62	0.25	2005 - 2008	118
Cameron Light & Power	MO	9,788	1.61	0.59	2005 - 2008	134
Clarence Cannon WWC, United Water	MO	N/A	6.45	1.64	2005 - 2006	66
Concordia Water Treatment Plant	MO	2,360	7.94	5.62	2005 - 2008	104
Creighton	MO	290	0.31	0.1	2005 - 2006	40

1 Systems reported concentrations from different water sources separately, so some systems may be listed more than once here
2 Source: U.S. EPA. Safe Drinking Water Information System (SDWIS). Available at: http://www.epa.gov/enviro/html/sdwis/sdwis_ov.html

Name of monitoring site[1]	State	Population served[2]	Maximum atrazine concentration (ppb)		Years sampled	Number of sampling dates
			Raw Water	Finished Water		
Orexel	MO	1,200	2.04	1.27	2006 - 2008	87
Hannibal Water Treatment Plant	MO	17,596	8.22	5.79	2005 - 2008	133
Harrison County #1	MO	900	1.48	1.43	2006 - 2008	80
Jamesport Water Treatment Plant	MO	600	2.95	2.2	2005 - 2008	137
La Plata Water Treatment Plant	MO	1,401	2.26	1.71	2005 - 2006	46
Marceline Water Treatment Plant	MO	2,548	1.67	0.53	2005 - 2008	125
Maryville Water Treatment Plant	MO	9,872	5.54	5.02	2005 - 2008	133
Maysville	MO	1,100	1.38	1.36	2006 - 2008	77
Middlefork Water Company	MO	N/A	2.81	2.32	2005 - 2008	135
Monroe City (Route J Lake)	MO	2,700	4.6	0.025	2005 - 2008	132
Monroe City (S. Lake)	MO	2,700	1.43	0.68	2005 - 2007	104
Monroe City Finished	MO	2,700	4.35	1.95	2008	33
Shelbina (Salt River)	MO	1,640	13.12	—	2005 - 2008	136
Shelbina (Shelbina Lake and Finished)	MO	1,640	6.9	0.19	2005 - 2008	136
Smithville Water Treatment Plant	MO	9,408	2.64	1.54	2005 - 2008	136
Unionville Water Treatment Plant (Thunderhead Lake or Lake Mahoney and Finished)	MO	2,000	2.96	0.65	2005 - 2006	62
Vandalia Water Treatment Plant	MO	2,863	10.15	2.23	2005 - 2008	133
Wyaconda Water Treatment Plant	MO	385	23.01	16.56	2005 - 2008	188
Johnston	NC	62,230	0.05	0.05	2006 - 2007	46
Monroe (John Glenn WTP)	NC	32,454	3.94	2.82	2005 - 2008	130
South Granville	NC	10,467	0.27	0.23	2008	22
Alliance Water Treatment Plant	OH	23,000	3.73	0.65	2005 - 2008	128
Blanchester	OH	4,500	31.25	37.3	2005 - 2008	136
Bowling Green Water Treatment Plant	OH	30,000	29.17	0.51	2005 - 2008	135
Cinnamon Lake Utility Co.	OH	1,522	2.18	1.99	2005 - 2008	136
Clermont Co. Water, BMWTP	OH	101,402	10.85	2.68	2005 - 2008	136
Defiance	OH	17,000	15.8	18.5	2005 - 2008	132
Delaware Water Plant	OH	33,480	30.43	19.33	2005 - 2008	136
Lake of the Woods Water Company	OH	475	8.09	4.9	2005 - 2008	126
Lima	OH	74,750	2.49	1.75	2005 - 2008	135

1 Systems reported concentrations from different water sources separately, so some systems may be listed more than once here.
2 Source: U.S. EPA. Safe Drinking Water Information System [SDWIS]. Available at: http://www.epa.gov/enviro/html/sdwis/sdwis_ov.html

Name of monitoring site[1]	State	Population served[2]	Maximum atrazine concentration (ppb)		Years sampled	Number of sampling dates
			Raw Water	Finished Water		
McClure Water Treatment Plant	OH	850	42.89	33.83	2005 - 2008	112
Monroeville	OH	1,433	21.84	0.28	2005 - 2007	103
Monroeville Reservoir & Finished	OH	1,433	0.79	0.025	2008	32
Monroeville W Branch Huron	OH	1,433	37.28	—	2008	32
Mt Orab (Mt Orab Reservoir and Finished)	OH	3,565	11.31	0.27	2005 - 2008	137
Mt Orab (Sterling Run Creek)	OH	3,565	227	—	2005 - 2008	90
Napoleon	OH	9,318	31.39	10.23	2005 - 2008	137
New Washington Water Plant	OH	987	3.26	2.62	2005 - 2008	123
Newark Water Works	OH	48,000	18.05	6.67	2005 - 2008	136
Norwalk Water Treatment Plant	OH	16,200	6.76	0.81	2005 - 2008	134
Ottawa	OH	4,367	1.63	1.37	2005 - 2008	134
Piqua (Gravel Pit)	OH	20,500	1.52	—	2005 - 2008	136
Piqua (Miami River)	OH	20,500	32.85	—	2005 - 2008	136
Piqua Swift Run Lake & Finished	OH	20,500	84.8	59.57	2005 - 2008	136
Shelby (Reservoir 2 and Finished)	OH	9,860	8.14	2.9	2005 - 2008	131
Shelby (Reservoir 3)	OH	9,860	2.25	—	2005 - 2008	129
Upper Sandusky	OH	6,600	1.74	1.82	2005 - 2008	122
Waynoka Regional Water	OH	1,400	5.39	2.45	2005 - 2008	138
Wilmington	OH	11,921	3.59	1.21	2005 - 2006	66
Wilmington (Caesar Creek Reservoir or Gowan Lake Reservoir and Finished)	OH	11,921	4.88	2.78	2005 - 2006	67
Aquilla Water Supply District	TX	N/A	4.00	2.33	2005 - 2006	59
BRA Granger Lake	TX	N/A	1.87	1.53	2005 - 2008	131
Brazosport Water Authority	TX	N/A	6.57	9.42	2005 - 2008	123
Cameron	TX	6,624	4.00	6.32	2006 - 2008	75
Cooper Water Treatment Plant	TX	5,184	4.35	4.18	2005 - 2008	117
Corsicana	TX	28,500	3.25	3.25	2005 - 2006	64
Crosby	TX	4,644	1.59	1.73	2008	19
Crosby, Gulf Coast Aquifer Wells	TX	4,644	1.71	—	2008	6
Ennis	TX	37,901	3.62	1.92	2005 - 2008	137
Marlin Water Treatment Plant	TX	6,200	3.99	3.77	2005 - 2006	64
Midlothian Water Treatment Plant	TX	25,515	2.71	2.93	2005 - 2008	137
Waxahachie Water Treatment Plant	TX	55,900	1.71	1.79	2005 - 2008	124

1 Systems reported concentrations from different water sources separately, so some systems may be listed more than once here
2 Source: U.S. EPA. Safe Drinking Water Information System (SDWIS). Available at http://www.epa.gov/enviro/html/sdwis/sdwis_ov.html

Endnotes

EXECUTIVE SUMMARY

1 http://www.nrdc.org/health/atrazine/

CHAPTER 1

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CHAPTER 2

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Attachment 27

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It's not easy being green: are weed-killers turning frogs into hermaphrodites?

Souder, William

In the summer of 1997, Tyrone Hayes, a biologist at the University of California, Berkeley, accepted what seemed a harmless offer to join a panel of eight other scientists investigating the safety of the common weed-killer atrazine. The panel had been commissioned by atrazine's inventor and primary manufacturer, the Swiss-based chemical giant then called Novartis and since renamed Syngenta. The company wanted to know if its product threatened "non-target" organisms, including fish, reptiles, and amphibians--creatures whose fate had remained largely unexplored through the half century in which atrazine had become the most heavily used herbicide in the United States as well as one of its most widespread environmental contaminants.

Hayes himself was acutely interested in discovering the causes of a global decline in frog populations that had worried scientists since the early 1990s. Many of the hormones and genes that regulate reproduction and development and metabolism in frogs perform similar functions in people, making frogs important proxies for humans--nature's test animals in a changing world. Syngenta's concern was different. The Environmental Protection Agency had been ordered by Congress to "reregister" atrazine as part of a program to subject a large number of older pesticides to current safety testing, a process that required considerable new data.

Initially, Hayes was asked only to review the scientific literature for studies involving atrazine and frogs. The review turned up nothing, so Hayes designed an experiment to test atrazine directly on the animals. "I honestly thought that the compound wouldn't do anything," Hayes says. "There was no basis that I knew of for a hypothesis that it would. My concern was how it would look to my colleagues. Would it look like I had prostituted myself to a company to do studies that weren't going to produce anything?" Hayes took a vote among his students in the Department of Integrative Biology, some of whom were so anticorporate, he says, that they wouldn't go to Starbucks. But they agreed to do the experiment. Over the course of the next two and a half years, Syngenta paid Hayes's lab $250,000.

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The experiment was similar to ones Hayes had performed many times before. Newly hatched tadpoles were reared in water containing atrazine in amounts ranging from .01 to 25 parts per billion (ppb) until the animals completed metamorphosis. The test animal was the African clawed frog, a species known as the "lab rat of amphibians" and typically referred to by its generic name, Xenopus. Once used in human pregnancy testing, Xenopus is easier to rear than native North American species, largely because it is entirely aquatic, can be readily force-bred, grows quickly through well-defined stages, and will eat almost any commercial animal feed. Hayes gives his tadpoles Purina Rabbit Chow.

In March 1999, Hayes and his students divided 900 Xenopus tadpoles among thirty small aquariums. Half of the tanks contained atrazine; the rest--the control tanks--did not. All the tanks were coded, so neither Hayes nor his students knew which animals were swimming in what dose. Every three days, the tanks were cleaned and the solutions replaced. After forty days, the tadpoles had become frogs. When Hayes examined the frogs, all the control animals were normal. So were all the females. But among the males that had been exposed to atrazine at concentrations of 1 ppb or more, about 80 percent had smaller than expected laryngeal dilator muscles--puny voice boxes.

Laryngeal muscle size is an important secondary sexual characteristic in frogs; male frogs rely on the strength and pitch of their mating calls to attract females. Male bullfrogs sometimes sit near a spring at the edge of a pond where the inflow of colder water constricts the larynx and lowers the tone of their call.

Examining the frogs more closely, Hayes was surprised to discover that about a third of the male frogs exposed to atrazine also had abnormal reproductive organs. Some had malformed or multiple sets of testes. Others had both testes and ovaries, sometimes in odd numbers. The co-occurrence of testes and ovaries is rare in vertebrates and rarer still in Xenopus. Yet in Hayes's experiment this morphology had been elicited at concentrations as low as .1 ppb, a tenth of the amount that altered their voice boxes. Such a dose is equivalent to a grain of salt dissolved in a ten-gallon aquarium. To put it another way, the federally established "safe" limit for atrazine in human drinking water is 3 ppb, thirty times the dose that turned some of Hayes's frogs into hermaphrodites.

Tyrone Hayes is five feet three and sturdy from years of predawn cycling and running. He has shoulder-length black hair, which he wears braided or in a ponytail, or, sometimes, swept back from his face in a stiff mane. Around the lab he's usually in shorts and a T-shirt, but for speaking engagements and faculty meetings, he favors a black suit, an iridescent tie, and dangly earrings. Hayes was born in 1967, in Columbia, South Carolina, where his father is a carpet layer. He attended Harvard, where he earned a summa cum laude for a thesis on how temperature influences development in wood frogs. In graduate school, at Berkeley, Hayes studied endocrinology, investigating the impact of environmental factors on frog hormones. At thirty-two, he became the youngest tenured professor in the department's history and was named a full professor three years later.

Hayes says that he was naive about how his findings would be received. After reporting his discovery to the other panelists studying atrazine, Hayes argued with them and with Syngenta for months about what to do next. There were protracted discussions about the statistical relevance of the voice-box data and

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disagreements over the pace of follow-up studies. Hayes was asked for repeated revisions of the "final" report on his results. He saw all of this as an effort to discourage him from publishing his findings. In November 2000 he quit the panel. In his letter of resignation he complained that were he to remain on the team, "recent history suggests that I will spend a great deal of effort preparing reports that will not be finalized in a timely manner, let alone published." He added, "It will appear to my colleagues that I have been part of a plan to bury important data."

In fact, Hayes's contract with Syngenta's atrazine panel did not prevent him from publishing his research. There was, however, an implicit understanding that panel members--in addition to scientists at Syngenta--would review one another's work. Hayes worried that such consultation, which had already slowed him, would eventually paralyze his research. Hayes's colleagues, meanwhile, wondered at his impatience. "Tyrone is an interesting person," says Keith Solomon, a professor of environmental biology at the University of Guelph, in Ontario, who contines to serve on Syngenta's panel. "But he's in a hurry."

In January 2001 staff scientists from Syngenta visited Hayes at Berkeley in an attempt to get him to rejoin the team. The meeting, which included discussions of a direct arrangement with Syngenta in which Hayes would continue his work, did not go well. "I'm certain they would have had control," Hayes says. Hayes instead went forward with money he had obtained from Berkeley and the National Science Foundation. He repeated the Xenopus experiment two times, and in April 2002 he published his findings in the Proceedings of the National Academy of Sciences.

He also performed a series of similar experiments using a common native species, the northern leopard frog. Hayes found that doses of atrazine as low as .1 ppb again caused various degrees of "sex reversal" in about a third of the males, and that some of the animals also displayed a freakish abnormality that Hayes had not seen in Xenopus: eggs forming in their testes. In the summer of 2001, Hayes and his students conducted field surveys of wild leopard frogs at eight locations in the United States and found the same deformities they had seen in the lab. At a site on the North Platte River in eastern Wyoming, far from the nearest farmland, Hayes discovered high levels of atrazine in the water and gonad problems in 92 percent of the male leopard frogs. In October 2002 he published these findings in Nature. The following summer he returned to the North Platte and found the atrazine contamination much reduced and only 8 percent of the frogs abnormal. A year later he measured no atrazine in the water at the site, and all the frogs were normal. (Hayes believes that the river had been temporarily contaminated somewhere upstream.)

In his published articles, Hayes argued that atrazine activates a gene that produces an enzyme called aromatase, which converts testosterone to estradiol, the strongest of the naturally occurring estrogens. Elevated levels of aromatase, he proposed, could explain the males' stunted voice boxes and multiple, mismatched sex organs--as well as the fact that atrazine appeared to have no effect on the females. Hayes called the process "chemical castration and feminization." He was not surprised that the abnormalities he found were associated with extremely weak doses of atrazine; hormones, including testosterone and estradiol, typically function at very low concentrations. "If you're a toxicologist, this is a low-dose effect," Hayes says. "If you're an endocrinologist, it's a reasonable effect."

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Chemical poisons tend to be more toxic as the dose increases the classic "linear" dose-response association. But chemicals that affect hormonal systems sometimes operate in nonlinear ways: In women, for example, estradiol is necessary to stimulate ovulation, but a large dose of estradiol--the amount contained in the birth control pill---cancels this effect.

The science of endocrine disruption, as chemical interference with hormones has been dubbed, is new and complex. Unlike acute toxins, which can kill an organism outright, endocrine disrupters cause subtle damage, such as reproductive-system abnormalities or conditions that can lead to cancer. Effects seen at very low doses but that do not occur at higher doses con found traditional toxicological assay techniques. In 1996, Congress directed the EPA to include endocrine-disruption studies as part of its safety screening of licensed chemicals, but a decade later the agency is still trying to develop standards for laboratory tests.

According to Bruce Blumberg, an associate professor of developmental and cell biology at the University of California, Irvine, scientists who study endocrine disruption often see dramatic biological effects when they expose cell cultures to weak chemical concentrations. Curiously, Blumberg says, research sponsored by chemical companies rarely detects such effects.

Atrazine is among the world's oldest and most effective herbicides--the aspirin of weed-killers. It was developed during a period of intense innovation in the chemical industry that began with the Second World War and the invention of 2,4-D, the first "selective" herbicide: it could kill weeds without killing the crops. (It was later mixed with 2,4,5-T by the military to make the decidedly nonselective defoliant Agent Orange.) Syngenta, a company with roots dating back a couple of centuries that also gave the world DDT and LSD, introduced atrazine to the market in 1959. The new chemical was far more selective than 2,4-D--it is nearly impossible to kill corn with the stuff--and it was an immediate hit with farmers. Syngenta does not divulge sales figures for individual products, but atrazine continues to contribute a significant portion of the company's U.S. revenues from selective herbicides, which last year totaled $1.9 billion worldwide.

Atrazine residues are not found in significant amounts in food. Nor is it especially poisonous to vertebrates; it's unlikely that you could dissolve enough atrazine in water to kill a frog. A handful of studies have linked atrazine exposure to increased incidences of cancer in humans, but many more studies have found no evidence of such a correlation. Hayes, for his part, believes that atrazine, because it may cause endocrine problems in people, could play an indirect role in cancer. Estrogen, he points out, is known to promote tumor growth; a current treatment for breast cancer involves a drug that inhibits the production of aromatase. "How can we take the risk of exposing people to something that does the opposite?" he asks. In 2000 the EPA--in a move that downgraded the agency's earlier concerns about atrazine and cancer--declared that the compound is "not likely to be carcinogenic to humans."

Nevertheless, a fraction of the nearly 80 million pounds of atrazine applied to crops in the United States every year ends up contaminating surface water, groundwater, rain, and even fog. In the spring, concentrations in rivers and streams in the Midwest frequently exceed 10 ppb, and Syngenta has twice

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voluntarily reduced the suggested application rate for atrazine on corn, from four pounds per acre to three in 1990, and to two and a half in 1992. Although atrazine breaks down fairly quickly in, soil and shallow surface water, it is more stable in larger bodies of water and in underground aquifers. In 1999 and 2000 the EPA and the United States Geological Survey, measuring reservoirs in agricultural areas of a dozen states, found atrazine in posttreatment drinking-water samples collected from community water systems, in some cases at concentrations of more than 2 ppb. In 2003 the EPA reported that a survey of more than 14,000 water utilities, drawing water from wells in twenty-one states, had found that atrazine, where it previously had been detected, averaged about .55 ppb--more than five times the amount that caused abnormalities in Hayes's initial experiment. Because water can take years to percolate down into aquifers, atrazine would still be found in well water for decades even if use of the pesticide were halted today. That very concern led the European Union to ban atrazine in the fall of 2003.

People, unlike frogs, don't undergo critical developmental stages exposed to the elements, and frogs may be particularly sensitive to waterborne chemicals. Still, in the same year atrazine was banned in the European Union, an American epidemiologist named Shanna Swan, then at the University of Missouri School of Medicine, published research showing reduced semen quality in men exposed to pesticides. Swan compared men in Columbia, Missouri, with men living in Minneapolis. The Columbia group had about half as many moving sperm in their semen as their Minneapolis counterparts. Urine samples from the Columbia group showed significantly higher herbicide residues. Swan says few of the men in Columbia were farmers and that she suspects their exposure to pesticides was through drinking water contamination. Reduced semen quality is correlated not only with reduced fertility but also with testicular cancer. One of the pesticides Swan detected in the Missouri group was atrazine.

On April 16, 2002, the day Hayes's Xenopus study appeared in print, The Wall Street Journal published a brief article about it, in which Tim Pastoor, Syngenta's North American head of research for human safety health issues, described Hayes's findings as "inconclusive." Syngenta, the Journal reported, "considers the Hayes study to be 'preliminary work' that might have to be retracted as the result of more detailed testing." Two months later, Hayes's former colleagues on Syngenta's atrazine research panel issued a press release stating that two teams of scientists, working independently, had tried to replicate Hayes's results and failed. Both studies had been funded by Syngenta and were led by members of the atrazine research panel. One was overseen by James Carr, a biologist at Texas Tech University; the other by John Giesy, a zoologist at Michigan State University. Hayes was furious. "Saying they couldn't replicate my work is different from saying they didn't replicate it," he says.

Reproducibility is a hallmark of good science, and the charge that a researcher's work cannot be duplicated is serious. An experiment that can't be repeated implies either incompetence or fraud on the part of the original author. A perfectly replicated experiment should always yield the same result, in the same way that two identical columns of numbers will add up to the same total. In practice, many variables come into play and experiments are never exactly the same. But as became clear from the data and descriptions of their experiments later submitted to the EPA, both Carr and Giesy departed from Hayes's methods--and neither proved as skillful at the difficult task of rearing frogs. Giesy performed two key

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experiments loosely modeled on Hayes's. In one of the experiments, more than three quarters of the frogs died. In both, the control tanks were accidentally contaminated with atrazine at concentrations averaging at least .1 ppb, rendering the results inconclusive. (Giesy says his experiments were no more contaminated than anyone else's and that he merely had reported the control levels more precisely.)

Carr had problems, too. His frogs had been overcrowded and underfed, and many of his tadpoles failed to achieve metamorphosis. Some that did took longer than usual to reach that stage. Carr did not test atrazine at concentrations of less than 1 ppb. Even so, his experiment did produce frogs with abnormal gonads, though he found the effect statistically significant only at 25 ppb--250 times the amount that caused abnormalities in Hayes's experiment. Ordinarily, the detection of a similar effect in an experiment that only approximates the original is considered evidence that the effect is "robust." (Carr did not respond to my requests for comment.)

In any case, Hayes's research had already caught the attention of the EPA. In April of 2002, Hayes had been contacted by Tom Steeger, a scientist in the agency's Office of Pesticide Programs, in Washington, who said in an email that it would be "imprudent" of the agency to ignore the "disturbing results" of Hayes's investigation. The following July, Steeger visited Hayes's lab, where the experiments on Xenopus and leopard frogs were under way. After Steeger returned to Washington, he exchanged dozens of emails with Hayes and other scientists on the atrazine panel and at Syngenta in an effort to determine who had gotten what right about frogs and atrazine.

The Environmental Protection Agency regulates pesticides under a law called the Federal Insecticide, Fungicide, and Rodenticide Act. Adopted by Congress in 1947 and extensively amended since, FIFRA is now a book-length set of rules, the most important of which is this: the EPA is supposed to weigh a pesticide's economic benefits against any "unreasonable adverse effects" it may have on the environment or on human health. In 1988, Congress adopted the provision to reregister pesticides that had been licensed before 1984.

The EPA does not actually investigate the economic benefits of any pesticide, nor does it usually conduct its own research on the safety of such compounds. When confronted with evidence that a pesticide has adverse effects, the EPA usually responds with a recommendation that the matter be studied further, and under the peculiar logic of pesticide regulation, it is the manufacturer and not the agency that is responsible for testing chemical products. (The EPA stipulates what kinds of studies are necessary and requires companies to submit raw data in addition to safety conclusions.)

One way to maintain the perception that a pesticide is safe is to take a very long time reviewing information suggesting it is not. The EPA routinely reframes questions about the safety of pesticides in such a way that they remain questions, and evidence of adverse effects usually results in a demand for more study. Pesticide makers are allowed extravagant amounts of time for such follow-up work. And because the companies know the EPA must carefully review every study they submit, pesticide makers can game the system by submitting flawed and inconclusive research. The EPA then judiciously pores over the new data, finds it wanting, and

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asks for something more definitive. The oversight the agency thus exercises can be thought of as a kind of business service. The EPA helps chemical companies understand safety concerns in terms of overhead. The agency refers to pesticide makers as "registrants," a term that makes them sound like guests in a luxury hotel, which in some ways does not seem far from accurate.

The Bush Administration has a deserved reputation for hostility to environmental regulation, but the EPA's process for licensing pesticides has become less stringent over the course of many years, under both Republican and Democratic leaders. According to a knowledgeable former EPA official, the agency was more aggressive in restricting and banning pesticides in its early years. It remained more independent and "professional" under the first President Bush than it has since become. During the Clinton years, the former official said, the agency adopted a conciliatory attitude toward pesticide manufacturers in an effort to counter the perception that it was staffed by environmental zealots. At the same time, chemical companies were becoming more adept at forging alliances with farm advocacy groups, which have enormous clout in Washington and have learned how to turn the EPA's "data addiction" to their advantage. "Scientists culturally cannot say no to data," the former official said of the staff in the agency's pesticide program. "It's hard for them to make a decision about what's in front of them when there is a promise of more information in the future." Delay, of course, has decided economic benefits for pesticide makers.

Syngenta's crop-protection division, where Tim Pastoor works, is located in Greensboro, North Carolina, in a leafy, campus-like complex just off Interstate 40. Pastoor, a pleasant, sandy-haired toxicologist, says the regulatory onus on his company is immense--a research program without end. Hearing that work disparaged because it's funded by the company "drives me crazy," Pastoor says. "It's as if they"--the company's safety studies--"are tainted when they're not." In an effort to anticipate the kinds of studies the EPA is likely to request of them, companies like Syngenta often undertake expensive research independent of the regulatory review process. When the company decided to look at atrazine's effects on frogs, it was under no obligation to do so. Pastoor says that since the reregistration process began, in 1994, Syngenta has spent $30 million on atrazine research and submitted close to 200 studies to the EPA. "I can assure you that I'm not concerned about the safety of atrazine use," Pastoor says.

Atrazine is one of nearly 900 pesticides that the EPA identified for reregistration eighteen years ago. In 1994, when the compound was still considered a cancer risk, it was placed under "special review." Twelve years later, with the August deadline for a final decision on reregistration approaching and the special review set to be completed within a year, the EPA's file on atrazine has swollen to more than a million pages of documents. The pace of reevaluation might have been even slower had it not been for a series of deadlines imposed on the EPA by a court order stemming from a case brought against the agency in 1999 by the Natural Resources Defense Council.

The NRDC, a well-funded environmental advocacy group based in Washington, D.C., is frequently in court against the EPA. With respect to atrazine, the group has sued the EPA for violating provisions of FIFRA, the Endangered Species Act, the Food Quality Protection Act, and the Federal Advisory Committee Act. These are not tort cases: the NRDC has sued not for damages on its own behalf or anyone else's

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but instead solely in an attempt to make the EPA follow the federal laws that govern its regulation of pesticides. Like the reregistration process itself, these court cases tend to drag on for years.

Aaron Colangelo, a slight and plainspoken thirty-one-year-old graduate of Harvard Law School and a principal litigator for the NRDC, says that the agency should have suspended atrazine in the spring of 2002, after Hayes published his first article. "There was certainly enough justification to do it," Colangelo says. In atrazine cases, he says, he has often found himself alone at the plaintiffs table across the aisle from attorneys for the EPA and Syngenta--despite the fact that the NRDC has never named the company as a defendant in any of its actions. The EPA apparently is not embarrassed to be joined in court by lawyers for a company that it is supposed to be regulating.

The NRDC has not been alone in urging the EPA to act against atrazine. In 2002 the attorneys general of New York and Connecticut asked the agency to ban atrazine. Judith Schreiber, chief scientist at the Environmental Protection Bureau in the New York Attorney General's Office, wrote a pointed letter to the EPA arguing that the agency's own review of atrazine risks for human health and the environment warranted cancellation of the pesticide. And she scolded the agency for ignoring Hayes's findings. The EPA had failed "to adequately consider the endocrine disruption and reproductive effects of atrazine," Schreiber wrote, adding that Hayes's aromatase theory suggested that atrazine could act through a "common mechanism among frogs, reptiles and mammals, including humans."

In the summer of 2002, Everett Wilson, chief of the U.S. Fish and Wildlife Service's Division of Environmental Quality, also complained to the EPA about atrazine. In a letter to the agency's chemical review manager, Wilson contended that atrazine could harm endangered species, especially amphibians, by interfering with their hormonal processes or by killing the aquatic plants and invertebrates that amphibians eat. Wilson cited the Barton Springs salamander, an endangered amphibian that is known to live only in a springfed pool in a park in downtown Austin, Texas. Water samples collected in Austin by the U.S. Geological Survey show that when it rains, atrazine from grass treatment contaminates the salamander's habitat in concentrations that are sometimes greater than .5 ppb. Unlike FIFRA, the Endangered Species Act, which was adopted by Congress in 1973, contains no provision for balancing adverse environmental outcomes against economic considerations; it simply prohibits harm to any of the more than 1,000 species on the endangered list.

In November 2002, Hayes proposed an experiment he believed could end debate over his findings: he offered to provide Xenopus specimens to three labs in order to run concurrent studies, one by him at Berkeley, one at a lab chosen by Syngenta, and the third at a lab selected by the EPA. Hayes said that he would train lab workers at all locations in protocols--including how to feed and care for the animals--at his own expense. At the experiments' conclusion, each lab would exchange a third of its animals with each of the other labs, allowing all three parties to examine one another's frogs for abnormalities.

The EPA and Syngenta declined Hayes's invitation to collaborate. Jim Carr said in an email that he was "in principle" not opposed to the idea, but complained that Hayes was insensitive to the fact that there were features of his experiment that

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"we do not wish to repeat." Keith Solomon agreed, reminding his colleagues by email of their previous inability to raise frogs using Hayes's methods.

Hayes says that, even allowing for start-up time, these new experiments could have been completed in a matter of months. Instead, the EPA asked for further analysis of the extant data, in the form of white paper that would consider seventeen recent studies--published and unpublished--involving atrazine and amphibians, including research by Hayes, Carr, and Giesy. (Twelve of the projects had been sponsored by Syngenta.) This white paper would, in turn, be submitted to the EPA's Scientific Advisory Panel, a group of seven scientists whose job is to provide the agency with "independent, external, expert scientific peer review." In this case, the panel was to be expanded to fifteen scientists, and a public hearing--a standard feature of such reviews--was scheduled for June 2003.

The white paper--written by Tom Steeger with help from Joe Tietge, a biologist at the EPA's Mid-Continent Ecology Division, in Duluth, Minnesota, who had led the agency's investigation of deformed-frog incidents several years earlier--was never conceived as a means of deciding the safety of atrazine. It was, according to the EPA, an effort to determine "whether there is a need for additional data to characterize more fully atrazine's potential risk to amphibian species, and, if so, what data should be developed." In other words, the white paper was intended from the outset primarily to help the agency decide what further research should be done on atrazine. Hayes deduced as much, and complained to Steeger that the white paper would merely lead to a routine call for more study--and that inclusion of Syngenta's dubious research was an effort to "dilute" his own legitimate findings with "garbage."

Extraordinary attention was paid to the white paper's wording. In May 2003 it was reviewed by two departments at the White House, the Council on Environmental Quality and the Office of Management and Budget, both of which advise the president on environmental policy. According to the NRDC's Aaron Colangelo, this degree of executive-branch involvement in the oversight of a single pesticide registration was unprecedented.

On June 17, 2003, the Scientific Advisory Panel convened for a four-day public hearing at the Crowne Plaza Hotel in the shimmery Crystal City suburb of Washington, D.C. Unlike peer reviewers for scholarly journals, who are unpaid and free to make whatever comments they like about the research they are asked to evaluate, the advisory panel members worked within narrow guidelines in assessing the white paper. They were paid $400 a day, and, although panelists sign detailed financial-disclosure forms crafted to expose conflicts of interest, there is no prohibition against scientists serving on the panel who receive research funding from the EPA in other areas and who thus might be reluctant to criticize its findings.

In their assessment, Steeger and Tietge wrote that there was enough evidence to "establish the plausibility of a hypothesis that atrazine could affect amphibian development," but, because of flaws in all of the existing studies, the EPA could neither accept nor reject such a theory. They proposed that Syngenta conduct further research. In its report to the EPA, submitted in August 2003, the Scientific Advisory Panel agreed that more research was needed in order to understand the effects of atrazine on frog development. The panel added that the

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existing data was sufficient to "warrant concern"--a conclusion only marginally more forceful than the white paper's ambiguous finding.

"I would never go on an EPA panel again," says Darcy Kelley, a biology professor at Columbia University who participated in the panel's deliberation, and who is a leading authority on sexual differentiation in Xenopus. "It's a curious process, which is run within a set of guidelines that guarantee nothing will be done." Kelley, who has visited the EPA's lab in Duluth, said she was puzzled that the agency hadn't tried to replicate Hayes's experiment and surprised that each of the seventeen studies was given equal weight in the EPA's evaluation. She found Hayes's research worrisome because hermaphroditism does not normally occur in Xenopus. "He had the most striking results I've seen in a long time," she said. "I'd have said if you want to err on the side of caution, then you should not re-license atrazine." But, as David Skelly, an ecologist at Yale University who was also on the panel, put it, the group was not permitted to reach such a "novel conclusion." Still, in its report, the panel noted that, with the exception of the two experiments by John Giesy at Michigan State, the laboratory studies all suggested that atrazine disrupts normal reproductive development in frogs. "The inability to detect gonadal abnormalities with atrazine exposure in (Giesy's experiments) should not detract from the positive results noted in the majority of the studies," the panel members wrote.

In the fall of 2003, the EPA concluded an interim reregistration of atrazine. In compliance with the recommendation of the advisory panel, the agency also ordered Syngenta to conduct additional experiments on frogs and atrazine. Two years later, in the summer of 2005, scientists at Syngenta began their initial testing of atrazine on Xenopus. They expect to have results by the end of this year, more than four years after Tyrone Hayes proposed the joint experiment that could have resolved the issue in a few months. Meanwhile, in all likelihood, the reregistration of atrazine will be finalized this August.

In January, Hayes published two new papers in Environmental Health Perspectives. In one paper, he showed that when frogs are exposed to atrazine in combination with other pesticides--as they are in the environment--the damage to the animals' hormonal systems is more severe than from exposure to atrazine alone. In the other, he reported that when male tadpoles are exposed to estradiol (or to a synthetic compound that suppresses testosterone) they develop the same kinds of gonadal abnormalities that are associated with atrazine--a finding, he argues, that provides further support for his theory of "chemical castration and feminization." Hayes has also been trying to figure out why some male frogs in his experiments fail to exhibit elevated levels of aromatase or gonadal abnormalities after being exposed to atrazine. (The reason, he thinks, may have something to do with natural differences in the rates at which the frogs develop.)

Although Syngenta's current research is not, strictly speaking, an attempt to replicate Hayes's work--the experiments involve alternative methods--Hayes says he has full confidence that they will find the same adverse effect. Different methods and different strains of Xenopus could result in somewhat different frequencies and patterns of abnormal gonadal development or even no deformities at all. But, Hayes says, he can think of no reason why the essential result would not be the same. He also knows of no reason why the EPA will not continue to do nothing as the testing moves on to another phase. "My view is that the EPA is never going to

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take action on atrazine," Hayes says.

Legally, the EPA needn't find a threat to human health to ban atrazine. Adverse effects in the environment are sufficient for the agency to take action, and in the view of many biologists it makes little sense to see humans in isolation from the environment. The question of what direct effects, if any, atrazine has on human health will be hard to answer, and will likely depend on inferences drawn from studies of surrogate species. Such inferences are never certain. Vertebrate toxicology is a kind of Russian roulette: Some species get lucky when they're exposed to chemicals; some don't. Thalidomide--the sedative that caused horrific birth defects in human infants in forty-six countries half a century ago--was believed safe because tests showed it had no effect on rats. In the very same ecosystems where Tyrone Hayes has found abnormal northern leopard frogs, he has also discovered that a close relative of that species--the plains leopard frog--appears to be unaffected by atrazine. As is usually the case with environmental contaminants, the real-world experiment is already up and running.

William Souder is the author of A Plague of Frogs and, most recently, Under a Wild Sky: John James Audubon and the Making of The Birds of America, which was a finalist for the 2005 Pulitzer Prize in biography.

---- INDEX REFERENCES ----

COMPANY: CROWNE PLAZA HOTEL; SYNGENTA AG; NOVARTIS AG

NEWS SUBJECT: (Economics & Trade (1EC26))

INDUSTRY: (Animal Research & Animal Rights (1AN65); Bioethics (1BI56); Environmental (1EN24); Agriculture, Food & Beverage Regulatory (1AG56); Chemistry (1CH57); Agrochemicals (1AG08); Chemicals (1CH04); Environmental Regulatory (1EN91); Manufacturing (1MA74); Science (1SC89); Science & Engineering (1SC33); Healthcare (1HE06); Healthcare Policy (1HE46); Physical Science (1PH15); Nature & Wildlife (1NA75); Agriculture (1AG63); Pesticides (1PE12); Agriculture, Food & Beverage (1AG53))

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NATURAL RESOURCES DEFENSE COUNCIL

Sounding the Depths II

The Rising Toll of Sonar, Shipping and Industrial Ocean Noise on Marine Life

Most whales and many other marine species depend on sound as they hunt for food, avoid predators, find mates, and maintain their awareness in the darkness of the sea. But over the past century the acoustic landscape of the ocean has been transformed by human activity -- intensely loud military sonar, oil-and-gas surveys, and the ever-increasing traffic of commercial ships. This noise can have impacts on marine life ranging from long-term behavioral change to hearing loss to death. This November 2005 second edition of NRDC's groundbreaking 1999 report on ocean noise has been completely rewritten to reflect the rapid growth of the scientific record. It reviews the science, surveys the leading contributors to the problem, and suggests what might be done to reduce the impacts of noise on the sea -- before the proliferation of noise sources makes the problem unmanageable.

OVERVIEW & QUICK REFERENCE
Press release (11.21.05)
Protecting Whales from Dangerous Sonar (an overview)

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Chapter 2: Dynamite and Fog -- A Survey of Noise Sources
Chapter 3: The Tyranny of Small Decisions -- Domestic Regulation of Ocean Noise
Chapter 4: Noise Without Borders -- The Growing International Response

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Watch this powerful movie about the deadly effects of underwater sonar narrated by Pierce Brosnan.

Or watch a video statement by Pierce Brosnan.

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SOUNDING THE DEPTHS II:

The Rising Toll of Sonar, Shipping and Industrial Ocean Noise on Marine Life

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NATURAL RESOURCES DEFENSE COUNCIL
November 2005

ABOUT NRDC

The Natural Resources Defense Council is a national nonprofit environmental organization with more than 1 million members and online activists. Since 1970, our lawyers, scientists, and other environmental specialists have worked to protect the world's natural resources, public health, and the environment. NRDC has offices in New York City, Washington, D.C., Los Angeles, and San Francisco. Visit us at www.nrdc.org.

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This report is dedicated to Ben White, a fearless campaigner for marine mammals, who passed away this summer. Few have cared as passionately as Ben about the health of our oceans and the welfare of the creatures that live there.

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EXECUTIVE SUMMARY

It is a commonplace among divers and oceanographers that the ocean is no "silent world," as Jacques Cousteau had written, but an exceptionally noisy place. Most whales and many other marine species depend on sound as they hunt for food, detect predators, find mates, and maintain their awareness in the darkness of the sea. Over the past century, however, the acoustic landscape of the ocean has been transformed by human activity. Some biologists have compared the increasing levels of background noise in many places off our coasts to a continuous fog that is shrinking the sensory range of marine animals. Others, concerned about a growing number of whale mortalities linked to military sonar, have compared the effects of intense sound to those of dynamite. Together these analogies suggest the range of impacts that noise can have: from long-term behavioral change to hearing loss to death.

Since 1999, when the first edition of this report was published, the scientific record and the public's awareness of the issue have grown with astonishing rapidity. It has become increasingly clear that the rise of ocean noise presents a significant, long-term threat to an environment that is utterly dependent on sound. Our purpose in this report is to review the science, survey the leading contributors to the problem, and suggest what might be done to reduce the impacts of noise on the sea—before the proliferation of noise sources makes the problem unmanageable.

Defining the Problem

"Undersea noise pollution is like the death of a thousand cuts. Each sound in itself may not be a matter of critical concern, but taken all together, the noise from shipping, seismic surveys, and military activity is creating a totally different environment than existed even fifty years ago. That high level of noise is bound to have a hard, sweeping impact on life in the sea. Regulating these sound sources can be difficult, but one has to start somewhere. Every breath we take is dependent on the ocean. And unless we really understand how that vast system works and take better care of it, it isn't just the ocean that's in jeopardy. It's our whole future that's at stake."

DR. SYLVIA EARLE, FORMER CHIEF SCIENTIST, NATIONAL OCEANIC & ATMOSPHERIC ADMINISTRATION

THE RISE OF AN ENVIRONMENTAL PROBLEM

There is general agreement that hearing is probably the primary sense of whales, dolphins, and other marine species, as vitally important to them as seeing is to us. Yet the acoustic environment is increasingly overshadowed by a gamut of military, commercial, and industrial sources: dredgers that clear the seabed for ship traffic, pipelines, and structures; high explosives for removing oil platforms and testing the seaworthiness of military ships; pile drivers for construction; harassment devices for fisheries; tunnel borers; drilling platforms; commercial sonar; modems; transmitters; and innumerable jet skis and power boats. In deep water, background noise seems to be growing by about three to five decibels per decade in the band occupied by commercial ships. In some areas near the coast, the sound is persistently several orders of magnitude higher than in less urbanized waters, raising concerns about chronic impacts on marine life.

Among the leading contributors to the problem:

▸ **Military active sonar systems** put out intense sound to detect and track submarines and other targets. Mid-frequency tactical sonar, which is currently installed on close to 200 American vessels and on the ships of other navies, is linked to a growing number of whale strandings worldwide. Low-frequency sonar, which has proliferated rapidly over the last decade, can travel hundreds of miles at intensities strong enough to affect marine mammals. Navies are increasingly using both types of systems (a list of which is contained in the report) in coastal waters.

▸ **High-energy seismic surveys** are used by industry to detect oil and gas deposits beneath the ocean floor. Surveys typically involve firing airguns every few seconds at intensities that, in some cases, can drown out whale calls over tens of thousands of square miles. The industry conducts more than 100 seismic surveys

each year off the coast of the United States, and that could increase significantly with the passage of the Energy Policy Act of 2005, which mandates an inventory of the entire U.S. outer continental shelf. Global hot spots (which are mapped in the report) include the Gulf of Mexico, the North Sea, and the west coast of Africa.

▶ The low-frequency rumble of engines, propellers, and other **commercial shipping** noise can be heard in virtually every corner of the ocean. Over the last 75 years, the number of merchant ships has tripled, and their cargo capacity (which relates roughly to the amount of sound they produce) has increased steadily. Some believe that the biggest ships will become faster and larger still, possibly tripling in capacity, and that their numbers will double over the next 20 to 30 years. Increasingly, short hauls between ports could take cargo ships nearer to shore—directly through coastal habitat for many marine species.

That some types of sound are killing some species of marine mammals is no longer a matter of serious scientific debate. A range of experts, from the International Whaling Commission's Scientific Committee to the U.S. Navy's own commissioned scientists, have agreed that the evidence linking mass strandings to mid-frequency sonar is convincing and overwhelming. Suspect strandings have occurred off the Bahamas, the Canary Islands, the U.S. Virgin Islands, North Carolina, Alaska, Hawaii, Greece, Italy, Japan, and other spots around the world. Some stranded animals have been found to suffer bleeding around the brain, emboli in the lungs, and lesions in the liver and kidneys, symptoms resembling a severe case of decompression sickness, or "the bends." That these injuries occurred in the water, before the animals stranded, has raised concerns that whales are dying in substantially larger numbers than are turning up onshore. Other sources of noise, such as the airguns used in seismic surveys, may have similar effects.

But to many scientists, it is the cumulative impact of subtle behavioral changes that pose the greatest potential threat from noise, particularly in depleted populations: what has been called a "death of a thousand cuts." We know that sound can chase some animals from their habitat, force some to compromise their feeding, cause some to fall silent, and send some into what seems like panic. Preliminary attempts at modeling the "energetics" of marine mammals (the amount of energy an animal has to spend to compensate for an intrusion) suggest that even small alterations in behavior could have significant consequences for reproduction or survival if repeated over time. Other impacts include temporary and permanent hearing loss, which can compromise an animal's ability to function in the wild; chronic stress, which has been associated in land mammals with suppression of the immune system, cardiovascular disease, and other health problems; and the masking of biologically important sounds, which could be disastrous for species, like the endangered fin whale, that are believed to communicate over long distances.

Although marine mammals have received most of the attention, there are increasing signs that noise, like other forms of pollution, is capable of affecting the entire web of ocean life. Pink snapper exposed to airgun pulses have been shown to suffer virtually permanent hearing loss; and the catch rates of haddock and cod have plummeted in the vicinity of an airgun survey across an area larger than the state of Rhode Island. Indeed, fishermen in various parts of the world have complained of declines in catch after intense acoustic activities, like oil and gas surveys and sonar exercises, moved onto their grounds, suggesting that noise is seriously altering the behavior of commercial species. Other potentially vulnerable species include brown shrimp, snow crabs, and the giant squid, which is known to have mass stranded in the vicinity of airgun surveys.

THE DOMESTIC AND GLOBAL RESPONSE

As yet, there is no domestic or international law to deal comprehensively with ocean noise. The closest approximation in the United States is the Marine Mammal Protection Act (MMPA), which requires those who would harm animals incidentally, as an

unavoidable consequence of their business, to first obtain permission from one of the wildlife agencies. Congress dictated a precautionary approach to management given the vulnerable status of many of these species, their great cultural and ecological significance, and the exceptional difficulty of measuring the impacts of human activities on marine mammals in the wild.

When it has come to ocean noise, however, the MMPA's mandate has not been fulfilled.

▶ **Most of the leading contributors to the problem of ocean noise are not currently regulated.** With few exceptions, the U.S. Navy has not sought to comply with the MMPA on its sonar training exercises; oil and gas companies often conduct surveys off Alaska and in the Gulf of Mexico without authorization; and commercial shipping remains entirely unregulated. Lack of adequate funding is partly to blame, as is the recalcitrance of some powerful noise producers; but it can also be said that the agency with primary authority, the National Marine Fisheries Service (NMFS), has tied its own hands, declining to use the enforcement power available under law.

▶ **Mitigation measures that could make the most difference are generally not imposed.** As concern has mounted, scientists and policymakers have given more thought about ways to prevent and mitigate the needless environmental impacts of ocean noise. Among the most promising measures are geographic and seasonal restrictions and technologies that curb or modify sound at the source. To date, however, regulators have relied primarily on operational requirements, such as visual monitoring, whose effectiveness—particularly for some of the most vulnerable species of whales—is highly limited.

▶ **Legal standards are increasingly being defined in ways that limit the MMPA's effectiveness.** The NMFS has moved the threshold for regulatory action steadily upward over the years without any breakthroughs in research and, indeed, while studies on some species would seem to lead in the opposite direction. And changes that Congress has made to the threshold make the Act more difficult to enforce.

▶ **Cumulative impacts of ocean noise have not been addressed in a meaningful way.** This record is partly due to the basic empirical difficulty of determining when a population-level impact might occur, but also to the fragmentation of the permitting process, which relieves pressure on the agency to consider a broader set of impacts.

But undersea noise is not just a national issue: It is a global problem. Many noise-producing activities occur on the high seas, a gray zone of maritime jurisdiction, and both sounds and affected species have little respect for boundaries. Fortunately, as scientific and public consensus has crystallized around ocean noise, so has international recognition that the strategy for reducing it must be regional and global. A number of international bodies, including the European Parliament, the International Whaling Commission's Scientific Committee, and several regional seas agreements, have begun to address the problem, urging that nations work together. Options range from the direct, comprehensive control that a federal system like the European Union can exercise; to the guidelines or regulations that specialized bodies such as the North Atlantic Treaty Organization and the International Maritime Organization can propose for certain activities; to the coordination that regional agreements can bring, particularly to matters of habitat protection. Unfortunately, the present U.S. administration has opposed the international regulation of active sonar, which may weaken its leadership and standing on the broader issue of ocean noise.

THE WAY FORWARD

The mass strandings that have emerged over the last several years are a wake-up call to a significant environmental problem. We do not believe that an issue of this complexity can or will be settled tomorrow. Yet now is the moment when progress is possible, before the problem becomes intractable and its impacts irreversible.

With this in mind, NRDC recommends that the following steps be taken:

▶ **Develop and implement a wider set of mitigation measures.** Regulatory agencies in the United States, the NMFS and the Fish and Wildlife Service, should move beyond the inadequate operational requirements that are currently imposed and develop a full range of options, particularly geographic and seasonal restrictions and technological (or "source-based") improvements.

▶ **Build economies of scale.** Agencies should use programmatic review and other means to develop economies of scale in mitigation, monitoring, and basic population research. In conducting programmatic review of noise-producing activities, the agencies should take care to make threshold mitigation decisions early in the process and to allow public participation at every stage, as the law requires.

▶ **Improve enforcement of the Marine Mammal Protection Act.** The NMFS should exercise the enforcement authority delegated by Congress under the Act to bring clearly harmful activities, such as sonar exercises and airgun surveys, into the regulatory system and should adopt process guidelines to ensure that an arm's length relationship is maintained with prospective permittees. And Congress should add a "citizen-suit" provision to the MMPA, which would empower the public to do what, in some cases, the regulatory agencies will not.

▶ **Increase funds for permitting and enforcement.** The U.S. Congress should increase the NMFS's annual budget for permitting and enforcement under the MMPA.

▶ **Set effective standards for regulatory action.** So that the MMPA can serve the protective role that Congress intended, the act's standards for "negligible impact" and behavioral "harassment" should protect the species most vulnerable to noise, ensure that major noise-producing activities remain inside the regulatory system, and enable wildlife agencies to manage populations for cumulative impacts.

▶ **Establish a federal research program.** Congress should establish a National Ocean Noise Research Program through the National Fish and Wildlife Foundation, or similar institution, allowing for coordination, reliability, and independence of funding. A substantial portion of the budget should be expressly dedicated to improving and expanding mitigation measures.

▶ **Commit to global and regional solutions.** The United States and other nations should work through specialized bodies such as the International Maritime Organization to develop guidelines for particular activities like shipping noise; through regional seas agreements to bring sound into the management of coastal habitat; and through intergovernmental regimes, like the European Union, to develop binding multinational legislation.

CHAPTER 1

THE RISE OF OCEAN NOISE

One bright March morning in 2000, Ken Balcomb awoke to find a Cuvier's beaked whale stranded in the shallows behind his house in the Bahamas. In a way it was a fortuitous landing, for Balcomb was no newcomer to whale rescues. He was a marine biologist who had, in fact, pursued this very species off the Bahamian coast for almost ten years. He knew as well as anyone how uncommon it is even to glimpse these animals, which spend their lives diving on the continental shelf, and how extraordinary it is for one to strand. The biologist and his colleagues labored for an hour that day coaxing their discovery back to deeper water. Several times they succeeded in pointing it away from the beach, but it kept circling around, disoriented. When at last the whale was on its way, Balcomb's cell phone began to ring. Another beaked whale was reported to have come ashore, one mile south at Rocky Point.[1] By the end of the day, more than a dozen of these rare creatures, plus two whales of a completely different family, would be found stranded over hundreds of miles of beach in the northern islands.[2]

If every major environmental issue has a turning point, a moment when its significance becomes too apparent to ignore, that moment for the issue of ocean noise came in Ken Balcomb's backyard in the Bahamas. For it was soon discovered that the strandings there had been caused by military active sonar, a source of intense, mid-frequency sound.[3] Suddenly more money was available for research, and more and more people, including scientists, regulators, the media, and the public, began to pay attention to the problem. In 2004, four years after the whales came ashore, the Scientific Committee of the International Whaling Commission (IWC)—one of the world's preeminent groups of whale biologists—would report that ocean noise poses a significant and growing threat to populations of marine mammals.[4]

NO SILENT WORLD

Keep your eyes open the next time you dive. Just as you submerge, you'll see the horizon contract sharply. If the sea is calm and the water clear, you might see 90 or a 100 feet ahead, but if it's riled by wind your perspective might be limited to a fraction of that distance, maybe a few body lengths, just far enough to see the fins and suits of your fellow divers. At 20 feet below, the ocean can appear to humans, as to all species that rely mainly on sight for navigation, as a dark and boundless fog. Another 100 feet and it can seem like starless night.

Some 50 million years ago, the ancestors of our modern whale and dolphin (the cetaceans) withdrew from the land back into the sea, accomplishing one of the more extraordinary turnabouts in evolution. Along the way, they had to adapt themselves to the sea's perceptual challenges.[5] Their ability to see was severely limited by the darkness and turbidity of the water (under most conditions a mature great whale cannot even see its own flukes), and their sense of smell was too poorly developed to work over a sufficiently large range.[6] The answer that evolution provided to their perceptual difficulty appears to have been hearing: They compensated for lack of sight by altering the way they hear.

In place of the thin, pneumatic film that lines the terrestrial middle ear, the first cetaceans grew a thick, fibrous mantle that insulated them from the intense pressures they would experience on dives. And within the inner ear, in the conch-shaped spiral at the center

of hearing, some evolved features that could read a spectrum of sounds inaudible or barely audible to most land-based animals.[7] As with many evolutionary adaptations, these changes in the cetacean ear exploited a feature of the physical environment: the great efficiency of water as a carrier of sound. If light propagates poorly beneath the surface, sound travels easily, roughly five times faster and many times farther than in air.

Low-frequency sound can travel very great distances in seawater, so it should not surprise us from an evolutionary point of view that some marine mammals regularly produce sounds below 1,000 Hertz (Hz), in the lower register of human hearing. The endangered blue whale, the largest creature on earth, is known to produce loud, long infrasonic moans. Another great whale, the fin whale, emits a string of steady pulses at the absolute human threshold of sound—a call heard with such ubiquity that for years divers mistook it for the creaking of the ocean floor.[8] It has been suggested that the calls of these and other baleen whales might form the basis of vast oceanic networks, linking animals traveling singly or in small pods hundreds or even thousands of miles apart.[9]

Most impressive of all marine mammal sounds, perhaps, are the "songs" of the humpback whale, which are organized like birdsong into phrases and themes that change continually over time. A complete cycle may run as long as a concerto.[10] Some specialists believe that they are meant to convey salient facts about the singer's reproductive fitness—his species, sex, location, and willingness to mate—to interested females miles away.[11]

The uses to which marine mammals put their sophisticated hearing are only partly known, but what evidence we have suggests enormous variety, a set of crucial roles played throughout the life cycle. Many species are dependent on sound for their food, most famously the dolphins and porpoises that use the fine echoes from their high-pitched clicks to hone in on fish and other prey.[12] Some species are thought to rely on sound to navigate, such as the bowhead whales north of Alaska that may listen for echoes to avoid thick floes of ice in their migration path.[13] We know that sound binds pups and calves to their mothers, helps animals find their mates, aids them in avoiding predators and other dangers, and, in general, enables them to negotiate a world that is largely unavailable to sight.[14] Virtually every activity of biological significance to marine mammals (at least while they are underwater) depends on their ability to hear.

> *"I've spent much of my life in the sea. A long time ago, my father said this was 'a silent world.' We now know it is far from silent. In fact, this world is home to whales and dolphins that depend on sound to communicate, to find food, to find mates, and to navigate. I'm very concerned that sound is being used for industrial, scientific, and military purposes at such high intensities that it may be harming whales and dolphins. The oceans are becoming more and more polluted by sound from many sources. Each additional insult further undermines the quality of the ocean environment for its residents."*
>
> JEAN-MICHEL COUSTEAU, FOUNDER AND PRESIDENT, OCEAN FUTURES SOCIETY

And they are not the only ocean species that have evolved in this direction. Though the architecture of their ears may differ, fish are equipped, like all vertebrates, with thousands of tiny hair cells that vibrate with sound, making it intelligible to the brain; and unique to them is an organ called the lateral line, a band of sensory cells running the length of the body that can pick up sound at low frequencies.[15] Fish use sound in many of the ways that marine mammals do: to communicate, defend territory, avoid predators, and, in some cases, locate prey.[16] Some species of reef fish, which spend the early part of their lives in open water, use sound to locate the reefs that they will eventually make their home.[17] The males of a species known as the plainfin midshipman put out a low hum to let the females know they're available.[18]

There is general consensus that, in the darkness of the ocean, marine mammals and perhaps other species have come to rely on hearing as their primary sense.[19] Audition is as integral to their health and welfare as vision is to ours.

UNDERSEA NOISE POLLUTION

Unfortunately, over the past hundred years, the songs of whales have increasingly been joined by human noise: the drone of ship propellers and ship engines, the blast of seismic airguns prospecting for oil, the intense rumble and whine of military active sonar. These and other human enterprises can be heard in virtually every corner of the ocean, from the Russian far east to the Gulf of Mexico to the Mediterranean Sea.

Suppose that you submerged a powerful transmitter in waters off the California coast and rigged it to produce deep, bass notes at high volumes. How far might those sounds travel? Easily hundreds of miles, given the slow rate at which noise can attenuate in water; perhaps thousands, were they to enter one of the ocean's natural sound "channels", which concentrate and carry noise like ducts made of metal or concrete.[20] The genius of water as an acoustic medium was demonstrated in clear terms in 1991, when scientists broadcast a loud, foghorn-like signal off Heard Island, a remote spot south of Australia. The signal traveled within a sound channel through the Indian Ocean and up into the Pacific Ocean, finally reaching a receiver off Coos Bay, Oregon, some three hours later. A "sound heard round the world," it was called at the time.[21]

Not all sounds carry as far, of course. In general, the higher a signal goes in pitch, the quicker it is absorbed by seawater. Noise in the mid-frequency range, a part of the spectrum we tend to associate with human speech, certainly can't span the globe like the tones produced at Heard Island, though it can still travel far enough to cause whales to strand tens of miles away.[22] Sounds of higher frequencies, including those that are too high-pitched for humans to hear, affect marine mammals only at shorter distances.[23] But every source of intense noise in the ocean leaves an environmental footprint.

Just how quickly the noise level is rising depends on where you are. In deep water, at some distance from the coast, background noise seems to be growing by about 3 to 5 decibels per decade in the band occupied by commercial ships. One researcher found a 15-decibel boost between the years 1950 and 1975

TABLE 1.1
Comparison of Some Major Sources of Undersea Noise

Sound Source	Pressure Level	Duration*	Frequency (kHz)	Direction
Ship Shock Trial (10,000 lb. TNT)	299 decibels (peak)**	10 milliseconds	Broadband, with most energy in the low frequencies	Omni-directional
Airgun Array	235–259 decibels (effective peak)	20–30 milliseconds, repeated approx. every 10 seconds	Broadband, with most energy < 0.3 kHz	Pointed at ocean floor
Low-Frequency Military Sonar (SURTASS LFA)	235 decibels (effective)	6–100 seconds, repeated every 6–15 minutes	0.1–0.5 kHz	Pointed into water column
Mid-Frequency Military Sonar (AN/SQS-53C system)	235+ decibels	0.5–2 seconds, repeated every 28 seconds	2.6–3.3 kHz, centered at 2.9 kHz	Pointed into water column
Supertanker	185–190+ decibels (effective)	Continuous	Broadband, with most energy in the low frequencies	Omni-directional
Acoustic Harassment Device	190–205 decibels	0.5–2 seconds, repeated every few seconds	8–30 kHz, usually narrowly focused	Omni-directional
Acoustic Deterrence Device (NMFS-regulated)	132 decibels	300 milliseconds, repeated every few seconds	8–12 kHz, centered at 10 kHz	Omni-directional

Source: Adapted from Hildebrand (2004), Richardson et al. (1995), Navy (2001), Navy and Commerce (2001)

*The durations noted here are for sounds measured near the source. Certain features in the marine environment can cause even brief signals to travel in such a way as to seem almost continuous.

**It is customary to report pressure levels as an average, measured over the positive length of a sound wave, but where the wave is particularly short, as in the case of an explosion or an airgun pulse, "peak" levels are commonly used. Levels marked "peak" in this chart denote the sound's maximum pressure, not an average. "Effective" levels are used for technologies with multiple sources of sound, like arrays of airguns or sonar transducers, and give a sense of how strong they seem when measured beyond the point where their sound waves converge.

alone.[24] He predicted that the trend would slacken in the waning years of the 20th century, but a recent study off the California coast suggests that the pace remains reasonably strong, rising by about one order of magnitude in the lowest frequencies over 25 years.[25]

To gauge the extent of the problem, biologists have frequently called for the production of a noise "budget," which would itemize the energy going into the water on an oceanic, regional, and local scale.[26] Some areas for some species are surely becoming nonviable. In some places near the coast, in gulfs, bays, and harbors, for example, the noise is persistently several orders of magnitude higher than in less urbanized waters, raising concerns about chronic impacts on marine animals.[27]

The most common human-made source of low-frequency ocean noise is shipping. A century and a half ago, when ships were wind-powered, the schooners and clippers of the U.S. merchant marine hardly generated any noise at all, and the sea was a significantly quieter place.[28] All that changed with the advent of the propeller engine. A modern-day supertanker cruising at 17 knots (roughly 20 miles per hour) fills the frequency band below 500 Hz with a steady blare, reaching source levels of 190 decibels or more.[29] Its approach can easily be heard a day ahead of its arrival. Midsize ships such as tugboats and ferries produce sounds of 160 to 170 decibels in the same range.[30] The cumulative output of all these vessels—tens of thousands of container ships and tankers, ocean liners and motor boats, icebreakers and barges—is the drone that has raised the background level of noise throughout much of the world's oceans and radically altered the acoustic landscape in some areas near the coasts.

But ships are not the only sources of undersea noise. To detect oil and gas deposits beneath the ocean floor, most companies rely on the explosive power of airguns, arranged in rows behind a small ship. The guns fire at short intervals, discharging tens of thousands of blasts powerful enough to ricochet off layers of sedimentary rock deep within the seabed, thousands of feet below. A large-scale airgun array can produce sounds above 250 decibels—about the loudest noise that humans produce short of dynamite.[31] The dredging that is necessary to lay undersea pipelines and maintain shipping lanes for tankers generates continuous, broadband noise, especially in the low frequencies. Still more noise is produced by a gamut of sources during the production phase itself and concludes with the use of high explosives for platform removal.[32] Each year more than 100 seismic surveys take place off the coast of the United States, and that number could increase significantly with the passage of the Energy Policy Act of 2005, which mandates that an inventory be taken of the entire outer continental shelf.[33]

DEALING WITH THE DECIBEL

Comparing undersea noise with the noise in our own environment is tricky business, and the trouble begins with terminology, with what some acousticians have called "the elusive decibel." Technically speaking, the decibel is not a unit of measurement. It does not represent anything in the physical world, as a yard once signified the distance between the nose and thumb of whoever sat upon the throne of England. Like a cipher, the decibel acquires meaning indirectly, by its reference to a standard that in turn represents the world.

None of this would matter if decibels were always based on the same standard. But the standard that scientists use to measure sound in water differs from the one used to measure sound in air. To simplify matters, all decibel levels cited in this report (except as noted) have been gauged to 1 micro-Pascal (1 μPa), the standard reference pressure for waterborne sounds, rather than to 20 micro-Pascals (20 μPa), the standard for atmospheric sounds. For practical purposes, this means that you will have to *subtract 26 decibels* from the figures given here to begin to draw comparisons with noise in air. So the 200-decibel roar of a supertanker becomes a 174-decibel rumble—less impressive perhaps, but still about as strong as a commercial jet at takeoff, measured about three feet away.

What, then does, the decibel accomplish? Much as the Richter scale does for earthquakes, the decibel scale expresses sounds logarithmically, in increasing orders of magnitude. It enables us to compare sounds of radically different intensities, from a quiet breeze to a nuclear explosion, without having to manage long arrays of zeros. For example, the acoustic difference between a "pinger" (a deterrent used by fisheries) and the Navy's standard mid-frequency sonar system can be expressed as a difference of 100 decibels, although in fact the Navy's transmissions are roughly 10 billion times more intense.

But the source of ocean noise that has generally inspired the most concern is high-intensity active sonar, which has been linked to a growing number of whale strandings in the Bahamas and elsewhere. Mid-frequency tactical sonar, used by the world's navies for detecting and tracking submarines, is currently installed on close to 200 American submarines and surface ships; other systems are deployed by air or are dropped into the sea on buoys.[34] Most of the world's modern navies have one or another mid-frequency system in their fleets. At the cutting edge of sonar technology are the long-range, low-frequency systems that have proliferated rapidly over the last decade. The U.S. Navy's entry, known as SURTASS LFA (LFA stands for Low Frequency Active), was commissioned in the mid 1980s and deployed for the first time just three years ago. Two ships equipped with LFA are currently sweeping the northwest Pacific Ocean with low-frequency sound that can travel for hundreds of miles at intensities strong enough to affect marine animals.[35]

Military active sonar, seismic airguns, and commercial ships have frequently been identified in both the scientific and policy literature on noise as sources of serious concern.[36] But they are joined by many others: dredgers that clear the seabed for ship traffic, pipelines, and structures; high explosives for removing oil platforms and testing the seaworthiness of military ships; pile drivers for construction; harassment devices for fisheries; tunnel borers; drilling platforms; commercial sonar; modems; transmitters; and innumerable jet skis and power boats.

The upward trend in undersea noise pollution shows no sign of abating. On the contrary, as international trade expands and military hardware proliferates, and as decisions are made to extract more and more resources from the sea, the ambient level of noise in the oceans will continue to rise. One leading panel of whale biologists, the Cetacean Specialist Group of the IUCN-World Conservation Union, observed that the trend is unlikely to reverse itself over the next century unless serious steps are taken.[37] What effect all of this will have on marine life and marine habitat is a matter of increasing concern.

SOUND EFFECTS

More than one researcher has told the story of being at sea, listening through underwater microphones, or hydrophones, and finding that the whale calls they came to hear were barely audible over the din of industrial noise. How then, one might ask, are the whales managing to hear each other? Some biologists have compared the increasing levels of background noise in many places off our coasts to a continuous fog that is shrinking the sensory range of marine animals. Others, concerned about the acute injuries and deaths linked to active sonar, have compared its effects to those of dynamite. That such disparate metaphors have been used is an indication of the range of impacts that noise can have on life in the sea. (See Table 1.2.)

As a general rule, the nature and severity of any acoustic disturbance will vary with the animal's distance from the source. Near the center, where the noise is most intense, the impacts are direct and extensive, like dynamite: acute physiological damage and even death may occur if the source is strong enough. Farther out, as the noise attenuates, the character of its impact changes, grading downward through degrees of hearing loss and behavioral change, where it can take on the properties of a debilitating fog. One might depict the entire range of acoustic influence as a series of concentric rings radiating outward, not unlike the models tacticians devise for calculating the effects of shock waves. Not every creature within those rings will suffer harm: much depends on the specific characteristics of the sound, how it travels through the water forming beams and shadow zones, and on the sensitivity of the animal at critical frequencies. But following this scheme, one can begin to visualize the range of potential damage that undersea noise can incur.[38]

We know certain factors can complicate the situation and make matters worse. Beaked whales, and perhaps other species as well, don't seem to obey the rules about physical injury and, for reasons that are as yet unclear, suffer severe and probably lethal trauma at much greater distances and lower intensities than anyone would expect. Other species, like the harbor porpoise, are notoriously sensitive to

anthropogenic noise and will flee tens of miles to escape it, endangering themselves in the process.[39] Geography is another confounding factor. A rocky seafloor can cause sound to reverberate, turning a brief, if intense, signal into a virtually continuous din, and features like bays and channels can create traps for marine mammals, leading them to strand as they run from a sound field. Biologists have only begun to investigate the harm that a powerful noise source can do in the wild.

Lethal Impacts

On September 25, 2002, a group of marine biologists was vacationing along the Isla de San Jose in Baja, California, when they spotted two rare beaked whales lying along a strand of beach. The whales had not been dead long. Local fishermen had seen them come to shore the previous morning and had tried without success to push them back to sea. Hoping to preserve the bodies, the biologists quickly jumped on their radio and managed to hail a research boat that was swinging just past the island to the south. Remarkably, the boat was a seismic vessel operated by Columbia University. It was streaming behind it an unusually large array of airguns, and it had been heading close towards the island, firing several times a minute, on the morning the whales stranded.[40]

Meanwhile, more than 5,000 miles away in the Canary Islands, beaked whales of three different species were turning up on the beaches of Lanzarote and Fuerteventura. Tourists looked on as rescuers from a local stranding network struggled to keep the animals cool and wet; behind them along the horizon were warships from a naval exercise that was taking place offshore. When the whales died, their bodies were rushed to the University of Las Palmas de Gran Canaria, yielding some of the best evidence to date of the damage caused by active sonar.[41] For many observers, the concurrence of two beaked whale strandings on the very same day, in different parts of the world, only begged the question of how serious and widespread the noise problem had become.

> *"We would like to state at the outset that the evidence of sonar causation is, in our opinion, completely convincing and that therefore there is a serious issue of how best to avoid and minimize future beaching events."*
>
> THE JASON GROUP, A GROUP OF EXPERTS THAT REPORTS TO THE PENTAGON ON DEFENSE AND SCIENCE ISSUES, IN A 2004 REPORT COMMISSIONED BY THE U.S. NAVY

Mass strandings of whales are by far the most dramatic impacts attributed to ocean noise. They upset communities and trigger investigations, and explaining them has become the focus of a considerable amount of scientific effort. It is helpful to be clear about what we do and do not know.

Is sonar killing whales? That some types of active sonar are killing some species of marine mammals is no longer a matter of serious scientific debate. Beaked whales, a group of rarely seen, deepwater species, seem acutely vulnerable to the effects of mid-frequency sonar; and there is now a long and growing list of incidents in which these species (and sometimes others) come to shore and die while naval exercises unfold in the distance. Suspect strandings have occurred in Greece, during the trial of a NATO sonar system; on the islands of Madeira and Porto Santo, during a NATO event involving subs and surface ships; in the U.S. Virgin Islands, during a training exercise for Navy battle groups; in the Bahamas, the Canaries, Japan, Alaska, and other spots around the world. (See Table 1.3.) On several occasions, bodies have been recovered in time to give evidence of acoustic trauma.

When you take the plain coincidence of mass strandings with sonar use, add to it the extraordinary quality of these events (only a few beaked whale species are known to naturally strand in numbers), and top it off with a suite of physical evidence garnered over several years, the pattern is undeniable.

In a recent symposium at the International Whaling Commission, more than 100 whale biologists concluded that the association between sonar and beaked

TABLE 1.2
Potential Impacts of Sound in the Marine Environment

Impact	Type of Damage Possible
Physiological	
Non-auditory	• Damage to body tissue (e.g., internal haemorrhaging, rupture of lung tissue) • Embolism (and other symptoms consistent with decompression sickness, or "the bends")
Auditory	• Gross damage to the auditory system (e.g. rupture of the oval or round window on the threshold of the inner ear, which can be lethal; rupture of the eardrum) • Vestibular effects (i.e., resulting in vertigo, disequilibrium, and disorientation) • Permanent hearing loss (known as permanent threshold shift, or PTS) • Temporary hearing loss (known as temporary threshold shift, or TTS)
Stress-related	• Compromised viability of individual • Suppression of immune system and vulnerability to disease • Decrease in reproductive rate
Behavioral	• Stranding and beaching • Interruption of normal behaviors such as feeding, breeding, and nursing • Loss in efficiency (e.g., feeding dives are less productive, mating calls are less effective) • Antagonism toward other animals • Displacement from area (short-term or long-term)
Perceptual	• Masking of communication with other members of the same species • Masking of other biologically important sounds, such as the calls of predators • Interference with the ability to acoustically interpret the environment • Interference with food-finding
Chronic	• Cumulative and synergistic impacts • Sensitization to noise, exacerbating other effects • Habituation to noise, causing animals to remain near damaging levels of sound
Indirect effects	• Degradation of habitat quality and availability • Reduced availability of prey

Sources: Adapted from Simmonds & Dolman (2004) and Dinter (2004), and supplemented by Fernandez et al. (2005) and other recent findings.

whale deaths "is very convincing and appears overwhelming."[42] Back in the United States, a report commissioned by the Navy said much the same thing. "We would like to state at the outset," the authors wrote (all of them experts in bioacoustics and underwater physics), "that the evidence of sonar causation is, in our opinion, completely convincing and that therefore there is a serious issue of how best to avoid and minimize future beaching events."[43] Other scientific bodies have reached the same conclusion.[44] The case against airguns is not nearly so extensive, but has raised strong concerns nonetheless.[45]

What is causing the whales to die? The picture that many have in mind when they imagine a sonar stranding is of whales panicking and driving themselves to shore. That was certainly our presumption when we wrote, in 1999, that whales had fatally beached themselves during a NATO exercise as though they had all suddenly taken flight.[46] But the physical evidence recovered from strandings since then has led in an unexpected direction. Although the whales that stranded in the Bahamas and the Madeira Archipelago looked healthy enough, on closer observation it became clear that they were bleeding around the brain (and, in the case of the Bahamas animals, in other parts of the body as well).[47] These were not superficial cuts or abrasions, the sort of injuries that one regularly sees in stranded animals; they almost certainly happened while the whales were still in the water.

Then the September 2002 strandings in the Canaries added a new wrinkle. According to a report in the journal *Nature*, the Canary whales—while showing the same bleeding as their predecessors—also disclosed a host of tiny emboli, or bubbles, in their lungs, and lesions in their livers, lungs, and kidneys.[48] Remarkably, the bubbles and lesions suggested nothing so much as a severe case

CONTINUED ON PAGE 10

TABLE 1.3
Mass Strandings Coincident with Naval or Seismic Activities

Location	Date	Species Found	Circumstances	References
Alaska (Gulf of Alaska)	June 2004	Beaked whales (6)	Coincides with naval exercise Northern Edge04	Moore & Stafford 2004
Bahamas	Mar. 2000	Blainville's beaked whales (3), Cuvier's beaked whales (9), unspec. beaked whales (2), minke whales (2)	Coincides with transit of Navy vessels using mid-frequency sonar (AN/SQS-53C and AN/SQS-56); tissue analysis shows lesions consistent with acoustic pathology	Commerce & Navy 2001; Balcomb & Claridge 2001
Brazil (Abrolhos Banks)	June–Oct. 2002	Humpback whales (8)	Strandings are correlated with opening of area to oil exploration	Engel et al. 2004
Canary Is.	Feb. 1985	Cuvier's beaked whales, Gervais' beaked whale (10-12 total)	Coincides with naval maneuvers observed off coast	Simmonds & Lopez-Jurado 1991; Martín etal. 2004
	Nov. 1988	Cuvier's beaked whales (3), northern bottlenose whale (1), pygmy sperm whales (2)	Coincides with naval exercise FLOTA 88	Simmonds & Lopez-Jurado 1991; Martín et al. 2004
	Oct. 1989	Blainville's beaked whales (2), Cuvier's beaked whales (15+), Gervais' beaked whales (3)	Coincides with naval exercise CANAREX 89	Simmonds & Lopez-Jurado 1991; Martín et al. 2004
	Dec. 1991	Cuvier's beaked whales (2)	Coincides with naval exercise SINKEX 91	Martín et al. 2004
	Sept. 2002	Blainville's beaked whales, Cuvier's beaked whales, Gervais' beaked whales (14+ total)	Coincides with naval exercise NEOTAPON 2002; tissue analysis of beached whales reveals emboli and other symptoms suggestive of decompression sickness	Jepson et al. 2003; Martín et al. 2004
	July 2004	Cuvier's beaked whales (4)	Coincides with naval exercise MAJESTIC EAGLE 04; animals partly decomposed, but tissue analysis suggests emboli similar to those seen in Sept. 2002 strandings	A. Fernández, pers. comm. (2004)
Galapagos Is.	Apr. 2000	Cuvier's beaked whales (3)	Coincides with operations of seismic research vessel, though with vessel 500km distant from stranding site	Gentry 2002
Greece	May 1996	Cuvier's beaked whales (12)	Coincides with NATO trial of low- and mid-frequency sonar system (TVDS); strandings are highly correlated with sonar use; subsequent NATO investigation rules out all other physical environmental causes	A. Frantzis 1998; NATO SACLANT Undersea Research Center 1998
	Sept.–Oct. 1997	Cuvier's beaked whales (9)	Coincides with naval activity	NATO SACLANT Undersea Research Center 1998; A. Frantzis 2004
Gulf of California	Sept. 2002	Cuvier's beaked whales (2)	Closely timed with approach of seismic research vessel	Hildebrand 2004
Hawaiian Is.	July 2004	Melon-headed whales (approx. 200)	Coincides with naval exercise RIMPAC 04; like other strandings listed here, an extraordinarily unusual event	Navy 2004; M. Kaufman 2004a
Italy	May 1963	Cuvier's beaked whales (15)	Coincides with naval exercises	IWC 2004
Japan (Sagami and Suruga Bays)	Mar. 1960	Cuvier's beaked whales (2)	Strandings are highly correlated with presence of U.S. naval base at Yokosuka; researchers conclude that the record strongly suggests a relationship between Navy acoustics and mass strandings of beaked whales off Japan	Brownell et al. 2004 (based on Japanese stranding record)
	Mar. 1963	Cuvier's beaked whales (8–10)		
	Feb. 1964	Cuvier's beaked whales (2)		
	Mar. 1967	Cuvier's beaked whales (2)		
	Jan. 1978	Cuvier's beaked whales (9)		
	Oct. 1978	Cuvier's beaked whales (4)		

TABLE 1.3 (continued)
Mass Strandings Coincident with Naval or Seismic Activities

Location	Date	Species Found	Circumstances	References
	Nov. 1979	Cuvier's beaked whales (13)		
	July 1987	Cuvier's beaked whales (2)		
	Feb. 1989	Cuvier's beaked whales (3)		
	Apr. 1990	Cuvier's beaked whales (6)		
Madeira Is.	May 2000	Cuvier's beaked whales (3)	Coincides with NATO exercise using surface vessels and submarines; necropsies show hemorrhaging consistent with results from Bahamas strandings from same year	L. Freitas 2004
North Carolina (Outer Banks)	Jan. 2005	Pilot whales (31), pygmy sperm whales (2), minke whale (1)	Coincides with ESGEX exercises and other sonar use; tissue scans show hemorrhaging in pygmy sperm whale and pilot whale consistent with other stranding events	Investigation in progress; see M. Kaufman 2005b
Virgin Islands	Oct. 1999	Cuvier's beaked whales (4)	Coincides with COMPTUEX exercise; strandings on St. Thomas, St. John, and St. Croix	NMFS 1999, 2002; Mignucci-Giannoni et al. 2000
Washington (Puget Sound)	May 2003	Harbor porpoises (as many as 11)	Coincides with transit of Navy vessel operating mid-frequency sonar (AN/SQS-53C)	NMFS 2004, 2005

Sources: See list at close of Endnotes, page 75.

VIDAL MARTIN, SECAC

Members of a stranding team examine one of the beaked whales that died in the Canary Islands, in September 2002. The investigation yielded some of the best evidence to date on the damage done by active sonar.

of decompression sickness, or "the bends," to which it was previously thought that deep-diving marine mammals were immune.[49]

Humans suffer from the bends when bits of gas precipitate out of the blood, forming bubbles that can riddle organ tissue and block the passage of oxygen. In marine mammals, the sequence of events that could lead to such trauma remains uncertain. Panic might force the whales too rapidly to the surface, causing bubbles to form, or it might push them to dive sooner than they should, before they can eliminate the nitrogen they've accumulated on previous descents.[50] Some scientists believe that the sonar itself could activate the bubbles, which would expand to devastating effect as the whales rose to the surface.[51] Or perhaps both behavior and physiology are to blame.[52] All of these ideas are plausible. Regardless, enough papers have been produced in support of the bends hypothesis—papers on dive behavior, veterinary pathology, and bubble growth—to make it the dominant theory in the field.[53] Of course it would be a mistake, should the theory prove correct, to assume that every animal that strands from sonar is a victim of decompression sickness. Some may die simply because the noise disorients them, for instance. There are many possible pathways to the beach.[54]

Because we don't know exactly how sonar kills whales, we can't say that the problem is limited to mid-frequency sources or, for that matter, to sonar. Experts believe that low-frequency sound can activate and spur the growth of nitrogen bubbles just as easily as mid-frequency sound; and events like the death of those two beaked whales in Baja naturally raise the stakes.[55] If low frequencies do prove injurious, the consequences for some species could be profound, particularly as long-range sonar proliferates among our allies and as airguns move into the deeper waters that beaked whales prefer.

How many whales are dying? The global magnitude of the problem is simply not known. To begin with, much of the world lacks networks to identify and investigate stranding events, and even in countries with established response teams, only a fraction of all strandings are reported. Naturally animals that die at sea are even more difficult to detect, since many species quickly sink beneath the water.[56] According to scientists at the National Marine Fisheries Service (NMFS), the government agency charged with the protection of marine mammals, most Cuvier's beaked whale casualties are bound to go undocumented because of the remote siting of sonar exercises and the small chance that a dead or injured animal would actually strand.[57]

Odds are that the mass mortalities we have seen represent only a snapshot of a larger problem.

That beaked whales are suffering injury in larger numbers than are turning up on shore would be consistent with one of the most disturbing findings from the Bahamas, the only stranding event for which baseline survey data are available. Since the Navy passed through in March 2000, the cohort of Cuvier's beaked whales that had been photo-identified and recorded for years has virtually disappeared, leading researchers to conclude that nearly all of the animals died of physical injury or, at the very least, were driven to permanently abandon their habitat.[58] Five years later, the species is slowly returning, but sightings are still far below what they had been.[59] Although not much is known about beaked whale ecology, the latest research suggests that some Cuvier's whales might aggregate in small populations, taking up residence along the edges of the continental shelf.[60] What scientists fear is that, under the right conditions, even the transient sweep of a sonar vessel or other source could devastate a local population.[61] In the Bahamas, that is precisely what appears to have happened.

Paradoxically, the focus on beaked whales may have caused us to undercount the impacts of noise on other species. Mass strandings of beaked whales first attracted notice because of their strangeness and rarity. When a biologist sees numbers of these animals come ashore in a single day over long stretches of beach, he can rest assured that he is witnessing something unusual; but species that strand more commonly tend not to raise the same alarm bells.

Now that is beginning to change. Biologists have noted that both minke whales and pygmy sperm whales have beached along with beaked whales, and other species have had what may have been their own run-ins with sonar.[62] Last year, for example, 200 melon-headed whales appeared one morning in Hanalei Bay as active sonar blared some 25 miles offshore.[63] And as we go to press in November 2005, pathologists in North Carolina are investigating a mass stranding of three species along the Outer Banks—an event that could yield the first physical evidence of acoustic trauma in cetaceans other than beaked whales.[64] If the bends theory proves correct, deep divers such as sperm whales would presumably be among the most vulnerable.[65]

So this is what we know. We know that beaked whales, especially Cuvier's beaked whales, are acutely vulnerable to some types of active sonar, and we are beginning to find that other species may be vulnerable, too. We know that mid-frequency signals can cause serious injury and death (and at levels of exposure far below those we'd expect to cause permanent hearing loss), and there is good reason to believe that at least some low-frequency sounds can do the same.[66] But we don't yet understand the mechanisms that are bringing whales to their end, nor do we understand the magnitude of the problem today or in the past. Last year, biologists from the United States and Japan noticed a concentration of beaked whale mass strandings along the Japanese coast near Yokosuka, one of the primary bases for U.S. naval activity in the western Pacific.[67] As many have recognized, there is a need for more of this sort of retrospective analysis, along with other research—and there is an immediate need to reduce the harm.

Behavioral and Perceptual Impacts

Just as worrisome as mass strandings is the prospect of long-term abandonment, a situation in which large numbers of marine mammals vacate their habitat, disrupting their life cycles, to escape human noise. Such seemed to be the case with the California gray whale, which deserted one of its historic breeding grounds in Baja following a month of sonic experimentation in the mid 1980s.[68] Two decades earlier, the whales abandoned a different Baja lagoon when commercial shipping and industry moved in and did not return for several seasons after the activities stopped.[69] Short of strandings, large-scale abandonment may be the most extreme sort of behavioral response to noise.

But abandonment represents just one end of a spectrum of reactions seen in marine mammals in the wild. Many species, including sperm whales, bowhead whales, and populations of narwhals in the Arctic, are known to sometimes cease vocalizing for hours or

days in the presence of low-frequency sound.[70] Others extend their calls or songs, or modulate them in ways that suggest an effort to compensate, as humans do when we try to talk over a loud noise in our environment.[71] Some species respond by altering their dive patterns, spending more or less time underwater before coming up for air.[72] And it has been suggested that exposing an animal to intense sounds, without affording it the time to approach and investigate on its own, may induce a type of aggressive, agonistic response that can lead to violence and physical injury.[73] Recent improvements in technology, particularly the invention of satellite tags that can stick onto an animal's skin, are giving us a better window on the acute impacts of ocean noise.

For scientists, though, all of this begs the question of significance—the actual biological consequences of a disruption for an individual, a population, or a species. To be sure, the severity of some responses to sound is beyond doubt. When a military jet comes in low and fast above a seal rookery, it can spark a stampede in which pups can be trampled and killed; when industry moves into a breeding lagoon or a feeding ground, it can drive the animals out.[74] The deeper question for science concerns the subtler disturbances that affect large numbers of animals every day, everywhere in the world. To many, it is these unobserved changes in behavior that pose the greatest potential threat from noise, a "death of a thousand cuts" that ultimately could cause more harm than strandings, particularly in depleted populations.[75] If sperm whales begin to break off early from their dives, what effect does that have on their feeding? If fin whales can no longer communicate with one another over long distances, or if their songs and calls are altered, are they losing crucial opportunities to breed?

A panel of biologists that considered these issues last year came up with a conceptual model to express the cumulative significance of noise. Like chains in a fence, exposure levels were linked to shifts in behavior, shifts in behavior to disruptions in key activities such as feeding and breeding, disruptions in key activities to changes in birth and mortality rates, and changes in vital rates to population impacts.[76] But information at each stage of the analysis is sorely lacking, and some of it may not be discoverable for years, if at all.[77] Although the consequences for species may be profound, they are often difficult to observe and to grasp.

The case of noise avoidance is illustrative. Short-term avoidance, perhaps because it is somewhat easier to observe than other responses, is what wildlife agencies most commonly look for in deciding what amounts to a "significant" behavioral change. Gray whales have been shown to avoid some 120-decibel sounds, altering their migration routes by a mile or more.[78] A regulator might say that such minor deviations are not necessarily harmful; indeed, in the final analysis, they might even prove beneficial, drawing the animal away from the source, where it would suffer injuries more acute than the stress and enervation of an unexpected detour.

But the regulator's calculus might change if the deviation were greater (as in the case of migrating bowhead whales, which give a wide berth to airguns), or if small detours were repeatedly made in the course of a 3,000-mile migration. Perhaps we should be even more concerned about the whale that doesn't swerve away, that has become habituated to the sound but presses on regardless, or that willfully suffers discomfort or compromises feeding to remain in productive water. The animals that don't seem to flee from a noise source may be those whose options are most limited.[79]

One of the ways that biologists can begin to get at these subtleties is by considering their "energetics," the amount of energy a marine mammal has to spend, as though in a balance sheet, to compensate for an intrusion. Taking this approach, it becomes apparent that even a small alteration in behavior could have significant consequences for reproduction or survival if repeated over time. For example, the female fin whale (next to blue whales, the largest animal on the planet) has been said to require an additional 50 percent above her own calorie supply each year to safely birth and nurse a calf.[80] If this is true, the analysis goes, even a 10 percent loss in intake could slow the mother down from producing one calf every *two* years to producing one calf every *four*. (The mother might

continue to breed every two years, but her calves would receive less nourishment and would presumably have a poorer shot at survival.)[81] The fact is that the ocean does not always allow much margin for error. There are vulnerable populations in noisy habitat—orcas in Puget Sound, sperm whales in the Gulf of Mexico, belugas in the St. Lawrence estuary—for which a biological balance sheet is sorely needed.[82]

At certain frequencies, human noise can also affect marine animals indirectly, by "masking" biologically significant sounds as, say, in our own lives, an important conversation might be lost in the rumble of a low-flying plane. The potential consequences are not trivial. Marine mammals and other species use sound to navigate, to locate each other for mating, to find food, to avoid predators, and to care for their young. Any interference or noise that undermines their ability to hear these critical acoustic signals jeopardizes their ability to function and, over time, to survive.

The impact of masking might be most pronounced in species that rely on long-distance signaling, as the blue and fin whales are thought to do.[83] Over the years, with the steady rise of low-frequency noise from shipping and other activities, the horizon of communication for these species has collapsed in many places around the world from hundreds to tens of thousands of miles.[84] What that might mean for their reproduction and recovery—these endangered whales that are so widely dispersed about the ocean and yet seem to lack established breeding grounds—is unknown.[85] A range of other species may also be affected: not only marine mammals, but also such fish as the haddock, perch, and cod, which are sensitive to low-frequency sound.[86] As significant as these effects may be, we have scarcely begun to study them.

Other Physiological Impacts

At bottom, sound is a physical phenomenon: a force passing in the form of a wave through water or air, compacting and rarefacting the molecules it crosses. The tiny cochlear hairs in our inner ears vibrate with that force, and so we "hear"; but, as the injuries seen in stranded whales suggest, these are not the only parts of the body affected by sound. Low-frequency noise can agitate nerve endings deep within the skin or cause gas bubbles to form in the gastrointestinal tract, which may explain the discomfort divers have felt, even at long distances, around the Navy's LFA sonar system. At certain frequencies, sound can cause the air-filled tissue in the lungs to vibrate sympathetically, a condition called resonance that, in its extreme form, may lead to hemorrhaging.[87] And, as we have seen, a broad range of sounds appear to have the ability of activating bubbles in the blood, a pathology that may lie behind the mass strandings.

Extensive injury may result from underwater explosions, such as the Navy uses to test the seaworthiness of new ships and submarines. The shock wave from an explosion is rapidly followed by intense oscillations of sound: fronts of positive and negative pressure that form as hot gases are created in the blast, and as these fronts pass through an animal, the pressure surging around its lungs and viscera, around its natural pockets of air, body tissue may burst their walls and bleed into the cavities, possibly resulting in death. To escape physiological damage from a 220-pound underwater blast (Navy shock trials typically involve detonations of 10,000 pounds) a human diver would have to swim about two miles away.[88] For many species of fish, particularly those with air-filled bladders, a discharge at that range would be fatal. Dolphins and whales, having much greater mass, could presumably withstand injury at closer distances, but the fact that existing standards are based mainly on terrestrial animals should caution regulators toward conservatism.[89]

Auditory harm. It doesn't require an explosion to disable or damage the ear.[90] Prolonged exposure to continuous noise, as from shipping and other sources, can also bring about hearing loss, analogous to the ringing of the ears we experience after a few minutes on a busy factory floor, or to the obliviousness that hangs about us for several hours after a rock concert, when colleagues have to raise their voices to be heard. Audiologists call this impairment "threshold shift," after the minimum volume, or threshold, that a sound

must reach for an individual to detect it. On exposure to some loud sound, one's acoustic threshold rises in the vicinity of the frequency, sometimes by a few decibels, sometimes by more. For a marine mammal, each additional decibel can mean the loss of vital information: the call of a calf, or of a predator, or of a prospective mate.

Threshold shift can be permanent or temporary, depending upon the duration and the intensity of the animal's exposure, but even temporary shifts will turn permanent if repeated often enough. Humans begin to suffer temporary hearing loss after a few minutes of mowing the lawn (roughly 90 decibels, by the standard used to measure sound in air).[91] Subject yourself to the same noise over an eight-hour workday and you could develop permanent deafness at sensitive frequencies within a few years.[92] For most marine mammals, the quantities are far less certain. Experts seeking a threshold, particularly in the case of the great baleen whales, the mysticetes, are often forced into the realm of speculation, having to conjecture, first of all, about the animals' hearing ability under optimal conditions (an unknown baseline) and then having to extrapolate from other species as to the additional energy they can bear.

Over the last several years, researchers in California and Hawaii have directly measured hearing loss in a small number of species. Animals were trained to tolerate exposure to tones that ranged from the nearly instantaneous to the almost hour-long, at levels that might trigger only minor and temporary threshold shifts, and then to submit to a hearing test often not much different from the one children take in school.[93] The goal of these experiments was not only to ascertain the point at which certain types of noise might cause hearing loss; it was also to understand, in a general way, how the duration of a sound determines its impact.[94] Through such a discovery, one could predict the damage that longer-term exposures might cause. Unfortunately, it is not clear (assuming one could project beyond the small stable of species and animals that have been examined) how the results would apply to real-life conditions, in which potentially harmful exposures are intermittent.

For cetaceans, which are highly dependent on their acoustic sense, the consequences of any degree of hearing loss can be serious. Even short-term disability could result in poor communication, compromised feeding, and various sorts of erratic behavior that, among other things, could leave an animal more vulnerable to predators. In Newfoundland some years ago, in a feeding ground for humpback whales, fishermen saw a sharp increase in the number of whale entanglements after blasting and other industry activity moved in. The whales had not responded in any obvious way to the activity, but the circumstances suggested to researchers that the entrapments were a secondary effect of damaged ears.[95] Off the Canary Islands, two sperm whales that had been struck and killed by ships showed signs of low-frequency hearing loss.[96] Despite these indications, little work has yet been done to document or model the indirect impacts of hearing damage on marine mammals in the wild.

Stress. Although stress can play an important role in how we respond to danger, we all know that carrying it around for months or years can be decidedly unhealthy. In many species, including people, long-term stress is associated with suppression of the immune system, cardiovascular disease, and other health problems. Animals that have adapted themselves to a noisy habitat may exhibit no overt signs of disturbance, yet still experience the chemical changes associated with stress; and in at least some terrestrial species, those changes have been known to frustrate reproduction and hinder the survival of offspring.[97] The question for marine mammals is not whether noise causes stress, but whether animals manage to habituate to it.[98] Twenty years ago, the U.N. Environment Progamme called on the international scientific community to study this long-term threat, particularly by "monitoring stress in whales produced by boat traffic, seismic exploration, and other manmade disturbances," and several National Research Council reports have recommended that the issue be pursued.[99] Thus far, very little has been done.

Impacts on Other Marine Species

Although marine mammals have received most of the attention, they are not the only species affected by undersea noise. Impacts on fish are of increasing concern because of the critical role that they play in the food web and the enormous pressure that many populations, depleted by years of exploitation, are already under. There are signs that some fish species may be profoundly affected by sound.

One of the pathways for damage in fish is hearing. An alarming series of recent studies showed that airguns can severely harm the hair cells of fish (the organs at the root of audition) either by literally ripping them from their base in the ear or by causing them to "explode."[100] Fish, unlike mammals, are thought to regenerate hair cells, but the pink snapper in those studies did not appear to recover within several weeks after exposure.[101] As in marine mammals, sound can also cause temporary hearing loss. Even at fairly moderate levels, noise from outboard motor engines is capable of temporarily deafening some species of fish, and other sounds have been shown to affect the short-term hearing of a number of other species, including sunfish and tilapia.[102] The species most at risk may be the so-called hearing "specialists," fish like the herring and the American shad, whose swim bladders help channel sounds directly to the ear, leaving them more sensitive to noise across a broader frequency range.[103] But for any fish that is dependent on sound and relies on it for such daily necessities as predator avoidance, even a temporary loss of hearing (let alone the virtually permanent damage seen in snapper) will diminish its chance of survival.[104]

Nor is hearing loss the only effect that ocean noise can have on fish. For years now, anglers and trawlers in various parts of the world have complained about declines in their catch after intense acoustic activities moved into the area, suggesting that noise is seriously altering the behavior of some commercial species.[105] A group of Norwegian scientists attempted to document these declines in a Barents Sea fishery and found that catch rates of haddock and cod (the latter known for its particular sensitivity to low-frequency sound) plummeted in the vicinity of an airgun survey across an area larger than the state of Rhode Island.[106] Several other species, herring, zebrafish, pink snapper, and juvenile Atlantic salmon, have been observed to react to noise with acute alarm.[107] Fishermen have also expressed concern for the welfare of fish eggs and larvae. Preliminary studies show that, for at least a few species, intense noise can kill larvae outright or retard their development in ways that may hinder their survival later.[108]

If fish have received some attention in recent years, the current science affords little more than a glimpse at the potential effects of noise on other species, such as invertebrates. Many of these creatures have ear-like structures or sensory mechanisms that could leave them open to injury or disturbance.[112] The few species that have been studied include the giant squid, which twice now have stranded in numbers in the vicinity of airgun surveys; the brown shrimp, whose growth

THE AIRGUN AND THE SQUID

One of the most mysterious creatures in the sea is the giant squid, *Architeuthis dux*. Though a mature animal may run 60 feet from the tip of its fins to the ends of its feeding tentacles—the length of a sperm whale—until very recently it had never been seen or recorded alive.

In September 2003, four giant squid washed up dead along the southern coast of the Bay of Biscay in Spain.[109] That so many appeared at once was astonishing to local scientists; ordinarily, only one giant squid is found along the Spanish coast each year.[110] It turned out that this extraordinary event occurred while an airgun survey was taking place off the coast of Bilbao, and investigators recalled how, only two years earlier, five more animals were found stranded or floating in the water after another seismic survey had come through. All of the squid had damaged ears, and some had massive injury in their organ tissue. Scientists now speculate that the creatures, whose metabolisms are adapted for life in the deep ocean, may have died of suffocation after the booming of the airguns caused them to surface.[111]

BOB CRANSTON/ANIMALS ANIMALS

and reproduction have been stunted from being raised in a noisy environment; and the snow crab, which, in some preliminary research, showed signs of ovary and liver damage on exposure to airgun noise.[113]

Perhaps the more glaring omission in the literature on noise is the sea turtle, nearly every species of which is highly endangered. Like fish, sea turtles have no external ears. Sound is conducted entirely through their ear bones and, it is thought, their shells; and the sounds for which they have the greatest sensitivity are low-frequency sounds.[114] Some species have been shown to surface, to startle, and to move away from various kinds of deep-pitched sources.[115] In one case, changes in blood chemistry were observed, indicating increased levels of stress.[116] Yet the potential significance of ocean noise for these animals has not yet been explored.

In short, the science on species other than marine mammals is scattershot, consisting of bits and pieces of knowledge that often raise more questions than they answer. But there is enough information to indicate that the problem runs well beyond whales. Some activities—airgun surveys are the most prominent—clearly have the power to harm a wide variety of species; indeed, the motive for much of the science we do have is the increasing concern that fishermen and fisheries managers have felt about offshore exploration. So many species are now beginning to show sensitivity to such activities that we must ask whether noise, like other forms of pollution, is capable of affecting the entire web of ocean life.

KNOWLEDGE AND ACTION

In 1994, a panel organized by the National Research Council to assess our state of knowledge in the field concluded in effect that we were ignorant. "Data... are scarce," the panel said. "Although we do have some knowledge about the behavior and reactions of certain marine mammals in response to sound, as well as about the hearing capabilities of a few species, the data are extremely limited and cannot constitute the basis for informed prediction or evaluation of the effects of intense low-frequency sounds on any marine species."[117]

> *"[We] unanimously agreed that there was now compelling evidence implicating anthropogenic sound as a potential threat to marine mammals. This threat is manifested at both regional and ocean-scale levels that could impact populations of animals."*
>
> 2004 REPORT OF THE INTERNATIONAL WHALING COMMISSION'S SCIENTIFIC COMMITTEE, SUMMARIZING THE CONCLUSIONS OF MORE THAN 100 BIOLOGISTS

The past 10 years have seen a remarkable expansion in research and in our knowledge and awareness of the impacts that noise pollution can have. In the history of the development of this issue, the strandings of beaked whales in the Bahamas, the Canary Islands, and elsewhere may come to be seen as a wake-up call. It has been made abundantly clear by those events that it can cause marine mammals serious harm; and we know from experimental research that noise can damage other species, such as commercial fish, as well. We know that sound can chase some animals from their habitat, force some to compromise their feeding, cause some to fall silent, and send some into what, to a disinterested observer, seems very much like panic.

We know something about the serious effects that noise pollution can have in the short term, but far less than we should about its long-term consequences. Lack of sufficient funding is partly to blame, but the problem has a second cause in the nature of marine science itself. Whales and other species are notoriously difficult to study in the wild, requiring ship time, trained observers, and significant advancements in technology. Since marine mammals are generally long-lived, an investigation into the subtle, cumulative effects of undersea noise could take many years.

In the end, cause and effect may prove impossible to untangle. Why is it that the Southern right whale, whose range extends south from Brazil and South Africa into the Subantarctic, has begun to recover from centuries of hunting, while its cousin the Northern right continues to languish along the U.S. coast? How does one distinguish the biological effects of chemicals, climate, fishing, and disease from those of noise pollution? Damage can take place for years before it is detected. After all, it took more than

three decades from the first reported strandings for science to draw a link between mass whale mortalities and active sonar.

Long-term solutions will not come easy. In the United States, the governing law is tough in theory but weak in practice. Making the necessary improvements will require more scientific knowledge and political resolve than have yet been advanced. Furthermore, since the noise proliferation problem is global, it must ultimately be redressed on an international scale, involving countries whose conservation laws may be weaker than our own. We do not believe that an issue as complex as undersea noise pollution can or will be settled tomorrow. Yet now is the moment when significant progress at least is possible, before the problem of increasing noise pollution becomes intractable and its impacts irreversible. Suggesting a course we might productively follow, one that allows time for further study while protecting marine life *today*, is the aim of this report.

CHAPTER 2

DYNAMITE AND FOG: A SURVEY OF NOISE SOURCES

The waves of noise released by ships, airguns, and sonar systems have sometimes been compared to the broad, disabling rays of a domestic floodlight. Just as our eyes are blinded in the floodlight's beam, the analogy goes, so some marine mammals are effectively "blinded" by sound, unable to discern other sounds in their vicinity. But acoustic waves don't blanket the sea in quite the way the floodlight does a backyard. To begin with, they are more highly susceptible to environmental influences, such as water pressure, temperature, and salinity. Given the right combination of factors, they might run for miles just beneath the ocean's surface or else bound between the depths and shallows in long, irregular arcs. Each of the major noise-producing activities discussed in this report (military, industrial, and commercial) is distinct in the noise it produces.

These activities differ in other important ways as well. For some, such as commercial shipping, noise is an unwanted and unnecessary by-product; for others, such as military sonar exercises, the production of sound is intentional and may be essential to their goals. Certain activities concern us for their long-term or seasonal impacts, their contribution to the growing "fog" of noise that degrades habitat off our coasts; others concern us partly or primarily for their acute effects.[1] Some sources are stationary while others are mobile; some occur in shallow water while others are based offshore. Each activity has a range to cover, a constituency to satisfy, and a specific ecological cost.

In this chapter, we survey the leading polluters, consider their environmental impacts, and suggest what might be done to lighten their footprint on the sea.

HOW TO REDUCE NOISE

One of the great challenges in managing any form of pollution is coming to terms with the diversity of activities that produce it. Air pollution, for example, is a product of auto exhaust, factory smoke, power plant emissions, and a profusion of other sources; fortunately, our clean air laws are savvy enough to deal with them separately even as they articulate a comprehensive program.[2] To manage the problem of undersea noise pollution, a similar approach is necessary. Reducing harm to marine life will require creative, targeted management, choosing from the best available standards and options, (see Table 2.1), and adapting them to each of the major contributors to the problem.

The approach for which perhaps the broadest consensus has emerged among observers is geographic restriction. In essence, the goal is to avoid sensitive areas, either throughout the year or during those times when vulnerable species are thought to be present. Breeding and feeding grounds and migration routes for large baleen whales are the most salient examples, and come strongly recommended by the International Whaling Commission's Scientific Committee, among others.[3] One would naturally want to avoid essential habitat for endangered whales at least while the whales are there. But areas of high species abundance, marine sanctuaries and protected areas, and places with treacherous geography such as bays, canyons, and channels should also be avoided.

To accomplish this, it is often recommended that the wildlife agencies compile a list of "hot spots," areas of biological importance that may be subject to

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TABLE 2.1
Mitigation Measures for Ocean Noise

Type	Method	Description
Geographic Mitigation	Year-round restrictions	Activities are restricted year-round in high-risk areas, such as critical habitat for endangered species; habitat where vulnerable species (like beaked whales) are expected to occur in abundance; and areas whose geography (bays, channels, canyons) may leave animals particularly susceptible to acoustic impacts. As a group, geographic restrictions have been recognized to be of particular benefit to marine mammals.
	Seasonal restrictions	Activities are restricted from an area to avoid times of year when certain species are present. Seasonal restrictions have been strongly recommended in the case of large migratory whales, which often travel thousands of miles each year between feeding and breeding grounds. For example, it has been suggested that oil-and-gas companies off Gabon avoid running seismic surveys during the winter, when baleen whales are breeding offshore.
	Site selection	Polluters avoid concentrations of marine mammals and other marine life by identifying and using low-risk areas. As a mitigation technique, the benefits of site selection are self-evident, but it is best employed for activities like sonar exercises that have sufficient flexibility in their planning.
Source-Based Mitigation	Engineering and mechanical modifications	A sound source is modified to reduce impacts on marine life without precluding the activity for which it was intended. Keeping decibels down is one useful goal, but altering key characteristics such as frequency (as some European navies are considering for their active sonar systems) may also be effective. This method has been recognized to hold considerable promise for many activities, most notably for commercial shipping.
	Activity reduction	Alternatives are found that reduce the amount of time a particular source is active. This might be achieved in some cases by using alternative technologies like simulators to accomplish the same task, or by avoiding duplication of effort; but in general the option has not seriously been explored.
	Sound containment	A number of devices on the market (fabric curtains, bubble curtains, blasting mats) can act as inhibitors of underwater sound, containing it to a limited extent within a small area around the source. Generally the technology is most often used for sedentary activities, such as pile-driving and construction.
Operational Mitigation	Safety zones	Operators establish a safety radius around the source and either shut down or reduce power when marine mammals or other animals approach. Safety zones are useful in reducing some species' risk of exposure to the highest levels of sound (and are therefore widely prescribed), but the technique is hampered by deficiencies in available monitoring methods and by the small size of the zone (which typically represents a fraction of the total area of impact). Safety zones are best prescribed as part of a wider suite of mitigation measures.
	Warning sounds	Operators use sound to deter animals from approaching a sound source or to impel them to leave an area. By far the most common technique, known in the United States as"ramp-up" and elsewhere as "soft start," uses the source itself to provide a warning, starting at relatively low power then gradually working up before the activity begins. Although ramp-up iswidely applied, it has not been systematically tested, and there is evidence that some species do not swim away. Other aversive sounds have also been proposed. A number of recent studies leave in doubt whether they could ever be safely or effectively used; but they may yet have potential in situations such as shock trials, where high explosives are deployed within a limited area over a short period of time.
	Temporal restrictions	Operators desist from using their source at certain times of day, either because species are believed to engage in important behaviors at that time or because darkness or poor conditions at sea make visual monitoring impossible.
	Power limits	Operators take measures to lower the power of their sources, either temporarily or for the duration of an activity. Airguns can be taken off line, sonar systems can be powered down, and commercial ships can reduce speed (which in turn reduces cavitation at the propeller). Some jurisdictions (e.g., California, Great Britain) have specifically required that noise from certain activities be reduced to the lowest practicable levels.
	Other procedural requirements	As we learn more about the way in which noise affects marine life, other procedures suggest themselves. For example, under NATO's guidelines for sonar research, exercises must be planned to provide escape routes and avoid embayment of marine mammals.

high levels of noise, where additional activity should be avoided.[4] Perhaps just as useful would be a program to identify "cold spots," areas of potential value to noise-producers that contain few species and features of concern. Not every activity can benefit equally from geographic restriction. Some are limited in the range of locations they can operate. But for certain activities, like sonar exercises, careful siting could go a long way toward reducing risk for the most vulnerable species.

Source-based mitigation—promoting technologies that curb, modify, or eliminate noise at the source—is another essential component of a long-term policy on noise. A source-based approach to environmental protection is nothing new. Indeed, it is a page borrowed from our clean air and clean water legislation, which compel would-be polluters to use the "best available control technology" in outfitting their products and plants.[5] For this type of mitigation, commercial shipping holds particular promise. Regulators and members of industry have already begun to talk about "quiet" design elements like skewed blades, tip bulbs, and electric propulsion.[6]

Shipping seems promising for source-based mitigation not only because industry shares an interest in keeping noise down (noise being a sign of inefficient engineering), but also because much of the technology under consideration has been around for years on naval vessels and research ships, so that the leap to commercial use seems well within reason. Other activities that might benefit significantly from this approach will require more initiative to get off the ground. One technology that has already been applied is an acoustic curtain, made of bubbles, fabric, or both, which encircles a source and inhibits sound from escaping; but for now its use may be limited to sedentary activities such as pile driving in a shallow bay.[7]

Having opened an area to noise pollution, one might lessen the impact by placing operational requirements on the activity. Safety zones, perhaps the most common mitigation method today, require a crew to scan for whales and other species near the source and to temporarily shut down or reduce power if animals are spotted within a prescribed distance. Typically, the scanning is done by a crew member posted on deck; in some cases, planes, boats, hydrophones, and high-frequency, whale-finding sonar (controversial for putting additional noise in the water) have been used. Sometimes crews are required to "ramp up" their source, starting it up at relatively low power and then gradually raising the output, so that, in theory, animals have time to move away. Other requirements limit the times of day that a source can operate, restrict the amount of power it can put out, or direct how it should move in the water. The researchers behind NATO's active sonar tests, for example, are asked to plan their exercises to provide escape routes and avoid embayment of marine mammals.[8]

Thus far, much of what has been prescribed as mitigation in the United States rests upon two operational fixes: safety zones and ramp-up. Unfortunately, both methods are limited. Safety zones do help reduce some species' risk of exposure to the highest levels of sound, but are hampered by consistently low detection rates in monitoring. (Most methods of monitoring evolved for other purposes, such as taking census of populations, and are recognized to be unreliable for mitigation.) Furthermore, the small, one- or two-kilometer disc around the sound source that constitutes the typical safety zone does nothing for the animals living in the much vaster impact area beyond.

Ramp-up, for its part, has not been systematically tested, and there is evidence that some species such as sperm whales and pilot whales may not move away.[9] The wildlife agencies are obliged under the Marine Mammal Protection Act to prescribe "methods" and "means" of "effecting the least practicable adverse impact on [species and their] habitat."[10] How they might meet their legal mandate will vary by activity. What is critical is that the agencies, and the polluters they regulate, move beyond the well-worked confines of safety zones and ramp-up and consider a full range of options.

MILITARY: HIGH-INTENSITY ACTIVE SONAR

The principle behind active sonar should be familiar to anyone who has ever watched a submarine movie. Active systems produce intense waves of sound called

"pings" (though they can last far longer than the name implies) that sweep the ocean, striking the hulls of enemy boats. Their echoes are picked up on hydrophones and scrutinized by engineers. The current generation of tactical sonar was born in the early 1960s as the U.S. Navy scrambled for ways to detect and track long-range Soviet subs. These new systems, tuned in the mid-frequencies above three kilohertz, were far more robust and had a much larger range than the higher-frequency models they came to replace.[11] A Soviet Romeo hiding beneath the surface could be detected from dozens of miles away.[12]

By the end of the Cold War, active mid-range sonar had become the standard method for localizing submarines, not only for the U.S. Navy, which now deploys them on almost 60 percent of its 300 surface ships and submarines, but also for many other nations, including the United Kingdom, Belgium, France, Germany, Spain, Canada, Norway, Italy, the Netherlands, Portugal, and Turkey.[13] (See Table 2.2 for a survey of active systems used by the United States and its NATO allies.)

Used for both force protection and tactical prosecution, mid-frequency systems are mounted to the hulls of ships, air-deployed via helicopter and fixed-wing aircraft, set aboard submarines, and dropped into the ocean as part of floating sensors known as sonobuoys.[14] Although the precise output of many of these systems has not been publicly disclosed, some are clearly capable of generating sounds of extraordinary intensity. During the March 2000 mass stranding of whales in the Bahamas, for example, source levels from one system were reported to exceed 235 decibels, creating a swath of 160-decibel sound extending tens of miles away.[15] It is mainly this device—AN/SQS-53C (or "53-Charlie")—and its cousins that have been implicated in a growing series of whale strandings.[16] With the demise of the Soviet Union, military planning has shifted from deep-sea surveillance to littoral combat, and more and more exercises are taking place in coastal waters, only adding to scientists' concerns.[17]

But sonar development didn't stop with mid-frequency systems. In the 1980s, as part of the general rearmament during the Reagan years, the U.S. Navy began a classified program to develop a new, more far-reaching breed of active sonar—a system capable of detecting deep-sea Soviet submarines over long ranges by bombarding thousands of square miles of ocean with noise in the low-frequency band.[18] Formerly, the Navy did the job of long-range detection with passive equipment. It relied throughout much of the Cold War on a network of sensitive hydrophones, known as SOSUS, that were fixed in critical locations around the globe; and later it rigged long arrays of hydrophones behind a battery of surface ships, creating a mobile version of the same idea. As submarines grew quieter, with nuclear and electric engines replacing diesel, the Navy kept pace by devising newer and better algorithms, able to sift through reams of incoming data for the latest class of Soviet sub.[19]

The Navy's low-frequency sonar system, SURTASS LFA, was designed for the vastness of the open ocean.[20] Its 18 transmitters, fixed to a central cable and lowered into the water through a slot in the ship's hull, can produce sound above 140 decibels (a level known to affect the behavior of large whales) more than 300 miles away.[21] When the system was tested off the California coast in 1994, its signal was detectable across the entire North Pacific basin, showcasing a geographic range that is orders of magnitude greater than existing tactical sonar.[22] Some 39 boats had once been dedicated to the project.[23] Although with budget cuts that number has been reduced, the Navy still plans to deploy four separate LFA systems, two in the Atlantic and two in the Pacific.[24] One prototype, housed in a former pipe ship that the Navy converted for the purpose, was used repeatedly for field tests through the 1990s, and a second ship, the USNS *Impeccable* (designed specifically for the LFA system), was ready for trials in 2004.[25] The Navy soon expects to double its deployment.

A number of European navies, including those of Britain, France, and the Netherlands, are also developing systems that generate far-traveling, low-frequency sound.[26] Britain's entry in the shipboard low-frequency race is Sonar 2087, a product of the multinational

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TABLE 2.2
Active Sonar Systems in Use or Development by NATO Member States

Country	Name	Frequency	Manufacturer	Deployment
United States	AN/AQS-22 (Airborne Low Frequency Sonar (ALFS))	Medium	Raytheon	Helicopter (MH-60R)
United States	AN/BQQ-5	Low	IBM	Submarine (SSN 637, SSN688, and SSN 726 class)
United States	AN/BQR-19	High	Raytheon	Submarine (Ohio class)
United States	AN/BQS-4	Medium	EDO	Submarine (Lafayette class)
United States	AN/BQS-15	High	Ametek	Submarine (Ohio class)
United States	AN/SQQ-23	Medium (4-8 kHz)	Raytheon	Surface ship (DDG-2 & DDG-16 class)
United States	AN/SQS-26	Medium	EDO	Surface ship (FF-1052 and FFG-1 class)
United States	AN/SQS-53A/B/C/D	Medium (2.6-3.3 kHz)	EDO	Surface ship (FFG-7, DD-963, CG-47, and DDG-51 class)
United States	AN/SQS-56	Medium (6.8-8.2 kHz)	Raytheon	Surface ship
United States	AN/SSQ-62B/C/D/E (Directional Command Activated Sonobuoy System (DICASS))	Various	Sparton, UnderSea Sensor Systems	Sonobuoy
United States	AN/UQQ-2 (Surface Towed Array Sensor System Low Frequency Active (SURTASS LFA))	Low (100-500 Hz)	Raytheon, Lockheed, Johns Hopkins, Alpha Marine	Surface ship (Cory Chouest, TAGOS class)
United States	AN/UQN-4A (Sonar Sounding Set)	N/A	EDO	Surface ship (various classes)
United States	Folding Lightweight Active Sonar for Helicopter (FLASH)	Medium	Thales Underwater Systems	Helicopter (SH60R)
United States	Mobile Underwater Debris Survey System (MUDSS)	Low and high	NASA, U.S. Navy	Surface ship
Belgium	Mine Countermeasures System (TSM 2200 Mk3 and Propelled Variable Depth Sonar (PVDS))	High	Thomson-Sintra, Thales Underwater Systems	Surface ship (Tripartite Minehunter class)
Belgium	SQS-510	Medium (2-8 kHz)	Computing Devices Company, C-Tech	Surface ship
Canada	Helicopter Long Range Active Sonar (HELRAS)	Medium	L3 Communications	Helicopter (Sea King)
Canada	SQS-510	Medium (2-8 kHz)	Computing Devices Canada	Surface ship (Halifax and Iroquois class)
Canada	Towed Integrated Active-Passive Sonar (TIAPS)	Low	Computing Devices Canada, Hermes Electronics, UnderSea Sensor Systems Group	Surface ship (Province class)
Canada	Type 2040	Medium	Thomson-Sintra	Submarine (Victoria class)
Denmark	CSU-83	Medium	Atlas Elektronik	Submarine (Kronborg class)
France	DUBA-25	Medium	Thomson-Sintra	Surface ship (D'Estienne D'Orves class)
France	DUBV-23/24	Medium (~5 kHz)	Thomson-Sintra	Surface ship (Georges Leygues, Cassard, Tourville, Suffren, and Jeanne D'Arc class)

TABLE 2.2 (continued)
Active Sonar Systems In Use or Development by NATO Member States

Country	Name	Frequency	Manufacturer	Deployment
France	DUBV-43 Variable Depth Sonar	Medium	Thomson-Sintra	Surface ship (Georges Leygues, Tourville, and Suffren class)
France	Folding Lightweight Active Sonar for Helicopter (FLASH)	Medium	Thales Underwater Systems	Helicopter (NFH90)
France	Mine Countermeasures System (TSM 2200 Mk3 and Propelled Variable Depth Sonar (PVDS))	High	Thomson-Sintra, Thales Underwater Systems	Surface ship (Tripartite Minehunter class)
France	SLASM (Systeme de lutte anti sous-marine)	Low	Thales Underwayer Systems	Surface ship (Tourville and DeGrasse class)
France	TMS 4110CL	Medium	Thales Underwater Systems, Whitehead Alenia Systemi Subacquei	Surface ship (Horizon class)
France	TSM 223 Suite	N/A	Thales Underwater Systems	Submarine (SSK Agosta class)
Germany	DSQS–11	High	Atlas Elektronik	Surface ship (Hameln and Frankenthal class)
Germany	DSQS-21	Medium and high	Atlas Elektronik	Surface ship (Bremen class)
Germany	DSQS-23	Medium	Atlas Elektronik	Surface ship (Brandenburg class)
Germany	DSQS–24	Medium (6-9 kHz)	Atlas Elektronik	Surface ship (Sachsen class)
Germany	Low Frequency Active Sonar System (LFASS)	Low	N/A	Surface ship (Brandenburg class)
Germany	MOA 3070	High	Atlas Elektronik	Submarine (U212 class)
Germany	Sonics System (Folding Lightweight Active Sonar for Helicopter (FLASH) and Helicopter Long Range Active Sonar (HELRAS))	Medium	L3 Communications	Helicopter (NFH)
Greece	CSU-83 Suite	Medium	Atlas Elektronik	Submarine (Glavkos class)
Greece	SQS-26CX	Medium	EDO	Surface ship (Ipiros class)
Italy	DE-1160 (based on SQS-56)	Medium	Raytheon	Surface ship (Artigliere and Luop class and Garibaldi class aircraft carriers
Italy	DE-1167	Medium	Raytheon	Surface ship (Durand de la Penne, Maestrale, and Minerva class)
Italy	IPD-703, IPD-705	N/A	Selenia	Submarine (Primo Longobardo and Salvatore Pelosi class)
Italy	MOA 3070	High	Atlas Elektronik	Submarine (Type 212A)
Italy	Sonics System (Folding Lightweight Active Sonar for Helicopter (FLASH) and Helicopter Long Range Active Sonar (HELRAS))	Medium	Thales Underwater Systems, L-3 Communications, Agusta	Helicopter
Italy	SQS-23	Medium (4-8 kHz)	Raytheon	Surface ship (Vittorio Veneto class)

TABLE 2.2 (continued)
Active Sonar Systems in Use or Development by NATO Member States

Country	Name	Frequency	Manufacturer	Deployment
Italy	TMS 4100CL	Medium	Thales Underwater Systems, Whitehead Alenia Systemi Subacquei	Surface ship (Horizon class)
Italy	UMS 4100 (based on Spherion Sonar 2050 and DUBV-23)	Medium	Thomson-Sintra, Thales Underwater Systems	Surface ship
The Netherlands	DSQS-24	Medium	Atlas Elektronik	Surface ship (De Zavan Provincien class)
The Netherlands	Low Frequency Active Sonar (LFAS)	Low	N/A	Surface ship (Karel Doorman class)
The Netherlands	Mine Countermeasures System (TSM 2200 Mk3 and Propelled Variable Depth Sonar (PVDS))	High	Thomson-Sintra, Thales Underwater Systems	Surface ship (Tripartite Minehunter class)
The Netherlands	PHS-36	Medium	Thales Nederlands	Surface ship (Karel Doorman class)
The Netherlands	SQS-509	N/A	Northrop Grumman	Surface ship (Jacob von Heemskerck and Kortenaer class)
The Netherlands	Sonics System (Folding Lightweight Active Sonar for Helicopter (FLASH) and Helicopter Long Range Active Sonar (HELRAS))	Medium	Thales Underwater Systems, L-3 Communications, Agusta	Helicopter (NH-90)
The Netherlands	TSM 2272	Medium	Thomson-Sintra	Submarine (Walrus, Zeeleeuw, Dolfijn, and Bruinvis class)
Norway	Combined Active Passive Towed Array Sonar (CAPTAS)	Low	Thales Underwater Systems	Surface ship (Nansen class)
Norway	CSU-83 Suite	Medium	Atlas Elektronik	Submarine (Ula class)
Norway	Helicopter Long Range Active Sonar (HELRAS)	Medium	L-3 Communications	Helicopter
Norway	Spherion MRS 2000	Medium	Thales Underwater Systems	Surface ship (Nansen class)
Norway	UMS 4100 (based on Spherion Sonar 2050 and DUBV-23)	Medium	Thomson-Sintra, Thales Underwater Systems	Surface Ship
Portugal	DUUA-2	Medium (8.4 kHz)	Thomson-Sintra	Submarine (Albacora class)
Portugal	SQS-510	Medium (2-8 kHz)	Computing Devices Canada	Surface ship (Vasco da Gama, and Comandante Joao Belo class)
Spain	DE-1160 (based on SQS-56)	Medium	Raytheon	Surface ship (Alvaro de Bazan, Baleares, and Descubierta class)
Spain	DUUA-2A	Medium (4 kHz)	Thomson-Sintra	Submarine (S60 and S70 class)
Spain	DUUA-2B	Medium (8kHz)	Thomson-Sintra	Submarine (S70 class)
Spain	SQS-35 Variable Depth Sonar	High	EDO	Surface ship (Balcares class)
Spain	SQS-56	Medium (6.8-8.2 kHz)	Raytheon	Surface ship (Santa Maria class)
Turkey	AQS–18	Medium	L-3 Communications	Helicopter

TABLE 2.2 (continued)
Active Sonar Systems in Use or Development by NATO Member States

Country	Name	Frequency	Manufacturer	Deployment
Turkey	BQS-4	Medium	EDO	Submarine (Hirar Reis and Burak Reis class)
Turkey	CSU-83	Medium	Atlas Elektronik	Submarine (Preveze class)
Turkey	DE-1160 (based on SQS-56)	Medium	Raytheon	Surface ship (Barbados and Yavuz class)
Turkey	DUBA-25	Medium	Thomson-Sintra	Surface ship (D'Estienne D'Orves class)
Turkey	Helicopter Long Range Active Sonar (HELRAS)	Medium	L-3 Communications	Helicopter (S-70B)
Turkey	Sonar 2093	High (30-100 kHz)	Thales Underwater Systems	Surface ship (minehunters)
Turkey	SQS-26CX	Medium	EDO	Surface ship (Muavenet class)
Turkey	SQS-56	Medium	Raytheon (6.8-8.2 kHz)	Surface ship (Gaziantep class)
United Kingdom	Folding Lightweight Active Sonar for Helicopter (FLASH)	Medium	Thales Underwater Systems	Helicopter (Merlin)
United Kingdom	Medium Frequency Sonar (MFS)-7000	Medium	Ultra Electronics, EDO	Surface Ship (Daring class)
United Kingdom	Sonar 2016	Medium	Thales Underwater Systems	Surface ship (Manchester and Boxer class and Invincible class aircraft carriers)
United Kingdom	Sonar 2050	Medium	Ferranti, Thomson-Sintra	Surface ship (Sheffield and Cornwall class)
United Kingdom	Sonar 2074 (also included in Sonar 2076 Suite)	Low	Marconi/Plessey, Thales Underwater Systems	Submarine (Astute, Swiftsure, and Trafalgar class)
United Kingdom	Sonar 2077	High	Marconi	Submarine (Swiftsure and Trafalgar class)
United Kingdom	Sonar 2087 (integrated with Sonar 2050)	Low and medium (below 2 kHz)	Thales Underwater Systems	Surface ship (Duke class, candidate for Future Surface Combatant)
United Kingdom	Sonar 2089	Low	Thales Underwater Systems	Helicopter (Merlin)
United Kingdom	Sonar 2093	High (30-100 kHz)	Thales Underwater Systems	Surface ship (Sandown class)
United Kingdom	Sonar 2193	High	Thales Underwater Systems	Surface ship (Hunt class)

Thales Underwater Systems. Twelve devices have already been ordered for installation in the Royal Navy's Type 23 frigates, and the system could become standard aboard all 16 frigates in the class; it's also a candidate for inclusion in the "Future Surface Combatant," the next generation of British warship.[27] Compounding the risk, Sonar 2087 puts out sound in the mid-frequency band as well. The signals do not appear to be as intense, but the sheer number of devices proposed by the Royal Navy dwarfs that of its American counterpart.

Over the past five years, consensus has grown about the risks of high-intensity active sonar to marine life. As discussed in Chapter 1, the use of sonar—particularly mid-frequency sonar—has been linked by overwhelming scientific evidence to a series of mass mortalities of whales from the Canary Islands to the Caribbean to Japan. The lesions and hemorrhaging seen in some of the stranded animals indicate that they were seriously injured at sea, and many biologists are concerned about the impact sonar could be having on discrete populations of whales, particularly the beaked whales that have thus far been the focus of investigation. Other impacts, though more subtle, may be no less serious in the long term.

Mid-frequency sonar has been observed to disrupt the feeding of orcas and to cause porpoises and other species to panic and flee.[28] Low-frequency sonar has been shown to alter the singing of humpback whales, an activity essential to the reproduction of this endangered species, and to injure and kill some species of fish at levels orders of magnitude less intense than the U.S. Navy had predicted.[29]

There is also evidence to suggest that sonar, or at least the low-frequency variety, may pose a risk to human health. A number of U. S. Navy divers who participated in a medical study claimed to have felt vertigo, motion sickness, and odd sensations in the abdomen and chest on exposure to the LFA system. One subject who experienced these symptoms shortly after surfacing appears to have suffered a series of relapses, beginning one hour after his initial recovery. Months later he would complain of irritability, mental dysfunction, and seizures.[30] That the signal might have contributed to the diver's chronic illness is cause for concern and should at least prompt further investigation. What could be the consequences for civilian divers, equipped for recreation, lacking special training, and exposed under less controlled circumstances than the military personnel in the Navy's studies?

Against this background, the debate has shifted from whether sonar causes harm to how the harm can be reduced.

Mitigating Active Sonar

The mitigation method used most consistently by the U.S. Navy, as by other noise-producers, is the common safety zone. At the behest of the Fisheries Service, the Navy monitors for marine mammals and sea turtles within a short radius (two kilometers) of its LFA vessels, and it has scouted for animals in at least some mid-frequency exercises as well.[31] It has also put an effort into improving the technology of monitoring, equipping its LFA crewmen with special binoculars called "Big Eyes" and its LFA ships with hydrophones and whale-finding sonar.[32]

But in the case of active sonar, the flaws inherent in any safety zone become especially glaring. For example, the best available evidence indicates that some beaked whales are killed by sonar many miles from the source and well outside the perimeter of presumed safety.[33] These deep divers are not as yet detectable on hydrophones, their size and diving behavior makes them a challenge for whale-finders, and they are very difficult to spot in the water even under optimal conditions. It has been estimated that in anything stronger than a light breeze, only 1 in 50 beaked whales surfacing in the direct track line of a ship would be sighted.[34] Obviously something more is needed.

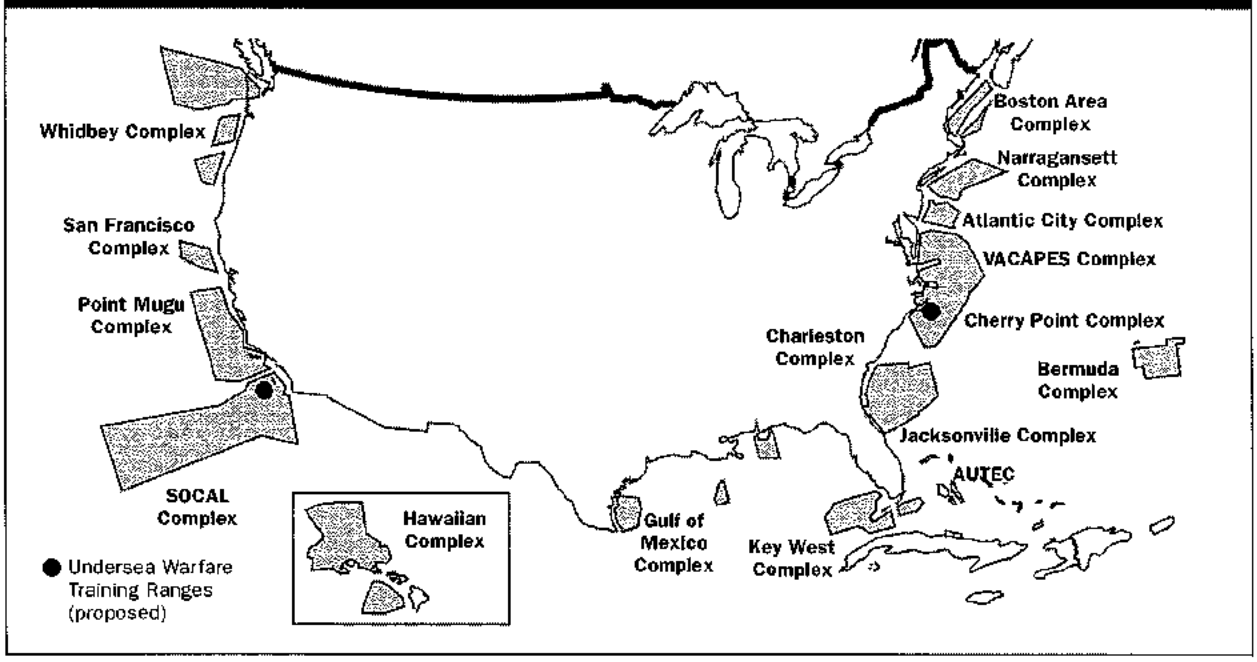
A far more promising approach is geographic or seasonal avoidance. Active sonar is used primarily in training exercises, and, while navies want a range of oceanographic conditions to train in, they also have some flexibility in where and when they choose to operate.[35] Increasingly, there are signs that planners are beginning to take habitat into consideration. In the wake of the Bahamas strandings, the U.S. Navy

excluded sonar exercises from the Northeast and Northwest Providence channels. The Spanish government, given the long history of strandings on its shores, banned the use of active sonar around the Canary Islands.[36] Yet, welcome as these developments are, they only chip around the edges of the problem. Careful siting—particularly to avoid densities of beaked whales—should become standard operating procedure for the "swept channel" exercises, the fleet exercises, the sonar exercises that unfold in all parts of the world throughout the year.

Of high priority for this mitigation strategy are the naval ranges and operations areas off our coasts. Among the activities that take place there are missile tests, which can cause seals and sea lions to stampede, killing their pups; ship-shock trials, which involve detonations of thousands of pounds of high explosives; ordnance firing; and, of course, testing and training with sonar.[37] More than 700,000 square miles of ocean—an area roughly three times the size of Texas—fall within one or another of the complexes in which the Navy's operations areas are contained (see Figure 2.1).[38] Of particular concern is a plan to establish as many as three specialized training areas for acoustics training along the coasts: one off North Carolina, one off Southern California, and possibly one in the Hawaiian Islands.[39] These "undersea warfare training ranges" would become epicenters of acoustic activity, and should be sited with care.

Engineering and design changes have also been proposed. We know, in a general way, which characteristics of sonar signals are likely to be especially damaging to marine life: signals that spike quickly (or, technically speaking, have rapid "rise times"), that spread widely (broad, "omni-directional" beams), that travel further (long "horizontal propagation"), that put out more energy (high "source levels"), and that transmit for a greater percentage of time (high "duty cycles"). In Europe, the Norwegian and Dutch navies have begun to experiment with the characteristics of their mid-frequency systems, endeavoring to find some alternative, a frequency perhaps, that would prove less hazardous to beaked whales.[40] The Dutch, we've been told, are also contemplating a reduction in power.[41] Back home, the Navy's research arm commissioned a preliminary study of engineering solu-

Figure 2.1 Navy Complexes off the U.S. Coast



Sources: GlobalSecurity.org, U.S. Department of the Navy

tions, but to our knowledge the issue has not been revisited; and calls for a return to passive systems, or for increased use of simulators in training, have generally been dismissed.[42]

Persuading the navies of the world to reduce their acoustic footprint is no simple task. Navies are given considerable deference under domestic and international law, are only haltingly held accountable by regulatory agencies, and are not designed for public transparency. Perhaps the biggest progress in the United States has been made through the courts and the threat of litigation.

In the early 1990s, the U.S. Navy conducted over two dozen field tests of its LFA system in disregard of permitting and other environmental requirements. But it was not until the agency came under pressure from NRDC and others that it took a second look and agreed to conduct a programmatic environmental review, sponsor research on the system's effects, and seek permits from the wildlife agencies for routine use.[43] In 2002, when the government granted the Navy permission to deploy the system in as much as three-quarters of the world's oceans, it was sued, and the court's decision became the basis of successful negotiations between conservationists and the Pentagon.[44] The agreement limited the Navy's routine deployment to the areas of greatest strategic concern (specific areas in the northwest Pacific Ocean), set exclusion zones to protect marine animals there—and proved once again that environmental protection and military training are not mutually exclusive.[45] By contrast, in the absence of litigation, the Navy has failed to respond requests to mitigate its use of mid-frequency sonar with common-sense measures that could reduce the harm.[46]

> *"It is undisputed that marine mammals, many of whom depend on sensitive hearing for essential activities like finding food and mates and avoiding predators, and some of whom are endangered species, will at a minimum be harassed by the extremely loud and far traveling LFA sonar. . . . Further, endangered species, including whales, listed salmon, and sea turtles, will be in LFA sonar's path. There is little margin for error without threatening their survival. For example, if even a few endangered gray whales of the mere 100 which remain near Sakhalin Island are disturbed by LFA and fail to mate or give birth, that population might well disappear permanently. Similarly, some populations of endangered sea turtles are so precarious that even the loss of a small number would be catastrophic to their survival. Yet their size makes them difficult to detect, and therefore almost impossible to avoid, if LFA sonar is operated in areas that they frequent. Absent an injunction, the marine environment that supports the existence of these species will be irreparably harmed."*
>
> U.S. MAGISTRATE JUDGE ELIZABETH LAPORTE ON THE POTENTIAL IMPACTS OF LOW-FREQUENCY ACTIVE SONAR (2003)

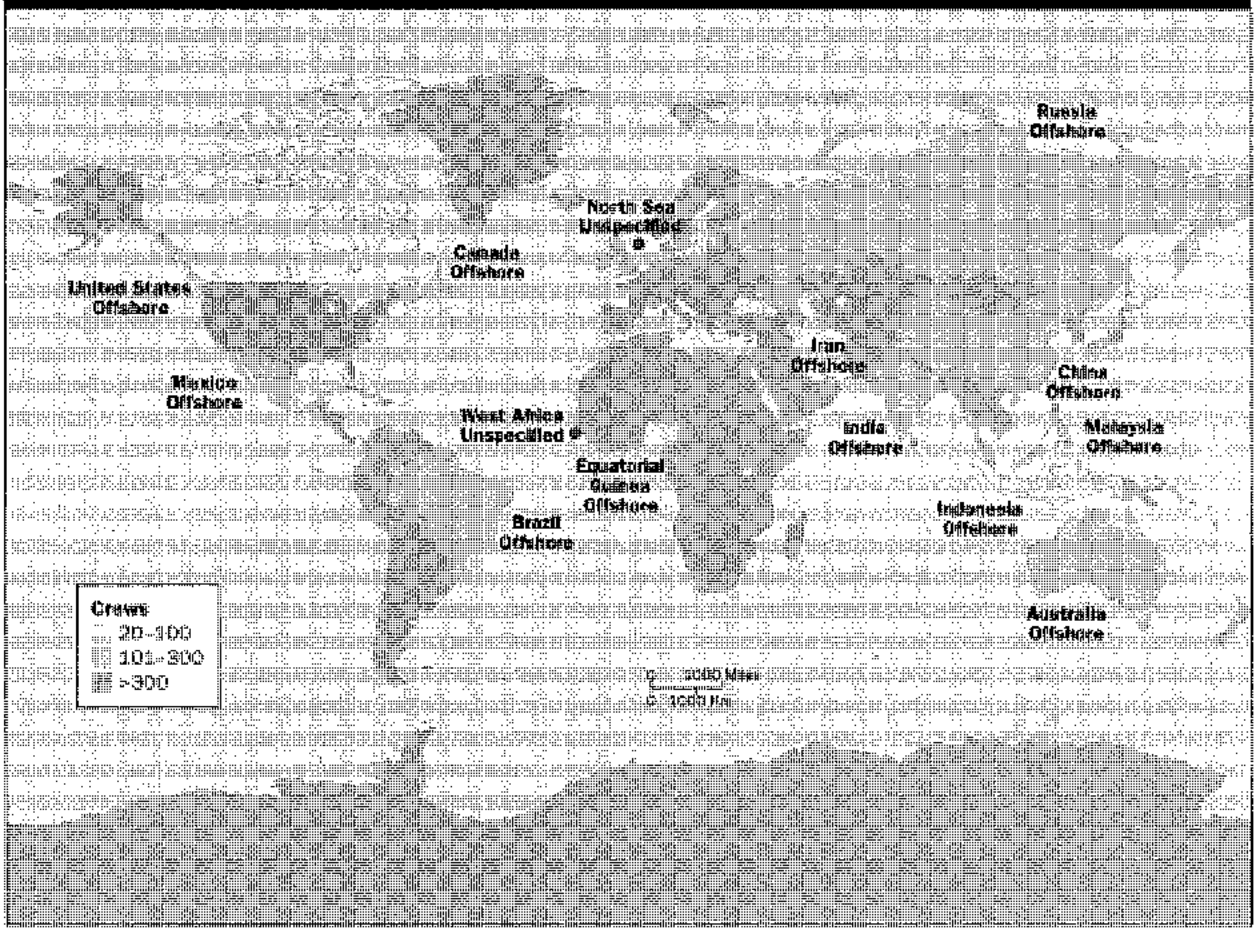
Increasingly, because of its extensive geographic range, active sonar has come to be understood as a global environmental problem, demanding a global solution. A number of international bodies (discussed in Chapter 4) have called for concerted action to control, eliminate, or otherwise regulate the spread of high-intensity sonar and other anthropogenic noise sources; and a coalition of groups in Europe and the United States have appealed to NATO for leadership in recommending common-sense restrictions.[47] Public uneasiness about the environmental impacts of this technology is growing. The question is whether the military will rise to the challenge and prevent needless harm to the oceans.

INDUSTRY: HIGH-ENERGY SEISMIC SURVEYS

The age of marine geology began on dry land. In 1924, a set of portable seismographs was fanned out across a Texas field and a measure of dynamite was exploded. Before long it was reported that oil had been found.

The idea behind seismic exploration is simple enough. Energy from an explosion or other source is sent beneath the sediment of the earth, down to the subjacent rock. Although much of it is simply absorbed there, some returns to the surface bearing a wealth of information for a geophysicist to decipher. In particu-

Figure 2.2 Global Hotspots for Offshore Seismic Exploration (January 2002–February 2005)



Source: Based on monthly crew counts compiled by IHS Energy.

lar, one can tell whether any of the formations commonly linked to oil or natural gas deposits are present below—as the technique used in Texas proved. Within a few decades, seismic exploration had been exported to the outer continental shelf. Crews were sent mineral prospecting along the east and west coasts of United States, setting off explosions underwater.

The charges used in the early days of surveying were eventually set aside in favor of airguns, long bazooka-shaped instruments that could be yoked behind a ship in complex arrays and towed about the ocean. Today, airguns are the worldwide industry standard. Discharged in tandem, they can produce short, pulsed sounds of extraordinary intensity, effectively reaching as high as 260 decibels—higher than virtually any other human source save for the explosives they replaced.[48]

The downward orientation of the airguns—the fact that they are pointed toward the sea floor and not, like sonar, into the water column—limits to some degree the distance their pulses might cover, but recent studies indicate that they can travel very far nevertheless. If the sea floor is hard and rocky, the noise can be heard for thousands of miles. Under the right conditions, it can reverberate or propagate in such a way as to sound nearly continuous, threatening to mask the calls of baleen whales and other animals that rely on the acoustic environment for their breeding and survival.[49] Recently, a team of biologists monitoring fin and blue whales in the northwest Atlantic Ocean found that the noise from a single seismic survey flooded their entire study area, more than 100,000 square miles in size.[50]

While the strandings record has focused attention on the damaging effects of military sonar, seismic exploration has also begun to raise alarm. In its 2004 report, the Scientific Committee of the International Whaling Commission (IWC) concluded that increased noise from geophysical exploration, among other activities, was "cause for serious concern" and outlined measures to reduce its impacts, particularly on large whales.[51] Its conclusion was based both on theoretical concerns about masking and population-level impacts, and on a spate of recent observations and experiments confirming that seismic pulses can indeed kill, injure, and disturb a range of marine animals.[52]

In 2002, in Mexico's Gulf of California, two Cuvier's beaked whales stranded in close association with geophysical surveys that were being conducted in the area.[53] That same year, adult humpback whales were found to have stranded in unusually high numbers along Brazil's Abrolhos Banks, where oil and gas surveys were being conducted for the first time.[54] (The Brazilian government was troubled enough by these findings to put the area off-limits to airguns.)[55]

In 2001, substantial numbers of western Pacific gray whales—a critically endangered population—were displaced by surveys from a portion of their only known feeding grounds off the Russian coast.[56] Some scientists have asserted that the persistent use of airguns in areas like Sakhalin Island (with its gray whales) and the northwest Atlantic (with its population of fins) should be considered sufficient to cause population-level effects.[57] Other marine mammal species known to be affected by airgun arrays include sperm whales, whose distribution in the northern Gulf of Mexico has been observed to change in response to seismic operations; bowhead whales, which have been shown to avoid survey vessels to a distance of more than 15 miles while migrating off the Alaskan coast; and harbor porpoises, which have been seen to engage in dramatic avoidance responses at significant distances from the array.[58]

Some of the most troubling research on seismic impacts concerns not marine mammals but commercial species of fish. One series of studies demonstrated that airguns can cause extensive and apparently irreversible damage to the inner ears of pink snapper, damage severe enough to compromise survival, even at exposure levels that might occur several kilometers from a source.[59] Other studies suggest strong behavioral reactions. In Norway, for example, catch rates of cod and haddock fell dramatically (between 45 and 70 percent) in the vicinity of an airgun array, affecting fishermen across an area more than 1,700 square miles in size, and did not recover within five days after operations ended.[60] A similar experiment showed a precipitous decline (above 50 percent) in a rockfish fishery exposed to a single survey.[61] Whether the decline is due to species leaving the area, changing their swim depth, or in some cases suffering injury is not known; in any event, the studies have caused concern in quarters beyond the environmental community.[62] Not only could such disruptions potentially have widespread effects on the health of individual populations, but the decline in catch rates demonstrated by these studies have obvious economic ramifications. Cod fishermen off Cape Breton, Canada, which has seen a bonanza of seismic work with the development of new fields there, have already complained about their falling catch.[63]

> *"The process of exploration [for offshore oil and gas] is by its very nature dirty work. It requires exploring for hydrocarbons. To discover where they are, very short bursts of very high-energy noise are exploded within the ocean and injected into the earth. Those acoustic explosions are repeated over and over again, 24 hours a day, for days on end. They are the modern form of exploratory dynamite, controlled explosions going off every 9 to 12 seconds. They represent the most severe acoustic insult to the marine environment I can imagine short of naval warfare."*
>
> DR. CHRIS CLARK, DIRECTOR OF CORNELL UNIVERSITY'S BIOACOUSTICS PROGRAM, IN A 2000 STATEMENT TO THE CANADIAN GOVERNMENT ON THE POTENTIAL IMPACTS OF SEISMIC EXPLORATION

It is possible that invertebrates, too, are affected. In the last five years (as noted in Chapter 1), two mass strandings of giant squid have been linked to surveys off the Spanish coast. Some of the squid showed massive damage to their internal organs, and investigators have proposed that the creatures died from having been forced to surface.[64] Other, smaller species of squid were observed, in a study sponsored by the Australian petroleum industry, to startle and surface at noise levels that might occur miles from a source.[65] Meanwhile, a preliminary report from Canada suggests that airguns may cause internal injury in snow crabs.[66] Studies such as these have begun to reveal the dimensions of the risk that seismic work entails.

TABLE 2.3
Seismic Exploration Around the World, January 2002–February 2005

Ranking	Offshore Area	Crews	% of Total Crews	Cumulative % of Total Crews
1	United States Offshore	410	18.8	18.8
2	China Offshore	190	8.7	27.6
3	Brazil Offshore	154	7.1	34.6
4	India Offshore	133	6.1	40.7
5	Mexico Offshore	103	4.7	45.5
6	West Africa Offshore	95	4.4	49.8
7	North Sea	86	4.0	53.8
8	Indonesia Offshore	86	4.0	57.7
9	Australia Offshore	85	3.9	61.6
10	Malaysia Offshore	77	3.5	65.2
11	Nigeria Offshore	64	2.9	68.1
12	Russia Offshore	58	2.7	70.8
13	Iran Offshore	39	1.8	72.6
14	Equatorial Guinea Offshore	37	1.7	74.3
15	Canada Offshore	28	1.3	75.6
16	Norway Offshore	27	1.2	76.8
17	United Kingdom Offshore	27	1.2	78.0
18	Morocco Offshore	25	1.1	79.2
19	Ukraine Offshore	23	1.1	80.2
20	Yuri Korchagin	23	1.1	81.3
21	Congo Offshore	22	1.0	82.3
22	Vietnam Offshore	20	0.9	83.2
23	Trinidad-Tobago Offshore	20	0.9	84.2
24	Turkey Offshore	20	0.9	85.1
25	North Barents Sub-Basin	19	0.9	85.9
26	Black Sea	15	0.7	86.6
27	New Zealand Offshore	15	0.7	87.3
28	Algero-Provencal Basin	14	0.6	88.0
29	Cameroon Offshore	14	0.6	88.6
30	South Africa Offshore	14	0.6	89.3
31	Caspian Sea	14	0.6	90.0
32	Oman Offshore	13	0.6	90.6
33	Mediterranean Sea	12	0.5	91.1
34	Gulf of Suez	11	0.5	91.6
35	Kazakhstan Offshore	9	0.4	92.0

Sources: Based on monthly crew counts compiled by IHS Energy.

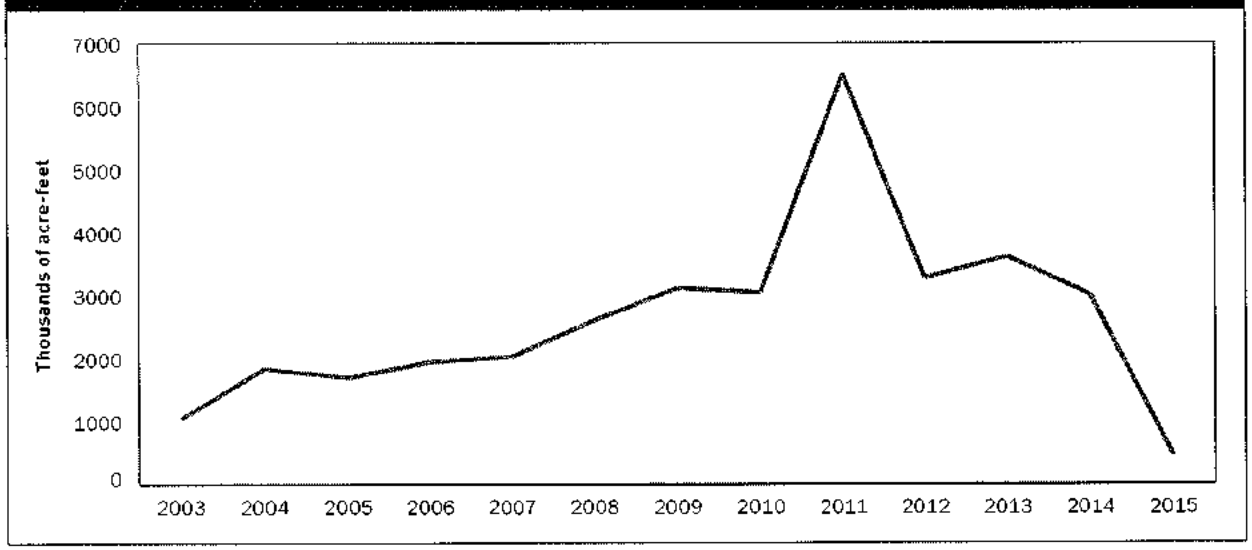
Once a mineral deposit has been found, the extraction and production process begins, and though the survey stage generates much higher levels of noise, in certain respects these later phases can be even more intrusive, at least to local habitat. Seismic exploration, after all, is sometimes transient: several weeks or months of intense activity, all told, and when an area has been mapped, the survey ships depart. But an oil platform is always long-term: years or decades of drilling, pumping, and shipping, not to mention the construction and demolition of the platform itself, the installation of pipeline, and sometimes the dredging of the sea bottom to accommodate the new activity. With full-scale development come the consequences of continuous noise, the risk that some marine animals, especially those sensitive to low-frequency sound, will abandon their habitat while others persist through difficult conditions.

Of course, certain technologies used in the trade are more intrusive than others. The giant platforms on metal stilts that seem to symbolize the offshore industry are much noisier, generally speaking, than production islands; and for boring into the ocean floor, the conventional drillship, with its large, resonant hull, makes the biggest racket. Quieter alternatives include semi-submersible ships, with machinery that lies well above the water; special floating rigs known as caissons; artificial islands; and platforms mounted directly on the ocean floor.[67] More than 4,000 platforms are currently active in the Gulf of Mexico.[68]

On the U.S. continental shelf, the business of offshore production is concentrated in the Gulf, particularly in the petro-rich canyons off Louisiana and Texas, and the pace of business there is only projected to increase over the next decade. In 2003, more than 1,000 lease blocks were surveyed seismically. The government projects that the number will continue to rise through the year 2011, when the lease blocks covered by seismic crews will reach above *six times* the number surveyed two years ago.[69] (See Figures 2.3 and 2.4.) Lease blocks are typically about three miles on a side, so the total area represented by these numbers is substantial. Over the next three years alone, the area of the Gulf covered by seismic surveys would approach 80,000 square miles, an area larger than the entire state of Florida.[70] Changes in the market mean that companies are expanding into deep-water fields that have not been tapped before. By 2011, deep water may account for 80 percent of oil production in the Gulf.[71]

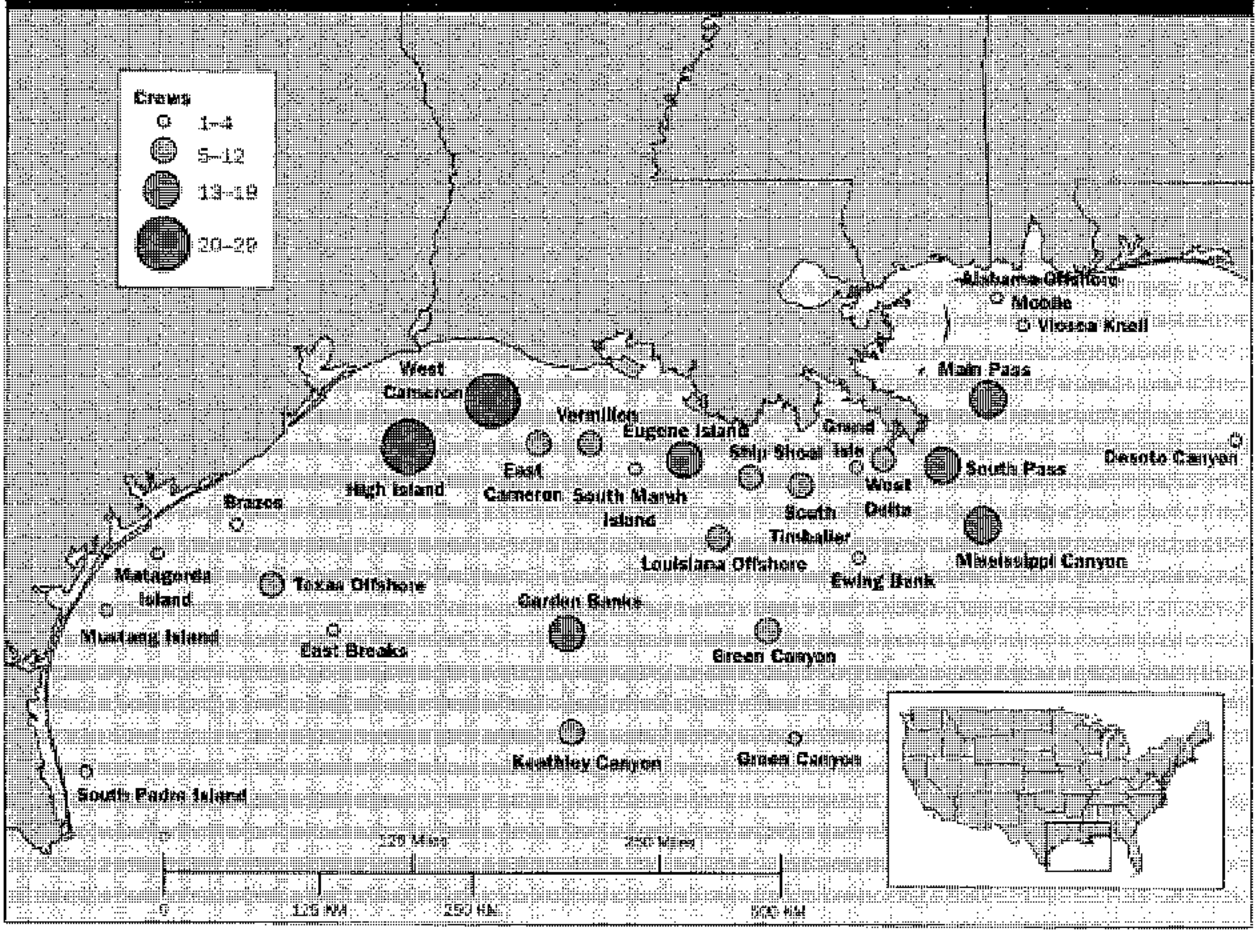
But the past few years have been good for the offshore oil industry in other parts of the country

Figure 2.3 Projections of Future Seismic Surveys in the Gulf of Mexico



Source: Minerals Management Service

Figure 2.4 U.S. Gulf of Mexico Seismic Survey Areas by Crew Count (January 2002–February 2005)

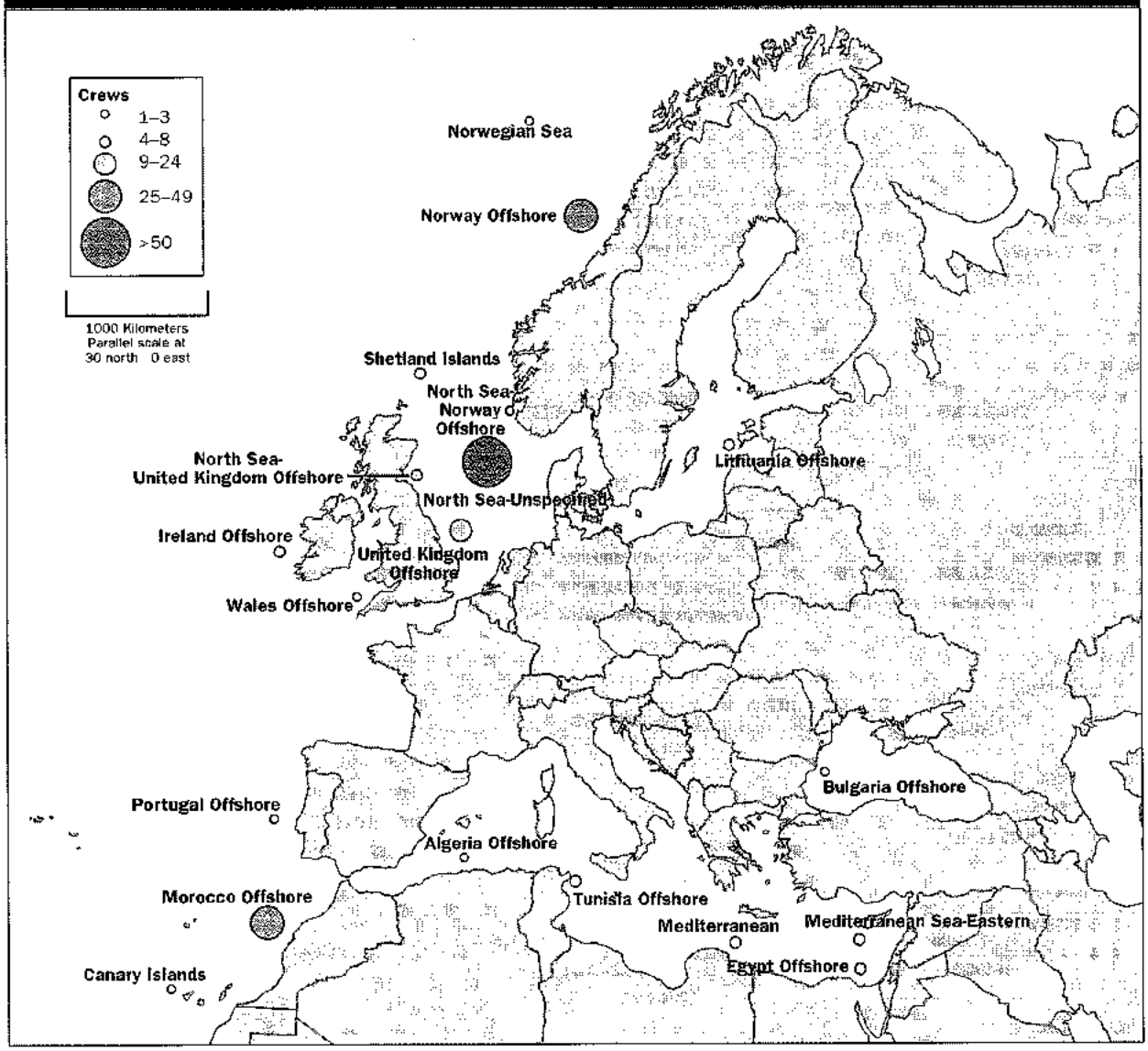


Source: Based on monthly crew counts compiled by IHS Energy.

as well. Off Alaska, the Bush administration has opened more and more of the Beaufort Sea to leasing and is now poised to do the same with the Chukchi Sea on the coastal frontier.[72] Some of the new areas for sale lie offshore the Arctic National Wildlife Refuge and include habitat for the bowhead whale and other endangered wildlife.[73] This year has also seen a revival of interest in leasing off the east and west coasts. With prices rising at the pump, Congress recently mandated that the Minerals Management Service conduct an offshore inventory for oil and gas throughout the entire outer continental shelf of the United States, a step that many see as a prelude to undermining the federal drilling moratorium, which has been in place since the early 1980s.[74] And in the wake of Hurricane Katrina, calls to reopen the moratorium areas are intensifying.[75] It is not surprising, in this light, that companies are taking action to preserve their remnant leases (there are 37 off California alone), biding their time until the moratorium comes to an end.[76]

While the northern Gulf of Mexico is the most intensely surveyed body of water in the world, development is occurring in virtually every major coastal region. Brazil has seen exploration increase significantly over the last decade, as have China and India; together, the three countries account for more than 20 percent of all the offshore seismic work conducted over the last three years. The west coast of Africa is another site of recent interest, and off the west coast of Europe the North Sea remains a mainstay of global exploration and production. (See

Figure 2.5 European Seismic Survey Areas by Crew Count (January 2002–February 2005)



Source: Based on monthly crew counts compiled by IHS Energy.

Figure 2.5.)[77] About 25 crews on average are shooting airguns somewhere in the world on any given day of the year.[78]

With political change, previously untapped fields have come onto the market. One site that the International Whaling Commission has viewed with intense concern lies along the southeast coast of Sakhalin Island, where a consortium of Japanese and Western businesses is developing one of the largest oil and gas operations in the world.[79] The projects jeopardize a number of sensitive species, including the only known population of western Pacific gray whales, which were hunted virtually to extinction. Less than 100 adults—fewer than 30 of them reproductive females—are thought to remain.[80] In February 2005 a panel of independent scientists concluded that ship strikes, oil spills, habitat disturbance, and noise pollution "pose potentially catastrophic threats to the population."[81] Because under international law a state maintains exclusive

rights over its continental shelf lands and may explore, exploit, or preserve them as it sees fit, what protection coastal areas receive, either in mitigation from operators or in moratoria on production, depends largely on domestic policy.[82] Unfortunately, in cash-strapped states like Russia, the conservation ethic may find it tough going against oil's financial appeal.

Mitigating Seismic Surveys

In the United States, offshore production is regulated principally by the Minerals Management Service (MMS), a branch of the Interior Department, as well as by the wildlife agencies, the National Marine Fisheries Service and U.S. Fish and Wildlife Service. The MMS chooses which tracts to lease, accepts bids from developers, and oversees exploration and production: at once, both vendor and guardian of our natural resources. The agency is, in fact, compelled by law to protect marine life throughout the leasing process.[83] Yet the system it manages is of Byzantine complexity, and the agency's central mission—to facilitate mineral production—is often difficult to reconcile with environmental protection.[84]

For many years, long after the scientific record began to turn, the MMS considered airgun surveys so benign in most cases as to preclude environmental review, even in the northern Gulf of Mexico, where the shooting can seem ubiquitous.[85] Even today the agency's oversight over exploration in the Gulf is deficient. No permits have been obtained by MMS or required of industry under the Marine Mammal Protection Act, and although the agency issued a preliminary environmental assessment last year for activities in the Gulf, its sufficiency has been questioned by the Fisheries Service, which has itself undertaken a full-fledged review. In 2002, the MMS imposed a limited set of requirements to protect the Gulf's populations of whales.[86] Current guidelines provide only for "ramp-up" and for a plainly inadequate safety zone running 500 meters from the sound source; they encourage the use of hydrophones in monitoring for whales, but do not require them.[87]

> *"Commercial fishermen have long considered the operations of offshore seismic surveys to be disruptive to their fishery operations. This is not a phenomenon peculiar to any one country, but is a view widely held by many fishermen across the world."*
>
> "MARINE SEISMIC SURVEYS," A 2000 REPORT ON THE IMPACTS OF AIRGUNS PRODUCED FOR THE AUSTRALIAN PETROLEUM PRODUCTION EXPLORATION ASSOCIATION

The guidelines issued by several other nations, including Great Britain, Australia, and Brazil, and by state regulators in California, are generally more robust.[88] Some require that operators tailor their array to the lowest practicable level, that they maintain a safety zone up to six times the radius of the one prescribed by the MMS, and that they use hydrophones that are still merely optional in the Gulf.[89] Notably, the British guidelines give at least a nod to safer engineering. They require that industry work to suppress or baffle the higher-frequency noise pulsing from their guns, noise that is completely superfluous from the company's point of view but still constitutes a significant part of the blast.[90] Yet the requirement is not strongly enforced, and to our knowledge industry has never placed a suppressor on a working airgun.

Other mechanical fixes deserve attention as well. Improvements in signal processing could mean that less low-frequency sound, which accounts for most of an airgun's energy, would be required. A device called a marine vibrator, whose noise doesn't spike as high or as fast and which puts out less energy, may hold potential as an alternative.[91]

Finally, as the International Whaling Commission's report on noise makes clear, geographic and seasonal restrictions are imperative, especially for the great whales that return each year to special sites around the world to feed and calve.[92] Industry says it may run its surveys off Gabon outside the winter season, when humpback whales gather to breed; and Brazil, as we have noted, set a year-round restriction on the Abrolhos Banks, where a suspect series of strandings have occurred.[93] Investors hunting for oil and gas deposits often have less flexibility than the military in siting their activities, but Gabon and Brazil prove it can and should be done. In the United States, the law demands that "the timing and location of leasing" reflect "a proper balance" between environment and

AIRGUNS AND SCIENCE

Oil development is not the only purpose for which large airgun arrays are deployed. Among other agencies, the National Science Foundation (NSF) regularly dispatches survey vessels around the globe to map the ocean floor or investigate geologically interesting formations. In January 2005, for instance, the NSF-sponsored research vessel *Maurice Ewing* began a survey of the Chicxulub Crater near the northern shore of the Yucatan Peninsula in Mexico, hoping to learn more about the crater's origins more than 60 million years ago. (The Chicxulub survey was just one of several undertaken each year as part of NSF's Ocean Drilling Program and other initiatives.) Three years earlier, in September 2002, the *Ewing* was conducting a seismic survey in the Sea of Cortez when two stranded beaked whales were discovered on an adjacent beach by vacationing NOAA scientists. Future projects were careful to include mitigation measures, but their adequacy was questioned, and the *Ewing*, now an object of controversy, was denied permission to operate offshore by the governments of Mexico and Bermuda.[94] Now Columbia University and the NSF are planning to put a new boat in the water, the *Marcus G. Langseth*, with a 40-gun array.[95] Oceanography's contribution to ocean noise is overwhelmed by the oil and gas industry's, but the way that the Fisheries Service chooses to deal with the *Langseth* may have implications for the entire field.

industry.[96] Avoiding vulnerable populations should become the norm.

In the battle over seismic exploration, the year 2006 may be pivotal. Early this winter, the MMS will send a report to Congress that may shed light on what its new oil and gas inventory, essentially an unfunded mandate, might mean for marine life.[97] In the summer, biologists from the Scientific Committee of the International Whaling Commission will hold a workshop on airguns and whales.[98] And, of course, as we go to press in November 2005, the 28-year fight in Congress over the offshore drilling moratorium is raging once again.[99] In 1999, we observed it would be premature to pronounce the era of mineral production finished outside the Gulf of Mexico. Until conservation and alternative fuels become a political priority, the controversy over seismic exploration will only increase.

COMMERCE: SHIPPING NOISE

If proof were still needed that we live in a global economy, we would only have to count the great ships of foreign registry that pass our shores each day. Their numbers over the years have substantially enlarged. In the 1930s, the world merchant fleet was composed of some 30,000 ships, including our own; by 1999, there were 82,000 active vessels of significant size.[100] In the last 15 years of the 20th century, sea-borne trade rose by 50 percent to approximately 5 billion tons of cargo per year, representing more than 95 percent of the world's trade.[101] Fifteen hundred petroleum tankers, one-third of the global fleet, were expected to enter U.S. harbors annually: 8,000 stops expected for New York and New Jersey, 10,000 for Galveston, Texas, and 3,000 for San Francisco (to name a few ports of call).[102] And each sweep raises the level of noise in our coastal waters.

Ships produce undersea noise in a variety of ways. Their engines roar, their bearings rattle, and their outer hulls may vibrate, radiating sound. But the chief source of noise is the ship's propeller, which in gaining speed forces the water around its blades to rupture. Tiny bubbles form and collapse (a process known as cavitation), releasing what one noted acoustician described as a tremendous "hiss."[103] If the ship is old and the propeller has gone several years without a proper cleaning, as may be true of many of the vessels in our aging fleet, the hissing may be worse: Barnacles stuck to the blades effectively broaden their surface area, allowing more bubbles to form.[104]

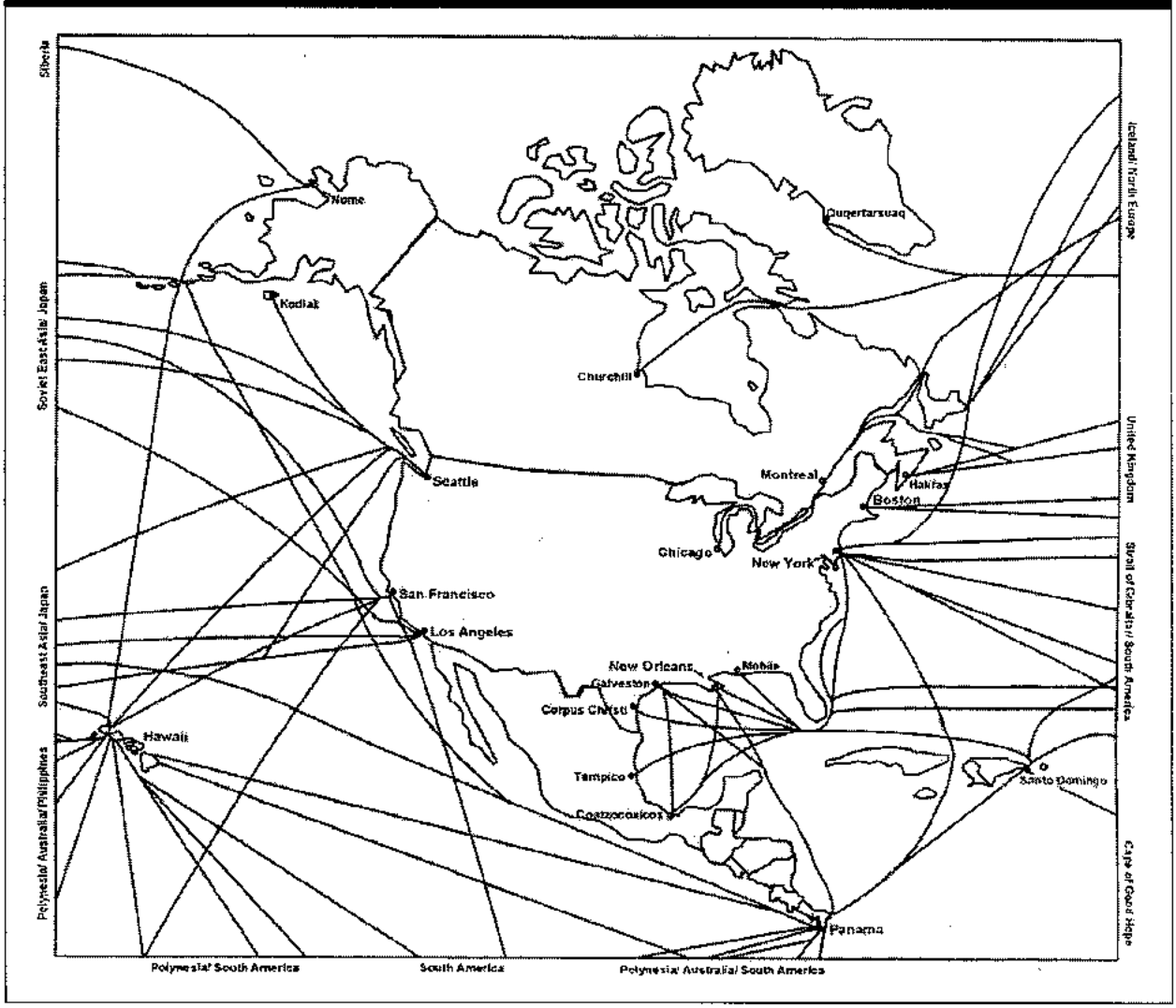
Each vessel has its own acoustic signature. The sound it generates depends upon its size and shape, its length, its capacity and load, its speed, and its mode of operation.[105] In general, though, most of the energy is concentrated in the low frequencies, with some large container vessels, freighters, and supertankers generating peak sound levels of 190 decibels below 500 hertz and reaching as high as 220 decibels in the very lowest frequencies.[106] The greater the ship's volume, the greater its acoustic output tends to be—an unfortunate fact given that the average size of commercial vessels has swelled to about 6,300 gross tons.[107] The largest ships will become narrower, faster, and larger (possibly tripling in capacity) and will multiply.

Indeed, it is reasonable to assume that their number will double over the next 20 to 30 years.[108] While tugboats and ferries are significantly quieter, 150 to 170 decibels measured at the source, their effects cannot be discounted, especially in such well-trafficked spots as Puget Sound and Cape Cod Bay.[109]

Cruise ships, too, have contributed their share to the problem, with their number and size increasing dramatically during the 1990s. While in 1990 there were just three "super ships" (vessels exceeding 70,000 tons), in 1999 there were 29; and more people were taking cruises than ever before, sometimes to biologically sensitive areas, with the number of passenger berths nearly doubling over the decade.[110] Add to all these the low roar of motorboats and jet skis tearing along the shoreline and one has in sum a leading contributor to the rise of undersea noise around the world.[111]

It has been said that shipping noise is inescapable, that it can be heard in every corner of the ocean.[112] One of the consequences of an expanding global marketplace has been the spread of shipping noise through the Southern Hemisphere, around ports and in developed areas along the coasts. The expansion is almost certain to continue.[113] Cargo transports to previously undeveloped

Figure 2.6 International Shipping Lanes in North American Waters



Source: U.S. Department of State

parts of the world are expected to double. High-speed, catamaran-shaped ferries and supersized cruise ships will anchor in brand-new ports in formerly remote or unreachable areas throughout Asia and Latin America.[114] Closer to home, the next few decades may see a boom in "short sea shipping," an established practice in Europe and one currently being promoted in the United States by the federal Department of Transportation.[115] The routes that cargo ships are likely to use for their increasingly short hauls between ports would take them nearer to shore and directly through coastal habitat for many marine mammals.[116] (See Figure 2.6 for a survey of international lanes off the United States.)

A substantial body of literature already exists documenting the response of whales and other species to various kinds of ships.[117] Some animals have been seen to avoid them, by swimming miles off or by diving; others are known to sometimes approach or (like some species of dolphins) to draw close and ride the bow waves, perhaps exposing themselves in the process to damaging levels of noise. Belugas in the Arctic (though not elsewhere) have been seen to respond dramatically to approaching ships and icebreakers, sending out alarm calls, changing their dive patterns, and in some cases moving more than 50 miles out of the boats' way.[118] Narwhals, by contrast, often react by freezing in place and falling silent.[119] Manatees off Florida have been found to change their fluke rate, heading, and dive depth in response to approaching vessels.[120] And there is evidence to suggest that gray whales, humpback whales, and belugas have been displaced from habitat in which shipping or boating increased.[121]

Perhaps of greatest concern is the possibility that shipping's low-frequency drone will "mask" or interfere with the ability of some species to communicate in ways that are essential to their survival and recovery.[122] Extensive as it may seem, however, the science of shipping noise is also critically limited. Few studies have attempted to capture the long-term impacts that vessel traffic is feared to have on marine mammal populations. And much of the existing research focuses on the effects of smaller, specialized craft such as whale-watch boats and icebreakers, and not of the cargo ships, supertankers, and cruise ships that are thought to be some of the biggest contributors to ocean noise worldwide.[123]

Reducing Shipping Noise

Quiet design has been an objective of shipbuilders for years. Large naval budgets have been devoted to the task of hiding active ships and submersibles from foreign sonar, and although many of these innovations are narrowly tailored to military purposes, a few might well be taken up commercially. Several methods exist for abating the hiss of cavitation. Propellers can be designed with "sweeping" or "skewed" blades and special contour details; with bulbs on the tips; or with refined trailing edges, which can help keep the blades from vibrating, or "singing."[124] They can also be designed so that their pitch is adjustable for different loads, requiring less power to operate.[125] And periodic maintenance is important, since failure to scrape barnacles from propeller blades and fasten loose components can significantly boost emissions.[126]

While propellers are the main concern, steps might also be taken to reduce engine noise. Years ago, commercial boats drew their power from high-speed turbines that had to be geared down to drive the propellers, creating a tremendous amount of noise. Today, most get their power from diesel engines, a choice that still radiates substantial acoustic energy. A quieter option is the electric generator, familiar to naval architects who have used it for decades to quiet ships and submarines, and now increasingly used on cruise ships concerned about passenger comfort.[127] There are also numerous devices available for insulating engine noise from a ship's hull: isolation mounts, damping tiles, flexible hoses, and wires. Completely isolating the house-size diesel engines that are found on many large ships would be prohibitively expensive, if not physically impossible, but might well be feasible on smaller craft.[128]

From a ship owner's point of view, every decibel that a boat puts into the ocean is wasted energy. Some steps taken to cut down on cavitation can make for a more efficient ship that is less costly to run—one reason why the prospect of quiet commercial ship design seems so attractive. Unfortunately, even the most basic cost-benefit analyses have yet to be con-

ducted. Part of the difficulty is that until recently many owners and operators weren't aware of the potential environmental costs of ocean noise, the way they've been aware of the human health risks from noise radiated through the air.[129] Marine biologists don't work on shipping staffs, nor do naval ship architects or designers.

Design standards in general are difficult for any single country to impose. Although the U.S. government has every right to set standards on American ships regardless of where they travel, the number choosing to fly the flag is small. Fewer than half of the large commercial vessels owned by Americans are American-registered.[130] In sheer numbers, the U.S. merchant fleet ranks 12th behind such unlikely contenders as Panama and Liberia, whose treatment of shipowners is less restrictive.[131] If we toughen our standards, some domestic ship-owners may feel the lure of foreign registry. As for foreign vessels, the government's power to regulate them grows the closer they come to shore.[132] Ships that enter our internal waters are subject to our design requirements.[133] Under this exception, Congress passed the Oil Pollution Act of 1990, which requires a double hull of every tanker, domestic or foreign, using a U.S. port.[134] That is much more than lip service: Roughly 6,000 very large ships, a number approaching half of the active world fleet in that class, enter our ports each year.[135] Typically, however, requirements for ship design are adopted through the International Maritime Organization (IMO) in the United Nations.

Another strategy, which to some extent is already being pursued, would redirect traffic around important coastal habitat. In 1980, the early departure of humpback whales from Glacier Bay, Alaska, which researchers linked to increased traffic from cruise ships, prompted the government to restrict the numbers coming into the area.[136] As part of the monitoring program, some cruise lines even agreed to noise testing at the U.S. Navy's submarine warfare center in Ketchikan.[137] All this was made possible by the bay's situation within the Glacier Bay National Park, established in 1980.[138] Similarly, our National Marine Sanctuaries, or at least those parts that fall within the U.S. territorial sea, can be protected from any form of intrusion envisaged within their original management plans; and the Secretary of Commerce has authority to negotiate with foreign governments for their protection.[139] But to reroute ships in its *exclusive economic zone*, an area that extends from the 12-mile line to the high seas, a state first has to obtain permission from the IMO.[140] That much has been done to reduce the risk of oil spills in the Monterey Bay National Marine Sanctuary and to save right whales off the East Coast from ship strikes.[141] Rather than the exception, such cooperation in protecting significant species and habitat needs to become the rule.[142]

In May 2004, the National Marine Fisheries Service convened a symposium of interested stakeholders, including representatives from the shipping industry,

MASKING THE GREAT WHALES

The effects of auditory masking are difficult to document in the wild, especially among the large whales. It seems plausible, however, that the detection of faint sounds—the sounds most vulnerable to masking—would be vital to the well-being of cetacean populations. For sperm whales, detecting faint sounds is often essential in locating prey, the squid that are their usual diet: a whale may scan 400 meters ahead for the squid's relatively weak echo. Sperm whales may rely upon long-range audition in other ways as well. Hearing the distant calls of killer whales may give them precious time to flee or adopt a defensive formation around their calves. Detecting faint clicks from a pod of female sperm whales—over perhaps a dozen or more kilometers of ocean—may mean the difference between a bull's mating or not, or between a calf's reuniting with its family group or not.

For blue and finback whales, which disperse over vast ocean basins and do not appear to have well-defined breeding grounds, long-range communication seems particularly critical. Even modest increases in background noise levels could dramatically decrease the range at which these whales detect one another. Should breeding behavior be disrupted over wide enough areas, entire populations could be threatened. Unfortunately, shipping noise dominates the very range of frequencies used by these baleen whales for communication. Loud as they are, the great whales may prove a poor match for human noise.

—Dr. Lindy Weilgart, Dalhousie University

the military, scientific institutions, environmental groups, and government agencies.[143] While only a first step, the gathering itself reflected a consensus of concern about shipping noise: a mutual self-interest in addressing the problem through concerted domestic or international measures, changes in ship design, or other potential strategies, existing or yet unknown. How such measures will be developed or imposed—under the IMO (using the International Convention for the Prevention of Pollution from Ships, or MARPOL, for example), through the United Nations (using the Law of the Sea Convention), or through tax incentives and voluntary guidelines—remains to be seen.[144]

FISHERIES: ACOUSTIC HARASSMENT DEVICES

For all their differences, the sources of undersea noise covered thus far are alike in one respect: They disturb marine mammals incidentally, as an unintended consequence of normal operations. Fisheries, by contrast, are sometimes deliberate in their noise pollution. It is their intention that marine mammals be disturbed.

Acoustic deterrence devices, known as "pingers," were first deployed in 1994 by a major gillnet fishery in the Gulf of Maine. The fishery had reached an impasse with the local population of harbor porpoises. Each year, 2,000 animals—well beyond the legal limit—were snared in its gillnets, often fatally. Conventional measures having failed, the fishery decided to give acoustics a try. The noise emitted would be shrill (130 decibels in the mid-frequencies) but brief, strong enough to deter an animal from approaching but not enough to induce discomfort. That first season was a success, reducing the fishery's by-catch of porpoises, and although further trials met with mixed results, the pinger has been discussed as a partial solution to some aspects of the enormous by-catch problem.[145] Given their low output, pingers are by far the least offensive of the sources discussed in this report, although, even here, overuse could deplete habitat for sensitive species.[146]

Acoustic harassment devices (AHDs) are another matter. Where pingers are designed to warn animals away from a dangerous situation, AHDs mean to cause them pain, making the environment intolerable and driving them from habitat where fish grow. The somewhat milder versions first put on the market in the early 1980s seemed to enjoy only passing success. After several weeks of use, the local seals and sea lions would begin treating the noise as a kind of dinner bell and return in droves.[147] The models currently used by Canadian fisheries emit very short, mid- to high-frequency pulses at considerable intensities, usually more than 190 decibels at the source.[148] That's enough sound to clear an area not only of its pinnipeds, but of other species as well. Harbor porpoises, for instance, have been known to disappear within two miles of a single AHD, raising concerns that a few devices placed in strategic locations, within straits or around the mouths of bays, could degrade many miles of habitat for that species.[149] And, in one of the few long-term studies conducted on any source of ocean noise, orcas were found to abandon part of their range for years after a handful of AHDs rendered it uninhabitable. (The devices had been intended to discourage harbor seals.)[150] If AHDs are to be used at all, they must be confined to highly specific situations where less intrusive methods have failed and where potential encroachments on marine life are minimal.[151]

"Pulsed Power" is a more recent entry in this line of increasingly intrusive technology. Designed by the Pacific States Marine Fisheries Commission, the system differs from previous AHDs in producing a shock wave along with an acoustic signal. It covers a far broader range of frequencies (from 2.5 to 114 kilohertz) and generates sound far more intense (above 230 decibels at maximum output) than the standard AHD.[152] Field tests were planned in 1999 off the coast of San Diego, to determine whether the generator could effectively drive California sea lions from fishing boats. More ominous than any test, though, was the prospect that the system might eventually become standard equipment aboard the hundreds of recreational vessels that fish in southern California waters. Faced with a storm of opposition from scientists and conservationists, the test was abandoned; but the problem of predation has only increased in recent

years, making it unlikely that we have seen the last of this dangerous AHD.

In 1994, in a nod to fisheries, Congress exempted nonlethal methods of deterrence from its ban on marine mammal harassment (see Chapter 3) and charged the wildlife agencies with regulating them.[153] No rules have been adopted as yet; the Fisheries Service proposed a few in 1995 but has since been silent.[154] The most salient of these proposals would prohibit the use of any device that separates mothers from their offspring—a thoughtful standard, if a hard one to enforce.[155] The others do not reach far beyond this, however, and additional provisions would be needed to ensure the safety of marine mammals.

To begin with, harassment devices should not be permitted near endangered or threatened species such as the Steller sea lion, whose rookeries neighbor a number of commercial fisheries off the Alaskan coast. Their pulses should be focused, not radiated in all directions, and should be acoustically tailored to the target population, reducing their effects on others.[156] Finally, care must be taken to exclude them from passages and corridors that marine animals habitually use. How widely AHDs might be deployed off our coasts remains to be seen. But unless the wildlife agencies take the broad view and regulate these devices for their cumulative impact, they could become another significant American source of undersea noise.

CHAPTER 3

THE TYRANNY OF SMALL DECISIONS: DOMESTIC REGULATION OF OCEAN NOISE

There are no animals on the planet as culturally iconic, as ecologically significant, and yet as thoroughly resistant to study as whales. Because they spend much of their lives underwater, they are hard to observe; because they live so long, they are difficult to track over lengths of time relevant to their species' survival. The inscrutability of whales and other marine mammals places them at some peril. To tell that a whale population is in serious decline can take decades, millions of dollars, and several scientific careers.[1] For many species off the U.S. coast, we do not even know enough to say what a population is.

The world did not wake up to the fact that marine mammals required protection until well into the last century. Many years of whaling, sealing, and tuna fishing had brought a long list of species to the verge of extinction, and modern industry was creating problems of its own in the form of oil spills, ship strikes, and a host of other insults.[2] The urgency of their plight and their extraordinary significance moved Congress toward a policy of conservation. In 1972, the Marine Mammal Protection Act (MMPA) was passed into law.[3] It remains the nation's leading instrument for the conservation of whales, dolphins, porpoises, and other marine mammal species, more than 20 of which—from the great blue whale to the Hawaiian monk seal—are still considered endangered or threatened.[4]

The MMPA stands as a model of precautionary legislation, at least in its design. Rather than place the critical "burden of proof" on conservation science and defer the regulation of human activities until their harms have been proven, the Act takes the view that activities with the potential to injure marine mammals or disrupt their behavior should be regulated.[5] Congress dictated a cautious approach to management given the vulnerable status of many of these species as well as the exceptional difficulty of measuring the impacts of human activities on marine mammals in the wild. "[I]t seems elementary common sense," the sponsoring committee noted in sending the bill before the House, "that legislation should be adopted to require that we act conservatively—that *no steps* should be taken regarding these animals that might prove to be adverse or even irreversible in their effects *until more is known*."[6]

Unfortunately, in the case of undersea noise, the MMPA's mandate has not yet been fulfilled.

OCEAN NOISE AND THE LAW

The heart of the MMPA is its so-called "take" provision, a moratorium on "harassing, hunting, capturing, or killing" any marine mammal.[7] On its face, the provision seems comprehensive, uncompromising, and clear: Before engaging in any activity that might harm a protected species, an individual must apply to one of two designated wildlife agencies, the National Marine Fisheries Service (NMFS) or the U.S. Fish and Wildlife Service (USFWS), for an "incidental take authorization." Which agency receives the application depends on the species affected. The USFWS covers sea otters, polar bears, walruses, manatees, and dugongs, and NMFS takes responsibility for all the rest. If the activity is thought to have more than a "negligible impact," it

falls under the moratorium; if not, and if the proposed "take" is deemed both small and limited in its geographic scope, the user receives a letter of authorization with a list of conditions to reduce the risk of harm.[8]

But the cautious approach to conservation that Congress intended has not easily worked for a problem on the scale of ocean noise. From shipping alone, there are simply too many sources to be effectively treated on an *ad hoc* basis, and there are too many marine species, such as sea turtles and fish, that fall outside the law's protection. Adding to the woes of the current system is chronic underfunding. According to virtually all stakeholders, NMFS' lack of resources—resources for permitting, for environmental reviews, and for enforcement—has been a fundamental impediment to regulation. The result is a system that takes too narrow a view of the activities to be regulated, leaving much of the problem unaddressed.

When Congress has engaged on these issues, it has often been to exempt activities from the regulatory process, working clauses into the law's fine print. An early example is the exception made for fisheries, added in 1994, which allows operators and owners a choice of non-lethal devices "to deter a marine mammal from damaging the gear or catch."[9] More recently, as part of the National Defense Authorization Act for 2004, Congress approved a series of loopholes for Department of Defense "readiness" activities and a blanket two-year exemption from the entire statute that can be invoked by the Secretary of Defense without any meaningful oversight.[10] These special exemptions have undermined fair and conservative implementation of the MMPA.

A vast and growing problem, an opaque environment, inadequate funding of the regulatory agencies, powerful economic and political interests thrown into the mix: these are some of the factors that make ocean noise so extraordinarily difficult to manage. The principal policy questions confronting the regulatory agencies and Congress are the subject of this chapter.

THE THRESHOLD QUESTION: DEFINING "TAKE"

The permit system established by the Marine Mammal Protection Act is based on a set of deceptively simple standards. With some exceptions, activities that incidentally "take" a protected animal are subject to review by the wildlife agencies; those found to have more than a "negligible impact" on a population or stock are impermissible.[11] But what do these terms mean in practice?

"Negligible impact" has been a cipher for decades. In the 1980s, a federal court described it as "undefined and ambiguous... at best," and so it remains, despite some attempts to clarify it after the decision came down.[12] Clearly more work is needed if that standard is to serve the protective role that Congress intended. But over the last five years, it is the other major standard, the one that lies at the threshold of the regulatory process, that has preoccupied the wildlife agencies. What sort of impact constitutes a "take" of a marine mammal, triggering the jurisdiction of government regulators?

In the Marine Mammal Protection Act, the word "take" is tersely defined. It means no more than "to harass, hunt, capture, or kill" a marine mammal (or to attempt the same). In this sparse phrase, a single term, "harassment," is left to cover virtually the full range of impacts that humans can cause short of death.[13] Thus did the definition of "harassment"—a word that on its face might suggest some trivial effect—become one of the cornerstones of the Act.

In 1994, Congress amended the MMPA to draw at least one basic distinction in the universe of harms. "Level A" harassment would refer to the potential for physical injury, and "Level B" to an activity's potential to disrupt behavioral patterns such as migrating, feeding, and mating.[14] The distinction may seem reasonable enough on its face. Intuitively, a physical injury seems worse than a behavioral change. Yet in disrupting vital behaviors, humans may hinder an animal's survival without causing direct physical injury, and an intense source of undersea noise has the potential to disrupt the behavior of many thousands of animals. Accounting for the subtleties of "Level B" harassment has generated more than its share of controversy.

In the search for a credible noise standard for "take," one of the first numbers to emerge was 120 decibels. That criterion derived largely from a series of experiments conducted in the 1980s off the central California

coast, in which migrating gray whales were exposed to increasing levels of low-frequency industrial noise.[15] When the received level rose above 120 decibels, the majority of whales passing by the loudspeaker veered away, some by as much as a mile, before resuming their normal course.[16] But the implications for policy were limited, given that the number did not account for variations among species, differences among types of man-made sounds, or the range of behavioral impacts that might occur. Nor did it touch upon the question of biological significance. In 1997, a scientific panel convened in California to develop guidelines for seismic surveys fixed on 140 decibels as the threshold of concern, the point at which one should begin worrying about disruptions in biologically important behaviors.[17]

The Fisheries Service, however, has before and since relied on higher numbers: 160 decibels for seismic projects, roughly 180 decibels for tests with high explosives, and a sliding scale of exposures for some intermittent sounds with 165 decibels at the fulcrum.[18] Many have noticed that the numbers have notched steadily upwards without any corresponding breakthroughs in research and, indeed, while studies on some species (on beaked whales, harbor porpoises, and sperm whales, for example) would seem to lead in the opposite direction.

Since 1998, NMFS has wanted to put its treatment of harassment on a surer footing. Last January, after some years of discussion, it advanced six alternatives for new "acoustic criteria guidelines" that would determine when a "take" occurred.[19] The current numbers would be replaced with a matrix of thresholds that would be "tailored to particular species groups and sound types" and would account not only for a sound's intensity but for its *duration* as well (the latter a welcome improvement over current practice).[20] Surprising to many observers, however, was the fact that behavioral impacts did not appear even to be considered in three of the proposed alternatives.[21] Those alternatives would be based instead entirely on the vulnerability of the mammalian inner ear, despite general acceptance that behavioral impacts are more common than physiological ones and can have severe consequences for protected species.[22] Nor would injuries to organs other than the ear, such as those seen in sonar-stranded whales, be considered by the agency at all.[23] It was not clear that any of the proposals could address long-term impacts or the subtler effects of noise, or even that the entire suite of proposals, being so disparate, could serve as the basis for an informed decision.[24]

Meanwhile, Congress has entered the debate by reopening the language in the statutory definition of harassment. In 2003, as noted above, Congress acceded to the Pentagon's request for a number of exceptions to the Marine Mammal Protection Act that it had rejected the previous year, including a weakened "harassment" definition that would apply to both defense activities and to federal research. To meet the new threshold, an activity would have to disrupt marine mammal behavioral patterns, such as breeding or nursing, to the point where they are "abandoned or significantly altered."[25]

The new language may seem innocuous at first blush, but the problems it poses are serious. In many cases, the term "significantly altered" has not been scientifically defined, and some programs could evade the Act's requirements by relying on its inherent uncertainty (and on NMFS' record of lax enforcement) and not seeking authorization in the first place. When a panel

> *"Measures to protect species and their habitats cannot always wait for ultimate certainty levels of scientific confirmation. In such cases it is appropriate to adopt the precautionary principle. Certainly, for example, in the case of slowly rising ambient noise levels, documenting the negative effect on blue whale populations would require more than a human lifetime. Cases involving the exclusion of a highly endangered population (e.g., western north pacific gray whales) from its critical habitat, or the insidious degradation of a species' critical habitat due to multiple and possibly compounding factors (e.g., noise, contaminants, food depletion), require strong, prompt action, and particular vigilance."*
>
> 2004 REPORT OF THE INTERNATIONAL WHALING COMMISSION'S SCIENTIFIC COMMITTEE, SUMMARIZING THE CONCLUSIONS OF MORE THAN 100 BIOLOGISTS

of scientists floated similar language a few years earlier, the Marine Mammal Commission cautioned that it would threaten "the precautionary burden of proof that has been the hallmark of the Marine Mammal Protection Act since its inception in 1972."[26]

The fact is we know far too little about marine mammal hearing, behavior, and ecology to set any standard or apply any number with confidence. "The problem in determining the biological significance of marine mammal responses," a National Research Council report observed in early 2005, "is that often we do *not* know them when we see them."[27] How does one know when a powerful noise source has compromised a whale's ability to detect predators, or separated it from its calves, when that whale is underwater or 10 miles away? What does it mean for a humpback whale to change its song patterns, or for a sperm whale to alter the way it dives? Getting to the bottom of these questions will take years—even decades.

In the meantime, regulators would do well to take a conservative approach. Several years ago it was thought that auditory impacts, particularly the damage sound can do to the fine hair cells of the inner ear, marked the threshold for injury in marine mammals.[28] We have since seen a growing number of instances of severe non-auditory injury, strandings, and death, based apparently on levels of exposure below those that are assumed to cause hearing loss. To ignore this information, or to proceed in the development of criteria that address only one form of potential harm while ignoring or denigrating the evidence of others, is a certain prescription for confusion and failure.

As a matter of sound environmental policy, we recommend that any standard proposed by the wildlife agencies or by Congress for "Level B" harassment meet the following three tests.

1. The standard must protect marine mammals in the most vulnerable situations. It must therefore address the dangerous behavioral responses that experts believe may play a role in strandings and mortality events; the plight of acutely sensitive species such as harbor porpoises, which react dramatically to even relatively low levels of sound; the potential for noise to undermine foraging and other essential behaviors in subtle but incrementally serious ways; the long-term effects of stress; and the particular needs of threatened and endangered populations, such as the western gray whale, for which a maximum exposure level of 120 decibels was recently recommended.[29]

2. The standard must ensure that major noise-producing activities remain inside the regulatory system. Any compromise in the review of activities that clearly threaten marine mammals—such as military active sonar, seismic surveys, and commercial shipping—would fail the MMPA's fundamental goal of protecting these species.

3. The standard must allow the wildlife agencies to manage populations for cumulative impacts. A more comprehensive approach to the problem is impossible if the threshold for regulatory concern is set too high. In setting standards, agencies should distinguish between a sound's potential for adverse impact (the threshold) and the degree of significance that impact could have.

The stakes for marine mammal protection could not be greater. Unless the standards the agencies set are responsibly cautious and comprehensive, much of the problem will remain outside the law: unmitigated, unmonitored, and unknown.

Recommendations

▸ Any threshold standard proposed for behavioral "harassment" under the MMPA should protect the species most vulnerable to noise, ensure that major noise-producing activities remain inside the regulatory system, and enable wildlife agencies to manage populations for cumulative impacts.

▸ NMFS should clarify the meaning of "negligible impact," so that it may serve the protective role that Congress intended.

SMALL DECISIONS: ADDRESSING CUMULATIVE IMPACTS

Environmental damage does not happen in a vacuum. New housing developments cut into the same

wetlands as the roads built to accommodate them. Exhaust from your car mixes with the exhaust from the cars of your neighbors, adding to global warming. Many environmental concerns cannot be isolated because they are part of a complex web of relationships. Yet decisions about how to produce cars, houses, and roads are frequently made as though nothing else were happening in the world. For decades, groups like NRDC have expressed concern about the phenomenon of "segmentation": the tendency of regulators to limit their view to the activity at hand, or sometimes even to just one phase of an activity, and overlook the suite of impacts and encroachments that are bearing down on a resource. Two panels that recently assessed the state of the oceans, the Pew Oceans Commission and the U.S. Commission on Ocean Policy, lamented the lack of ecosystem management across a range of marine issues.[30]

For a problem as sweeping and complex as undersea noise, the goal surely must be to reconcile the need for project-by-project review with the necessity of broad, cumulative, long-range planning. By such a standard, ocean noise has not been addressed successfully.

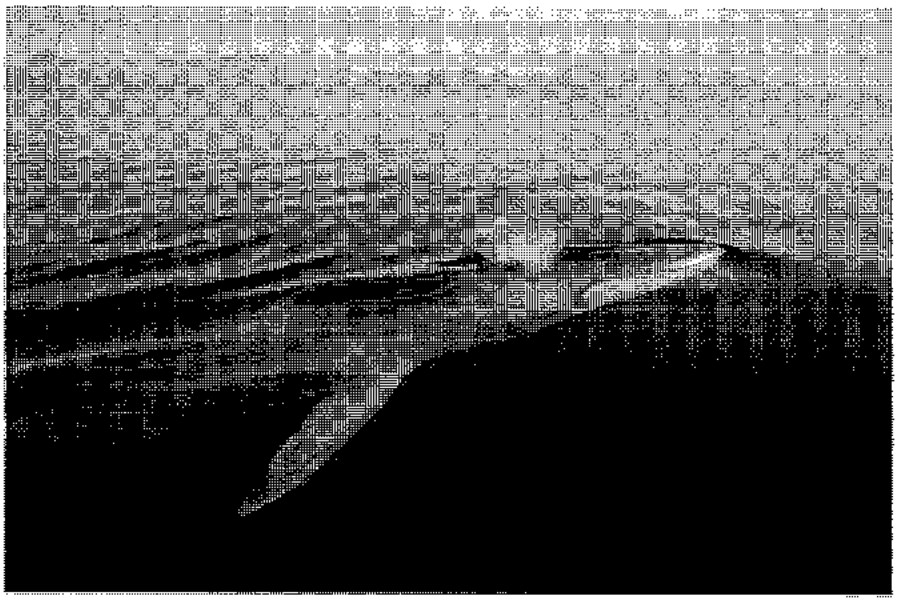
The activities that typically come before the National Marine Fisheries Service for review are transient and limited in range, often involving a single source. A researcher wants to investigate an unusual feature on the ocean floor, or an agency plans to do some underwater construction. The agency's analysis in such cases tends to be qualitative. It lays out, through modeling, the number of times each species of animal would be expected to undergo some significant behavioral effect—and then concludes in summary that the impacts will be negligible.[31] In 10 years, NMFS has never concluded that a noise-producing activity would have more than a negligible impact on marine mammals.

To be sure, this track record has something to do with the basic empirical difficulty of determining when a population-level impact might occur. But it has also to do with the fragmentation of the permitting process, which relieves pressure on the regulators to consider a broader set of impacts. Technically, NMFS, like all federal agencies, is required to take cumulative effects into account in any environmental review it prepares.[32] In practice, however, the basic information it needs is lacking, the underlying biology is undeveloped, and the resources aren't available to fill in the gaps.

The current situation at NMFS may exemplify what the ecologist William Odum called "the tyranny of small decisions." The agency's policy on ocean noise has been fragmented into many discrete, seemingly independent policies, in such a way that the big picture is lost.[33] Not only is risk assessed on a project-by-project basis, but so are measures to reduce risk. The narrow scope of most permitting decisions accounts at least in part for the agency's emphasis on operational schemes like "safety zones" and "ramp-up" (described in Chapter 2), which can be imposed on individual activities with relative ease but at best alleviate only part of the problem. The only area in which NMFS (to its credit) has begun to seek broader solutions is commercial shipping.[34] But to make serious progress on the issue of ocean noise will require economies of scale.

One way the agency can broaden its perspective is by looking at certain activities programmatically, so that, instead of considering, one by one, each Navy sonar exercise that takes place off North Carolina (for example), it would first consider the gross impacts that all exercises in that area are having. In fact, the Fisheries Service seems ready to move in this direction. Under the MMPA, it has the power to issue regulations of a categorical nature, either at the request of applicants or on its own initiative, that reach beyond the individual operation to a wider class of activity.[35] Last November, NMFS said it would prepare a programmatic analysis of oil-and-gas surveys in the Gulf of Mexico; very soon it may be reviewing a programmatic application from the National Science Foundation for that group's airgun use.[36] From the standpoint of efficiency alone, it should be obvious why programmatic review would appeal to a burdened agency.

Indeed, the interest in a comprehensive approach to noise is so strong in certain quarters that some have called for programmatic review beyond what existing law can provide. It has been suggested, for example, that the system should focus directly on marine mammal populations, so that all impacts on (say) California gray whales from noise, toxics, fishing, climate change,



FLIP NICKLIN/MINDEN PICTURES

Fin whales (*Balaenoptera physalus*), seen here surfacing in Baja California, Mexico, are among the fastest cetaceans and can sustain speeds of nearly 60 miles per hour. They can reach depths of 750 feet with ease and remain underwater for up to 15 minutes.

and a parade of other threats would be regulated in one process, much as marine mammal by-catch in fisheries is regulated today.[37] But there are serious drawbacks to this approach. Most populations of marine mammals off our coasts are not well defined; most impacts of sound are extremely difficult to monitor and assess; the rights to produce noise in beleaguered areas may be hard to apportion; and the sheer breadth of activities to be accounted for would make any analysis a matter of guesswork. It will be years before such a system could be viable. The more productive course for now is to continue to focus on specific activities, but on a broader scale.

For NRDC, the critical thing is that this new class of review do more than add efficiency to an underfunded process—that it actually serve as a better vehicle for assessing and reducing the cumulative effects of noise. Making such a process meaningful for the environment requires genuine commitment from an agency, and in the past, and in other arenas, federal agencies have not always been as committed as one would desire. Much has been written about the successes and failures of programmatic assessment under the National Environmental Policy Act, often called the Magna Carta of environmental law. Its regulations expressly allow for the tiering of reviews from general to specific, but, too often, "tiering" has been used as a device for hiding the ball and deferring analysis until key decisions on a project have been made.[38]

For its part, the Fisheries Service should be careful in defining the scope of review. Mitigation decisions such as geographical restrictions and source-based engineering should be made up front, as they arise, when the options before the agency are widest, and not deferred until all possible data about impacts are in. And public participation should be guaranteed through every stage of assessment. It does not bode well that in its review of the Navy's LFA system, arguably the first programmatic action that has come before it, the agency deferred its decisions about specific sites from the open comment period to a closed-door process in which neither the public nor the wider scientific community had a say.[39]

Properly applied, what might programmatic review make possible?

First, it could help us learn more about where marine animals are. As early as 1994, commentators urged NMFS to undertake basic research on the marine mammal populations off our coasts most likely to bear the brunt of industrial noise.[40] Not only is this information essential to any informed policy, it is also required to fulfill the agency's duty under the law to reduce impacts to the lowest practicable level. (Indeed,

as one court has noted, NMFS is obliged to consider alternative sites as a potential means of reducing impacts.)[41] But even in well-trafficked parts of the ocean, the intelligence on many species—their distribution, their abundance, and the size and structure of their populations—is meager. For lack of better information, populations of marine mammals are frequently defined in terms of geography, not biology, meaning, for example, that Cuvier's beaked whales off the west coast of the United States are not broken down into smaller, local units but are treated collectively as part of one vast northeast Pacific stock.[42] Programmatic review can serve as a lever for obtaining population data in key areas, as has been done for sperm whales in the Gulf of Mexico (though, notably, not for beaked whales and endangered species in the Navy's LFA operating areas in the western Pacific). And it can help advance modeling on both the habitat preferences of sensitive species and on noise levels in vulnerable areas.[43] Identifying and cooling off acoustic "hotspots" should become a central goal of the permitting process.

Second, programmatic review can aid in monitoring the effects of noise in heavily used areas. Under current law, monitoring and reporting are required of every activity that gets a permit.[44] According to experts, this should mean that monitoring plans are designed to confirm the assumptions on which the permit was granted.[45] But when NMFS says that a noise producer must monitor for impacts, it usually expects only a view from the bridge: how many animals were spotted within the safety zone, how many times was the system shut down, and the like. The reports that come back tell little about what marine mammals and other species actually experienced, and what information they do contain isn't compiled across activities in a way that might produce a common field of knowledge.

Economies of scale can make for better monitoring. A set of full-fledged, long-term plans should be put in place both for the seismic industry in the Gulf of Mexico, which is currently under programmatic evaluation, and for naval operations areas, which generally are not. As part of those plans, the agency should set clear, conservative, observable limits that would trigger a reopening of permits and additional review if exceeded.[46] (Providing triggers for review is standard in many other areas of environmental management.)[47]

Finally, NMFS should use programmatic review and other mechanisms at their disposal to encourage new technology. The Navy and oil-and-gas industry have put money into improving monitoring devices such as hydrophones and whale-finding sonar, and no doubt their interest can be credited in part to the emphasis that the agency has placed on safety zones.

Beyond this, however, is a battery of solutions for ships, seismic, and sonar that has only begun to be explored. Spread over time and over multiple projects, research and development becomes a feasible enterprise. For seismic exploration, the agency's first step might be to hold a workshop, along the lines of its 2004 shipping symposium, focusing on mitigation. For shipping, NMFS should actively pursue the course it chartered last year, and the Navy, whose powers of submarine detection stand to benefit from a quieter ocean, should commit resources to the process. The sooner we establish the terms of mitigation, the greater our ability to ease the economic burdens of compliance—and the less likely we will see an environmental train wreck in the future.

Recommendations

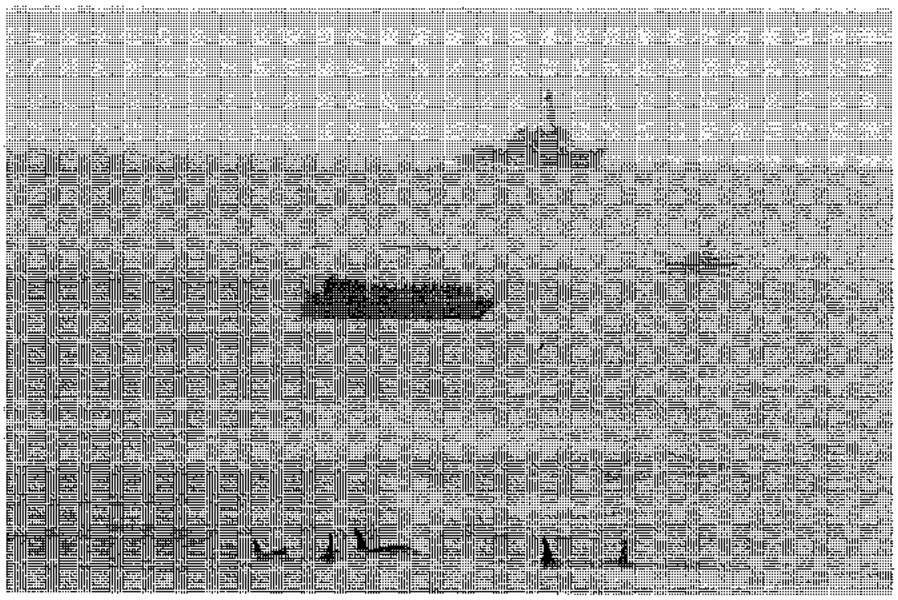
▸ NMFS should engage where appropriate in programmatic environmental reviews for noise-producing activities, taking care to make threshold mitigation decisions early in the process and to allow public participation through all stages of the process, as the law requires.

▸ The wildlife agencies should use programmatic review and other means to develop economies of scale in monitoring, mitigation, and basic population research.

▸ Congress should increase NMFS' budget for permitting under the Marine Mammal Protection Act by at least $1 million per year.

CARROTS AND STICKS: ENFORCING THE LAW

It is a commonplace that the law is only as strong as the will to enforce it. Even the best-conceived, best-



CENTER FOR WHALE RESEARCH

A pod of orcas mills in the shallows while a Navy ship sweeps Haro Strait, Washington, with mid-frequency sonar. The orcas are from a population that the government has proposed listing under the Endangered Species Act.

intentioned legislation is bound to fail if activities don't make it through the door and into the regulatory process, and if violators aren't held accountable. For a number of reasons, by no means entirely the fault of the agency, NMFS' enforcement of the law on ocean noise has been uneven.

In some respects, enforcement of the law has been paradoxical. Shipping, considered one of the leading noise polluters on a global scale, is also the least regulated, while a comparative lightweight, scientific research, is far more strictly scrutinized. Since 1994, the National Marine Fisheries Service has repeatedly reviewed permit applications from oceanographers and marine biologists seeking to generate undersea noise in the course of their research, but not one from the countless supertankers and cargo ships rumbling in and out of our ports.

If a petroleum company fails to obtain a permit under the MMPA, as Conoco-Phillips recently did for a survey in the species-rich Gulf of Alaska, NMFS generally doesn't flex its regulatory muscle to bring it into compliance.[48] In fact, dozens of oil-and-gas surveys have taken place over the last decade off Alaska, but only five by NRDC's count have been permitted; and in the Gulf of Mexico surveys continue to take place without authorization.[49] Lack of adequate funding for enforcement is partly to blame. Still, it is possible that the situation would improve across the board if the agency were to show its mettle in an individual case.

The case of active sonar is perhaps most troubling, if only because its impacts on marine mammals are most clear. It cannot be fairly said that the Navy will not engage in any environmental review. Sometimes the Pentagon will prepare an "overseas environmental assessment," a closed-door analysis conducted under the terms of a presidential order; yet it seldom undertakes the public environmental review that the National Environmental Policy Act, our flagship environmental law, requires. On occasion, it will consult with NMFS about the risks an exercise may pose for endangered species; the problem is that it has shown itself willing to withdraw from the process if the agency starts asking questions.[50] And, absent the threat of litigation, the Navy historically has not sought to comply with the Marine Mammal Protection Act on its sonar exercises, tests, or trials—even of mid-frequency sonar systems that have repeatedly been linked to mass strandings of whales. The initial challenge for any meaningful management of active sonar is to involve the Navy in a publicly accountable process, and, as this report goes to press, there are some indications that the Navy may be moving toward participation.[51] For its part, NMFS has

attempted to draw the Navy into the regulatory process through softer means, but it is unclear whether its approach will succeed in encouraging full compliance with the law.

By the same token, NMFS has never pursued an enforcement action after the fact for any noise-producing activity, not even in the best-documented cases. In one incident, a Navy ship conducting a "swept channel" sonar exercise just off the Washington state coast was reported to cause scores of orcas and harbor porpoises to panic and flee. The orcas were part of a well-studied population; their panic was independently witnessed by a number of research biologists and whale-watch operators, and had actually been filmed by a team of scientists whose research post overlooked the shore; the sound of the sonar, an intense, reverberant, mid-frequency screech, was recorded on hydrophones as the ship passed through.[52] But the agency did not seek penalties for the Navy's violation of the Marine Mammal Protection Act.[53] A bill introduced in Congress in 2005 would raise the civil and criminal penalties for violating the MMPA, but in the wake of the Washington state incident and other events, one has to question whether NMFS would ever seek enforcement against the Navy or another major noise producer.[54]

The integrity of any environmental review depends in part on the ability of the government to exercise independent judgment, free from internal pressures. In some cases, however, the close relationship between NMFS and a permit applicant can raise concerns about whether NMFS is maintaining the good-faith objectivity that the law requires. For example, in the most prominent regulatory application filed to date on ocean noise—the Navy's application for a permit to deploy LFA sonar around the globe—the record indicates that the two agencies communicated on a daily basis and that NMFS' final decision was "jointly written."[55] When formal consultations on endangered species began in earnest in January 2001, the Navy's consultant submitted a detailed outline for NMFS to follow in achieving what was presented as the two agencies' common goal: supporting approval of the Navy's application.[56] The result, in that precedent-setting case, is that the agency's decision—and its underlying conclusion that the process could be "a model of the precautionary approach"—appears not to have been the product of the arm's-length regulatory process essential to the independent enforcement of law.[57]

Why hasn't NMFS ever compelled the Navy to obtain a permit for its mid-frequency exercises, or required an oil-and-gas company to receive authorization before conducting a seismic survey?

At least part of the problem is governance. The Office of Protected Resources, the small bureau with jurisdiction over most marine mammals, is situated within the Fisheries Service and the U.S. Department of Commerce, two agencies for which environmental protection is not always the primary mission; and some of the most powerful players in the country, starting with the Department of Defense, have compelling interests in the outcome of its decisions.

Managers have privately worked to persuade the Navy to comply with the law—and, of course, many in the Navy are committed to its ideal of environmental stewardship.[58] Unfortunately, there have been too many cases, even when a regulatory process has gotten underway, where the Navy has made it difficult, if not impossible, for NMFS to do its job. For example, a Navy program known as LWAD (for "Littoral Warfare Advanced Development"), which tested experimental sonar systems off our shores, developed a pattern of opening its endangered species consultations at the last possible moment, sometimes the very day before a ship was due to set sail, leaving NMFS either to approve those tests without adequate review or to force their cancellation.[59]

And the Navy has shown its willingness to withdraw from review altogether if regulatory pressure becomes uncomfortable. When the wildlife agency asked the Navy for more information about a mass stranding off the U.S. Virgin Islands—the strandings having occurred as the Navy began a nearby exercise, the government of the Virgin Islands having reported hearing sonar in the water—the Navy's response was to end consultation on the exercise.[60] (It appeared to do the same with its LWAD program, after a regional

office refused to rubber-stamp a consultation there.)[61] For even the most conscientious manager, holding one of the strongest institutions in the government accountable cannot be an easy thing.[62]

But part of the problem is that the agency has tied its own hands. To judge from its record, NMFS appears to have taken the position that it cannot act preemptively to keep a violation of the Marine Mammal Protection Act from occurring. Yet Congress has given it broad authority to enforce the Act.[63] NMFS could seek an injunction against a would-be polluter, so long as it is consistent with the law's objective of protecting and conserving marine mammals.[64] It could inform polluters, like the oil companies that shoot without permits in Alaska, that it will bring an enforcement action if they proceed, and could seek penalties after the fact even if outside experts haven't videotaped the results.[65] And it could unilaterally adopt rules and regulations to govern harmful activities, such as sonar exercises, regardless of whether an applicant steps through the door.[66] When it comes to ocean noise, there is no significant legal obstacle we can see to improved enforcement of the law.

The consequences of letting things pass are serious. Activities go unregulated, resources are committed before mitigation can be planned, and marine life suffers. Congress should add a "citizen-suit" provision to the Act, which would empower the public to do what, in some cases, NMFS will not. More fundamentally, however, the wildlife agencies should use the authority they have been delegated and bring greater rationality and equity to the management of ocean noise.

Recommendations

▸ In addition to increasing funding for agency enforcement, Congress should add a "citizen-suit" provision to the MMPA, allowing for judicial oversight over private activities that would harm marine mammals without authorization.

▸ NMFS should adopt process guidelines to ensure that an arm's-length relationship is maintained with prospective permittees.

▸ NMFS should exercise the enforcement authority delegated by Congress under the Act to bring clearly harmful activities into the regulatory system.

THE ROLE OF RESEARCH: CHARTING A NATIONAL PROGRAM

Ocean noise is an issue on the frontiers of science. To understand how whales are affected, investigators not only have had to conduct new studies, they also have had to invent new technologies for monitoring species in the wild. The developing record on strandings alone has involved experts from fields as diverse as diver physiology, veterinary pathology, and marine bioacoustics, and their findings have begun to unsettle long-held beliefs about how marine mammals function. All of this helps make ocean noise a challenging area of study, one that requires both substantial and reliable sources of funding and considerable amounts of time.

To help meet these needs, NRDC recommends that Congress create a federal program for coordinating research. The idea of a national ocean noise research program has been endorsed now by a number of scientists and scientific bodies, including a National Research Council panel, and there are several good reasons to support it.[67] A centralized program would be better suited both to pool money for costly work and to guarantee funding beyond the veil of uncertainty that marks the annual budget cycle for most agencies. And it could address issues that would otherwise fall through the cracks between the mission-oriented studies that most agencies undertake.

A national research program could also allow for greater diversity and independence of funding—an important consideration in a field dominated by a single source. As it stands, the U.S. Navy sponsors fully 70 percent of the research on ocean noise in the United States and 50 percent of all such research worldwide.[68] Its budget for noise began to expand in the mid-1990s in response to threats of litigation. By 2006, the budget is expected to top $16 million.[69]

Unfortunately, that level of funding, valuable as it has been, can create the appearance of conflict of interest and undermine public confidence in the science. A

similar observation was made in 2000 by a National Research Council panel on noise. "Sponsors of research need to be aware," the panel said, "that studies funded and led by one special interest are vulnerable to concerns about conflict of interest. For example, research on the effects of smoking funded by [the National Institutes of Health] is likely to be perceived to be more objective than research conducted by the tobacco industry."[70] Maintaining confidence in ocean noise research, both inside and outside the scientific community, is vital to its future support.

In the field of marine mammal science, some have taken comfort in the notion that the Navy's research arm, the Office of Naval Research (ONR), is walled off from the rest of the Navy.[71] Yet this comfort is misplaced. On at least one occasion, ONR placed a "pretty scorching phone call" to a researcher who took a public position critical of the Navy's position on sonar, after naval operations interceded and told ONR that the researcher's comments were "out of the box."[72] (The researcher and his colleagues had submitted several pages of technical comments to the Fisheries Service, which was in the process of assessing the environmental impacts of a Navy sonar system.)[73] In any case, much of the Navy's new funding for noise does not derive from its basic science office. By 2006, more than $6 million for acoustics research, about 40 percent of the total, is expected to come each year from the Chief of Naval Operations.[74] Other fields of science have recognized the potential for conflict when stakeholders on an issue provide so much of the funds.[75]

A bill introduced into Congress in 2005 would establish a targeted ocean noise research fund within the National Fish and Wildlife Foundation, a nonprofit created by Congress to leverage partnerships between the private and public sectors.[76] The Foundation could serve as a base for a national program that pools money, enables multi-year projects, increases funding independence, and provides for transparency and public participation in an area that needs both.

No one should expect results overnight. Often, as in other areas of science, the findings of one study only raises questions that more work is needed to resolve. In 1997, for example, as part of a Navy research program on the impacts of low-frequency sonar, a group of biologists spent several weeks off the coast of Kaua'i investigating whether sonar could affect the singing (and, by implication, the breeding) of endangered humpback whales. The study showed that some of the whales did indeed alter their singing, but scientists came to vastly different conclusions about the signifi-

A NATIONAL OCEAN NOISE RESEARCH FUND

The National Fish and Wildlife Foundation shall establish a national ocean noise pollution research endowment fund, to be used by the Foundation to support research and management programs that contribute to the understanding, evaluation, mitigation, or management of the effects of ocean noise on marine species, including marine mammals and fish.

The Foundation shall form, within 90 days of the establishment of the endowment fund, a council of advisors for the administration of the endowment fund. Such council shall consist of persons knowledgeable in the science and policy of marine acoustic pollution and shall include among its members one representative appointed by the National Marine Fisheries Service, one representative appointed by the Marine Mammal Commission, and representatives from the scientific community and from nongovernmental conservation or wildlife protection organizations. The council shall identify funding priorities, review and select proposals, and evaluate projects that are supported by the endowment fund.

It is the intent of Congress that in making expenditures from the endowment fund, the Foundation should give priority to funding projects on marine noise pollution that the council determines will address (for example):

- causal mechanisms for mass strandings and observed traumas in beaked whales and other cetaceans;
- the development of models to predict population-level consequences of anthropogenic sounds;
- subtle changes in marine mammal behavior, such as those related to masking, caused by anthropogenic sounds;
- the development of noise-induced stress indicators in marine mammals, fish, and other marine life; and
- the development of methods for siting noise-generating activities with the purpose of reducing impacts on the marine environment.

From § 402 of the National Oceans Protection Act, a bill introduced in Congress in June 2005

cance of the impact. Years later the community continues to disagree over what the study proves.[77]

The fact is that getting to the bottom of the behavioral impacts of ocean noise, which may in the end prove more serious than strandings, is an inordinately difficult task that could take decades. Definitive information may not be available until long after critical decisions about sonar, shipping, and offshore development are made. This is not to denigrate the scientific method, of course, but to recognize the deliberateness of its speed. Protective measures cannot wait for scientific certainty. Given what is at stake for marine animals, it is vital that any large-scale research program commit a substantial portion of its budget, at the outset, to developing and improving the mitigation tools discussed in this report. The one indispensable goal of research is that it produce real benefits for the ocean.

There is no question that scientific research is integral to any future solution to the problem of undersea noise. Knowing why some sources cause whales to strand could hold the key to preventing mortalities in the future; knowing where beaked whales and other species are likely to be found would better enable us to avoid them. Creating a national research program could bring us closer to the answers.

Recommendation

▶ Congress should establish a National Ocean Noise Research Program through the National Fish and Wildlife Foundation, or similar institution, allowing for coordination, reliability, and independence of funding. A substantial portion of the budget should be expressly dedicated to improving and expanding mitigation measures.

CHAPTER 4

Noise Without Borders: The Growing International Response

It is in the nature of pollution to disrespect borders and ocean noise pollution is no exception. Indeed, one can think of few forms of pollution that are more transnational. Some of the sounds described in this report can travel hundreds of miles underwater at intensities strong enough to affect marine life. Many of the species they affect are migratory, and many of the activities that generate the noise cross boundaries or take place on the high seas, in a gray zone of maritime jurisdiction. As an environmental problem, the extent of undersea noise is global, its sources and influence spanning virtually every region of the world.

The case of the California gray whale is illustrative. Each winter, thousands of these giants traverse the Gulf of Alaska and ply the coasts of British Columbia, Washington, Oregon, and California on their way to Baja, Mexico, their southern breeding grounds. In legal terms, that means they pass through the waters of at least three sovereign states and in and out of the territorial sea.[1] How can one country adequately protect a creature so unconstrained by human boundaries and from a form of pollution that itself could emanate from many miles away?

Fortunately, as scientific and public consensus has crystallized around ocean noise, so has international recognition that the strategy for addressing it must be as global as the problem. In 2004, several prominent multinational institutions addressed the issue and urged joint steps for its reduction. The European Parliament, for example, called for "moratoriums and restrictions on the use of high-intensity active sonars" by its 25 member states.[2] Sixteen countries that border the Mediterranean and Black Seas called for "a common set of guidelines" to reduce noise pollution in those waters.[3] The World Conservation Congress of the IUCN, one of the world's leading bodies for conservation policy, urged its member states to work through the United Nations and within multilateral agreements for the control of undersea noise.[4] And the Scientific Committee of the International Whaling Commission recommended that countries cooperate to monitor ocean noise levels and to develop basin-scale noise limits.[5] These actions reflect an emerging consensus that the problem of ocean noise must be addressed promptly and multilaterally, as well as by states acting alone.

The question is how best to accomplish the task. Some have suggested that a new agreement specific to ocean noise may be necessary, analogous to those that have been put in place for other forms of transboundary pollution, if only to vest some international authority with the power to advance the issue.[6] Others hold that the universe of existing instruments provides all the authority that is needed for coordinating efforts among states.[7] And if you side with the latter, or believe that some action within existing bodies is prerequisite to any specific agreement on noise, the question remains which instruments are most suitable. Should you work with those that aim to regulate pollution or with those whose mission is to protect sensitive marine species and habitats? Should you seek action on a regional level, perhaps through the network of regional seas agreements that are facilitated by the

EXCERPT FROM EUROPEAN PARLIAMENT RESOLUTION

Whereas a growing body of research, including evidence published by 18 European scientists in Nature (October 9, 2003), confirm that the very loud sounds produced by high-intensity active naval sonars pose a significant threat to marine mammals, fish, and other ocean wildlife...

The European Parliament

(2) *Calls* on the Member States to actively pursue, in the framework of NATO and other international organisations, the adoption of moratoriums and restrictions on the use of high-intensity active sonars in naval operations and the development of alternative technologies;

(3) *Calls* on the Member States to immediately restrict the use of high-intensity active naval sonars in waters falling under their jurisdiction; [and]

(6) *Calls* on the [European] Commission and the Member States to set up a Multinational Task Force to develop international agreements regulating noise levels in the world's oceans, with a view to regulating and limiting the adverse impact of anthropogenic sonars on marine mammals and fish.

From the European Parliament Resolution on the Environmental Effects of High-Intensity Active Naval Sonar (2004)

United Nations, or within global conventions like the ones that presently improve the lot of biological diversity or migratory species?

The international community has not yet settled on a single best approach to addressing ocean noise and may never do so.

There is, in fact, no silver bullet. Binding global mandates may seem like a panacea, but none is likely to be adopted any time soon, and efforts spent advocating for them may be better spent on voluntary guidelines more likely to influence behavior in the short term. Regional seas agreements are well set up to promote geographical mitigations, especially in marine protected areas, and could play an important role in defining "best practices" through voluntary guidelines, though they are unlikely to drive development of new control technologies. For now, we will treat these options as complementary strategies, all of which should be pressed into service as we work toward a worldwide solution.

THE MULTILATERAL APPROACH

In 1982, after years of conferences, workshops, and negotiation, the United Nations agreed upon a document that many have hoped will serve as a constitution for the oceans: the Convention on the Law of the Sea.[8] The convention is the most far-reaching treaty yet devised for the global marine environment and, having been ratified by almost 150 countries (though not the United States), represents the will of the vast majority of the peoples of the world.[9] Importantly, the Law of the Sea defines the term "pollution" in a way that brings anthropogenic noise within its scope: as "the introduction by man, directly or indirectly, of substances *or energy* into the marine environment."[10] As many have noted, the reference to energy plainly subsumes harmful noise, both as a matter of treaty interpretation and as a matter of physics.[11] Under the Convention, all forms of pollution are subject to multilateral action, and countries are obligated to work together on rules for their prevention, reduction, and control.[12]

For many pollutants, it remains to be seen how this duty will be implemented. For ocean noise, options range from the direct, comprehensive control that a federal system like the European Union can exercise; to the guidelines or regulations that specialized bodies such as the North Atlantic Treaty Organization (NATO) and the International Maritime Organization (IMO) can propose for certain activities; to the coordination that regional agreements can bring, particularly to matters of habitat protection.

The prospect of binding multinational legislation is most alive in Europe. In calling for restrictions on active sonar in 2004, the European Parliament, the

CONTINUED ON PAGE 59

TABLE 4.1
International Conventions, Agreements, and Treaties with Relevance to Ocean Noise

Agreement	Full name	Coverage	Mechanism(s) for addressing undersea noise	Extent of action taken on noise, todate	U.S. a party?
Abidjan Convention	Convention for Co-Operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region. Established under UNEP Regional Seas Programme.	Regional: Marine areas within the national jurisdictions of contracting parties in Western and Central Africa	Provisions for the prevention and reduction of pollution, including energy; for the conservation of marine resources; and for the preparation of environmental impact assessments. Art. 4, 8, 11, 13(2).	None	No
ACCOBAMS	Agreement on the Conservation of Cetaceans of the Black Sea, Mediterannean Sea and Contiguous Atlantic Area. Established under CMS.	Regional: The Black Sea, Mediterannean Sea and Contiguous Atlantic Area	Provisions for the regulation of pollution; for the management of human-cetacean interactions; for the management of cetacean habitat; and for the preparation of environmental impact assessments. Art. 2; Annex 2.	Significant: Development of guidelines on noise-producing activities and passage of resolution recognizing noise as pollution and urging reduction of noise in sensitive habitats	No
Antarctic Treaty	Antarctic Treaty and 1991 Protocol on Environmental Protection	Regional: Antarctic waters	Provisions for comprehensive ecosystem protection and prohibitions on the taking or harmful interference with any mammal, except by permit. 1991 Protocol on Environmental Protection, Art. 3 and Annexes 1-2, 4, 5.	Limited: Consideration of noise within the Antarctic Treaty Consultative Forum and by the Scientific Committee on Antarctic Research	Yes
ASCOBANS	Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas. Established under CMS.	Regional: Marine environment of the Baltic and North Seas	Provision for the prevention of significant disturbance of small cetaceans, "especially of an acoustic nature." Annex at 1.	Significant: Resolution urging parties to reduce the impact of noise on cetaceans from specified activities through the adoption of mitigation measures	No
Barcelona Convention	Convention for the Protection of the Marine Environment and Coastal Region of the Mediterranean. Established under UNEP Regional Seas Programme.	Regional: Marine environment of the Mediterranean Sea	Provisions for the prevention and reduction of pollution, including energy; for the conservation of threatened species and their habitat; and for the preparation of environmental impact assessments. Art. 4, 7, 10.	Limited: The Offshore Protocol, not yet in force, would require environmental review of seismic surveys	No
Bern Convention	Bern Convention on the Conservation of European Wildlife and Natural Habitats	Regional: Wild flora and fauna of Europe	Provisions for the conservation of marine species and their habitat, including especially vulnerable migratory species. Art. 1 - 10.	None	No

TABLE 4.1 (continued)
International Conventions, Agreements, and Treaties with Relevance to Ocean Noise

Agreement	Full name	Coverage	Mechanism(s) for addressing undersea noise	Extent of action taken on noise, todate	U.S. a party?
Bonn Convention (CMS)	Convention on the Conservation of Migratory Species of Wild Animals	Global: Terrestrial, marine and avian migratory species throughout their ranges	Provisions for the conservation of migratory species, especially species listed as endangered. Art. 3.	Limited: Some documents express concern about the possible negative impacts to migratory species of emissions of noise	No
CBD	Convention on Biological Diversity	Global: The conservation of biodiversity	Provisions for the conservation of species and habitat, and for the preparation of environmental impact assessments. Art. 8, 14.	Limited: General mention of noise pollution in a recent meeting report from the Ad-hoc Open Ended Working Group on Protected Areas	No
CCAMLR	Convention on the Conservation of Antarctic Marine Living Resources. Established under UNEP Regional Seas Programme.	Regional: The conservation of Antarctic marine living resources	Provisions for the conservation of marine resources and ecosystems. Art. 2, 9.	None	Yes
European Union Habitats Directive	Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna	Regional: The conservation of natural habitats and wild fauna and flora in Europe	Provisions for the protection of species and the management of key habitat. Art. 3–16.	Limited: the Council of the European Union has stressed the importance of considering underwater noise as a source of pollution	No
Helsinki Convention	Convention on the Protection of the Marine Environment of the Baltic Sea Area. Established under UNEP Regional Seas Programme.	Regional: The Baltic Sea	Provisions for the prevention and reduction of pollution, including energy; for the conservation of natural habitats and biological diversity; and for the preparation of environmental impact assessments. Art. 3, 7, 9, 12, 15; Annex VI.	None	No
ICRW	International Convention on the Regulation of Whaling	Global: The conservation of whale stocks	Provisions for the conservation of whale stocks, though its mandate to address environmental threats to cetaceans is disputed. Art. 4, 5.	Significant: Scientific Committee has placed noise on its standing agenda and expressed serious concerns about harm to populations of whales from noise. Resolutions passed by the Commission urge action to reduce noise in sensitive whale habitat.	Yes

TABLE 4.1 (continued)
International Conventions, Agreements, and Treaties with Relevance to Ocean Noise

Agreement	Full name	Coverage	Mechanism(s) for addressing undersea noise	Extent of action taken on noise, todate	U.S. a party?
IMO Convention	International Maritime Organization Convention	Global: The coordination of matters concerning maritime safety and efficiency of navigation	Authority to issue regulations and guidelines concerning maritime safety, the prevention and control of marine pollution from ships and other matters concerning the effect of shipping on the marine environment. Art. 15.	Limited: Resolution naming noise as one operational pollutant of shipping to consider in the identification and designation of Particularly Sensitive Sea Areas (PSSAs). Res. A.927(22), Annex 2 at Para. 2.2.	Yes
MARPOL	International Convention for the Prevention of Pollution from Ships	Global: The protection of the marine environment from pollution from ships	Options limited because agreement covers "pollution" by substances, not energy.	None	Yes, except has not ratified Annexes IV or VI
Nairobi Convention	Convention for the Protection, Management, and Development of the Marine and Coastal Environment of the Eastern African Region. Established under UNEP Regional Seas Programme.	Regional: Marine areas within the national jurisdictions of contracting parties in Eastern Africa	Provisions for the prevention and reduction of pollution, including energy; for the protection of marine resources; and for the preparation of environmental impact assessments. Art. 4, 8, 10, 13(2).	None	No
OSPAR	Convention for the Protection of the Marine Environment of the Northeast Atlantic. Established under UNEP Regional Seas Programme.	Regional: The conservation of the marine environment of the Northeast Atlantic	Provisions for the prevention and reduction of pollution, including energy; and for the protection of ecosystems and biological diversity from the adverse effects of human activities. Art. 2, 5; Annex V.	Limited: Recognition of noise as a potentially dangerous effect of human activity that may need to be regulated in MPAs, and preparation of a comprehensive overview of the impacts of noise on the marine environment	No
SOLAS	International Convention for the Safety of Life at Sea	Global: The specification of minimum standards for the construction, equipment and operation of ships, to advance human safety	Provisions for standards of ship design, though perhaps limited by treaty's scope.	None	Yes
UNCLOS	United Nations Convention on the Law of the Sea	Global: All matters relating to the uses of the oceans and seas and their resources	Provisions for the prevention and reduction of pollution, including energy; for the protection of marine resources; and for the preparation of environmental impact assessments. Art. 192, 194, 206, 209.	Limited: Consultative body has recommended that the General Assembly consider the impacts of ocean noise on marine living resources	No

branch of the European Union that is directly elected by citizens, asked for member states to take action through international institutions such as the Union itself. That action would include placing limits on the use of military sonar in European waters, developing alternative technologies, and adopting common standards to reduce impacts not only on marine mammals but on fisheries as well.[13] A few months later, the European Council, the Union's main decision-making body, recommended that undersea noise be addressed within the new marine policy in development for European seas.[14] Its recommendation paves the way for the inclusion of undersea noise in binding legislation to be adopted by the European Commission, which in turn could lead to real restrictions on noise-producing activities in European waters.

A few international bodies have the general expertise to deal with particular aspects of the problem. For active sonar, NATO is a logical place to turn, not because the Secretary General holds sway over the navies of the Alliance and can bind them all to regulation (he cannot), but because it is perhaps the world's best network for the coordination of military policy. NATO's research arm has adopted guidelines for sonar exercises under its purview, which, though flawed, contain some genuinely progressive elements; perhaps more significantly, it recently convened a workshop for naval policymakers to review the science on sonar and discuss ways to mitigate damage. The workshop was organized in response to European and American nongovernmental organizations, which petitioned the Secretary General and state ambassadors for action, but unfortunately groups from outside the military have not been engaged by NATO in this unfolding process.[15]

For shipping noise, the highest source of authority is the IMO, which was founded under the United Nations banner in 1948 to oversee the gamut of issues concerning commercial ships. Thus far, the IMO's one foray into ocean noise pollution has been in setting guidelines for "Particularly Sensitive Sea Areas," areas such as the Florida Keys off the United States and the Paracas National Reserve off Peru that require special protection from shipborne impacts because of their recognized significance.[16] The guidelines list shipping noise as an appropriate target of management for these areas, and the IMO could and should adopt measures to protect them from harmful noise.[17] Another option is to place the discussion of noise on the agenda of the IMO's Marine Environment Protection Committee, which helps administer a variety of programs under agreements, conventions, and charters. For seismic exploration, however, the other major contributor to ocean noise, there is no specialized international authority that could be brought to bear.

Regional bodies provide another possible framework for action, or at least for the coordination of action. The 12 so-called regional seas agreements that were negotiated through the United Nations, the handful of other agreements that were established independently, and the two European instruments specifically aimed at protecting whales, dolphins, and porpoises—all of these documents have provisions relevant to noise. Not surprisingly, the bodies that have made the most progress thus far are the two cetacean agreements, which respectively cover the Black and Mediterranean Seas (ACCOBAMS) and the Baltic and North Seas (ASCOBANS).

Both agreements have set processes in motion to develop guidelines for noise-producing activities. For example, the members of ACCOBAMS, urging "extreme caution" on noise producers, have charged their Scientific Committee with producing "a common set of guidelines" for activities with the potential to harm cetaceans.[18] How those guidelines will be implemented or enforced is not clear. But because regional instruments like ACCOBAMS allow for cooperation among states at reasonable scales, some commentators have suggested that they are likely to provide the most progress on noise in the short term, regardless of their legal enforceability.[19]

Regional agreements may also be among the best vehicles for inscribing sound into the management of coastal habitat. The OSPAR Convention, which protects the environment of the northeast Atlantic, has already identified noise as a potentially dangerous form of human disturbance that may need to be regulated within the region's marine protected

areas.[20] Also of note are more far-reaching instruments such as the Convention on Biological Diversity, which is attempting to coordinate management of protected areas on the national, regional, and global levels.[21] Several commentators have embraced such approaches as allowing states the flexibility to focus on areas and animals most harmed by undersea noise.[22]

Despite these many options and overlapping mandates for action, existing law does have limitations. Consider the difficulties faced in addressing shipping noise. The Law of the Sea demands that states reduce pollution from ships, but—jealous of "sovereign immunity" and the right of "innocent passage"—it also confines states in the requirements they might impose on foreign vessels.[23] And although an international regime called MARPOL (the International Convention for the Prevention of Pollution from Ships) exists to pick up the slack, and although MARPOL sets forth detailed, binding standards for ship design and operations, it is categorically focused on substances such as oil and sewage—not on noise.[24] Whether other authorities, voluntary arrangements with industry, or port-based regulation can fill the jurisdictional gaps remains to be seen.[25]

The international community has begun at least to consider developing new instruments. Among the items in the European Parliament's resolution on sonar is an appeal for establishing a multinational task force, whose aim would be to construct new agreements reducing the impacts of sonar as well as other sources.[26] The IUCN, in its resolution, called on its Commission on Environmental Law to counsel states and intergovernmental organizations on the development of legal instruments.[27] Yet the politics of creating a new agreement out of whole cloth, and in the face of such powerful interests as the military and global petroleum industry, may prove too difficult to overcome, at least in the short term. Even amending MARPOL to permit the regulation of noise could take years. Thus, while we agree it is worth considering whether new law is needed, and while we would welcome the formation of a task force to advance the issue, we won't expect consensus to emerge any time soon.

In the meantime, we should look for creative and cooperative steps that can be taken now. To deal with the gap in regulating vessel noise, for example, it has been suggested that industry and regulators consider action within the Safety of Life at Sea Convention, which, though concerned primarily with human safety,

CALLING LONG DISTANCE

I once traveled 400 miles across the eastern tropical Pacific by square-rigger, stopping every three hours to listen through a hydrophone. Though we seldom saw porpoises, at every stop we heard at least a few porpoise cries. Sometime they were very far away, but they were always there. Their calls were like some vast net cast across the sea. The cries of porpoises are too high-pitched to travel very far, so each animal probably can hear only a few of the animals closest to it. To keep together as a herd, porpoises in the open ocean would have to pass information along by repeating it. But given what one learns by playing the game of "Telegraph," any system which relies on the repetition of messages from individual to individual becomes plagued by errors. I suspect that herds can function effectively only if the signals that organize them are audible to every animal in the herd. Therefore what I will take as a herd of whales is a group of whales, all of whose members can hear all other members under average wind conditions most of the time. I feel safe in assuming that however simplistic such a definition may be, it is likely to be a great deal better than calling a group of whales that is visibly moving together in some united purpose a "herd." In the latter case, there is a very large chance that all one is seeing is a *part* of the herd.

Blue and fin whales make sounds so loud they can propagate up to four thousand miles at useful intensities through the layer of ocean known as the deep sound channel. Such animals would be audible anywhere in a 50 million square-mile area of deep ocean. If a fin whale was born with an adaptation that enabled it to detect another whale's signal just one decibel deeper in the background noise, that whale would now be able to hear its chums a thousand miles further away, adding another 28 million square miles—an area almost the size of the Atlantic Ocean—to its acoustic range. But in reality, a difference of one decibel is audible only under the best listening conditions, which suggests just how strong are the selective pressures on whales to make and hear loud sounds.

—Dr. Roger Payne, President, Ocean Alliance

FROM THE ACCOBAMS RESOLUTION ON ANTHROPOGENIC OCEAN NOISE (2004)

Aware of the fact that cetaceans are particularly vulnerable to disturbance;

Recognizing that anthropogenic ocean noise is a form of pollution, comprised of energy, that can have adverse effects on marine life ranging from disturbance to injury and mortality;

Aware that some types of anthropogenic noise can travel hundreds and even thousands of kilometers underwater and, more than other forms of pollution, are not restricted by national boundaries...

The Meeting of the Parties [to ACCOBAMS]

(1) *Urges* Parties and non Parties to take a special care and, if appropriate, to avoid any use of man-made noise in habitat of vulnerable species and in areas where marine mammals or endangered species may be concentrated, and undertake only with special caution and transparency any use of man-made noise in or nearby areas believed to contain habitat of Cuvier's beaked whales (*Ziphius cavirostris*), within the ACCOBAMS area;

(4) *Urges* Parties to consult with any profession conducting activities known to produce underwater sound with the potential to cause adverse effects on cetaceans, such as the oil and gas industry, oceanographic and geophysical researchers, military authorities, shoreline developers, and the aquaculture industry, recommending that extreme caution be exercised in the ACCOBAMS area, the ideal being that the most harmful of these activities would not be conducted in the ACCOBAMS area until satisfactory guidelines are developed; [and]

(5) *Encourages* the development of alternative technologies and requires the use of best available control technologies and other mitigation measures in order to reduce the impacts of man-made noise sources in the [ACCOBAMS] Agreement area....

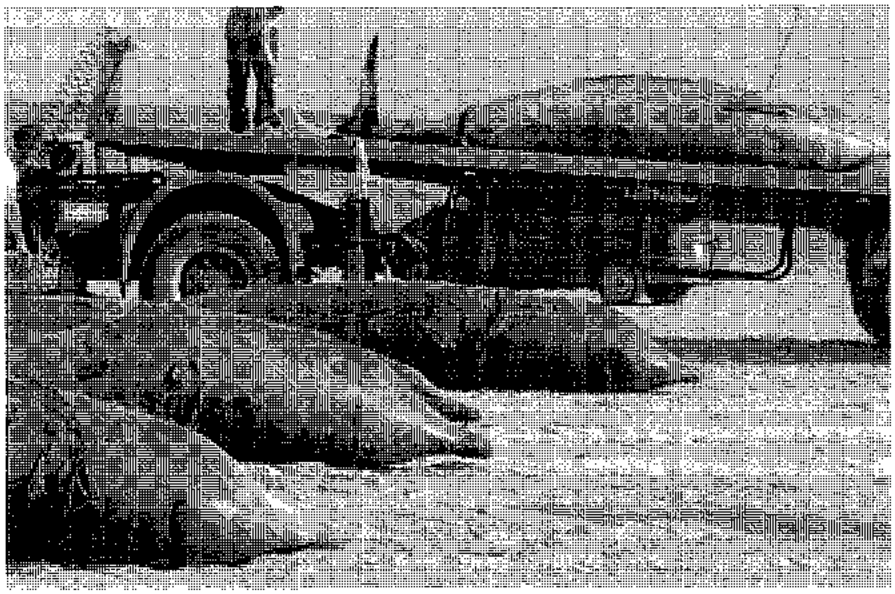
could well be an appropriate vehicle to tackle the problem of engine noise or even, arguably, cavitation.[28] In the near term, resource management should be used hand in hand with pollution control, and indeed all options should be considered, recognizing that there may never be one overarching solution.

STATE BY STATE

In the Marine Mammal Protection Act, the United States has what may well be the world's most comprehensive statute for the conservation of these animals, but of course many states have strong domestic laws to protect the sea. Indeed, the Law of the Sea imposes a general duty on all states to conserve the marine environment within their jurisdiction as well as a specific duty "to prevent, reduce, and control pollution of the marine environment from any source."[29] The extent of a country's obligations to "prevent, reduce, and control" ocean noise pollution depends on the authority it enjoys. A state may be obligated to take action given its direct control or sponsorship of a harmful activity, its general authority over the territorial sea and exclusive economic zone (EEZ), or its power over ships that fly its flag or use its ports.[30] With jurisdiction comes responsibility.

Some countries have already begun to fulfill the charge. For example, in 2004 the Spanish Ministry of Defense announced a prohibition on all active sonar exercises off the coast of the Canary Islands, a region that has seen a tragic string of whale strandings linked to naval exercises.[31] With this action Spain became one of the first countries to voluntarily exclude sonar from waters known to shelter sensitive species. (The United States ceased training in the Providence Channels of the Bahamas after its sonar transit in March 2000 caused mass mortalities there.)[32] A number of other countries have begun curbing the impacts from noise under their domestic species and habitat legislation.[33]

But all states could do more. The IUCN has entreated its member governments to require best available control technologies of noise sources, to avoid the use of noise in vulnerable habitat, and to consider noise restrictions in managing marine protected areas.[34] Under international law, a state wields considerable control over activities that take place in its territorial sea, which generally extends 12 nautical miles (slightly



VIDAL MARTIN, SECAC

Beached whales lie dead on the beach in the Canary Islands after a multilateral sonar exercise takes place off shore. The Spanish government has since banned the routine use of military sonar there.

more than 13 statute miles) from the coast.[35] But even in the area of lesser jurisdiction that lies beyond the EEZ, which runs 200 nautical miles out to sea, each coastal state has the sovereign right to manage living and nonliving resources, including oil and gas deposits, and to provide for the protection and preservation of the marine environment.[36]

Taking advantage of this considerable authority, individual states have begun to regulate the use of airguns and other sources in their EEZ.[37] Of particular importance is the consideration given to noise in the management of coastal habitat. Indeed, the Law of the Sea obliges parties to take special measures for the preservation of rare or fragile ecosystems, particularly those that host imperiled species.[38] Brazil, after a spate of suspicious whale strandings in the Abrolhos Banks—a breeding ground for humpback whales—banned seismic exploration there, earning plaudits from the Scientific Committee of the International Whaling Commission.[39]

Some powers and obligations of ocean noise management extend even beyond the territorial sea and EEZ. The duty to control pollution applies to all activities that a state may undertake, wherever the activity is located.[40] Under the Law of the Sea, states are obliged to prevent, reduce, and control pollution from vessels flying their flag, which at a minimum means enforcing international standards such as those that the IMO prescribes.[41] They are also required to conduct an environmental review whenever their activities anywhere in the ocean "may cause substantial pollution of or significant and harmful changes to the marine environment."[42] This obligation applies to all activities "under [a state's] jurisdiction or control," and therefore encompasses state-licensed oil and gas exploration, marine research, and commercial shipping, among others.[43] Preparing and circulating an environmental assessment, though merely a procedural step, can serve two important functions: It can ensure that countries understand the environmental implications of activities over which they exercise some measure of control, and it can advance the international community's knowledge of the scope of the problem of undersea noise. Australia, the United Kingdom, and the United States are some of the nations that have issued relevant assessments under their laws.

Yet the limits to individual state action are clear. Many countries around the globe simply lack the necessary legislation, and some of those that do have apposite laws on the books lack the capacity to enforce them. Then there are the constraints and confusions of jurisdiction. Even within its own territorial sea and EEZ, for example, a state isn't free to prescribe what conditions it wishes on military vessels or on commercial ships flying foreign

flags.[44] More generally, no one state, acting with best intentions but alone, can fully protect highly migratory whales or prevent noise generated in distant waters from invading its seas. Given these constraints on individual action, some level of cooperation is required.

FORWARD AND BACK

The last five years have seen a tremendous increase in awareness of ocean noise pollution as an issue that must be addressed multilaterally. But with progress has come the opening signs of retreat.

Particularly disheartening is the position that the United States has begun to take internationally on military active sonar. In 2004, the administration formed an interagency working group under the aegis of the State Department, made up of officials from the wildlife agencies, the Marine Mammal Commission, and the various branches of government that use high-intensity noise in the sea. The group's purpose was to coordinate the government's efforts on noise in the international arena, but the group soon became a vehicle for the development of preemptive policy. The most significant position it adopted, after what was described as "contentious internal debate" between Navy officials and wildlife specialists, is to oppose "any international regulatory framework addressing military use of active sonar," no matter what the science may now or in the future suggest.[45] Whether the administration would oppose the regulation of other sources of noise such as shipping or airgun surveys remains an open question; but the position it has taken on sonar does no service to its standing on the issue generally, or to its desire for international cooperation and information sharing.

Ultimately the key to quieting the oceans lies in building awareness, which in turn will feed the political will for change. More coordination is needed to understand the adverse impacts of human noise, and more research is needed on ways to reduce those impacts. Individual countries and organizations should step up and take the lead on practical, albeit partial, solutions to the undersea noise problem. Strengthening domestic protections for marine mammals and endangered species, establishing best practice guidelines, regulating for noise within marine protected areas, and helping to improve control technology—these are some of the things that can and should be done. The means exist to advance the issue, and with each passing year, the reasons for doing so are becoming more and more clear.

ENDNOTES

Chapter 1

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2 Ibid, p. 4; U.S. Department of Commerce and U.S. Department of the Navy, *Joint Interim Report: Bahamas Marine Mammal Stranding Event of March 15–16, 2000* (Washington, D.C.: U.S. Department of Commerce, 2001), p. 6.

3 Commerce and Navy, *Joint Interim Report*, p. ii

4 International Whaling Commission, *2004 Report of the Scientific Committee* (Cambridge, Eng.: IWC, 2004) § 12.2.5.1, Annex K at § 6.4 (reprinted in *Journal of Cetacean Research & Management*, vol. 7,May, 2005).

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11 P. Tyack, "Differential Response of Humpback Whales to Playbacks of Song or Social Sounds," *Behavioral Ecology and Sociobiology* vol. 13 (1983): p. 49 (unequivocal approach to sounding whales known to occur at distances as large as 9 km); and "Interactions between Singing Hawaiian Humpback Whales and Conspecifics Nearby," *Behavioral Ecology and Sociobiology* vol. 11 (1981): p. 105 (matters relevant to reproduction conveyed). Others have proposed that the purpose of humpback songs is echolocation. L.N. Frazer and E. Mercado III, "A Sonar Model for Humpback Whale Song," *IEEE Journal of Oceanic Engineering* vol. 25 (2000): pp. 160–82.

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19 See, e.g., B. Würsig and W. J. Richardson, "Effects of Noise," in *The Encyclopedia of Marine Mammals* W. F. Perrin, B. Würsig, and J.G.M. Thewissen, eds., (New York: Academic Press, 2002), p. 794; M. L. Jones, S. L. Swartz, & M. E. Dahlheim, *Census of Gray Whale Abundance in San Ignacio Lagoon: A Follow-Up Study in Response to LowWhale Counts Recorded During an Acoustical Playback Study of Noise-Effects on Gray Whales* (Washington, D.C.: Marine Mammal Commission, 1994) (MMC No. MM2911023-0), p. 28. See also A. N. Popper, "Effects of Anthropogenic Sounds," pp. 26–27.

20 The rudiments of underwater sound propagation are reviewed, e.g., in Richardson et al., *Marine Mammals and Noise*, pp. 59–86.

21 A.E. Bowles, M. Smultea, B. Wurzig, P. DeMaster, and D. Palka, "Abundance of Marine Mammals Exposed to Transmissions from Heard Island Feasibility Test," *Journal of the Acoustical Society of America* 96 (1994): pp. 2481–2482.

22 See Commerce and Navy, *Joint Interim Report*, pp. 7–11, 30–37.

23 See the discussion of acoustic deterrent and harassment devices in Chapter 2, "Fisheries: Acoustic Harassment Devices."

24 D. Ross, "On Ocean Underwater Ambient Noise," *Institute of Acoustics Bulletin*, vol. 18 (Jan.–Feb., 1993), pp. 5–8.

25 Ibid (prediction); R.K. Andrew, B.M. Howe, J.A. Mercer, and M.A. Dzieciuch, "Ocean Ambient Sound: Comparing the 1960s with the 1990s for a Receiver off the California Coast", *Acoustics Research Letters Online*, vol. 3 (2, 2002): pp. 65–70.

26 See, e.g., National Research Council, *Ocean Noise and Marine Mammals* (Washington, D.C.: National Academies Press, 2003), pp. 10–11, 127–29.

27 See, e.g., J.R. Potter and E. Delory, "Noise Sources in the Sea and the Impact for Those Who Live There". (paper presented at Acoustics and Vibration Asia '98, Singapore, Nov. 1998), pp. 3–4 (waters of Singapore and elsewhere); International Whaling Commission, 2004 Report of the Scientific Committee, Annex K at § 6.2 (Cape Cod Bay and Ligurian Sea).

28 R. Payne, *Among Whales*, p. 369 (noting that "there was absolutely no ship traffic noise at all").

29 Richardson et al., *Marine Mammals and Noise*, pp. 116–17; D. Ross, *Mechanics of Underwater Noise* (New York: Pergamon, 1976). Please note that all the estimates provided in this section are "source levels," measures of a sound's acoustic pressure one meter from its source.

30 Richardson et al., *Marine Mammals and Noise*, pp. 112–13; P. Tyack, W. A. Watkins, and K. M. Fristrup, "Marine Mammals, Ocean Acoustics, and the Current Regulatory Environment" (unpublished essay) (reviewing literature).

31 Compare Richardson et al., *Marine Mammals and Noise*, Table 6.6 ("Air-gun Arrays") and Table 6.7 ("Explosives").

32 National Research Council, *Ocean Noise and Marine Mammals* (2003)

33 This figure is based on data received by IHS Energy and published in *World Geophysical News*. Energy Policy Act of 2005, Pub. Law 109-58, § 357 (2005).

34 RADM S. Tomaszeski, "Navy Generated Sound in the Ocean," (presentation given at the first plenary meeting of the U.S. Marine Mammal Commission Advisory Committee on Acoustic Impacts on Marine Mammals, 3 Feb. 2004), sl. 10. For examples of mid-frequency sonar, see Chapter 2, "Military: High-Intensity Active Sonar."

35 70 Fed. Reg. 49914-15 (authorizing current deployment). On the potential impacts of the LFA system, see Chapter 2, "Military: High-Intensity Active Sonar."

36 See, e.g., International Whaling Commission, *2004 Report of the Scientific Committee*, §12.2.5.1.

37 IUCN Cetacean Specialist Group, *Dolphins, Whales, and Porpoises: 2002–2010 Conservation Action Plan for the World's Cetaceans* (Gland, Switz.: IUCN-World Conservation Union, 2003): p. 19.

38 The model of sonic influence presented here may be compared with the "zone of influence" model described in Richardson et al., *Marine Mammals and Noise*, pp. 325–86 (zones of audibility, of responsiveness, of masking, and of hearing loss, discomfort, or injury). As noted above, recent findings on beaked whales in particular complicate the outlines of the model.

39 See NMFS, *Assessment of Acoustic Exposures on Marine Mammals in Conjunction with* USS Shoup *Active Sonar Transmissions in the Eastern Strait of Juan de Fuca and Haro Strait, Washington, May 5, 2003* (Silver Spring, Md.: NMFS, 2005), pp. 9–10; personal communication with D. Bain, University of Washington (reporting strong avoidance of harbor porpoise from airgun use).

40 B. Taylor, J. Barlow, R. Pitman, L. Ballance, T. Klinger, D. DeMaster, J. Hildebrand, J. Urban, D. Palacios, and J. Mead, "A Call for Research to Assess Risk of Acoustic Impact on Beaked Whale Populations" (paper submitted to the IWC Scientific Committee, Sorrento, Italy, June 2004), p. 1 (IWC Doc. SC/56/E36); J. Hildebrand, "Impacts of Anthropogenic Sound on Cetaceans" (paper submitted to the IWC Scientific Committee, Sorrento, Italy., June 2004), pp. 24–25 (IWC Doc. SC/56/E13).

41 A. Fernández, J.F. Edwards, F. Rodríguez, A. Espinosa de los Monteros, P. Herráez, P. Castro, J.R. Jaber, V. Martín, and M. Arbelo, "Gas and Fat Embolic Syndrome' Involving a Mass Stranding of Beaked Whales (Family *Ziphiidae*) Exposed to Anthropogenic Sonar Signals," *Veterinary Pathology*, vol. 42 (2005): pp. 446–57; V. Martin, A. Servidio, and S. Garcia, "Mass Strandings of Beaked Whales in the Canary Islands," in *Proceedings of the Workshop on Active Sonar and Cetaceans of the European Cetacean Society* P. Evans and L. Miller, eds., (Oxford, Eng.: European Cetacean Society, 2004), pp. 33–36.

42 International Whaling Commission, *2004 Report of the Scientific Committee*, Annex K at § 6.4.

43 H. Levine, *Active Sonar Waveform* (McLean, Va.: The JASON Group, 2004), p. 1 (JSR-03-200).

44 See, e.g., "Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea, and Contiguous Atlantic Area," *Man Made Noise*, ACCOBAMS Sci. Comm. Rec. 2.7 (2003) (formal recommendation of ACCOBAMS Scientific Committee); European Cetacean Society Council, "Statement on Marine Mammals and Sound" (2003) (official statement of European Cetacean Society Council).

45 Taylor et al., "A Call for Research"; International Whaling Commission, *2004 Report of the Scientific Committee*, § 12.2.5.1.

46 See p. 8 of the first edition of this report.

47 Commerce and Navy, *Joint Interim Report*, pp. 11–16 (Bahamas); D.R. Ketten, "Beaked Whale Necropsy Findings" (report to NMFS, 20 Sept. 2002) (Madeira), p. 22; L. Freitas, "The Stranding of Three Cuvier's Beaked Whales *Ziphius cavirostris* in Madeira Archipelago-May 2000," in *Proceedings of the Workshop on Active Sonar and Cetaceans*, P.G.H. Evans and L.A. Miller, eds., (Oxford, Eng.: European Cetacean Society, 2004), pp. 28–32 (Madeira). The Bahamas whales were also bleeding in their inner ears and in the auditory fats, a pad of conductive tissue that lies along the jaw. Commerce and Navy, *Joint Interim Report*, pp. 11–16.

48 P.D. Jepson, M. Arbelo, R. Deaville, I.A.P. Patterson, P. Castro, J.R. Baker, E. Degollada, H.M. Ross, P. Herráez, A.M. Pocknell, F. Rodríguez, F.E. Howie, A. Espinosa, R.J. Reid, J.R. Jaber, V. Martín, A.A. Cunningham, and A. Fernández, "Gas-Bubble Lesions in Stranded Cetaceans," *Nature* ,vol. 425 (2003): pp. 575–76. The findings of Jepson et al. have received a more extensive treatment in Fernández et al., "Gas and Fat Embolic Syndrome."

49 Ibid. A couple of recent studies have demonstrated that nitrogen bubbles can naturally form in diving cetaceans. See P.D. Jepson, R. Deaville, I.A.P. Patterson, A.M. Pocknell, H.M. Ross, J.R. Baker, F.E. Howie, R.J. Reid, A. Colloff, and A.A. Cunningham, "Acute and Chronic Gas Bubble Lesions in Cetaceans Stranded in the United Kingdom," *Veterinary Pathology*, vol. 42 (2005): pp. 291–305; M.J. Moore and G.A. Early, "Cumulative Sperm Whale Bone Damage and the Bends," *Science*, vol. 306 (2004): p. 2215.

50 T.M. Cox, T.J. Ragen, A.J. Read, E. Vos, R.W. Baird, K. Balcomb, J. Barlow, J. Caldwell, T. Cranford, L. Crum, A. D'Amico, G. D'Spain, A. Fernández, J. Finneran, R. Gentry, W. Gerth, F. Gulland, J. Hildebrand, D. Houser, T. Hullar, P.D. Jepson, D. Ketten, C.D. MacLeod, P. Miller, S. Moore, D. Mountain, D. Palka, P. Ponganis, S. Rommel, T. Rowles, B. Taylor, P. Tyack, D. Wartzok, R. Gisiner, J. Mead, & L. Benner, "Report of a Workshop to Understand the Impacts of Anthropogenic Sound on Beaked Whales" (in press) (reviewing plausible mechanisms to explain beaked whale strandings); R.W. Baird, D.L. Webster, D.J. McSweeney, A.D. Ligon, G.S. Schorr, & J. Barlow, "Diving Behavior of Cuvier's and Blainville's Beaked Whales: Implications for Mass-Strandings in Relation to High-Intensity Sonar" (paper submitted to the 16th Biennial Conference on the Biology of Marine Mammals, San Diego, California, 12–16 Dec. 2005) (presenting results of dive studies).

51 D.S. Houser, R. Howard, and S. Ridgway, "Can Diving-Induced Tissue Nitrogen Supersaturation Increase the Chance of Acoustically Driven Bubble Growth in Marine Mammals?" *Journal of Theoretical Biology* vol. 213 (2001): pp 183–195; L.A. Crum, M.R. Bailey, J. Guan, P.R. Hilmo, S.G. Kargl, T.J. Matula, & O.A. Sapozhnikov, "Monitoring Bubble Growth in Supersaturated Blood and Tissue *Ex Vivo* and the Relevance to Marine Mammal Bioeffects," *Acoustics Research Letters Online* vol. 6 (2005): pp. 214–20; J.R. Potter, "A Possible Mechanism for Acoustic Triggering of Decompression Sickness Symptoms in Deep-Diving Marine Mammals" (paper presented at the IEEE International Symposium on Underwater Technology 2004, Taipei, Taiwan, Apr. 2004).

52 See P.D. Jepson et al., *Gas-Bubble Lesions in Stranded Cetaceans*, pp. 575–576.

53 Many of the relevant papers are cited in this section. The gas bubble theory was highlighted by a recent workshop, organized by the Marine Mammal Commission, as plausible and "in need of intensive study." Cox et al., "Report of a Workshop," p. 19, 26.

54 See NMFS, *Assessment of Acoustic Exposures*, p. 10.

55 Houser et al., "Can Diving-Induced Tissue Nitrogen Supersaturation"; Crum et al., "Monitoring Bubble Growth."

56 H. Whitehead and R. Reeves, "Killer Whales and Whaling: The Scavenging Hypothesis," *Biology Letters* (in press) (indicating tendency of various large whales to sink or float). Even in a well-studied inshore population of killer whales, only a total of 14 carcasses were recovered out of 200 individuals known to have died along a well-populated coast (a 7 percent carcass detection rate); Pers. comm. between L. Weilgart, Dalhousie University, and J. Ford, Canadian Department of Fisheries and Oceans (2005).

57 "Cuvier's Beaked Whale (*Ziphius cavirostris*): California/Oregon/Washington Stock" in J.V. Carretta, K.A. Forney, M.M. Muto, J. Barlow, J. Baker, and M. Lowry, *U.S. Pacific Marine Mammal Stock Assessments: 2003* (La Jolla, Cal.: NMFS Southwest Fisheries Science Center, 2004), p. 147.

58 Personal communication with K. Balcomb, Center for Whale Research, June 2005; K. Balcomb and Claridge, "A Mass Stranding of Cetaceans."

59 Personal communication with K. Balcomb, Center for Whale Research, June 2005; International Whaling Commission, 2004 *Report of the Scientific Committee*, Annex K at § 6.3; K. Balcomb and Claridge, "A Mass Stranding of Cetaceans."

60 T. Wimmer and H. Whitehead, "Movements and Distribution of Northern Bottlenose Whales, *Hyperoodon ampullatus*, on the Scotian Slope and in Adjacent Waters," *Canadian Journal of Zoology*, vol. 82 (2004): pp. 1782–94. M. L. Dalebout, K. M. Robertson, A. Frantzis, D. Engelhaupt, A A. Mignucci-Giannoni, R. J. Rosario-Delestre, and C. S. Baker, "Worldwide Structure of mtDNA Diversity among Cuvier's Beaked Whales (*Ziphius cavirostris*): Implications for Threatened Populations," *Molecular Ecology*, vol. 11 (2005): pp. 3353–71.

61 See, e.g., Letter from H. Whitehead, Dalhousie University, to D. Wieting, NMFS (May 2001), p. 2 (comments submitted to NMFS concerning its

environmental review of the Navy's SURTASS LFA system). See also Dalebout et al., "Worldwide Structure," p. 3354.

62 Commerce and Navy, *Joint Interim Report*, p. iii (minke whales); Martin et al., *Mass Strandings of Beaked Whales*, p. 35 (pygmy sperm whales).

63 RADM S. Tomaszeski, "Update on Melon-Headed Whales Stranded in Hawaii" (presentation given at the third plenary meeting of the U.S. Marine Mammal Commission Advisory Committee on Acoustic Impacts on Marine Mammals, July 29 2004). See also M. Kaufman, "Whales' Plight Revives Sonar Theory," *Washington Post*, July 11, 2004, sec. A.

64 M. Kaufman, "Whale Stranding in N.C. Followed Navy Sonar Use," *Washington Post*, Jan. 28, 2005, sec. A.

65 Moore and Early, "Cumulative Sperm Whale Bone Damage and the Bends," p. 2215; Potter, "A Possible Mechanism."

66 On exposure levels, see International Whaling Commission, *2004 Report of the Scientific Committee*, Annex K at § 6.3; K. Balcomb and Claridge, "A Mass Stranding of Cetaceans"; Commerce and Navy, *Joint Interim Report*, p. v; J. Hildebrand, K. Balcomb, and R. Gisiner, "Modeling the Bahamas Beaked Whale Stranding of March 2000" (presentation given at the third plenary meeting of the U.S. Marine Mammal Commission Advisory Committee on Acoustic Impacts on Marine Mammals, July 29, 2004).

67 By comparison, only two other possible mass strandings of beaked whales are known to have occurred over the rest of the entire Pacific coast of Japan. The authors concluded that a relationship between mass strandings and naval acoustics was "strongly suggest[ed]" by this record. R.L. Brownell, Jr., T. Yamada, J.G. Mead, and A.L. van Helden, "Mass Strandings of Cuvier's Beaked Whales in Japan: U.S. Naval Acoustic Link" (paper submitted to the IWC Scientific Committee, Sorrento, Italy, June 2004) (IWC Doc. SC/56E37). As in the case of many of the other incidents discussed above, most of the animals involved in these incidents over the years were observed to have stranded live.

68 Jones et al., *Census of Gray Whale Abundance in San Ignacio Lagoon*, pp. 25–26 ("Discussion and Conclusions"). In the course of their experiment, the researchers reproduced a variety of noises-"killer whale (*Orcinus orca*) sounds, oil-drilling sounds, outboard engine noise, gray whale vocalizations, and a calibration test tone"-broadcast continuously during sessions of six to eight hours over a monthlong period (120 hours total). Ibid., p. 2. Unfortunately, no additional acoustical information is provided.

69 P.J. Bryant, C.M. Lafferty, and S.K. Lafferty, "Reoccupation of Laguna Guerrero Negro Baja California, Mexico, by Gray Whales," in *The Gray Whale: Eschrichtius robustus* M.L. Jones, S.L. Swartz, and S. Leatherwood, eds., (New York: Academic Press, 1984), pp. 375–386.

70 See, e.g., Bowles et al., "Abundance of Marine Mammals" (sperm whales), K.J. Finley, G.W. Miller, R.A. Davis, and C.R. Greene, "Reactions of Belugas, Delphinapterus leucas, and Narwhals, Monodon monoceros, to Ice-Breaking Ships in the Canadian High Arctic," *Canadian Bulletin of Fisheries and Aquatic Sciences*, vol. 224 (1990): pp 97–117 (narwhals).

71 See, e.g., A.D. Foote, R.W. Osborne, and A. R. Hoelzel, "Whale-Call Response to Masking Boat Noise," *Nature*, vol. 428 (2004): p. 910, P.J.O. Miller, N. Biasson, A. Samuels, and P.L. Tyack, "Whale songs lengthen in response to sonar," *Nature* vol. 405: p. 903

72 See, e.g., D. Nowacek, M.P. Johnson, and P.L. Tyack, "North Atlantic Right Whales (*Eubalaena glacialis*) Ignore Ships but Respond to Alerting Stimuli," *Proceedings of the Royal Society of London: Series B, Biological Sciences*, vol. 271 (2004): pp. 227–31. See also Baird et al., "Diving Behavior of Cuvier's and Blainville's Beaked Whales."

73 See, e.g., S.H. Ridgway and D.A. Carder, "Behavioral Responses and Temporary Shift" (bottlenose dolphins exposed to one-second tones at 180 dB, seen to attack a biteplate in their tanks, "rushing towards it, biting it, thrashing around, and shaking the entire underwater platform").

74 Jones et al., *Census of Gray Whale Abundance*; Bryant et al.,*The Gray Whale*, pp. 375–386.

75 National Research Council, *Ocean Noise and Marine Mammals*, p. 108.

76 National Research Council, *Marine Mammal Populations and Ocean Noise: Determining When Noise Causes Biologically Significant Effects* (Washington, D.C.: National Academies Press, 2005), pp. 35–68.

77 The committee prefaced its report by warning that "[a] reader who expects this volume to provide a 'Eureka' moment of insight into the biological significance of marine mammal responses to noise will be disappointed." Ibid, p. xi.

78 C.I. Malme, P.R. Miles, C.W. Clark, P. Tyack, and J.E. Bird, "Investigations of the Potential Effects of Underwater Noise from Petroleum Industry Activities on Migrating Whale Behavior" (Anchorage, Ak.: Minerals Management Service, 1983) (NTIS PB86-174174), and "Investigations of the Potential Effects of Underwater Noise from Petroleum Industry Activities on Migrating Whale Behavior, Phase II: January 1984 Migration" (Anchorage, Ak.: Minerals Management Service, 1984) (NTIS PB86-218377).

79 C.M. Beale and P. Monaghan, "Behavioral Responses to Human Disturbance: A Matter of Choice?" *Animal Behavior*,vol. 68 (2004): pp. 1065–69 (concluding, on basis of study of birds, that animals who show greater sensitivity to human disturbance may be in better condition, and may therefore be less vulnerable, than those that show less sensitivity).

80 C. Lockyer, "Evaluation of the role of fat reserves in relation to the ecology of North Atlantic fin and sei whales," pp. 183–203 in *Marine Mammal Energetics, Society for Marine Mammalogy* A.C. Huntley, D.P. Costa, G.A.J. Worthy, and M.A. Castellini, , Special Publication No. 1 (1987).

81 This analysis appears in a discussion of long-term impacts and cumulative impacts on gray whales (from noise, contaminants, and other aspects of oil-and-gas development) in Independent Scientific Review Panel, *Impacts of Sakhalin II Phase 2 on Western North Pacific Gray Whales and Related Biodiversity* (Gland, Switz.: IUCN-World Conservation Union, 2005), p. 85.

82 See, e.g., D.E. Bain, R. Williams, and A. W. Trites, "A Model Linking Energetic Effects of Whale Watching to Killer Whale (*Orcinus orca*) Population Dynamics" (paper presented to the Orca Relief Citizens Alliance, June 2002) (estimating that a 10-decibel rise above ambient levels of noise could reduce orca foraging success off the San Juan Islands by as much as 80 percent).

83 The problem was first raised in R. Payne and D. Webb, "Orientation by Means of Long-Range Acoustic Signaling in Baleen Whales," *Annals of the New York Academy of Sciences*, 188 (1971) pp. 110–141.

84 See P. Tyack, "Behavioral Impacts of Sound on Marine Mammals" (presentation given at the first plenary meeting of the U.S. Marine Mammal Commission Advisory Committee on Acoustic Impacts on Marine Mammals, Feb. 4, 2004), sl. 19.

85 Croll et al., "Only Male Fin Whales Sing Loud Songs."

86 See generally A.A. Myrberg, Jr., "Fish Bio-acoustics: Its Relevance to the 'Not So Silent World,'" *Environmental biology of Fishes*, vol. 5 (1980): pp. 297–304 (discussion of masking in the damselfish); Popper, "Effects of Anthropogenic Sounds," p. 27 (noting concern about masking); "Ocean Noise and the Behavior of Marine Animals: Relationships and Implications," in *Effects of Noise on Wildlife*, J.L. Fletcher and R.G. Busnel, eds (New York: Academic Press, 1978) (survey of low-frequency specialists).

87 N.C. Flemming and M.D. Max, eds., *Scientific Diving: A General Code of Practice*, 2d ed. (Flagstaff, Ariz.: Best, 1996) (sponsored by the World Underwater Federation and UNESCO's Intergovernmental Oceanographic Commission), Ch. 10.7; see also Richardson et al., *Marine Mammals and Noise*, pp. 381–83.

88 Richardson et al., *Marine Mammals and Noise*, pp. 378, 380 (citing G.A. Young, "Concise Methods for Predicting the Effects of Underwater Explosions on Marine Life," a 1991 paper published by the Naval Surface Weapons Center, White Oak Lab, serial no. MP-91-220). The two-mile figure is based upon a worst-case scenario.

89 See generally J.T. Yelverton, "Underwater Explosion Damage Risk Criteria for Fish, Birds, and Mammals" (paper presented at the 102nd Meeting of the Acoustical Society of America, Dec. 1981) (body size a relevant factor for terrestrial animals). Apposite data for medium-size terrestrial animals is provided in Richardson et al., *Marine Mammals and Noise*, p. 377 (Table 10.2).

90 Some injuries to the ear do seem particular to blast trauma. At close distances, the small bones, or ossicles, that carry sound waves from the eardrum to the inner ear may suffer damage, bringing on permanent

deafness; or worse, the oval window that protects the inner ear may rupture, causing a fatal loss of cerebrospinal fluid. See D. A. Helweg, "Criteria for Marine Mammal Auditory Threshold Shift," in Chief of Naval Operations, Shock Testing the Seawolf Submarine: Final Environmental Impact Statement (Arlington, Va.: U.S. Navy, May 1998) (Appendix E).

91 Richardson et al., *Marine Mammals and Noise*, p. 99 (Table 5.2).

92 29 C.F.R. § 1910.95(b)(1) (Table G-16-Permissible Noise Exposures). The permissible sound level rises to 110 decibels for exposures lasting one half-hour each day.

93 See D. Kastak, R.J. Schusterman, B.L. Southall, and C.J. Reichmuth, "Underwater Temporary Threshold Shift Induced by Octave-Band Noise in Three Species of Pinnipeds," *Journal of the Acoustical Society of America*, vol. 106 (1999): pp. 1142–48 (follow-on study in press); J.J. Finneran, C.E. Schlundt, R. Dear, D.A. Carder, and S.H. Ridgway, "Temporary Shift in Masked Hearing Thresholds (MTTS) in Odontocetes after Exposure to Single Underwater Impulses from a Seismic Watergun," *Journal of the Acoustical Society of America*, vol. 111 (2002): pp. 2929–40; P.E. Nachtigall, A.Y. Supin, J.L. Pawloski, and W.W.L. Au, "Temporary Threshold Shifts after Noise Exposure in a Bottlenose Dolphin (*Tursiops truncatus*) Measured Using Evoked Auditory Potentials", *Marine Mammal Science*, vol. 20 (2004): pp. 673–87.

94 Humans, for example, appear subject to the "equal energy hypothesis," which holds that hearing loss depends on the total amount of energy that the individual has received. A long, low-intensity exposure can be as damaging as a short, high-intensity exposure.

95 Researchers examined the ears of two of the whales that died in fishing nets and found that their ears were indeed damaged. S. Todd, P. Stevick, J. Lien, F. Marques, and D. Ketten, ""Behavioral Effects of Exposure to Underwater Explosions in Humpback Whales (*Megaptera nomeangline*)," *Canadian Journal of Zoology*, vol. 74 (1996): pp. 1661–1672.

96 M. André, C. Kamminga, and D. Ketten, "Are Low-Frequency Sounds a Marine Hearing Hazard: A Case Study in the Canary Islands," *Proceedings of the Institute of Acoustics*, vol. 19 (1997): p. 82 (and subsequent work from same study).

97 See, e.g., F.H. Harrington and A.M. Veitch, "Calving Success of Woodland Caribou Exposed to Low-Level Jet Fighter Overflights," *Arctic*, vol. 45 (1992): pp. 213–218. See also R. P. Larkin, L. L. Pater, and D. J. Tazik, *Effects of Military Noise on Wildlife: A Literature Review* (Champaign, Ill.: U.S. Army Construction Engineering Research Laboratories, 1996), pp. 36–37 (USACERL Technical Report 96/21) (birds).

98 T.A. Romano,, M.J. Keogh, C. Kelly, P. Feng, L. Berk, C.E. Schlundt, D.A. Carder, and J.J. Finneran, "Anthropogenic Sound and Marine Mammal Health: Measures of the Nervous and Immune Systems Before and After Intense Sound Exposure," *Canadian Journal of Fisheries and Aquatic Sciences*, vol. 61 (2004): pp. 1124–1134 (finding elevated stress levels in bottlenose dolphins and a beluga whale after short-term exposures to impulsive noise).

99 United Nations Environment Programme, *Marine Mammals: Global Plan of Action* (New York: UNEP, 1985), p. 30 (UNEP Regional Seas Reports and Studies No. 55). See also, e.g., National Research Council, *Ocean Noise and Marine Mammals*, pp. 104–05.

100 R. McCauley, J. Fewtrell, and A.N. Popper, "High Intensity Anthropogenic Sound Damages Fish Ears," *Journal of the Acoustical Society of America*, vol. 113 (2003): p. 640.

101 Ibid., p. 641. Some of the fish in the study were sacrificed and examined *58 days* after exposure.

102 A.R. Scholik and H.Y. Yan, "Effects of Boat Engine Noise on the Auditory Sensitivity of the Fathead Minnow, *Pimephales promelas*," *Environmental Biology of Fishes*, vol. 63 (2002): pp. 203–09; A.R. Scholik and H.Y. Yan, "The Effects of Noise on the Auditory Sensitivity of the Bluegill Sunfish, *Lepomis macrochirus*," *Comparative Biochemisty and Physiology Part A*, vol. 133 (2002): pp. 43–52; M.E. Smith, A.S. Kane, and A.N. Popper, "Noise-Induced Stress Response and Hearing Loss in Goldfish (*Carassius auratus*)," *Journal of Experimental Biology* vol. 207 (2003): pp. 427–435 (2003); A. N. Popper, "Effects of Anthropogenic Sounds," p. 28.

103 See M.E. Smith, A.S. Kane, and A.N. Popper, "Acoustical Stress and Hearing Sensitivity in Fish: Does the Linear Threshold Shift Hypothesis Hold Water?" *Journal of Experimental Biology*, vol. 207 (2004): pp. 3591–3602; A. R. Scholik and H. Y. Yan, "The Effects of Noise on the Auditory Sensitivity of the Bluegill Sunfish," pp. 43–52. Actual data on hearing capabilities exist for only a small fraction of the approximately 27,000 species of fish, and, for a great many of the later, not enough morphological data has been gathered to even allow scientistes to hazard a guess about how sensitive their hearing may be.

104 See A. N. Popper, "Effects of Anthropogenic Sounds," p. 29; McCauley et al., "High Intensity Anthropogenic Sound Damages Fish Ears," p. 641.

105 See "Noisy' Royal Navy Sonar Blamed for Falling Catches," *Western Morning News*, Apr. 22, 2002 (sonar off the U.K.); P. J. Hayne, president of Gulf Nova Scotia Fleet Planning Board, "Coexistence of the Fishery and Petroleum Industries," Oct. 2000, www.elements.nb.ca/theme/fuels/percy/hayne.htm (May 15, 2005) (airguns off Cape Breton); R.D. McCauley, J. Fewtrell, A.J. Duncan, C. Jenner, M. N. Jenner, J.D. Penrose, R.I.T. Prince, A. Adhitya, J. Murdoch, and K. McCabe, *Marine Seismic Surveys: Analysis and Propagation of Air-Gun Signals, and Effects of Air-Gun Exposure on Humpback Whales, Sea Turtles, Fishes, and Squid* (Western Australia: Curtin U. of Technology, 2000), p. 185 (airguns in general).

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112 A. N. Popper, "Effects of Anthropogenic Sounds," p. 30.

113 A. Guerra et al., "A Review of Records of Giant Squid" (giant squid); J.P. Lagardère, "Effect of Noise on Growth and Reproduction of *Crangon crangon* in Rearing Tanks," *Marine Biology*, vol. 71 (1982): pp. 177–185 (brown shrimp); Fisheries and Oceans Canada, *Potential Impacts of Seismic Energy on Snow Crab* (Ottawa, Ont.: Fisheries and Oceans Canada, 2004) (Maritime Provinces Regional Habitat Status Report 2004/Draft) (snow crab).

114 See, e.g., S.M. Bartol, J.A. Musick, and M. Lenhardt, "Auditory Evoked Potentials of the Loggerhead Sea Turtle (*Caretta caretta*)," *Copeia*, vol. 99 (1999): pp. 836–40; M.L. Lenhardt and S.W. Harkins, "Turtle Shell as an Auditory Receptor," *Journal of Auditory Research*, vol. 23 (1983): pp. 251–60; M.L. Lenhardt, "Bone Conduction Hearing in Turtles," *Journal of Auditory Research*, vol. 22 (1982): pp. 153–60.

115 On the responses of sea turtles to low-frequency sounds, see, e.g., M.L. Lenhardt, "Seismic and Very Low Frequency Sound Induced Behavior in Captive Loggerhead Marine Turtles (*Caretta caretta*)," in *Proceedings of the Fourteenth Annual Symposium on Sea Turtle Biology and Conservation*, K.A. Bjorndal, A.B. Bolten, D.A. Johnson, and P.J. Eliazar, comps., (Miami: NMFS, 1994), pp. 238–40; M.L. Lenhardt, S. Bellmund, R.A. Byles, S.W. Harkins, and J.A. Musick, "Marine Turtle Reception of Bone-Conducted

Sound," *Journal of Auditory Research*, vol. 23 (1983): pp. 119–25; McCauley et al., *Marine Seismic Surveys*, pp. 179–81; S.E. Moein, J.A. Musick, J.A. Keinath, D.E. Barnard, M.L. Lenhardt, and R. George. "Evaluation of Seismic Sources for Repelling Sea Turtles from Hopper Dredges," in *Sea Turtle Research Program: Summary Report*, L.Z. Hales, ed., (Atlanta, Ga.: U.S. Army and U.S. Navy, 1995), pp. 90–93 (Tech. Rep. CERC-95).

116 Moein et al., "Evaluation of Seismic Sources," pp. 90–93.

117 National Research Council, *Low-Frequency Sound and Marine Mammals*, p. 1.

Chapter 2

1 A discussion of acute and chronic impacts appears in Chapter 1, "Sound Effects."

2 See, e.g., 42 U.S.C. §§ 7411 (standards for new stationary sources), 7521-7544 (motor vehicle emission and fuel standards), and 7571-7574 (aircraft emission standards).

3 International Whaling Commission, *2004 Report of the Scientific Committee*, § 12.2.5.2

4 Among those who have recommended a "hot spots" approach are the National Research Council, *Marine Mammals and Low-Frequency Sound: Progress since 1994* (Washington, D.C.: National Academies Press, 2000), pp. 63–64, 88–89; E. McCarthy, *International Regulation of Underwater Sound: Establishing Rules and Standards to Address Ocean Noise Pollution* (New York: Kluwer, 2004); and M. Jasny, *Sounding the Depths: Supertankers, Sonar, and the Rise of Undersea Noise* (New York: NRDC, 1999), pp. 16–20.

5 See, e.g., 33 U.S.C. § 1311(b)(1)(A) (Federal Water Pollution Control Act); 42 U.S.C. §§ 7411(h)(1), 7412(d)(3) (Clean Air Act).

6 See discussion below, "Commerce: Shipping Noise."

7 B. Würsig, C. R. Greene, Jr., & T. A. Jefferson, "Development of an Air Bubble Curtain to Reduce Underwater Noise of Percussive Piling, *Marine Environmental Research*, vol. 49 (1, 2000): pp. 79–93. See also 68 Fed. Reg. 64598-64560l (debating relative merits of fabric curtains and bubble curtains in context of construction project in San Francisco Bay).

8 NATO Undersea Research Centre, *SACLANTCEN Marine Mammal and Human Divers Risk Mitigation Rules: Planning* (La Spezia, It.: NURC, year unknown), p. 4–12.

9 C. J. Stone, *The Effects of Seismic Activity on Marine Mammals in UK Waters, 1998–2000* (Aberdeen, Scot.: Joint Nature Conservation Committee, 2002), p. 36 (JNCC Report No. 323).

10 16 U.S.C. §§ 1371(a)(5)(A)(ii)(I) ("small take authorization"), 1371(a)(5)(D)(ii)(I) ("incidental harassment authorization").

11 J.R. Benedict, "The Unraveling and Revitalization of U.S. Navy Antisubmarine Warfare," *Naval War College Review*, vol. 58 (2, 2005): p. 107.

12 Ibid.

13 On the Navy's use of sonar, see Tomaszeski, "Navy Generated Sound in the Ocean," sl. 10.

14 See Table 2.1. The Navy's current battery of mid-frequency systems includes AN/SQS-53, a hull-mounted system that is deployed aboard several classes of Navy frigates and destroyers as part of the AN/SQQ-89 sonar suite; AN/SQS-56, another hull-mounted system that operates at somewhat higher frequencies than AN/SQS-53; AN/SSQ-62, a command-activated sonobuoy system; and the Airborne Low Frequency System (or "ALFS"), which, notwithstanding its name, operates in the mid-frequency range between three and five kHz.

15 Commerce and Navy, *Joint Interim Report*, pp. 24, 36. The exact source level of this system is classified and was not divulged in the stranding report. Ibid.

16 See the discussion of strandings in Chapter 1, "Lethal Impacts."

17 The shift in naval doctrine is captured in a number of high-level documents, including Department of the Navy, *Forward... From the Sea* (Washington, D.C.: Navy, 1994).

18 General Accounting Office, *Undersea Surveillance: Navy Continues to Build Ships Designed for Soviet Threat* (Washington, D.C.: GAO, 1992), pp. 2–5 (GAO/NSIAD-93-53).

19 The history of sonar is briefly surveyed in Urick, *Principles of Underwater Sound*, pp. 2–11.

20 General Accounting Office, *Defense Acquisitions: Testing Needed to Prove SURTASS/LFA Effectiveness in Littoral Waters* (Washington, D.C., GAO, 2002), p. 1.

21 While the Navy has never formally divulged the system's source level, it has provided enough information for the public to get a clear idea. The source level of each speaker in the LFA array is approximately 215 decibels, making the effective source level of the entire array (in the far field) something approaching 240 decibels. Chief of Naval Operations, *Final Overseas Environmental Impact Statement and Environmental Impact Statement for Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) Sonar* (Washington, D.C., Navy, 2001), pp. 2–3, B-7. According to the Navy's estimates, the system's transmission loss at 300 miles could be as low as 77 decibels—meaning that theoretically the sound could exceed 150 or (though it is highly unlikely) even 160 decibels at that distance. "Initial Comments on LFA DEIS" (document prepared for Chief of Naval Operations Division N45G, Mar. 24, 1999), p. 11 (appended to document AR011215 in the Administrative Record filed in *NRDC v. Evans* (N.D. Cal. 2003)). *See also* Chief of Naval Operations, *Environmental Assessment for Use of Surveillance Towed Array Sensor System Low Frequency Active in Connection with a Submarine Security and Technology Program Test (CNO Project KTS4-4)* (Washington, D.C.: Chief of Naval Operations, 1997) (modeling, in some areas off the Aleutians, a level exceeding 140 decibels at 300 nautical miles from the array).

22 Letter from Dr. M. A. McDonald to D. Wieting, Office of Protected Resources, NMFS (May 2001), p. 1 (comments submitted pursuant to NMFS' review of the SURTASS LFA program).

23 General Accounting Office, *Undersea Surveillance*, p. 8.

24 67 Fed. Reg. 46783 (noting that, according to the Navy, the third and fourth LFA systems have been postponed until after the 2007 fiscal year).

25 69 Fed. Reg. 51997

26 *See, e.g.*, "Decision Looms on Sonar 2087," *Jane's Defence Weekly*, Nov. 22, 2000, p. 21; J. J. Lok, "Green Issues Loom Larger in Future Blue-Water Active Sonar Operations," *Jane's International Defense Review*, Aug. 2004, pp. 44–47.

27 U.K. Ministry of Defence, *Environmental Impact Assessment (EIA) in Support of the Procurement of Sonar 2087* (Bristol, Eng.: MOD, 2002), 2-2

28 NMFS, *Assessment of Acoustic Exposures*

29 Chief of Naval Operations, *Overseas Environmental Impact Statement and Environmental Impact Statement for Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) Sonar Tehnical Report 1* (Washington, D.C.: Navy, 2001), pp. 78–111 (humpback whales); A.W.H. Turnpenny, K.P. Thatcher, and J.R. Nedwell, *The Effects on Fish and Other Marine Animals of High-Level Underwater Sound* (Fawley, Eng.: Fawley Aquatic Research Laboratories, 1994).

30 The diver had been exposed to 160 decibels of sound for about 15 minutes. Memorandum from Lt. C. C. Steevens, U.S. Navy, to Lt. N. Carlson, Naval Submarine Medical Research Laboratory, U.S. Navy (May 17, 1994), Encl. 1. *See also* Memorandum from Dr. H. Hollien, *Institute for Advanced Study of the Communication Process*, University of Florida, to P. Smith, Naval Submarine Medical Research Laboratory, U.S. Navy (Mar. 23, 1993), p. 3 (describing 45 seconds exposure at around 150 decibels to "like being between two catapults on an aircraft carrier"); Chief of Naval Operations, *Final Overseas Environmental Impact Statement and Environmental Impact Statement for Surveillance Towed Array Sensor System Low Frequency Active (SURTASS LFA) Sonar Tehnical Report 3* (Washington, D.C.: Navy, 1999) pp. 9–11 (discussing numbers of Navy personnel reporting "very severe" and "beyond very severe" aversion at exposure levels between 136 and 157 decibels).

31 50 C.F.R. § 216.184(b) (LFA) (NMFS attaching 1 km buffer zone to the Navy's 1 km safety zone for the SURTASS LFA system); Commerce and Navy, *Joint Interim Report*, p. 50 (recommending safety zone monitoring for mid-frequency sonar exercises).

32 Navy, *Overseas Environmental Impact Statement and Environmental Impact Statement (SURTASS LFA)*, pp. 2–14 to 2–21.

33 See discussion in Chapter 1, "Lethal Impacts."

34 J. Barlow and R. Gisiner, "Mitigation and Monitoring of Beaked Whales During Acoustic Events," *Journal of Cetacean Research and Management* (in press) (number cited is based on draft text).

35 Personal communications with Navy personnel, 2005. *Cf.* Commerce and Navy, *Joint Interim Report*, p. 50 (recommending, with Navy concurrence, that Navy scrutinize future training sites "with an eye" towards minimizing risk of strandings).

36 Commerce and Navy, *Joint Interim Report*, p. 50 (Bahamas); Resolución 79/2004, 102 Boletín Oficial del Estado 16643–45 (Canary Islands). The exclusion area around the Canary Islands was defined by the Spanish Ministry of Defense, in consultation with the local government, later in the year. Statement of Bono Martinez, Senior Defense Minister of Spain (statement made to the Spanish Parliament on Nov. 3, 2004) (announcing moratorium).

37 See, e.g., 66 Fed. Reg. 41834 (missile launches); 66 Fed. Reg. 22450 (shipshock trials). The organization GlobalSecurity.org has compiled information about the activities held in many of the Navy's operations areas. See "Navy Test and Training Ranges," www.globalsecurity.org/military/facility/range-navy.htm (July 30, 2005).

38 The number cited represents our calculations based upon publicly available data on the dimensions of U.S. Navy complexes.

39 61 Fed. Reg. 22028 (east coast range); 64 Fed. Reg. 44716-44717 (west coast range); letter from Cpt. J.A. Bowlin, Pacific Missile Range Facility, U.S. Navy, to T. E. Johns, Hawaii Department of Land and Natural Resources (Apr. 29. 1999), p. 1 (Hawaiian range). See also K. Wiltrout, "Navy Sonar Under Scrutiny," *Virginian-Pilot*, May 3, 2005, sec. A (reporting Navy's intent to locate east coast range off North Carolina).

40 J. Janssen Lok, "Green Issues Loom Larger in Future Blue-Water Active Sonar Operations," *Jane's International Defense Review*, Aug. 2004, pp. 44–47.

41 Personal communication with Dr. M. Ainslie, TNO Physics and Electronics Laboratory, Sept. 29, 2004.

42 The study concluded-before most of the information on bubble growth had come to light-that more information on the causal mechanism was needed before a solution could be identified. See Levine, *Active Sonar Waveform*, p. 1.

43 "SURTASS Low Frequency Sound (LFS) Scientific Research Program (SRP)" (document prepared for meeting at Naval Postgraduate School, Monterey, Cal., Oct. 30, 1997), p. 18 (chart of LFA Sea Tests through May 1996). On the negotiation with the Navy that preceded its decision to bring the LFA system into legal compliance, see, e.g., letter from J. R. Reynolds, NRDC, to Hon. J. H. Dalton, Secretary of the Navy, R. A. Schmitten, Assistant Administrator for Fisheries, NMFS, and Dr. W. Fox, Director of the Office of Protected Resources, NMFS (18 Aug. 1995); S. S. Honigman, Navy General Counsel, to J. R. Reynolds, NRDC (Apr. 19, 1996).

44 50 C.F.R. § 216.180.

45 See Stipulation Regarding Permanent Injunction, NRDC v. Evans, 279 F.Supp.2d 1129-92 (N.D. Cal. 2003) (Civ. No. 02-3805-EDL). The government's appeal, which challenges only one of the several issues under multiple statutes that were decided against it, is still pending.

46 See Letter from J. Reynolds, NRDC, J. M. Cousteau, Ocean Futures Society, F. M. O'Regan, International Fund for Animal Welfare, and N. Rose, Humane Society of the United States, to G. R. England, Secretary of the Navy (July 14, 2004) (most recent formal request from conservation and animal welfare organizations); Letter from D. R. Schregardus, Deputy Assistant Secretary of the Navy (Environment), to J. Reynolds, NRDC (Sept. 30, 2004) (Navy response); Letter from J. Reynolds, NRDC, J. M. Cousteau, Ocean Futures Society, F. M. O'Regan, International Fund for Animal Welfare, and N. Rose, Humane Society of the United States, to D. R. Schregardus, Deputy Assistant Secretary of the Navy (Environment) (Oct. 26, 2004) (reply). In October 2005, a lawsuit was filed, citing the Navy's failure to obtain required permits or to undertake mandatory environmental reviews for its testing and training with mid-frequency sonar. A decision is not expected until 2006.

47 Letter from J. R. Reynolds, NRDC, A. Likhotal, Green Cross International, J. M.. Cousteau, Ocean Futures Society, F. M. O'Regan, International Fund for Animal Welfare, N. A. Rose, Humane Society International, and M. Simmonds, Whale and Dolphin Conservation Society, to J. de Hoop Scheffer, Secretary General of NATO, and Permanent Representatives of NATO Member States (Feb. 9, 2005).

48 Richardson et al., *Marine Mammals and Noise*, pp. 137, 145 (Tables 6.6 & 6.7).

49 International Whaling Commission, *2004 Report of the Scientific Committee*, Annex K at § 6.2 (reporting data on nearly continuous sound produced by seismic surveys); S.L. Nieukirk, K.M. Stafford, D.K. Mellinger, R.P. Dziak, and C.G. Fox, "Low-Frequency Whale and Seismic Airgun Sounds Recorded in the Mid-Atlantic Ocean," *Journal of the Acoustical Society of America*, vol. 115 (2004): pp. 1832–43 (describing significant propagation across mid-Atlantic to hydrophones located more than 3000 km away); D.A. Croll, C.W. Clark, A. Acevedo, B. Tershy, S. Flores, J. Gedamke, and J. Urban, "Bioacoustics: Only Male Fin Whales Sing Loud Songs," *Nature*, vol. 417 (2002): p. 809 (observing that rise in noise levels from seismic surveys, oceanographic research, and other activities could impede recovery in fin and blue whale populations).

50 International Whaling Commission, *2004 Report of the Scientific Committee*, Annex K at § 6.2.

51 Ibid., § 12.2.5.1.

52 Ibid., § 12.2.5.1, Annex K at § 6.2–6.3.

53 Hildebrand, "Impacts of Anthropogenic Sound on Cetaceans," pp. 24–25.

54 M.H. Engel, M.C.C. Marcondes, C.C.A. Martins, F. O Luna, R.P. Lima, and A. Campos, "Are Seismic Surveys Responsible for Cetacean Strandings? An Unusual Mortality of Adult Humpback Whales in Abrolhos Bank, Northeastern Coast of Brazil" (paper submitted to the IWC Scientific Committee, Sorrento, Italy, June 2004) (IWC Doc. SC/56/E28).

55 CONAMA [Brazil] -National Environment Council Res. 305 (July 2004).

56 D.W. Weller, Y.V. Ivashchenko, G.A. Tsidulko, A.M. Burdin, and R.L. Brownell, Jr., "Influence of Seismic Surveys on Western Grey Whales off Sakhalin Island, Russia, in 2001" (paper submitted to the IWC Scientific Committee, June 2002) (IWC Doc. SC/54/BRG14).

57 International Whaling Commission, *2004 Report of the Scientific Committee*, Annex K at § 6.2.

58 See, e.g., B.R. Mate, K.M. Stafford, and D.K. Ljungblad, "A Change in Sperm Whale (*Physeter macrocephalus*) Distribution Correlated to Seismic Surveys in the Gulf of Mexico," *Journal of the Acoustical Society of America*, vol. 96 (1994): pp. 3268–69 (abstract of observations of sperm whales); W.J. Richardson, ed., *Marine Mammal and Acoustical Monitoring of Western Geophysical's Open-Water Seismic Program in the Alaskan Beaufort Sea, 1998* (King City, Ont.: LGL, 1999) (LGL Rep. TA2230-3) (bowhead whales); personal communication with Dr. D. Bain, University of. Washington (Nov. 10, 2003) (harbor porpoises); Stone, *The Effects of Seismic Activity* (harbor porpoises). See generally Richardson et al., *Marine Mammals and Noise*, pp. 290–301.

59 R. McCauley, J. Fewtrell, and A.N. Popper, "High intensity anthropogenic sound damages fish ears," *Journal of the Acoustical Society of America*, vol. 113 (2003): pp. 638–42. See also R.D. McCauley, J. Fewtrell, A. J. Duncan, C. Jenner, M. N. Jenner, J.D. Penrose, R.I.T. Prince, A. Adhitya, J. Murdoch, and K. McCabe, *Marine Seismic Surveys: Analysis and Propagation of Air-Gun Signals, and Effects of Air-Gun Exposure on Humpback Whales, Sea Turtles, Fishes, and Squid* (Western Australia: Curtin University of Technology, 2000), pp. 126–61.

60 A. Engås, S. Løkkeborg, E. Ona, and A.V. Soldal, "Effects of Seismic Shooting on Local Abundance and Catch Rates of Cod (*Gadus morhua*) and Haddock (*Melanogrammus aeglefinus*)," *Canadian Journal of Fisheries and Aquatic Sciences*, vol. 53 (1996): pp. 2238–49.

61 J.R. Skalski, W. H. Pearson, and C. I. Malme, "Effects of Sounds from a Geophysical Survey Device on Catch-per-Unit-Effort in a Hook-and-Line Fishery for Rockfish (Sebastes ssp.)," *Canadian Journal of Fisheries and Aquatic Sciences*, vol. 49 (1992): pp. 1357–1365.

62 C.S. Wardle, T.J. Carter, G.G. Urquhart, A.D.F. Johnstone, A.M. Ziolkowski, G. Hampson, and D. Mackie, "Effects of Seismic Air Guns on Marine Fish," *Continental Shelf Research*, vol. 21 (2001): pp. 1005–1027.

63 P. J. Hayne, president of Gulf Nova Scotia Fleet Planning Board, "Coexistence of the Fishery and Petroleum Industries," Oct. 2000, www.elements.nb.ca/theme/fuels/percy/hayne.htm (May 15, 2005). See also McCauley et al., *Marine Seismic Surveys*, p. 185.

64 Guerra et al., "A Review of Records of Giant Squid."

65 R. D. McCauley et al., *Marine Seismic Surveys*, pp. 185–86.

66 The study, which was led by the Canadian Department of Fisheries and Oceans, placed hundreds of crabs in modified lobster traps in order to observe the effects of two blasts of a seismic airgun at noise levels significantly lower than those typically generated by the seismic industry. Although differences in the control and test environments make further study necessary, researchers observed damage (including hemorrhaging and membrane detachment) in the crabs' livers and ovaries and developmental delays in their larvae. Fisheries and Oceans Canada, *Potential Impacts of Seismic Energy on Snow Crab* (Ottawa, Ont.: Fisheries and Oceans Canada, 2004) (Maritime Provinces Regional Habitat Status Report 2004/Draft).

67 Richardson et al., *Marine Mammals and Noise*, pp. 127–35 (surveying noise output data from various methods of offshore drilling and production).

68 Personal communication with R. Brinkman, Gulf of Mexico Region, Minerals Management Service (Apr. 2005).

69 See Minerals Management Service, *Geological and Geophysical Exploration for Mineral Resources on the Gulf of Mexico Outer Continental Shelf: Final Programmatic Environmental Assessment* (New Orleans: MMS, 2004), Table II-4.

70 Ibid (our calculations).

71 EyeForEnergy.com, "Gulf of Mexico Production to Increase Over the Next Decade," Jan. 26, 2005, www.rigzone.com/news/article.asp?a_id=19765 (Oct. 2, 2005) (quoting Rebecca Watson, assistant secretary of the Interior for Land and Minerals Management).

72 Minerals Management Service, *Proposed Outer Continental Shelf Oil & Gas Leasing Program: 2002–2007 Environmental Impact Statement* (Herndon, Va.: MMS, 2002), pp. 3-51–3-53, Fig. 2-3 (describing breadth of Alaska planning areas intended for leasing); 70 Fed. Reg. 9099-9104 (noting intent to hold latest of 3 lease sales within Beaufort Sea); 70 Fed. Reg. 54406-54406 (noting intent to offer a more "substantial portion" of the Chukchi Sea planning area than had previously been contemplated).

73 See, e.g., 70 Fed. Reg. 9103. See also generally Minerals Management Service, *Proposed Outer Continental Shelf Oil and Gas Leasing Program*, pp. 3-51–3-53, Fig. 2-3.

74 Energy Policy Act of 2005, Pub. L. No. 109-58, § 357, 119 Stat. 594, 720. On concern for the offshore drilling moratorium, see, e.g., M. Clayton, "New Energy Probe May Harm Sea Life," *Christian Science Monitor*, Aug. 2, 2005, sec. A.

75 Staff of House Resources Committee, 109th Cong., *Proposed Recommendations for Second Energy Bill* (Comm. Print 2005), §§ 651-677 (proposal to reopen moratorium areas); B. Geman, "Resources Committee Clears ANWR, Offshore Drilling," *E&E Daily*, Sept. 29, 2005.

76 *League for Coastal Protection v. Norton*, No. C 05-0991 CW, slip op. at 1 (N.D. Cal., Aug. 31, 2005); *California ex rel. California Coastal Commission v. Norton*, 150 F.Supp.2d 1046 (N.D. Cal. 2001), aff'd, 311 F.3d 1162 (9th Cir. 2002).

77 As indicated in the table and accompanying figures, the analysis presented here is based on data obtained from IHS Energy, which tallies crew counts for its publication *Worldwide Geophysical News*.

78 According to data obtained from IHS Energy, close to 700 crews, on average, operated for periods of up to two weeks' duration during each of the last three years.

79 *Resolution on the Western North Pacific Gray Whale*, IWC Res. 2005-3 (2005); *Resolution on the Western North Pacific Gray Whale*, IWC Res. 2001-3 (2001); *Resolution on the Western North Pacific Gray Whale*, IWC Res. 2004-1 (2004).

80 See D. W. Weller, A. M. Burdin, B. Würsig, B. L. Taylor, and R. L. Brownell, Jr., "The Western Gray Whale: A Review of Past Exploitation, Current Status, and Potential Threats," *Journal of Cetacean Research and Management*, vol. 4 (1, 2002): pp. 7–12; D. W. Weller, Alexander M. Burdin, A. L. Bradford, Y. V. Ivashchenko, G. A. Tsidulko, A. R. Lang, and R. L. Brownell, Jr., "Status of Western Gray Whales off Northeastern Sakhalin Island, Russia, in 2003" (paper submitted to the IWC Scientific Committee, Berlin, F.R.G., June 2003) (IWC Doc. No. SC/56/BRG40).

81 Independent Scientific Review Panel, *Impacts of Sakhalin II Phase 2*, p. 3.

82 United Nations Convention on the Law of the Sea, Dec. 10, 1982, 21 I.L.M. 1261 (1982), Arts. 77, 81.

83 See, e.g., 43 U.S.C. § 1334(a) (granting Interior Secretary the right to prescribe rules and regulations for the "conservation of the natural resources of the outer Continental Shelf").

84 For one of the most recent cases, see *League for Coastal Protection v. Norton*, No. C 05-0991 CW, slip op. (N.D. Cal., Aug. 31, 2005).

85 In 1984, the MMS gave geophysical exploration a "categorical exemption" from the National Environmental Policy Act, which it did not reconsider until 1999. See Minerals Management Service, *Geological and Geophysical Exploration*, pp. A-3–A-4.

86 Minerals Management Service, "Implementation of Seismic Survey Mitigation Measures," attached as Addendum 1 to *Notice to Lessees and Operators (NTL) No. 2002-G07* (New Orleans: MMS, 2002).

87 Minerals Management Service, *Notice to Lessees and Operators (NTL) No. 2004-G01: Implementation of Seismic Survey Mitigation Measures and Protected Species Observer Program* (New Orleans: MMS, 2004), pp. 2–8.

88 Joint Nature Conservation Committee, *Guidelines for Minimising Acoustic Disturbance to Marine Mammals from Seismic Surveys* (Aberdeen, Scot.: JNCC, 2004) (Britain); Department of the Environment and Heritage, *Guidelines on the Application of the Environment Protection and Biodiversity Conservation Act to Interactions between Offshore Seismic Operations and Larger Cetaceans* (Canberra, Austr.: DEH, 2001) (Australia); CONAMA-National Environment Council Res. 305 (July 2004) (Brazil). Requirements for California have generally been defined on an ad hoc basis by state agencies, particularly the California Coastal Commission. See, e.g., California Coastal Commission, Consistency Determination No. CD-14-02, (2002).

89 See, e.g., Joint Nature Conservation Committee, *Guidelines*, §§ 1.1, 4 (source reduction and use of hydrophones); Department of the Environment and Heritage, *Guidelines*, Att. 6 (three km safety zone); California Coastal Commission, Consistency Determination No. CD-14-02 (source reduction).

90 Joint Nature Conservation Committee, *Guidelines*, § 1.1. On higher-frequency propagation from airguns, see Tolstoy et al., "Broadband Calibration," p. 4.

91 M. Deffenbaugh, "Mitigating Seismic Impact on Marine Life: Current Practice and Future Technology," *Bioacoustics*, vol. 12 (2002): pp. 316–18 (abstract of presentation made at Fish Bioacoustics Conference, Chicago, Ill., May 30–June 2, 2001).

92 International Whaling Commission, *2004 Report of the Scientific Committee*, § 12.2.5.2, Annex K at § 6.4 (2004).

93 Personal communication with C. Gill, International Association of Geophysical Contractors, April 2005 (Gabon); see *supra* for information about Brazil's restriction on the Abrolhos Banks.

94 R. Dalton, "Push to Protect Whales Leaves Seafloor Research High and Dry," *Nature*, vol. 428 (2004): p. 681.

95 See "R/V Marcus Ewing Replacement, the R/V Marcus Langseth" (report submitted to Council of the University-National Oceanographic Laboratory System, Mar. 29, 2005), p. 2; 70 Fed. Reg. 55631 (noting intent to prepare an environmental impact statement for the *Langseth's* activities).

96 43 U.S.C. § 1344(a)(3) (MMS instructed to "obtain a proper balance between the potential for environmental damage, the potential for the discovery of oil and gas, and the potential for adverse impact on the coastal zone").

97 Energy Policy Act of 2005, Pub. L. No. 109-58, § 357, 119 Stat. 594, 720.

98 International Whaling Commission, *2005 Report of the International Whaling Commission* (Cambridge, Eng.: IWC, 2005), § 12.4.3.

99 Staff of House Resources Committee, *Proposed Recommendations for Second Energy Bill*, §§ 651–677; Geman, "Resources Committee."

100 Compare L. Cuyvers, *Ocean Uses and Their Regulation* (New York: J. Wiley, 1984), p. 113 (Table 5.3. citing Lloyd's Register of Shipping), and National Research Council, *Ocean Noise and Marine Mammals*, p. 52–53 (Table 2.2, citing same).

101 J. Westwood, B. Parsons, and Will Rowley, "Global Ocean Markets," *The Hydrographic Journal*, Jan. 2002, p. 2.

102 Personal communication from LCDR F. Elfring, U.S. Coast Guard (July 30, 1997) (Coast Guard transit data for eight major ports, averaged from 1990 through the first quarter of 1997).

103 R. J. Urick, *Principles of Underwater Sound* (New York: McGraw-Hill, 1983), p. 334.

104 A large percentage of active vessels were built during the construction boom of the mid 1970s. U.S. Maritime Administration, *Outlook for the U.S. Shipbuilding and Repair Industry, 1997* (Washington, D.C.: MARAD, 1997), p. 41.

105 National Research Council, *Ocean Noise and Marine Mammals*, p. 74.

106 Richardson et al., *Marine Mammals and Noise*, pp. 116–117 (summarizing data on noise output of large commercial vessels); National Research Council, *Ocean Noise and Marine Mammals*, pp. 34–35.

107 Westwood et al., "Global Ocean Markets," p. 2.

108 Dr. B. L. Southall comp., *Final Report of the National Oceanic and Atmospheric Administration (NOAA) International Symposium: "Shipping Noise and Marine Mammals: A Forum for Science, Management, and Technology,"* May 18–19, 2004, Arlington, Virginia, U.S.A. (Silver Spring, Md.: NMFS, 2005), p. 10.

109 Richardson et al., *Marine Mammals and Noise*, pp. 113 (Table 6.3, output of smaller commercial vessels).

110 Westwood et al., "Global Ocean Markets," p. 2.

111 According to the National Marine Manufacturers Association, a Chicago-based trade organization that publishes statistics on U.S. boat registrations, the number of recreational vessels owned in the United States increased 7 percent from 15.8 million in 1995, to nearly 17 million in 2001. Reported in National Research Council, *Ocean Noise and Marine Mammals*, p. 50.

112 See, e.g., Payne, *Among Whales*, p. 369.

113 It is worth noting that, 20 years ago, measurements taken at locations in the North and South Pacific indicate average differences of 15 decibels at frequencies below 200 Hz. R.J. Urick, *Ambient Noise in the Sea* (Washington, D.C.: U.S. Navy Undersea Warfare Technology Office, 1984), pp. 2–8 (citing earlier research).

114 Personal communication with N. A. Brown, NAB & Associates, Nov. 2004.

115 In 2001, short sea shipping accounted for more than 40 percent of the European transport market. European Commission, *White Paper: European Transport Policy for 2010* (Luxembourg: Office for Official Publications of the European Community, 2001), p. 14. MARAD, the federal Maritime Administration, has launched a "Short Sea Shipping Initiative." MARAD, "Short Sea Shipping Initiative: The Wave of America's Future," www.marad.dot.gov/programs/shortseashipping.html (Sept. 10, 2005).

116 Southall, *Final Report*, p. 30.

117 Disturbance reactions as reported in the literature through 1995 receive a 20 page summary in Richardson et al., *Marine Mammals and Noise*, pp. 252–74. A more current list of sources can be found in M. Simmonds, S. Dolman, and L. Weilgart, eds., *Oceans of Noise 2004* (Chippenham, Eng.: WDCS, 2004), pp. 138–59.

118 Finley et al., "Reactions of Belugas, Delphinapterus leucas, and Narwhals, Monodon monoceros," pp. 97–117.

119 Ibid.

120 S.M. Nowacek et al., "Florida Manatees, *Trichechus manatus latirostris*, Respond to Approaching Vessels," *Biological Conservation*, vol. 119 (2004), pp. 517–523.

121 See Richardson et al., *Marine Mammals and Noise*, pp. 252–74; Simmonds et al., *Oceans of Noise*, pp. 138–59.

122 Southall, *Final Report*, pp. 6, 14, 31 (presenting concern of workshop participants and noting others that in the past have described masking as an important consideration).

123 Ibid, p. 15.

124 Ibid., p. 26; personal communication with N. Brown, NAB & Associates, Nov. 2004.

125 Southall, *Final Report*, p. 26.

126 Ibid., pp. 27, 28; personal communication with N. Brown, NAB & Associates, Nov. 2004.

127 Southall, *Final Report*, p. 26.

128 Ibid.

129 Personal communication with K. Metcalf, director of Maritime Affairs, Chamber of Shipping of America, Nov. 9, 2004.

130 Compare U.S. Maritime Administration, "Top 20 Merchant Fleets of the World: Self-Propelled Oceangoing Vessels 1,000 Gross Tons and Greater, as of July 1, 2004" and "Top 20 Merchant Fleets of the World by Country of Owner: Self-Propelled Oceangoing Vessels 1,000 Gross Tons and Greater, as of July 1, 2004," *Data and Statistics*, Sept. 29, 2004, www.marad.dot.gov/MARAD_statistics (Sept. 5, 2005).

131 U.S. Maritime Administration, "Top 20 Merchant Fleets of the World."

132 Indeed, under the Law of the Sea Convention, states have a duty to prevent, reduce, and control pollution of ships under their jurisdiction. Law of the Sea Convention, Art. 194(3) ("Measures to prevent, reduce, and control pollution of the marine environment").

133 Harbor waters lie inside the baseline devised for mapping the territorial sea, and are therefore considered "internal." See ibid., Arts. 7, 8, 11.

134 46 U.S.C. § 3703(a).

135 U.S. Maritime Administration, *Vessel Calls at U.S. Ports 2003* (Washington, D.C.: MARAD, 2004), p. 1 (Table II-2).

136 See discussion in Richardson et al., *Marine Mammals and Noise*, p. 267 (humpback research). When the Park Service attempted to increase traffic in the late 1990s, it was successfully challenged. *National Parks & Conservation Association v. Babbitt*, 241 F.3d 722 (9th Cir. 2001).

137 See Blair Kipple, *Southeast Alaska Cruise Ship Underwater Acoustic Noise* (Bremerton, Wash.: Naval Surface Warfare Center, 2002) (NSWC Tech. Rep. CSWCCD-71-TR-2002/574). In addition to the restrictive permitting process, Glacier Bay installed a hydrophone in the bay four years ago to track how much noise is being created from the cruise ships entering the bay. National Park Service, "Acoustic Monitoring Program," *Glacier Bay National Park & Preserve*, www.nps.gov/glba/InDepth/learn/preserve/projects/acoustics (Sept. 25, 2005).

138 The National Park Service has authority through its permitting system to regulate business operations within the boundaries of its parks. 36 C.F.R. § 5.3. Unfortunately, the state of Alaska and others have pressured the Park Service to admit more cruise ships into the bay, and the agency is expected to decide this October whether to accede. M. Volz, "Alaska Loses Glacier Bay Suit," *Associated Press*, 7 June 2005.

139 See generally 16 U.S.C. § 1433 *et seq.* (Marine Pollution, Research, and Sanctuaries Act). Under the act, the secretary's power to regulate activities is limited to the "terms of designation" under which each sanctuary was first proposed to Congress. 16 U.S.C. § 1434(a)(4). It is clear from the measures already taken that for many if not all of the sanctuaries, noise from vessels and low-flying aircraft fall under these "terms." See, e.g., 15 C.F.R. §§ 922.71(a)(4),(5) (Channel Islands N.M.S.); 922.132(a)(6), (7) (Monterey Bay N.M.S.); 922.184(a)(1),(2) (Hawaiian Islands Humpback Whale N.M.S.). The secretary's power to negotiate with foreign governments is established by 16 U.S.C. § 1435(b).

140 Law of the Sea Convention, Art. 211(5), (6) ("Pollution from vessels").

141 National Oceanographic and Atmospheric Administration, "Unprecedented Partnership Protects California Sanctuaries from Catastrophic Oil Spills," *NOAA News*, May 31, 2000, www.noaanews.noaa.gov/stories/s435.htm (Sept. 15, 2005) (Monterey Bay's collaboration with the IMO); Fisheries and Oceans Canada, "North Atlantic Right Whale," *Maritimes Region*, www.mar.dfo-mpo.gc.ca/masaro/english/Species_Info/Right_Whale.html (Sept. 15, 2005) (collaboration with the IMO on right whales in the Bay of Fundy).

142 Another possibility for reducing noise on large commercial vessels is simply to make ships slow down - especially in ecologically sensitive areas. Such a measure is also under consideration for northern right whale habitat, in order to reduce the risk of ship strikes that could drive the species to extinction. 70 Fed. Reg. 36121.

143 The symposium, "Shipping Noise and Marine Mammals: A Forum for Science, Management, and Technology," was held May 18-19, 2004, in Arlington, Virginia. See Southall, *Final Report*.

144 See discussion in Chapter 4, "The Multilateral Approach."

145 The development of pingers is summarized in R.R. Reeves, R.J. Hofman, G.K. Silber, & D. Wilkinson, eds., *Acoustic Deterrence of Harmful Marine Mammal-Fishery Interactions: Proceedings of a Workshop Held in Seattle, Washington, Mar. 20–22, 1996* (Silver Spring, Md.: NMFS, 1986), pp. 5, 14 (NOAA Tech. Mem. NMFS-OPR-10).

146 B. M. Culik, S. Koschinski, N. Tregenza, & G. M. Ellis, "Reactions of Harbor Porpoises *Phocoena phocoena* and Herring *Clupea harengus* to Acoustic Alarms," *Marine Ecology Progress Series*, vol. 211 (2001): pp. 255–60.

147 Ibid., p. 7.

148 Ibid.

149 P.I. Olesiuk, L.M. Nichol, P.J. Sowden, and J.K.B. Ford, "Effect of the Sound Generated by an Acoustic Harassment Device on the Relative Abundance and Distribution of Harbor Porpoises (*Phocoena phocoena*) in Retreat Passage, British Columbia," *Marine Mammal Science*, vol. 18 (2002): pp. 843–62.

150 A.B. Morton and H.K. Symonds, "Displacement of *Orcinus orca* by High Amplitude Sound in British Columbia, Canada," *ICES Journal of Marine Science*, vol. 59 (2001): 71–80.

151 Reeves et al., *Acoustic Deterrence*, pp. 29–30.

152 See NMFS, *Draft Environmental Assessment on the Testing of a Pulsed Power Generator to Reduce California Sea Lion Depredation of Gear and Catch in the Southern California Charter Boat Industry* (Silver Spring, Md.: NMFS, 1999), § 1.3.1 (reporting peak frequencies for direct and reflected waves); Greenridge Sciences, Inc., "Safety Zones for Marine Mammals Exposed to Sounds from Devices Designed to Repel Pinnipeds from the Vicinity of Commercial Fishing Vessels (paper prepared for NMFS, Dec. 1997), p. 2 (estimating source level at 231 dB re 1 Pa).

153 16 U.S.C. § 1371(a)(4)(A) ("[MMPA provisions] shall not apply to the use of measures to deter a marine mammal from damaging [fishing] gear or catch").

154 60 Fed. Reg. 22345-22348 ("Deterrence Regulations and Guidelines"). These regulations have been proposed by the National Marine Fisheries Service, which has jurisdiction over most marine mammal species; the U.S. Fish and Wildlife Service has not yet proposed any rules.

155 60 Fed. Reg. 22347 (proposing § 216.29(c)(2)(i)).

156 These recommendations were also made by the working group on harassment devices at the 1996 National Marine Fisheries Service workshop on acoustic deterrence. See Reeves et al., eds., *Acoustic Deterrence*, pp. 29–30.

Chapter 3

1 It has been observed, for example, that, even with statistical power analyses, "it would take over 10 years to detect an annual population decline of around 5 percent" in the relatively well-studied population of bottlenose dolphins in the Moray Firth, Scotland. Paul Thompson and Sue Mayer, "Defining Future Research Needs for Cetacean Conservation," in M.P. Simmonds and J.D. Hutchinson, eds., *The Conservation of Whales and Dolphins: Science and Practice* (New York: John Wiley & Sons, 1996), p. 411. See also generally W.C.G. Burns and M. Simmonds, "Some Preliminary Thoughts on the Application of the Precautionary Principle to Cetacean Conservation within the ACCOBAMS Area," in ACCOBAMS Secretariat, *Proceedings of the First Session of the Meeting of the Parties of the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea, and Contiguous Atlantic Area* (Monaco: ACCOBAMS, 2002), pp. 231–39 (in which Thompson and Mayer observation is cited).

2 For a history of the battle over whaling, see David Day, *The Whale War* (San Francisco: Sierra Club, 1987); K. Radway Allen, *Conservation and Management of Whales* (Seattle: U. of Washington/Washington Sea Grant, 1980), pp. 10–17.

3 16 U.S.C. §§ 1361(1) ("certain species and population stocks... are, or may be, in danger of extinction or depletion as a result of man's activities"), (6) ("marine mammals have proven themselves to be resources of great international significance"). The full text of the MMPA, as amended, appears at 16 U.S.C. § 1361 *et seq.*

4 50 C.F.R. §§ 17.11(h), 216.15 (species listed under the U.S. Endangered Species Act).

5 For a useful discussion of "burden of proof" in conservation management, see Elliott A. Morse, ed., *Global Marine Biological Diversity: A Strategy for Building Conservation into Decision Making* (Washington, D.C.: Island Press, 1993) (study co-sponsored by the World Bank).

6 The House Committee on Merchant Marine and Fisheries continued in sending the bill to the floor: "As far as could be done, we have endeavored to build such a conservative bias into the [Marine Mammal Protection Act]." U.S. Code Congressional & Administrative News (1972): p. 4148 (emphasis ours).

7 16 U.S.C. § 1362(13) ("The term 'take' means to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal").

8 The procedure is laid out in 16 U.S.C. § 1371(a)(5).

9 16 U.S.C. § 1371(a)(4).

10 National Defense Authorization Act for Fiscal Year 2004, Pub. L. 108-136, § 319, 117 Stat. 1795 (2003).

11 16 U.S.C. §§ 1371(a)(5)(A), (D).

12 *Kokechik Fishermen's Association v. Secretary of Commerce*, 839 F.2d 802 (C.A.D.C. 1988).

13 16 U.S.C. § 1362(13).

14 16 U.S.C. § 1362(18)(A).

15 National Research Council, *Marine Mammals and Low-Frequency Sound: Progress Since 1994, An Interim Report* (Washington, D.C.: National Academy Press, 1996), p. 19.

16 Malme et al., *Investigations on the Potential Effects of Underwater Noise*; Malme et al., *Investigations on the Potential Effects of Underwater Noise: Phase II*. Other studies on large whales figured in the criterion as well. See National Research Council, *Marine Mammals and Low-Frequency Sound*, p. 19.

17 High Energy Seismic Survey Team, High Energy Seismic Survey Review Process and Interim Operational Guidelines for Marine Surveys Offshore Southern California (Camarillo, Cal.: MMS, 1998).

18 See, e.g., 69 Fed. Reg. 16238 (seismic research in Chixulub crater); 63 Fed. Reg. 66072-66073 (SEAWOLF shock trials); 66 Fed. Reg. 43455-43456 (North Pacific Acoustic Laboratory); 67 Fed. Reg. 46778-46779 (SURTASS LFA).

19 70 Fed. Reg. 1871.

20 70 Fed. Reg. 1872.

21 70 Fed. Reg. 1873-74.

22 See discussion in Chapter 1, "Behavioral and Perceptual Impacts."

23 70 Fed. Reg. 1873-74.

24 See Comments from the U.S. Marine Mammal Commission to Mr. P. Michael Payne, National Marine Fisheries Service at 2-3 (Mar. 18, 2005).

25 16 U.S.C. § 1362(18)(B)(ii).

26 House Resources Committee, Subcommittee on Fisheries Conservation, Wildlife and Oceans, Oversight Hearing on the Marine Mammal Protection Act, 107th Cong., 1st Sess. 277-78 (Oct. 11, 2001). How NMFS will interpret the new definition is not yet clear. The one relevant authorization it has issued, concerning small explosives use by Elgin Air Force Base in the Gulf of Mexico, seems to equate "significantly altered" behavior with habitat avoidance. 70 Fed. Reg. 48677-78. It is not apparent whether NMFS' interpretation is limited to the case of single, small explosives (in which case it would be roughly consistent with previous authorizations) or whether it portends some more profound shift in understanding.

27 National Research Council. *Marine Mammal Populations and Ocean Noise*, p. xi.

28 See Chief of Naval Operations, *Final Overseas Environmental Impact Statement*, pp. 1-24–1-28 (using auditory impacts to set threshold of injury and citing three 1997–98 workshops in support).

29 See, e.g., Culik et al., "Reactions of Harbor Porpoises," (harbor porpoises, showing that 50 percent of animals avoid sound to a 100-decibel radius around an acoustic deterrent device); Independent Scientific Review Panel, *Impacts of Sakhalin II Phase 2*, pp. 36, 38 (western gray whale).

30 U.S. Commission on Ocean Policy, *An Ocean Blueprint for the 21st Century: Final Report of the U.S. Commission on Ocean Policy* (Washington, D.C.: USCOP, 2004), pp. 272–74; Pew Oceans Commission, *America's Living Oceans: Charting a Course for Sea Change: A Report to the Nation* (Arlington, Va.: Pew Oceans Commission, 2003), pp. vii–viii, 71.

31 See, e.g., 70 Fed. Reg. 47806 (geophysical survey in Arctic); 70 Fed. Reg. 8779-8783 (geophysical survey in Southwest Pacific).

32 40 C.F.R. § 1508.7.

33 William E. Odum, "Environmental Degradation and the Tyranny of Small Decisions," *BioScience* vol. 32 (1982): pp. 728–29. The term derives from economics.

34 Southall, *Final Report*, p. 34 (setting forth timeline of future work).

35 16 U.S.C. §§ 1373 (authorizing the Secretaries of Commerce and of the Interior to issue regulations as they deem "necessary and appropriate"), 1374(h)(1) (authorizing the Secretaries to issue regulations pursuant to any "general permits" they may grant).

36 69 Fed. Reg. 67535-67539 (oil-and-gas surveys); 70 Fed. Reg. 55630-55631 (NSF survey).

37 National Research Council, *Marine Mammal Populations and Ocean Noise: Determining When Noise Causes Biologically Significant Effects* (Washington, D.C.: National Academy Press, 2005), pp. 69–86.

38 40 Code of Federal Regulations 1502.20. According to the NEPA task force convened by the current administration, "[r]eliance on programmatic NEPA documents has resulted in public and regulatory agency concern that programmatic NEPA documents often play a 'shell game' of when and where deferred issues will be addressed, undermining agency credibility and public trust." NEPA Task Force, *Report to the Council on Environmental Quality: Modernizing NEPA Implementation* (Washington, D.C.: Council on Environmental Quality, 2003), p. 39. The task force recommended that CEQ establish a broad-based federal advisory committee to provide guidance on programmatic review.

39 In the LFA case, NMFS relegated site-specific decision-making to its issuance of Letters of Authorization, an agency-created process that has always been perfunctory. Compare 70 Fed. Reg. 49914 (issuance of Letters for Authorization for 2005–06 operation year) and 16 U.S.C. §1371(a)(5)(A) (description of permitting process, including notice and comment requirement).

40 National Research Council, *Marine Mammals and Low-Frequency Sound: Progress Since 1994*, p. 21.

41 NRDC v. Navy, 857 F.Supp. 737-78 (C.D. Cal. 1994).

42 Compare "Cuvier's Beaked Whale (Ziphius cavirostris): California/Oregon/Washington Stock," p. 145 (suggesting a single stock in the Northeast Pacific running from the Aleutians to Baja California) and Dalebout et al., "Worldwide Structure," pp. 3354, 3364 (suggesting that discrete local populations are possible).

43 For examples of some useful work in this area, see, *e.g.*, Erich Hoyt, *Marine Protected Areas for Whales, Dolphins, and Porpoises: A World Handbook for Cetacean Conservation* (London, Eng.: Earthscan, 2005); K.R. Kaschner, V. Watson, V. Christensen, A.W. Trites, & D. Pauly, "Modeling and Mapping Trophic Overlap between Marine Mammals and Commercial Fisheries in the North Atlantic," in D. Zeller, R. Watson, & D. Pauly, eds., *Fisheries Impacts on North Atlantic Ecosystems: Catch, Effort, and National/Regional Data Sets* (Vancouver, B.C.: UBC Fisheries Centre, 2001), pp. 35–45 (examples of approaches to distribution modeling and/or hotspot identification).

44 16 U.S.C. §§ 1371(a)(5)(A)(i)(II)(BB), 1371(a)(5)(D)(ii)(III).

45 Steven L. Swartz & Robert J. Hofman, "Marine Mammal and Habitat Monitoring: Requirements; Principles; Needs; and Approaches" (Washington, D.C.: Marine Mammal Commission, 1991) (NTIS PB91-215046).

46 NMFS is mandated to withdraw or suspend authorization if it finds that the activity may have more than a negligible impact on a marine mammal species or stock. 16 U.S.C. § 1371(a)(5)(B).

47 See, *e.g.*, 65 Fed. Reg. 35233-35255 (describing new monitoring guidelines for Habitat Conservation Plans under the U.S. Endangered Species Act). See also 43 C.F.R. § 1502.9(c)(1)(ii) (requiring preparation of supplemental environmental impact statement under NEPA where "significant new information" has emerged).

48 Letter from Rance R. Wall, Alaska Regional Supervisor, Minerals Management Service, to Rick Trupp, Veritas DGC (21 June 2005) (granting permit for Cook Inlet survey and recommending precautions to ensure that activities does not violate the MMPA). We have found no record in the Federal Register that Conoco-Phillips applied or obtained a permit from the wildlife agencies.

49 61 Fed. Reg. 38715; 62 Fed. Reg. 38263; 63 Fed. Reg. 40505; 64 Fed. Reg. 41384; and 66 Fed. Reg. 42515 (Alaska). On the Gulf of Mexico, see discussion in Chapter 2, "Industry: High-Energy Seismic Surveys."

50 See, e.g., Letter from William T. Hogarth, Regional Administrator, NMFS Southeast Regional Office, to RADM J. Kevin Moran, Navy Region Southeast (undated) (USVI exercise consultation); Email from Ken Hollingshead, NMFS, to John Mayer, Marine Acoustics, Inc., and other Marine Acoustics and NMFS personnel (19 Mar. 2002) (withdrawal from consultation on Vieques exercise).

51 70 Fed. Reg. 62102 (proposed Undersea Warfare Training Range).

52 NMFS, *Assessment of Acoustic Exposures*, pp. 3–4, 6; Center for Whale Research, Video Footage of Haro Strait, 5 May 2003 (on file with NRDC).

53 Compare NMFS, *Assessment of Acoustic Exposures* (final version, dated 7 Jan. 2005) and NMFS, *Assessment of Acoustic Exposures on Marine Mammals in Conjunction with* USS Shoup *Active Sonar Transmissions in Haro Strait, Washington—5 May 2003*" (draft versions, Sept. 2004).

54 Marine Mammal Protection Act Amendments of 2005, H.R. 2130, 109th Cong. § 8 (2005) (raising penalties for MMPA violations).

55 The relationship between NMFS and the Navy and its principal contractor unfolded across literally thousands of pieces of correspondence. By way of example, see Email from NMFS staffer, to Paul C. Stewart, Navy, and Others, Navy and NMFS (26 Feb. 2002) (describing the Final Rule as a "jointly written" document and a "joint project"); NMFS and Navy, "SURTASS LFA Proposed Rule Comments and Responses" (document NMFS 185h at 812-881 in the Administrative Record filed in *NRDC v. Evans* (N.D. Cal. 2003)) (assigning parts of LFA Final Rule to NMFS and Navy for drafting). To get a flavor of some of the discussion, see Email from NMFS staffer, to Clay Spikes, MAI (Jan. 24, 2001) (encouraging Navy to act against establishment of Marine Protected Areas so that "the enviros [don't] succeed in locking up a lot of offshore territory").

56 Clayton H. Spikes, "SURTASS LFA Sonar FEIS Biological Opinion" (submitted by email to Craig Johnson, NMFS, 29 Jan. 2001), p. 1 (stating goal of supporting conclusions in the Navy's environmental impact statement).

57 67 Fed. Reg. 46724.

58 See, e.g., Email from NMFS staffer to Paul C. Stewart, Navy (26 Feb. 2002) ("This is what one can expect when a person tries to be accommodating to the Navy").

59 On one particularly late submission, the Navy reportedly threatened the agency to "send a program manager down there to sit in your office until you sign off on this thing." Email correspondence among NMFS regional staff (Mar. 31, 2000) (document obtained through FOIA request).

60 See, as noted *supra*, Letter from William T. Hogarth (USVI exercise consultation); Email from Ken Hollingshead (19 Mar. 2002) (withdrawal from consultation on Vieques exercise).

61 The Navy discontinued its practice of consultation on LWAD sea tests after NMFS refused to allow "informal" consultation on a May 2000 exercise. See Email correspondence among NMFS regional staff (3 Oct. 2000) (document obtained through FOIA request).

62 Part of the problem is that the manager cannot necessarily expect support from his superiors. For example, according to a Navy official, the Navy "had issues during the [authorization of the North Pacific Acoustic Laboratory] which required the director of NMFS to 'order' the ESA folks to make the changes needed." Email from Paul C. Stewart, Navy, to Matthew K. Gagelin, Navy, and Others, Navy and Marine Acoustics (6 Mar. 2002).

63 16 U.S.C. § 1377.

64 *Baleto v. Baldrige*, 724 F.2d 758-59 (9th Cir. 1984) (holding that, where no express power to enforce a specific regulation appears in the statute, the outer limits of regulatory authority rest at "methods which depart radically from accepted norms. . . [or] methods of enforcing regulatory schemes"). By analogy with third-party suits, an injunction could be sought once the potential disturbance or injury becomes imminent. See *California by Brown v. Watt*, 520 F.Supp.1359 (C.D.Cal. 1981), aff'd in part, rev'd in part, and vacated in part, on other grounds, 464 U.S. 312 (1984).

65 16 U.S.C. § 1362(18) (defining harassment to include "potential" or "likely" harm). See also *NRDC v. Evans*, 279 F.Supp.2d. 1153-54 (N.D.Cal. 2003) (affirming that acts with the "potential" to disturb or injure amount to harassment under the Act).

66 16 U.S.C. § 1373. See also *Baleto*, 724 F.2d 759-60 (citing *Haig v. Agee*, 453 U.S. 280, 289-90 (1981) and *American Trucking Ass'n v. United States*, 344 U.S. 310 (1953).

67 National Research Council, *Ocean Noise and Marine Mammals*, p. 132. The NRC panel's vision of such a program, which would see it vested in a single federal agency (that, following an earlier panel's recommendation, could provide funding independence), differs somewhat from our own

68 RADM Steven Tomaszeski, "Navy Marine Mammal Overview" (presentation given at the first plenary meeting of the U.S. Marine Mammal Commission Advisory Committee on Acoustic Impacts on Marine Mammals, 5 Feb. 2004), sl. 8.

69 In 1995, the Navy and Scripps Institution of Oceanography entered into a settlement agreement with several plaintiffs, including NRDC, to conduct a multi-year Marine Mammal Research Program on the ATOC program. University of California, NRDC, et al., "Settlement Agreement and Release" (signed 2 June 1995). One year later, in response to a public campaign launched by many of the same groups, it agreed to establish a Scientific Research Program to investigate the environmental impacts of the LFA system. Letter from Steven S. Honigman (19 Apr. 1996). The Navy's noise research budget from the 2001 through the 2006 fiscal year is charted in Mardi Hastings and Frank Stone, "Total Navy Funding (FY01–FY06)" (part of untitled presentation given at the third plenary meeting of the U.S. Marine Mammal Commission Advisory Committee on Acoustic Impacts on Marine Mammals, 28 July 2004).

70 National Research Council, *Marine Mammals and Low-Frequency Sound*, p. 84. The panel recommended that an agency with greater independence manage the federal program.

71 D.P. Gannon, D.W. Johnston, A.J. Read, & D. Nowacek, "Resonance and Dissonance: Science, Ethics, and the Sonar Debate," *Marine Mammal Science* vol. 20 (2004): pp. 898–99. The letter is answered, making several of the arguments presented here, in L. Weilgart, H. Whitehead, L. Rendell, & J. Calambokidis, "Signal-to-Noise, Funding Structure *Versus* Ethics as a Solution to Conflict-of-Interest: Response to 'Resonance and Dissonance: Science, Ethics, and the Sonar Debate,' Marine Mammal Science 20:898–899," *Marine Mammal Science* vol. 21 (2005): pp. 175–77.

72 Correspondence between Marine mammal research program officer, Office of Naval Research, and Operations Manager for Navy sonar system, Office of the Chief of Naval Operations (6–9 Aug. 2001) (document AR24279 add. in the Administrative Record filed in *NRDC v. Evans* (N.D. Cal. 2003), on file with NRDC). Here, with names and other identifying information omitted, is the complete dialogue:

Operations Official (forwarding public comments that the researchers had submitted to NMFS): [ONR Official], is the Navy funding any [of these scientists'] research? Did they say anything to you on this issue?

ONR Official: Yes, I fund their research. They did mention that they would be sending in comments on LFA, but I did not get a copy of what they sent. I gather the input was not entirely positive.

Operations Official: [ONR Official], their comments were in the attachment. Yes, they were negative and in my opinion, out of the box. If they are funded by the Navy the proper way to bitch is via the sponsor (you), and not a letter to NMFS. All of the data cited was run by your office, we are not perfect and [Marine Acoustics, the Navy's contractor] has always tried to spin data, but I've tried to be objective. A letter from [these researchers] to NMFS is nothing more than an attempt to discredit the Navy and stop the deployment of LFA. Maybe I'm missing the big picture, what say you?

ONR Official: I told them as much in a pretty scorching phone call. I think they had some inkling that they might be about to take our money and make themselves look good to the enviros too, but I can't prove that. The main driver was [an environmental group]. All through this process [the researchers] had ignored the LFA issue, not responded to requests for comments, in the Federal Register, etc. Then one day [an environmentalist] calls them, and asks them if they had read the EIS. [The lead researcher] said "No," and [the environmentalist] said "I'll mail you a copy, and please send your comments to [NMFS] right away." Scientists are like that; they'll review anything they're asked to review and give their honest, sometimes harsh critique, without knowing any of the politics or circumstances. Its the way you do things in peer review of a colleague's paper, and they just apply the process to everything they read. If we had asked them to review it earlier we probably could have absorbed his criticism [on this particular issue] and thus defused any further criticism, but that's water under the bridge now. I also reminded [the lead researcher] that he was using data that he published after the EIS was written, and data that was not yet published; and I told him it was unfair to expect Navy to use information that he had not provided at the time the EIS was written. I got a sheepish apology for his not providing input earlier (even though we had not asked him directly for it), and for holding the EIS to his changing understanding of the problem as his research has progressed. But I don't know what good that does us.

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Chapter 4

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5 International Whaling Commission, *2004 Report of the Scientific Committee*, § 12.2.5.2.

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7 See, e.g., K. Scott, "International Regulation of Undersea Noise," *International & Comparative Law Quarterly*, vol. 53 (2004): p. 321 (arguing against a new multilateral instrument to deal with noise, since "the current network of pollution and biodiversity instruments already provides an ideal matrix for the future regulation of marine acoustic pollution").

8 T.B. Koh, "A Constitution for the Oceans" (remarks delivered at the 3rd U.N. Conference on the Law of the Sea, Montego Bay, Dec. 6 and 11, 1982) (Koh was president of the 3rd U.N. Conference).

9 The United States government has acceded to some of the terms of the Convention, but not necessarily to those affecting marine mammals and fisheries. Proclamation 5030, 48 Fed. Reg. 10605-10606 (Mar. 10, 1983) (Presidential Proclamation establishing a U.S. Exclusive Economic Zone).

10 Law of the Sea Convention, Art. 1(1)(4) (emphasis added).

11 See H.M. Dotinga and A.O. Elferink, "Acoustic Pollution in the Oceans: The Search for Legal Standards," *Ocean Development and International Law*, vol. 31 (2000): pp. 158–59; K. Scott, "International Regulation of Undersea Noise," p. 293. The IUCN has also formally recognized "that anthropogenic ocean noise, depending on source and intensity, is a form of pollution, comprised of energy, that may degrade habitat and have adverse effects on marine life ranging from disturbance to injury and mortality," IUCN-World Conservation Union, WCC Res. 3-053 (preamble).

12 Law of the Sea Convention, Art. 209(1).

13 European Parliament, EP Res. B6-0018/2004, paras. 1, 2, 6.

14 European Union Council, "Thematic Strategy to Protect and Conserve the Marine Environment, Draft Conclusions" (Dec. 21, 2004).

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Attachment 29

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Protest Raised over New Tests of Naval Sonar

July 24, 2007 from All Things Considered

ROBERT SIEGEL, host: From NPR News, this is ALL THINGS CONSIDERED. I'm Robert Siegel.

A long-running fight over whether a new Naval sonar hurts whales has flared up again. Federal regulators are about to decide whether to let the Navy test the new sonar in most of the world's oceans. In a video made by the Navy, the sonar sounds like this when it passes through a group of singing whales.

(Soundbite of whale song and sonar pinging)

SIEGEL: That was a humpback whale song followed by the resonant hum of new sonar. The sounds were processed to make them easier to hear.

Government biologists say the new sonar poses little threat to whales. But environmentalists who disagree are trying hard to stop the Navy's plans.

NPR's John Nielsen reports.

JOHN NIELSEN: In the language of the Navy, the new sonar is known as SURTASS LFA. Hanging in the water underneath a Navy research boat, it doesn't look especially impressive. Anybody who's been to a rock concert has seen bigger speakers than these. But when you turn it on, the SURTASS LFA outperforms every other sonar system in the world. Basically, it sends out blasts of energy that cover hundreds of square miles. The Navy built this system to find submarines that slipped past other kinds of sonar. The Pentagon says that makes it essential to the national defense.

Retired Vice Admiral Malcolm Fages put it this way in a Navy film promoting the new system.

Vice Admiral MALCOLM FAGES (US Navy): The SURTASS Low Frequency Active Acoustic System is a critical system, which will help us solve the anti-submarine warfare problem, particularly as the threat around the world continues to proliferate.

NIELSEN: But by some accounts, the very thing that makes SURTASS LFA so useful may also be making it a threat to marine mammals. Biologists say it's possible that the energy pulses sent out by the sonar could make it hard for these animals to communicate, navigate or even reproduce.

Joel Reynolds of the Natural Resources Defense Council says other kinds of sonar have done just that and more. He says the Navy needs to do more testing to prove that the new system is safe.

Mr. JOEL REYNOLDS (Director, Marine Mammal Protection Project, Natural Resources Defense Council): We simply can't allow the Navy to play Russian roulette with our oceans, but that's what the LFA system will do.

NIELSEN: Right now, the Navy is only allowed to test this sonar in an isolated part of the western Pacific. But they want to do much more by putting the devices on four ships that would range over most of the world's oceans. In order to do that, the Navy needs to get a permit from the National Marine Fisheries Service. And last month, that agency proposed to

grant it, concluding that the system posed a negligible threat to the health of marine mammals. Reynolds calls that a wild guess.

Mr. REYNOLDS: The fact of the matter is, they turn this system on and they have no real idea what it's doing because it goes so far they can't monitor it, much less regulate it.

NIELSEN: That's not an argument that seems to wash with the official who proposed to give the Navy the new permit, fisheries biologist Ken Hollingshead of the National Marine Fisheries Service. He says the Navy has spent millions on research into the side effects of the SURTASS LFA since 2002. He says those tests seem to show that while some kinds of whales stop singing and swim away when the sonar waves hit, there is no evidence that these whales have been harmed in any way. Hollingshead adds that his agency will make sure the Navy takes a lot of steps to ensure that the sonar isn't even turned on when whales are nearby.

Mr. KEN HOLLINGSHEAD (Biologist, National Marine Fisheries Service): They have visual observers watching on the surface. They have a passive acoustic listening for any vocalizations from marine mammals. It ensures that the area around the two kilometers around the LFA source does not have any marine mammals inside that area.

NIELSEN: Critics say those are good ideas, but argue that they may not be enough to protect whales. They also say the fisheries service hasn't given the public enough time to respond to the new plan, which was unveiled just two weeks ago. The public comment period on the new proposal closed today. Hollingshead says the agency has gotten thousands of requests to extend it. Hollingshead says he's considering those requests, but adds that the Navy's permits could be issued by the middle of August.

John Nielsen, NPR News, Washington.

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Attachment 30

Bulletin of the Atomic Scientists

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March/April 2004, Volume 60, Number 2, pp. 68-77

Prepared for Robert Norris (205.138.206.34)
on August 16, 2005 at 4:30 pm GMT

When the March/April 2004 issue was published, the Doomsday Clock remained at 7 minutes to midnight, where it had been since February 27, 2002 when the United States rejects a series of arms control treaties and announces it will withdraw from the Anti-Ballistic Missile Treaty. Terrorists seek to acquire and use nuclear and biological weapons.

The protection paradox

by Hans M. Kristensen, Matthew G. McKinzie & Robert S. Norris

Who's kidding who? If you think a missile defense deployment will make the world safer, take a look at how the United States reacted to the Soviet missile defense of Moscow.

THE UNITED STATES PLANS TO begin deployment of a limited ballistic missile defense system at Fort Greely in Alaska and Vandenberg Air Force Base in California by the end of 2004. With 10 silo-based interceptors intended to shoot down long-range ballistic missiles, the system will serve as "a starting point for fielding improved and expanded missile defense capabilities later," according to the White House. The system is expected to grow to 20 silo-based interceptors in 2005, and up to 100 interceptors in the following years.

How will other nuclear powers respond? Some suggest that Russia might modernize its forces to be able to overwhelm the U.S. system and that China might improve its intercontinental ballistic missiles (ICBMs) to ensure the credibility of its deterrent. But the Bush administration insists this won't happen.

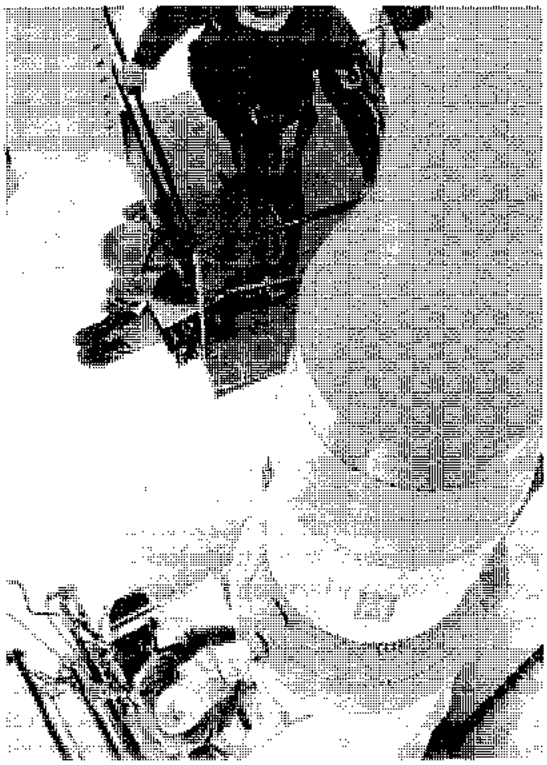
"Our missile defenses will be no threat to Russia," Douglas J. Feith, undersecretary of defense for policy, told the Senate Foreign Relations Committee in July 2001. Such U.S. defenses will not affect Russian capabilities, he said, so "there is no incentive for Russia to spend scarce resources to try to overcome them." And China, Feith claimed, "will continue [its] modernization whether or not we build missile defenses."

How can the Bush administration be so sure of how Russia or China will react? Its position is more wishful thinking than careful analysis. Had it bothered to examine how the United States itself reacted when faced with a Soviet missile defense system, it might have come to a different conclusion.

Documents recently declassified under the Freedom of Information Act (FOIA) reveal that in 1968 U.S. war planners sought to overwhelm Soviet defenses with enough nuclear firepower to kill tens of millions of people. The documents reveal that the United States considered all components of the Soviet anti-ballistic missile (ABM) system—missile interceptors, battle radars, and distant early warning radars—as high-priority targets for nuclear weapons.

Hans M. Kristensen, Matthew G. McKinzie, and Robert S. Norris work for the Natural Resources Defense Council in Washington, D.C. A footnoted version of this article appears online at www.thebulletin.org.

CORBIS



Missiles like this Minuteman II, shown in its North Dakota launcher, could have targeted Russian complexes.

The emergence of a Soviet missile defense system also spurred U.S. development of penetration aids ("pen-aids") and multiple independently targetable reentry vehicles (MIRVs), which vastly increased the U.S. stockpile. The United States undertook these efforts even though the Soviet ABM system was limited—similar in scale to the non-nuclear system planned by the Bush administration, which purports to defend against small attacks.

By reexamining the Soviet missile defense system of the late 1960s and how U.S. war planners might have planned to destroy it, and then by looking at how nuclear targeting is done today, it is clear that construction of a U.S. missile defense is actually cause for concern.

Soviet missile defense, 1968

The Soviet Union first deployed ballistic missile defense systems in the late 1960s. The most important was the A-35 anti-ballistic missile (ABM-1) defense system around Moscow, which began limited service in November 1967 with a few interceptors. The second, known as the Tallinn system, was located near Leningrad (now St. Petersburg) and became operational around the same time.

The A-35 Moscow system was originally designed to simultaneously intercept as many as eight incoming reentry vehicles. But there were doubts about whether it could intercept that many missiles, or missiles with multiple warheads and/or pen-aids (decoys that confuse radars). By 1968, the system was required to intercept only a single warhead or a single strike.

The initial system included 64 Galosh interceptors (ABM-1A, later upgraded to ABM-1B) located at four launch complexes outside Moscow. The Galosh had a 300-kilometer range and carried a warhead with a 2–3 megaton yield. Descriptions of the Soviet ABM system normally mention only four complexes, but a 1970 CIA report reveals that each complex consisted of two distinct launch sites separated by 4–7 kilometers. The four pairs of launch sites, the last of which became operational in early 1970, were arranged in a half-circle facing northwest, 85 miles (136 kilometers) from Moscow's center. Each launch site had eight reloadable aboveground launchers and three Try Add radars—one large radar for tracking and two smaller ones for tracking and guidance. A large Dog House tracking radar was built about 68 miles (109 kilometers) southwest of Moscow to track incoming reentry vehicles and provide battle management.

In addition to revealing the interceptor launch complexes, a CIA map released under FOIA shows that Moscow was also surrounded by 48 launch sites equipped with SA-1 Guild surface-to-air missiles. Twenty-six of the sites circled Moscow about 50 miles (80 kilometers) from its center; the other 22 sites formed an inner ring about 30 miles (48 kilometers) from Moscow's center. The 12-meter-long Guild missile had a range of 50 kilometers and could carry either a conventional or nuclear warhead.

Successful interception of reentry vehicles requires advance warning. In 1964, construction began on Hen House early warning radars, one at Skrunda in Lithuania and another at Olenegorsk on the Kola Peninsula. Hen House radars were designed to assess the size of an attack, confirm warnings from satellites and over-the-horizon radars, and provide target-tracking data to support ABM interceptor launches. The radars, located in the corridors through which U.S. ICBMs would strike Moscow, were almost entirely undefended and extremely vulnerable to the blackout that would result from nuclear airbursts.

The Tallinn system, named for the location where it was first detected, was deployed in a barrier line across the northwestern parts of European Russia, around Leningrad, and some parts of the southern approaches. After the conventionally armed SA-5 Griffon system was terminated in 1963, deployment of nuclear-capable SA-5B Gammon interceptors began at the old sites, with new sites constructed at Cherepovets, Liepaja, and Tallinn. The upgraded system became operational around 1966 or 1967.

In 1968, the total Tallinn system consisted of nearly 30 operational launch complexes with a similar number under construction. Each complex generally consisted of three launch sites. Each site had six SA-5B Gammon launchers and a

USAF

modest-sized Square Pair radar. Of the 30 operational complexes, only six were close enough to the Hen House radars in Olenegorsk and Skrunda to have a potential ABM role (see "Soviet ABM System, 1968," p. 73).

There was considerable disagreement within the U.S. intelligence community at the time about whether the improved Tallinn system was to defend against aircraft, ballistic missiles, or some combination of the two. The Defense Intelligence Agency (DIA) agreed with the air force, which in late 1967 concluded that the system "possesses significant capabilities in both a terminal defense and area ABM role." But six months later, in a memorandum for President Lyndon Johnson, newly appointed Defense Secretary Clark Clifford said an ABM capability "now appears unlikely."

The CIA concluded that it did "not believe there is any deployment of ABM defenses outside the Moscow area," and the Tallinn system was "unlikely to have a present ABM capability," though it acknowledged, "the state of available evidence does not permit us to exclude this possibility." This view was shared by the navy, which decided that the system had "negligible capabilities against ballistic missiles."

There was general agreement that the limited Moscow and Tallinn systems would not be able to counter a large U.S. ballistic missile attack. In fact, the CIA later concluded that it "doubt[ed] that the Soviets will have an ABM system worth deploying against the U.S. threat in the foreseeable future."

The effect on U.S. nuclear planning

Despite disagreements and doubts, U.S. nuclear planners gave high priority to targeting the Moscow and Tallinn systems, worrying that even a limited ABM capability could diminish a strike against Soviet ICBM silos by U.S. ICBMs, which would overfly Moscow.

Soviet planners estimated in the early 1970s that Moscow would be targeted by at least 60 warheads of 1 megaton each. Newly declassified U.S. documents show that they were fairly accurate. A strike plan against the Moscow and Tallinn defenses, to ensure "penetration of the ICBM force," was incorporated into the single integrated operational plan (SIOP) war plan and entered into effect January 1, 1968. In addition to an undisclosed number of Polaris submarine-launched ballistic missiles (SLBMs), the plan involved "more than 100 Minuteman" ICBMs—about 10 percent of the U.S. ICBM force at the time. The attack would come in two closely coordinated waves. In the first salvo, Minuteman I/II and Polaris missiles would strike the Hen House early warning radars and their Tallinn system defenses. In the second wave, the Dog House radar and the Try Add system around Moscow would be attacked.

Assumptions about the 1968 attack

In attempting to reconstruct how U.S. nuclear war targeters might have devised such a strike plan we have made some assumptions about the targets and the weapons. The CIA's 1967 National Intelligence Estimate concluded that Moscow's ABM system did not "cover all of the multidirectional U.S. missile threats to Moscow; it is subject to saturation and exhaustion," and "none of the system components are hardened against nuclear bursts."

The strike plan would likely have exploited these weaknesses to the fullest and made use of the surprise effect of the significantly shorter flight time of SLBMs. So we have assumed that the Polaris missiles were targeted against the soft Hen House and Dog

Projected U.S. ABM suppression strike, 1968*

Target	Weapon**		Warhead		Total	
	Type	No.	Type	Yield (kt)	Warheads	Yield (kt)
Moscow system						
Dog House radar	Polaris A3	2	W58	200	6	1,200
Eight ABM launch complexes	Minuteman I/II	64	W56	1,000	64	64,000
Subtotal		*66*			*70*	*65,200*
Tallinn system						
Tallinn launch complex	Minuteman I/II	8	W56	1,000	8	8,000
Liepaja launch complex	Minuteman I/II	8	W56	1,000	8	8,000
Cherepovets launch complex	Minuteman I/II	8	W56	1,000	8	8,000
Three Leningrad complexes	Minuteman I/II	24	W56	1,000	24	24,000
Subtotal		*48*			*48*	*48,000*
Early warning radars* **						
Hen House (Skrunda)	Polaris A3	2	W58	200	6	1,200
Hen House (Olenegorsk)	Polaris A3	2	W58	200	6	1,200
Subtotal		*4*			*12*	*2,400*
Total		**118**			**130**	**115,600**

kt=kilotons. *Based on 100+ Minuteman I/II missiles, plus Polaris missiles, designated for 1968 Soviet ABM suppression. (U.S. Strategic Air Command, "History of U.S. Strategic Air Command January–June 1968," February 1969, p. 300. Partially declassified and released under FOIA.) **The assignment of individual weapons to individual targets is not known. We assume each launch complex was targeted by eight Minuteman missiles, each carrying one W56 warhead (1-megaton yield). ***Two other Hen House radars were located near China but could not detect missiles launched over the North Pole.

Characteristics of U.S. nuclear weapons

	Weapon	Yield (kilotons)	Accuracy (meters)*	Reliability**	MIRVs
1968					
	W56 (Minuteman I/II)	1,200	930	80 percent	1
	W58 (Polaris A3)	200	1,480	80 percent	3
1989					
	W78 (Minuteman III)	335	300	80 percent	2–3
	W76 (Trident I C4)	100	460	80 percent	8

MIRVs=multiple independently targetable reentry vehicles. *Circular error probable.
**Average reliability.

House radars, while Minuteman ICBMs were focused on the interceptor complexes. Moreover, since we don't know the capability the nuclear war planners assigned SA-5B and ABM-1B interceptors, or whether they considered these longer-range Moscow interceptors more capable (they probably were), we have assigned an equal number of attacking warheads per launch site.

Based on these assumptions and detailed calculations described below, the use of "more than 100 Minuteman" ICBMs and at least six Polaris SLBMs against the Soviet missile defense system's 17 individual facilities results in a staggering average of eight 1-megaton warheads per interceptor launch site around Moscow and Leningrad. The combined force of the strike exceeds 115 megatons—the equivalent of more than 7,500 Hiroshima bombs. Under these assumptions, the Moscow system would be clobbered with 70 warheads; the Tallinn system would be hit with 48 (see "Projected U.S. ABM Suppression Strike, 1968," p. 71).

Modeling the 1968 strike

To better understand the methodology by which U.S. nuclear war planners probably arrived at such an enormous strike plan, we performed calculations of target hardness, damage expectancies, and nuclear weapons effects. Our assumptions about the characteristics of the two types of attacking U.S. nuclear weapons are provided (see "Characteristics of U.S. Nuclear Weapons," above). It is important to note that at the time, high yields were used to compensate for the weapons' relative inaccuracy. A 1-megaton warhead can destroy residential structures out to a radius of about 4.5 kilometers from its ground zero. Many currently deployed U.S. nuclear weapons can do more damage at lower yields because of significantly higher accuracies.

This strike has two types of targets: ABM radars, and surface-launched ABM interceptor missiles. The targets' hardness and the characteristics of the attacking weapons would dictate to 1968's U.S. nuclear war planners how many nuclear weapons to assign each target, and, for each weapon, the height of burst (HOB).

The height of burst determines whether there is fallout from a nuclear explosion; above a certain height, no fallout would be expected because the detonation is too high to kick up ground debris. For the attacking weapons in this scenario, the "no-fallout HOB" is 935 meters for a 1.2-megaton weapon and 457 meters for a 200-kiloton weapon. To increase damage to a hardened target, war planners may call for a HOB lower than the no-fallout height. The "optimum HOB" maximizes the area exposed to a given blast pressure. For some targets and nuclear yields, the optimum HOB is above the no-fallout height (as at Hiroshima and Nagasaki, for example).

A high-yield nuclear weapon detonated at a lower height could produce hazardous radiation levels hundreds of miles from ground zero. With information from the partially declassified 1989 NATO Target Data Inventory (NTDI) Handbook, we calculated the hardness of the Soviet ABM targets and the optimum heights of burst for the attacking weapons. The optimum heights of burst are above the no-fallout HOB for both target types; this would avoid radiation contamination of Russia and Europe. Factoring in weapon accuracy and reliability, we can also compute the kill probability for an individual warhead on a specific target (see "Optimized U.S. Nuclear Forces Attack on Soviet ABM Targets," p. 74).

Our calculations show that, using this methodology, a couple of W56 Minuteman warheads were needed to destroy each ABM launch site. The fact that the U.S. nuclear war planners of 1968 assigned about eight warheads to each target implies that they were concerned with the effectiveness of the Soviet missile defenses and used extra warheads to overwhelm them. The six Polaris warheads assigned to each radar target would have achieved a combined 88 percent kill probability.

Substantial blast and fire damage would be expected from the strike. Central Moscow would be initially undamaged but surrounded by a semi-circle of fire soon after the attack. If rain or snow were falling, radioactive contamination of Moscow might occur because of the phenomenon of rainout.

Pen-aids and MIRVs

Our reconstruction of the ABM strike does not take into account how well the Soviet missile defense systems would have worked. What our calculations do show, however, is that U.S. planners added a large number of weapons to the strike plan to overcome any attrition by the system.

In the early to mid-1960s, in anticipation of the Soviet missile defense

system, the United States developed pen-aids (decoys and chaff) to confuse interceptors. The United States wanted all its missile systems, whether SLBMs or ICBMs, "to be equipped with decoys capable of penetrating both area and local ballistic missile defenses." Some U.S. ICBMs had pen-aids, others did not; the Polaris SLBMs did not carry decoys (although subsequent Poseidon and Trident weapon systems did). In the 1968 strike plan described above, the Minuteman I reentry vehicles were equipped with "retro-rockets," and the Minuteman II carried Mk-11C reentry vehicles and Mk-1 pen-aids when available.

Another fundamental U.S. countermeasure to "saturate" the Soviet ABM system was the development and deployment of MIRVs. Many declassified documents from the time describe the MIRV development effort in an ABM context. The Polaris A3 carried three reentry vehicles, but the Poseidon SLBM that began replacing it in 1971 carried an average of 10 MIRVed warheads. Each warhead had a yield of approximately 50 kilotons and more than three times the accuracy of the Polaris A3. This meant the Poseidon could "be used to saturate an ABM defense or to attack independent soft targets."

The Minuteman III, deployed in 1970, and the current Peacekeeper ICBM carry two or three and 10 MIRVs, respectively. Individual missiles were eventually configured with different mixes of reentry vehicles and pen-aids to meet specific requirements of the mission.

British nuclear targeting of ABM systems

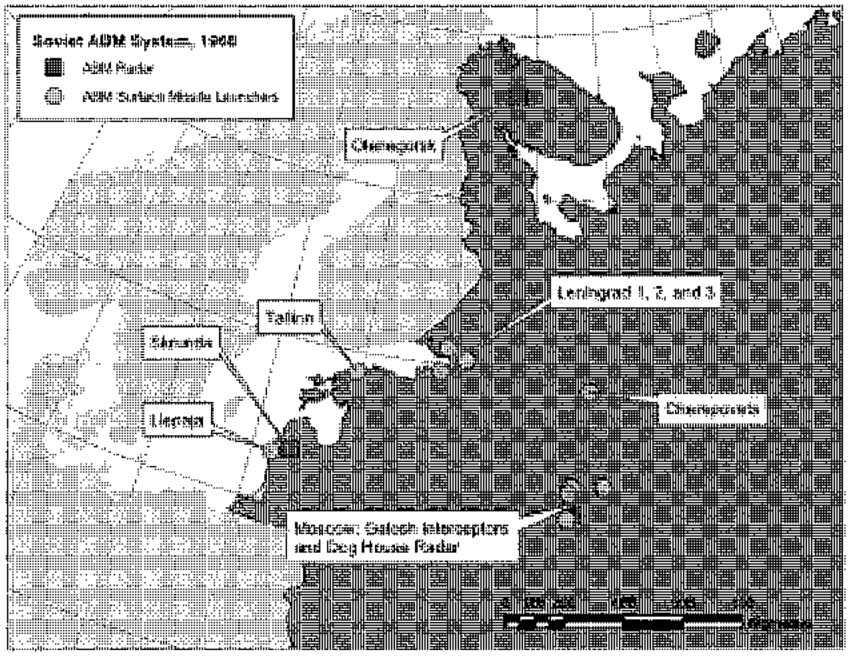
A British war plan supplemented the U.S. one. The first British nuclear-powered ballistic missile submarine (SSBN), the *Resolution*, sailed its first patrol in June 1968 armed with 16 U.S.-supplied Polaris missiles, each carrying three 200-kiloton warheads. Three more subs followed in June 1969, August 1969, and September 1970. The Polaris force took over the strategic role of the V-bomber.

By the end of the 1960s, targeting may have focused on Moscow, with all the missiles of a nuclear submarine committed to destroying the ABM system and the city. The capability of the Moscow ABM system might have limited the flexibility of British targeting by tying down most of the deployed force. Polaris appears to have been judged much more effective against the SA-5B Gammon interceptors of the Tallinn system. A 1970 study published by the British Atomic Energy Authority concluded that SA-5B interceptors were not a threat to British Polaris missiles, and that it would take only two Polaris missile payloads to saturate a standard SA-5B battery.

In 1972, the British government decided to develop a new front end for the Polaris missiles "designed specifically to penetrate [the] anti-ballistic missile defenses" around Moscow. This improved system, called Chevaline, was deployed in 1982. It carried pen-aids and three 40-kiloton maneuverable reentry vehicles that were "hardened" against the radiation effects of the nuclear ABM interceptors.

The Chevaline tied British targeting to Moscow. That changed in 1998, when Britain deployed Trident D5 missiles on four Vanguard-class SSBNs, returning flexibility to the war planners. "It is more than just the destruction of Moscow," said Field Marshall Nigel Bagnall, British chief of general staff from 1985 to 1988, "it is the destruction of the command and control system."

From late 1970 (when the British SSBN force became operational) through 1996 (when the Chevaline's operational deployment ended), the combined number of U.S. and British weapons assigned to suppress the Soviet ABM system may have been well over 200 warheads.



The Soviet ABM upgrade

Aware of the severe limitations of its A-35 Moscow ABM system, the Soviet Union began upgrading it in the mid-1970s. Like its predecessor, the upgraded system, called A-135, was designed merely to provide an "adequate" defense (as opposed to an "optimum" defense) against threats like a renegade U.S. SLBM attack, a "limited, provocative" U.S. ICBM at-

Optimized U.S. nuclear forces attack on Soviet ABM targets*

Attacking warhead	Target type	Optimum HOB**	Kill probability (excluding reliability)	Kill probability (including reliability)
1968				
W56; 1,200 kilotons	SA-5B/ABM-1B surface-to-air missiles	2,000 m	.99 percent	79 percent
W58; 200 kilotons	Radar installations	900 m	36 percent	30 percent
1989				
W78; 335 kilotons	Hardened silos similar to those of SS-7/8/9s	0–225 m	74 percent	59 percent
W76; 200 kilotons	Radar installations	700 m	92 percent	74 percent

m=meters. *Not considering ABM system effectiveness. **HOB=height of burst

tack, or a Chinese attack with as many as 100 intermediate-range missiles. The Moscow ABM capability was diminished by the reduction of interceptors in 1979–1980 from 64 to 32.

The upgrade was formally completed in 1989 (but had significant problems and was not fully operational until 1995). It added 68 launchers for a total of 100, the maximum permitted under the Anti-Ballistic Missile Treaty. Four new launch sites were built closer to Moscow, with new Gazelle (ABM-3) interceptors (17 launchers each) based in hardened silos to strike reentry vehicles inside the atmosphere. The Gazelle has a range of 80 kilometers and carries a 10-kiloton warhead.

The improved surface-mounted Galosh (ABM-1B) interceptors, of which only 16 of the original 64 remained in 1987, were replaced with 32 long-range Gorgon (SH-11/ABM-4) interceptors, deployed in hardened silos to engage incoming reentry vehicles outside the atmosphere. In 1989, there were four Gorgon sites with eight silos each. The Gorgon has a range of about 350 kilometers and carries a 1-megaton warhead.

The A-135, which some claimed was a scaled-up version of the U.S. Nike-X system, included a new Pillbox phased-array radar with 360-degree coverage at Pushkino, northeast of Moscow. The Pillbox, which became fully operational in 1990, was connected to other radars to track incoming warheads and guide the interceptor missiles toward their targets. The Soviets upgraded the Hen House radar at Skrunda to a much more capable large phased-array radar (LPAR), and added another LPAR to the system at Pechora in the northeastern Urals.

A U.S. response to the Soviet upgrade

Given the Soviet ABM modernization, how might U.S. nuclear planners have targeted the new A-135 system in 1989? Unlike our 1968 case study, neither the number of weapons nor their characteristics have been declassified. But from what we know about 1968 planning, targeting methodology, and our calculations of the above strike, it is possible to make a reasonable guess.

Well before the A-135 was completed, the United States concluded that despite the improvements, "the system cannot presently cope with a massive attack."

"With only 100 interceptor missiles," the Pentagon explained, "the system can be saturated, and with only the single Pillbox radar at Pushkino providing support to these missiles, the system is highly vulnerable to suppression." Even so, the Pentagon acknowledged, "It does provide a defense against a limited attack or accidental launch."

For the nuclear planners, one of the most important features of the upgraded Soviet system was that the new Gazelle interceptors could engage ICBM and SLBM reentry vehicles *after* most pen-aids were lost during reentry through the atmosphere. This capability meant that more attacking warheads would be needed to defeat the ABM system.

To better calculate and predict the loss of warheads in an attack, U.S. nuclear planners in 1986 acquired a new tool—the multiple engagement model (MEM). Developed by the Joint Strategic Target Planning Staff in charge of the SIOP, the MEM simulates warhead attrition caused by ABM interceptors.

Because of their capability for surprise, we assume that SLBMs in 1989 were primarily used to target the radars, much like the 1968 plan. Unlike in 1968, however, the new Poseidon and Trident I C4 SLBMs were equipped with pen-aids. Moreover, we assume that individual SLBMs assigned to take out the radars had been downloaded to carry only a few warheads (see "Characteristics of U.S. Nuclear Weapons," p. 72).

In 1968, Soviet interceptors were "soft" aboveground targets, but in 1989 both the Gorgon and Gazelle interceptors were deployed underground in hardened silos. We don't know whether the silos were hardened to the same degree as ICBM silos, but assumed a low hardness similar to the SS-7, SS-8, and SS-9 missile silos. Using the vulnerability numbers from the declassified NTDI Handbook, and including the weapon system's reliability, we calculated the optimum height of burst and kill probabilities for Soviet ABM targets attacked by U.S. nuclear forces in 1989 (see "Optimized U.S. Nuclear Forces Attack," above).

This shows that it would require at least two W78 warheads from a

Minuteman III, detonated at 225 meters, to achieve a kill probability greater than 80 percent for each interceptor silo. For the softer radar installations, a single W76 warhead detonated at 700 meters would have a kill probability of 74 percent. We have therefore assumed that each silo would be targeted with one ICBM with at least two W78 warheads at surface or shallow burst (approximately 200 meters), and that each radar would be targeted with two airburst W76 warheads from an SLBM.

Because each Gorgon launch site included eight interceptor silos, and each Gazelle launch site had nine silos, to achieve a kill probability of more than 80 percent would require a staggering 16–18 warheads per launch site. As a result, we estimate that a 1989 strike against the Soviet ABM system would have required more than 100 ICBMs and SLBMs with more than 200 warheads, for a combined explosive power of 68 megatons (see "Projected U.S. ABM Suppression Strike, 1989," p. 77).

Radioactive fallout from airbursts over the radar facilities would be limited, but the use of many surface or near-surface bursts over the interceptor launch sites would create considerable fallout over Moscow and the surrounding areas. Calculations performed with a U.S. Defense Department computer program, using historical weather patterns for December, show that an unsheltered population in Moscow and outside the city to a distance of 35–75 miles would receive a lethal dose of up to 10,000 rem during the first 48 hours after the attack. The radioactive plume would be carried by prevailing winds for hundreds of miles (see "Fallout From Projected U.S. Attack, 1989," below).

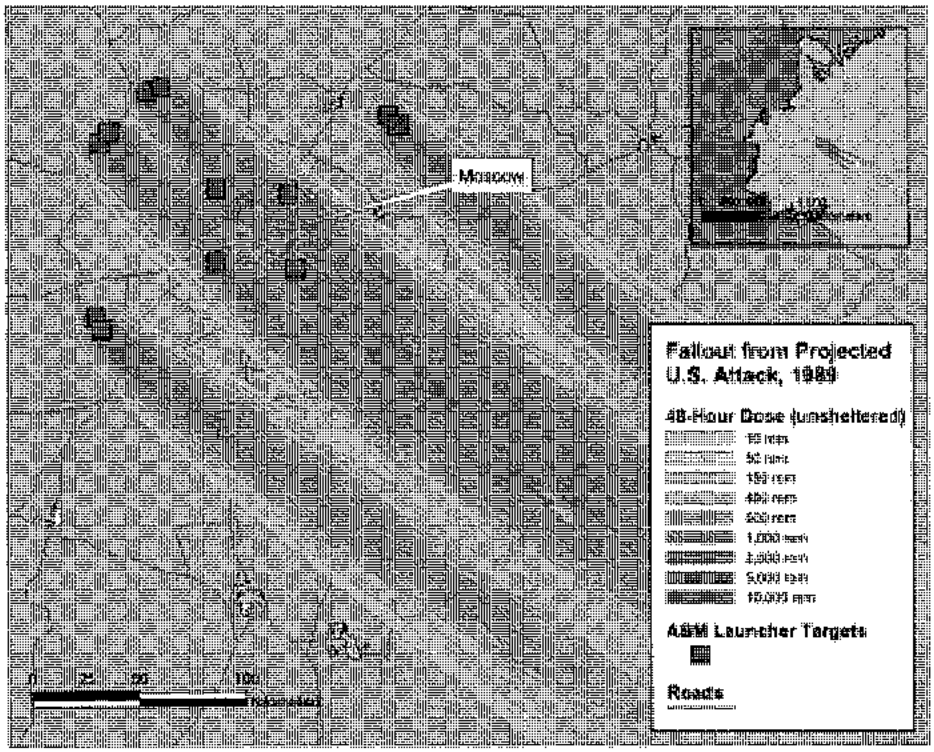
Modern anti-missile defense strike planning

Although U.S. offensive capabilities have changed considerably since 1989 with the advent of the Peacekeeper ICBM and Trident II D5 SLBM, the basic ABM mission remains the same: to destroy the ABM system and then the Russian leadership targets in Moscow, and to ensure penetration of the main ICBM force against Russian silos to the south and east.

In the late 1990s, the effects of the Soviet Union's demise reduced Russian ABM capabilities. The Skrunda radar closed in 1998, leaving a significant gap in Russia's ability to detect submarine missiles launched in shallow trajectories.

The same year, signs began to emerge that the Soviet ABM system was undergoing a more fundamental change—replacement of some or all of the nuclear warheads with *conventional* warheads. In February 1998, the commander in chief of the Strategic Rocket Forces said that the system needed some minor modifications, but that the "nuclear umbrella" over Moscow would once again be opened. A few days later, Col. Gen. Vladimir Yakovlev, commander in chief of strategic missile forces, suddenly declared that the ABM system, with conventional warheads on the Gorgon and Gazelle interceptors, was combat-ready and would be placed on 24-hour alert status.

Shortly thereafter, Gen. Eugene Habiger, U.S. commander of Stratcom, bluntly told reporters: "I'm at odds with the intelligence community regarding the ABM system around Moscow, in terms of its capability. . . . My view is the system is not as capable as the intelligence community says." Habiger added, "The Russians have told me that the system is no longer operational." Two months later, retired Russian generals told a conference in Washington, D.C., that Russia had removed the nuclear warheads from its ABM interceptors and replaced them with conventional warheads.



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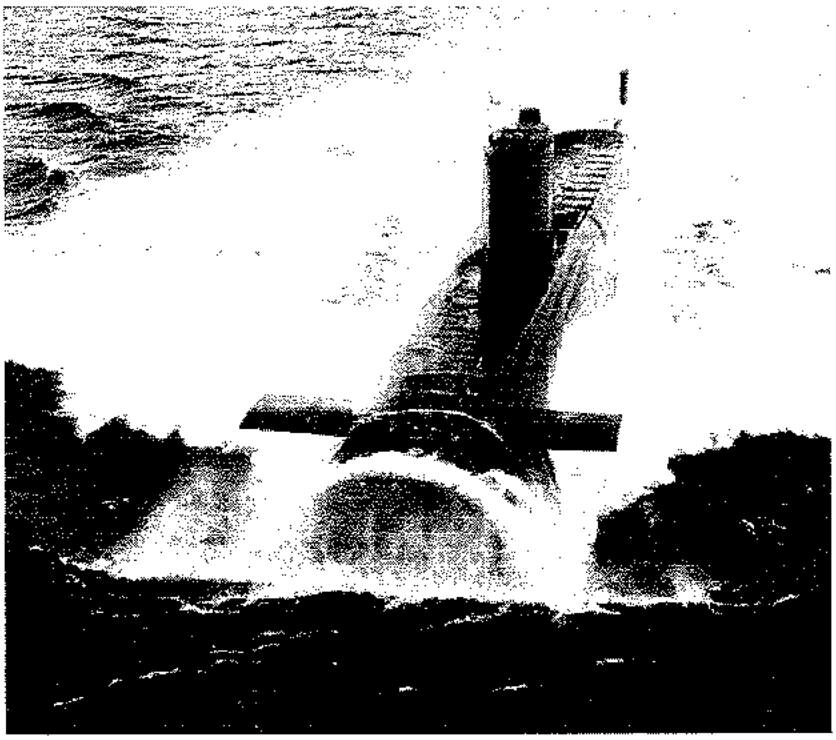

Britain's *Resolution* was armed with nuclear-capable Polaris missiles.

Armada International echoed this in April 2002, reporting that the A-135 system was stood down briefly in 1997–1998 for that purpose.

In contrast with these reports, British Defence Minister George Robertson wrote in late January 1989 to a member of Parliament about the status of the Russian ABM system: "We assess that the Moscow anti-ballistic missile system comprising the short range Gazelle and longer range Gorgon interceptors remains operational and effective. . . . Deployment of any significant upgrades in the near future appears unlikely."

Whether or not the system is still nuclear armed, it appears operational. In November 1999, Russia launched an unarmed Gazelle interceptor from the Moscow system in the first test launch since 1993. The U.S. State Department said the test was "distressing," and that "Russia is raising the specter of an arms competition when what we're trying to do is work cooperatively with them to focus on rogue states."

A second test followed in October 2002, when a long-range Gorgon interceptor was launched from the Sary Shagan test range in Kazakhstan. The test allegedly was part of further improvements to the A-135, and was followed by a Russian simulated attack on the Moscow ABM system. The exercise appears to have been a simulated strike against a future U.S. limited missile defense system.

In 2003, Russia decided to deploy additional SS-19 ICBMs equipped with MIRVed warheads. Russian President Vladimir Putin boasted that "their combat potential, including penetrating through any missile defense systems, is without peers."

This seems to indicate that Moscow is already adjusting its nuclear planning in anticipation of a future U.S. missile defense, much like the U.S. response to the Moscow ABM system in the 1960s. Russia is conducting its strategic planning in the context of the Bush administration's withdrawal from the ABM Treaty and construction of a 100-interceptor missile defense.

And despite the newly declared partnership with Russia, U.S. nuclear planners appear to be refining their nuclear-strike planning against the Russian ABM system. In November 2003, Stratcom initiated a new round of upgrades to its ABM attack-simulation program.

Major U.S. early warning radars are deployed at Thule, Greenland, and Fylingdales, England. (Additional facilities are scheduled to be built in Japan.) If these sites are not already considered high-value targets as central components of a missile defense system, they soon would be—just like the Soviet ABM radars, which became priority targets for U.S. planners.

An upgrade to the Thule and Fylingdales radars is part of the Bush administration's missile defense effort. Whether these facilities might be targets has created some debate in both countries, but the British and Danish governments have both dismissed the risks and agreed to support the Bush plan.

A mug's game

U.S. (and British) nuclear planners responded to the Soviet deployment of a limited missile defense system with enormous firepower. The large number of nuclear weapons that were assigned to overwhelm the Soviet ABM system and the substantial technical efforts the U.S. undertook to defeat it provide chilling examples of the attention missile defense systems attract from hostile nuclear planners. It is a history that fundamentally contradicts the portrayal of missile defenses as non-offensive, threatening no one. Ballistic missile defense systems threaten secured retaliation, and for smaller powers, deterrence itself.

Missile defense systems also indirectly threaten populations. The Soviet ABM system was intended to protect Moscow against nuclear at-

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tacks, but rather than shielding the capital from nuclear peril, the system in fact had the opposite effect of attracting nuclear warheads. Many other facilities would have been targeted in addition to the ABM system, including political and military leadership targets. "We must have targeted Moscow with 400 weapons," a former Stratcom commander has stated.

What is the relevance of this today? One could argue that all of this occurred during the Cold War, that U.S.–Soviet/Russian strategic competition is over, and that smaller nuclear powers do not have enough nuclear weapons to overwhelm missile defense systems. That may or may not be so. But at the superpower level, the action-reaction momentum seems to continue.

The United States apparently still targets the Moscow ABM system, and Russia appears to have begun adjusting its own forces to a future U.S. missile defense. The Bush administration's claim that its system will not be of concern to Russia may be true in a hypothetical Russian first-strike scenario with hundreds of missiles. But Russian planners are likely to be much more concerned with the effect on their surviving retaliatory capability after a hypothetical U.S. first strike has reduced the number of operational missiles. This will almost certainly drive new modernization efforts, newfound U.S.-Russian partnership or not.

For China, the situation is drastically different. The credibility of its nuclear retaliatory deterrent will be fundamentally challenged by a U.S. missile defense system. Ironically, the situation is similar to that in the late 1960s, when China was the "rogue" state used as the justification to build the first limited U.S. missile defense system. Back then, a system with 100 interceptors, the same capacity planned by the Bush administration today, was thought to be capable of reducing U.S. fatalities from a Chinese attack to "possibly zero, if the number [of Chinese missiles] does not reach 25." China today has approximately 20 ICBMs capable of hitting the U.S. mainland.

The current Chinese modernization program began more than a decade ago. The U.S. intelligence community estimates that by 2015, China will increase "several fold" the number of warheads primarily targeted against the United States. The Bush administration's claim that China will continue to modernize whether or not the United States builds missile defenses is a dangerous gamble that ignores the magnitude of the impact on the Chinese deterrent. "That impact will lessen if, as expected, China increases strategic nuclear arms over the next decade," said Stratcom commander Adm. James Ellis in 2001. But the U.S. experience with targeting Soviet missile defenses suggests that even the 75–100 warheads the U.S. intelligence community predicts China will have by 2015 may not be enough for it. The United States needed well over 100 missiles with even more warheads, pen-aids, and SSBNs to overwhelm the 1968 Soviet ABM system. The Chinese reaction to a more capable U.S. missile defense may spark similar changes in China's capabilities, as the CIA predicts: "MIRVing and missile defense countermeasures would be factors in the ultimate size of the force."

In the longer run, a missile defense system could also cause a doctrinal change, prompting China to abandon its purely retaliatory posture and replace it with counterforce targeting similar to that of the United States and Russia. As Admiral Ellis explained, "the more effective a U.S. missile defense system is in diminishing [the] retaliatory capability of Russian and Chinese deterrent forces, the greater the incentive for expansion of these forces to maintain their perceived deterrent effect."

The dynamics of nuclear competition and the history of the U.S. targeting of the Soviet ABM system remind us that missile defense systems are potent drivers of offensive nuclear planning. The missile defense that the Bush administration is building will be no exception, despite its limited capability, and it will almost certainly attract nuclear targeting from the start.

Projected U.S. ABM suppression strike, 1989

Target	Weapon*		Warhead		Total	
	Type	No.	Type	Yield (kt)	Warheads	Yield (kt)
Moscow system						
Cat House radar	Trident I C4	1	W76	100	2	200
Dog House radar	Trident I C4	1	W76	100	2	200
4 Gorgon launch complexes	Minuteman III	32	W78	335	64	21,440
4 Gazelle launch complexes	Minuteman III	68	W78	335	136	45,560
Subtotal		*102*			*204*	*67,400*
Early warning radars**						
Hen House radar (Olenegorsk)	Trident I C4	1	W76	100	2	200
LPAR radar (Skrunda)	Trident I C4	1	W76	100	2	200
LPAR radar (Baranovichi)	Trident I C4	1	W76	100	2	200
Subtotal		*3*			*6*	*600*
Total		**105**			**210**	**68,000**

kt=kilotons. *We assume each Gorgon launch complex was targeted by eight Minuteman III missiles, each carrying two 335-kiloton W78 warheads; that each Gazelle complex was targeted by nine Minuteman III missiles, also each carrying two W78s; and that each Trident was downloaded to at least two warheads. Both Moscow radars could also be targeted by warheads from a single missile. **The LPAR and Pillbox radars at Pechora and Moscow, respectively, were under construction in 1989, and would later be targeted as well.

Attachment 31

NATURAL RESOURCES DEFENSE COUNCIL

The Cheney Energy Task Force

A review and analysis of the proceedings leading to the Bush administration's formulation of its May 2001 energy policy.

In the spring of 2002, under order from a federal judge, the U.S. Department of Energy released to NRDC roughly 13,500 pages relating to previously secret proceedings of the Bush administration's energy task force. (President Bush formed the task force in early 2001 to develop a national energy policy, with Vice President Cheney at the helm.) Even though the government heavily censored the documents before supplying them to NRDC, they reveal that Bush administration officials sought extensive advice from utility companies and the oil, gas, coal and nuclear energy industries, and incorporated their recommendations, often word for word, into the energy plan.

See What the Records Reveal
Excerpts from Pages of Interest
Search the Task Force Records

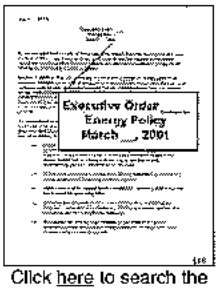
And what they don't:
DOE's index of withheld documents

NRDC's Analysis of the Records
Federal Court Orders Release of Cheney Energy Task Force Records
(Press Release, 4/1/04)
Energy Dept. Documents Verify Industry Influence
(Press Release, 5/21/02)
Industry had Extensive Access to Energy Task Force
(Press Release, 5/21/02)
Industry Writes Energy Task Force Report
(Press Release, 3/27/02)
DOE's False Claim that Green Groups Participated

Background
How NRDC Brought the Records to Light
Related Legal Actions

Related NRDC Webpages
Slower, Costlier, Dirtier
Responsible Energy Policy for the 21st Century

last revised 4.5.04



Click here to search the task force records.

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NATURAL RESOURCES DEFENSE COUNCIL

The Cheney Energy Task Force
A review and analysis of the proceedings leading to the Bush administration's formulation of its May 2001 energy policy.

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How NRDC Brought the Records to Light

In early 2001, Vice President Dick Cheney presided over a task force charged with setting a new national energy policy. For months high-ranking Bush administration officials met in secret with lobbyists and executives from utility companies and the oil, gas, coal and nuclear energy industries. In May 2001 the task force released its recommendations: more subsidies to polluting industries, more reliance on oil, more nuclear power. Despite NRDC's repeated requests for information, the Bush administration refused to disclose the names of industry participants in the task force or what they discussed with Bush policymakers.
In April 2001 NRDC filed a request under the Freedom of Information Act for access to the task force's records; the Bush administration refused to comply. NRDC filed suit, and a federal judge ordered the administration to turn over the documents. On March 25, 2002, nearly a year after first requesting them, NRDC received roughly 10,000 pages relating to the task force from the Department of Energy. Subsequently the department provided another 3,500 pages, but withheld more than 16,000 others.

On April 25 the Energy Department produced (again, under the judge's order) its "Vaughn index," which lists the task force documents the Energy Department has withheld in whole or in part.*

NRDC continues to challenge in court the Energy Department's efforts to maintain secrecy surrounding the task force deliberations.

*The Energy Department later determined that 16 pages withheld and listed on the Vaughn index could in fact be released, and provided them on June 3.

Press Releases

- May 21, 2002 - Energy Dept. Documents Verify Industry Influence
- May 21, 2002 - Industry had Extensive Access to Energy Task Force
- May 10, 2002 - Bush Admin. Continues to Deny Public's Right to Know
- April 26, 2002 - Energy Dept. Releases Index of Missing Documents
- April 11, 2002 - Energy Dept. Still Stonewalling
- March 27, 2002 - Heavily Censored Papers Show Industry Writes Energy Report
- Feb 27, 2002 - NRDC To Obtain Task Force Records
- January 30, 2002 - NRDC Asks Court To Force Immediate Release
- January 24, 2002 - Administration Snubs Lawsuit Seeking Facts On Task Force
- December 11, 2001 - NRDC Sues Department of Energy

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NATURAL RESOURCES DEFENSE COUNCIL

The Cheney Energy Task Force
A review and analysis of the proceedings leading to the Bush administration's formulation of its May 2001 energy policy.

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What the Documents Reveal

Before turning over the energy task force records to NRDC, the Bush administration removed extensive portions of information. Some pages were empty. Whole strings of correspondence were stripped to just a few words.

Yet even with this censorship the records reveal that industry lobbyists not only played a pivotal role in developing the administration's national energy strategy, they wrote much of it themselves. The administration sought the advice of polluting corporations early and often and then incorporated their recommendations into its policy, sometimes verbatim.

The following pages, while a tiny sampling of the task force records, illustrate both the influence industry lobbyists wielded and the degree to which the Bush administration continues to try to cloak the task force's proceedings in secrecy.

This blank page is typical of many of the documents the Department of Energy provided -- under court order

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This document and others like it may not provide many facts, but they do offer information about the extraordinary shroud of secrecy the Bush administration has wrapped around the energy task force.

I hope this information helps,
PJD

Everything else from the original document was removed before the Department of Energy turned this over to NRDC.

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In attachments accompanying this March 2001 email, Jim Ford of the American Petroleum Institute suggests wording for a presidential order giving special consideration to oil companies. In May 2001, President Bush indeed issued an executive order much like API's proposal.

Kelliher, Joseph

From: Jim Ford [Fordj@api.org]
Sent: Tuesday, March 20, 2001 2:51 PM
To: Kelliher, Joseph
Subject: Recommendations on National Energy Policy

Importance: High

HB Energy Intro 1.doc | HB Energy Upstream 2.doc | HB Energy Downstream 2.doc | HB Energy Marine 1.doc | HB Deepwater White Paper.doc | HB EPACT Impact Analysis.doc | HB Deepwater White Paper.doc | HB SPR.doc | HB RIK White Paper.doc | Energy EO Text.doc

Hi, Joe. As we discussed, attached are a set of papers on national energy policy recommendations. Much of it is designed to be self-explanatory. The last document is a suggested executive order to ensure that energy implications are considered and acted on in rulemakings and other executive actions. This draft has DOE as the coordinator. Probably also need to make energy a major portfolio item for a senior White House aide.

Let me know if you have questions or additional info needs. Thanks.

Jim Ford
682-8210
fordj@api.org <mailto:fordj@api.org>

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DOE002-0131

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The proposed executive order drafted by the American Petroleum Institute calls for federal agencies to issue a detailed statement on any action that "adversely affects energy supply, distribution or use."

Page 1 6/10/2001

Executive Order ____
Energy Policy
March __, 2001

By the authority vested in me as President of the United States by the Constitution and the laws of the United States of America, in order to help the Federal Government coordinate a national effort to ensure reliable and affordable supplies of energy for all Americans, it is hereby ordered as follows:

Section 1. Policy. It is critical that the United States develop an energy policy that increases domestic production of energy in an environmentally responsible manner, and promotes development of new technologies that can conserve fossil fuels and reduce energy-related pollution. Furthermore, given the projected 25 percent increase in demand for motor vehicle fuels by 2020 in the United States, it is critical that the United States develop an energy policy that expedites the expansion of facilities critical to production, transportation, and manufacturing of oil, natural gas, and petroleum products.

It is imperative that agencies consider the energy implications of environmental and other regulatory actions to avoid unintended and inordinate complications in energy production and supply. The following principles should guide agency decisions that may affect energy matters:

(a) Energy is a central part of the global economy in which supply and demand are best satisfied through free markets and private sector initiatives. Government policies that minimize interference with a free-market system will contribute to fewer supply disruptions and, consequently, will help moderate price variability.

(b) U.S. national security and economic vitality are enhanced by diversifying energy sources and increasing domestic supplies.

(c) Government policies should create a predictable operating and investment environment for energy suppliers.

(d) Environmental concerns must be addressed but free-market-based incentives, rather than governmental command and control, provide the best foundation for cost-effective solutions.

(e) Technology can help increase supplies, lower costs and improve environmental performance and energy efficiency, meriting both private initiative and government support.

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In essence this policy requires federal agencies charged with protecting Americans' health and environment -- including the Environmental Protection Agency, the Food and Drug Administration and the Federal Aviation Administration -- to evaluate the affect of their actions on oil companies.

Section 2. Consultation with Secretary of Energy Required. All federal agencies shall include in any regulatory action that could significantly and adversely affect energy supplies, distribution, or use, a detailed statement on (i) the energy impact of the proposed action, (ii) any adverse energy effects which cannot be avoided should the proposal be implemented, and (iii) alternatives to the proposed action. Prior to taking such regulatory action, the agency shall consult with, and obtain the concurrence of, the Secretary of Energy. The agencies' actions directed by this Executive Order shall be carried out to the extent permitted by law.

Section 3. Existing Regulations. To ensure that all existing rules, regulations, and agency policies are consistent with the President's priorities and the principles set forth in this Executive order, within applicable law, each agency shall within 90 days of the date of this Executive order, submit to the Director of the Office of Management and Budget a program under which the agency will periodically review its existing rules, regulations and policies to determine whether any such rules, regulations or policies could significantly and adversely affect energy supplies, distribution, or use and whether, after consultation with the Secretary of Energy, any such rule, regulation or policy should be modified or eliminated so as to make the agency's regulatory program in greater alignment with the President's priorities and the principles set forth in this Executive order. Any rules, regulations or policies selected for review shall be included in the agency's annual plan. The agency shall also identify any legislative mandates that require the agency to promulgate or continue to impose regulations that the agency believes are inconsistent with the policies set forth in this Executive order.

Sec. 4. Resolution of Conflicts. To the extent permitted by law, disagreements or conflicts between the Secretary of Energy and other agency heads that cannot be resolved by the Secretary of Energy and the other agency head shall be resolved by the President, or by the Vice President acting at the request of the President, with the Secretary of Energy and the other relevant agency head (and, as appropriate, other interested government officials). Vice Presidential and Presidential consideration of such disagreements may be initiated only by the Secretary of Energy, the head of the issuing agency, or by the head of an agency that has a significant interest in the regulatory action at issue. Such review will not be undertaken at the request of other persons, entities, or their agents.

Section 5. Definitions.

(a) "Agency," means any authority of the United States that is an "agency" under 44 U.S.C. 3502(1).

(b) "Regulation" or "rule" means an agency statement of general applicability and future effect, which the agency intends to have the force and effect of law, that is designed to implement, interpret, or prescribe law or policy or to describe the procedure or practice requirements of an agency.

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(c) "Regulatory action" means any substantive action by an agency that promulgates or is expected to lead to the promulgation of a rule, regulation or policy, including, but not limited to, notices of inquiry, advance notices of proposed rulemaking, notices of proposed rulemaking, and guidance documents.

Section 5. Judicial Review. This order does not create any right or benefit, substantive or procedural, enforceable at law or equity by a party against the United States, its agencies or instrumentalities, its officers or employees, or any other person.

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On May 18, 2001, President Bush issued an executive order remarkably similiar in structure, scope and language to the draft submitted two months earlier by the American Petroleum Institute.

Federal Register / Vol. 66, No. 99 / Tuesday, May 22, 2001 / Presidential Documents 28355

Presidential Documents

Executive Order 13211 of May 18, 2001

Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use

By the authority vested in me as President by the Constitution and the laws of the United States of America, and in order to appropriately weigh and consider the effects of the Federal Government's regulations on the supply, distribution, and use of energy, it is hereby ordered as follows:

Section 1. *Policy.* The Federal Government can significantly affect the supply, distribution, and use of energy. Yet there is often too little information regarding the effects that governmental regulatory action can have on energy. In order to provide more useful energy-related information and hence improve the quality of agency decisionmaking, I am requiring that agencies shall prepare a Statement of Energy Effects when undertaking certain agency actions. As described more fully below, such Statements of Energy Effects shall describe the effects of certain regulatory actions on energy supply, distribution, or use.

Sec. 2. *Preparation of a Statement of Energy Effects.* (a) To the extent permitted by law, agencies shall prepare and submit a Statement of Energy Effects to the Administrator of the Office of Information and Regulatory Affairs, Office of Management and Budget, for those matters identified as significant energy actions.

(b) A Statement of Energy Effects shall consist of a detailed statement by the agency responsible for the significant energy action relating to:

(i) any adverse effects on energy supply, distribution, or use (including a shortfall in supply, price increases, and increased use of foreign supplies) should the proposal be implemented, and

(ii) reasonable alternatives to the action with adverse energy effects and the expected effects of such alternatives on energy supply, distribution, and use.

(c) The Administrator of the Office of Information and Regulatory Affairs shall provide guidance to the agencies on the implementation of this order and shall consult with other agencies as appropriate in the implementation of this order.

Sec. 3. *Submission and Publication of Statements.* (a) Agencies shall submit their Statements of Energy Effects to the Administrator of the Office of Information and Regulatory Affairs, Office of Management and Budget, whenever they present the related submission under Executive Order 12866 of September 30, 1993, or any successor order.

(b) Agencies shall publish their Statements of Energy Effects, or a summary thereof, in each related Notice of Proposed Rulemaking and in any resulting Final Rule.

Sec. 4. *Definitions.* For purposes of this order:

(a) "Regulation" and "rule" have the same meaning as they do in Executive Order 12866 or any successor order.

(b) "Significant energy action" means any action by an agency (normally published in the **Federal Register**) that promulgates or is expected to lead to the promulgation of a final rule or regulation, including notices of inquiry, advance notices of proposed rulemaking, and notices of proposed rulemaking:

(1)(i) that is a significant regulatory action under Executive Order 12866 or any successor order, and

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(ii) is likely to have a significant adverse effect on the supply, distribution, or use of energy; or

(2) that is designated by the Administrator of the Office of Information and Regulatory Affairs as a significant energy action.

(c) "Agency" means any authority of the United States that is an "agency" under 44 U.S.C. 3502(1), other than those considered to be independent regulatory agencies, as defined in 44 U.S.C. 3502(5).

Sec. 5. *Judicial Review.* Nothing in this order shall affect any otherwise available judicial review of agency action. This order is intended only to improve the internal management of the Federal Government and does not create any right or benefit, substantive or procedural, enforceable at law or equity by a party against the United States, its agencies or instrumentalities, its officers or employees, or any other person.

THE WHITE HOUSE,
May 18, 2001.

[FR Doc. 01-12815
Filed 5-21-01; 10:13 am]
Billing code 3195-01-P

A second executive order issued on May 18 eased industry's access to gas reserves on public lands. The American Gas Association's proposed legislative language appears in the task force records; a side-by-side comparison of this industry-requested language and the subsequent executive order again shows that polluters were able to write their own rules by putting words in the president's mouth. Click here for a PDF file (261k) of the AGA's language; you can see the executive order online as published in the Federal Register.

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In this message a lobbyist from the Southern Company (an electric utility based in Atlanta, Georgia) writes to an Energy Department official suggesting that "reforming" the Clean Air Act and its enforcement be included in the energy plan.

Kelliher, Joseph

R. Cooper

(17)

From: Rilth, Michael J. [MJRilth@southernco.com]
Sent: Friday, March 23, 2001 9:43 AM
To: Kelliher, Joseph
Subject: NSR and Energy Strategy

Importance: High

A National Energy Strategy Sho...

Good morning.

This is the document I told you was in "the works" on NSR in relation to the
national energy strategy. As promised, it is attached.

I hope this is helpful. After talking with you yesterday, the last thing
you need is another issue to deal with. Thanks for your consideration.

Again, I look forward to lunch on Tuesday.

Best regards,

Mike

<<A National Energy Strategy Should Include Reform of EPA.doc>>

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Here the Southern Company recommends that the Bush administration reverse the Environmental Protection Agency's enforcement of "New Source Review" requirements for power plants. Through the exemption of "grandfathered" facilities, many older power plants are allowed to generate much more pollution than newer plants. The New Source Review program of the Clean Air Act requires utility companies to install pollution-cutting technologies at these plants when they undertake other upgrades.

A National Energy Strategy Should Include Reform of EPA's New Source Review Program

The Federal Clean Air Act established a "New Source Review" permitting program for industrial facilities that undergo "modifications" as defined in the Act and by the EPA could trigger a process called "New Source Review". This permitting process requires a detailed review by the EPA of modifications as well as possible retrofitting of additional pollution control equipment on the facility. In 1980, EPA adopted rules to implement the NSR program and these rules were amended in 1992 for facilities in the electric utility industry.

EPA's historical interpretation allowed plants to be maintained and repaired.
These rules and EPA's historical interpretation have generally been consistent with the intent of the statute, only focusing on changes or modifications that increased a facility's maximum achievable emission rate and not merely on more hours of operation. The rules also excluded from scrutiny routine repair and replacement of equipment and efficiency improvements at facilities from the definition of what constitutes modification. In a proposed, but never finalized, 1996 rule and in recent legal actions EPA has re-interpreted these regulations in extreme ways that not only places in legal jeopardy past work conducted at facilities but also threatens the safe, reliable and efficient operation of energy production facilities across the country.

EPA's new interpretation makes maintenance and repair subject to NSR.
EPA's re-interpretation of the NSR rules discourages any repair or replacement project that might make an electric utility generating unit more available to operate – projects that improve the safety, efficiency or reliability of the unit. These are the types of projects that are necessary for utilities to operate their units in a manner consistent with their duty to provide a reliable supply of electricity to their customers and to assure safe operations for their employees. Projects, like these, that only allow units to operate more hours have never been considered projects that trigger NSR modification requirements unless they also increase the design capacity of the unit to emit pollutants (*i.e.*, increase the maximum achievable emission rate). EPA's new interpretation brings into question any project that could enable a unit to operate more hours in the future than it had in the past.

EPA's new interpretation defines "routine" very narrowly.
EPA's modification requirements also do not apply to repair or replacement activities that are "routine" in the utility industry. In the final days of the Clinton Administration, EPA published in the Federal Register a notice announcing a Region V NSR applicability determination, affirmed by Administrator Browner, involving a turbine repair project at Detroit Edison's Monroe Power plant. In that determination, EPA established a 24 factor test that could render virtually any

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The Southern Company's suggestion was incorporated into the energy plan, launching the Bush administration's controversial effort to weaken the Clean Air Act and retreat from legal action against the nation's biggest polluters -- including the Southern Company.

project that improved efficiency or reliability at an existing electric utility boiler "non routine" and therefore potentially subject to NSR permitting requirements. This determination creates a serious regulatory impediment to utilities undertaking the type of projects that provide the only short-term hope of expanding existing generating capacity (*i.e.*, efficiency improvements) and of maintaining the availability of existing generation (*i.e.*, reliability improvement projects). The Utility Air Regulatory Group (UARG) has filed a "protective" petition to review that decision in the D.C. Circuit.

EPA's new interpretation threatens electricity reliability and efficiency. EPA's current interpretation of the NSR rules are counter to the need for the important safe, reliable and efficient operation of electric utility generating units across the nation. Especially in the energy short western U.S., the ability to maintain and operate generation could be compromised by EPA's current position. Put succinctly, the routine maintenance and repair of electric utility plants such has been performed in the industry over the last seventy-five years is not lawful under EPA's current interpretation.

A National Energy Strategy should reaffirm EPA's historical interpretations. A National Energy Strategy that is focused on increasing supply should find ways to resolve the inconsistency between the Strategy's goals and EPA's current NSR interpretation. This could be accomplished by EPA's confirmation of the historical approach to the NSR modification requirements which would exclude from NSR review projects that are routine repair and replacement and allow utilities and other industries to move forward with needed projects so long as the projects do not increase the maximum achievable emission rate of a unit. This reaffirmation of historical interpretations would insure the reliable supply of electric energy and would not negatively impact air quality.

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NRDC
THE EARTH'S BEST DEFENSE

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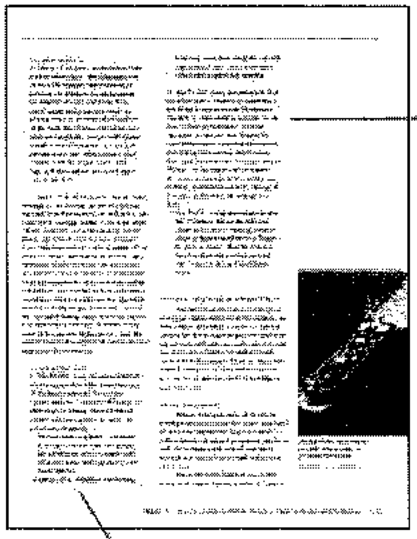
This excerpt from the energy task force's May 2001 report (page 7-14) reflects the Southern Company's recommendation regarding the New Source Review program of the Clean Air Act.



Recommendations:

* The NEPD Group recommends that the President direct the Administrator of the Environmental Protection Agency and the Secretary of Energy to take steps to ensure America has adequate refining capacity to meet the needs of consumers.
  - Provide more regulatory certainty to refinery owners and streamline the permitting process where possible to ensure that regulatory overlap is limited.
  - Adopt comprehensive regulations (covering more than one pollutant and requirement) and consider the rules' cumulative impacts and benefits.

* The NEPD Group recommends that the President to direct the Administrator of the Environmental Protection Agency, in consultation with the Secretary of Energy and other relevant agencies, to review New Source Review regulations, including administrative interpretation and implementation, and report to the President within 90 days on the impact of the regulations on investment in new utility and refinery generation capacity, energy efficiency, and environmental protection.
  - The NEPD Group recommends that the President direct the Attorney General to review existing enforcement actions regarding New Source Review to ensure that the enforcement actions are consistent with the Clean Air Act and its regulations.

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In these partially censored internal Department of Energy emails, Thomas Grahame* conveys to Robert Kripowicz* information received from the Edison Electric Institute on railroad rates and regulations as they relate to coal power plants. In the second (top) message, sent two hours later, Kripowicz forwards Grahame's message to Joseph Kelliher* with the news that, "This ends my chapter on coal transportation!"

b5

Kelliher, Joseph

From: Kripowicz, Robert
Sent: Thursday, April 05, 2001 4:26 PM
To: Kelliher, Joseph
Subject: FW: RR rates and regs, as they apply to coal power plants, possible recommendation

This ends my chapter on coal transportation!

Bob

-----Original Message-----
From: Grahame, Thomas
Sent: Thursday, April 05, 2001 2:47 PM
To: Kripowicz, Robert
Cc: Rusins, George; Carter, Douglas
Subject: RR rates and regs, as they apply to coal power plants, possible recommendation

Bob: I have now spoken with Fred Davis at EEI and to Bob Szabo at Van Ness, Feldman, on this issue. Chuck Lindeman suggested by yesterday's voice mail that I contact both in his absence.

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*These are the titles listed on the Energy Department website for the staff members mentioned above:
Joseph T. Kelliher, Senior Policy Advisor to the Secretary
Robert S. Kripowicz, Principal Deputy Assistant Secretary, Fossil Energy
Thomas Grahame, Coal Technology Analyst

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With this email, Bob Slaughter of the National Petrochemical Refiners' Association sent an attachment to Joseph Kelliher at the Energy Department describing the industry group's "current thinking as to what changes in national energy policy are needed to help the refining sector." Among the recommendations: "The EPA's enforcement campaign against U.S. refineries should be halted and reexamined."

D10

Kelliher, Joseph

From: Slaughter, Bob [Bob_Slaughter@nprade.org]
Sent: Thursday, March 22, 2001 3:52 PM
To: Kelliher, Joseph
Cc: Anthony, Betty; Sternfels, Urvan
Subject: NPRA Recommendations on National Energy Policy

natenergypoli.doc

Joe Kelliher: Attached is a short document which includes NPRA's current thinking as to what changes in national energy policy are needed to help the refining sector.

I would like specifically to highlight three:

One. We believe that the Administration is missing an important opportunity to improve energy policy by not addressing the onroad diesel sulfur rule. This rule will have a greater adverse supply impact than any other in the next five years and should be reviewed. Instead of requiring essentially 100% of onroad diesel output to be reduced from 500 ppm to 15 ppm sulfur by mid-2006, at a cost of $8 billion, the Administration could move the required supply date back to 2008-9 and provide a reduction in the diesel excise tax for 15ppm sulfur diesel sold in advance of the 2006 date. This could provide all the necessary supply for new trucks which need the diesel in 2006-7 (probably only 5% of demand). There are no environmental benefits from using the new diesel in old truck engines, so the program in its current form constitutes massive waste, since these trucks aren't a sufficient force in the market until 2009 at the earliest. This change will help prevent loss of diesel supply and refinery closures which will take place under the rule in its current form. The overall benefits of the program are not reduced. We would like to talk with you more on this.

Two. The EPA's enforcement campaign against U.S. refineries should be halted and reexamined. As you know, it is impossible to build new refineries, so the industry has had to add capacity at existing sites in an attempt to maintain an adequate supply of products for consumers in the past twenty years. Even at that, the industry has been able to keep U.S. capacity only flat over the past decade, so new demand has been met by increased imports of refined products. The Browner EPA launched an extensive and coordinated campaign against the industry, alleging that capacity additions during the past twenty years were not appropriately permitted. This despite the fact that refinery improvements were made with the knowledge of both state and federal environmental agencies and in keeping with permitting requirements as they were understood at that time. The EPA

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DOE012-0393

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has sent section 114 requests, in effect blanket subpoenas, to most refiners, and many are now facing notices of violation and legal action. A few have settled because they believe that it is easier to pay a fine, sign a consent decree and move forward than resist. All this comes at a time when federal and state authorities have urged the industry to continue its herculean efforts to produce product all-out to avoid shortages. EPA's actions are really nothing more than an attempt to discredit the industry and collect tribute in the form of fines in order to allow refiners to get on with their business. We believe that everyone in the industry should obey the law, and we believe that they do, often under difficult circumstances. But this activity goes far beyond the pale of reasonable enforcement activity and should cease.

Three. The Unocal patents, recently upheld by a federal court of appeals in a decision that the Supreme Court let stand, provide no real benefit to the industry or consumers. The huge royalties granted by a California District Court-- 5.3/4 cents/gallon--are far in excess of the cost of even the reformulated gasoline program and may well cost consumers over $200 million per year when implemented. The existence of the payents will increase the cost of gasoline, reduce supply, and eliminate all of the incentive for overcompliance with environmental regulations. The patent will also make it even harder to use ethanol in gasoline where ozone problems exist during the summer months (e.g. Chicago and Milwaukee). The Administration should study this issue and take steps to put any royalty collections on hold. Otherwise, this situation will affect Midwestern and East Coast gasoline supplies adversely this summer, as it did last year.

The rest of our thinking is attached. Thank you for your call yesterday. I'm available to discuss these matters with you at any time.

Bob Slaughter
NPRA 202.457.0480 x 152; home 202

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<<natenergypol2.doc>>

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This June 2001 email is to Francis Blake, then deputy secretary of energy, from Kyle McSlarrow, chief of staff to Secretary Abraham. Illustrating the close ties between the current Department of Energy and the industries it governs, McSlarrow points out that he inadvertently sent a message to Blake at the deputy secretary's former email address at General Electric.

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Marble, Alethia

From: McSlarrow, Kyle
Sent: Tuesday, June 12, 2001 4:13 PM
To: Blake, Francis
Subject: FW: POTUS event on Vampires

Sorry. I accidentally sent this to your old GE email.

-----Original Message-----
From: McSlarrow, Kyle
Sent: Tuesday, June 12, 2001 2:44 PM
To: Frank Blake (E-mail); Garman, David; Reed, Craig; Kolevar, Kevin; Faulkner, Doug
Subject: FW: POTUS event on Vampires

Frank, et al:

K

-----Original Message-----
From: Robert_C._McNally@opd.eop.gov%internet
[mailto:Robert_C._McNally@opd.eop.gov]
Sent: Tuesday, June 12, 2001 1:54 PM
To: McSlarrow, Kyle
Cc: D._Marcus_Sumerlin@opd.eop.gov%internet; Kevin_J._Martin@opd.eop.gov%internet; John_M._Ackerly@opd.eop.gov%internet
Subject: POTUS event on Vampires

Kyle--

Thanks,
Rob

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Attachment 32

Westlaw. NewsRoom

3/28/02 L.A. Times 22
2002 WLNR 12435234

Los Angeles Times
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March 28, 2002

Section: Main News

The Nation
Bush Gets One-Two Punch on Energy
ELIZABETH SHOGREN
TIMES STAFF WRITERS

WASHINGTON The Bush administration's contacts with energy industry lobbyists and campaign contributors, including Enron Corp., came under increased scrutiny on two fronts Wednesday.

Sen. Joseph I. Lieberman (D-Conn.), chairman of the Governmental Affairs Committee, asked the White House to disclose its contacts with Enron as part of a congressional probe into the energy giant's collapse.

And environmentalists asked a federal judge to order a hearing on what they call "stonewalling" by the Energy Department in the release of documents related to the administration's meetings with industry groups during drafting of a national energy policy.

"Too many watchdogs failed to bark" during the Enron debacle, Lieberman said. "I will not hesitate to ask for anything that helps us to investigate . . . what the federal government might have done to prevent, or at least anticipate, Enron's demise."

The White House is reviewing Lieberman's letter to White House Chief of Staff Andrew H. Card Jr., said spokeswoman Anne Womack. But, she added, "I think the American people are pretty sick and tired of these kinds of open-ended fishing expeditions."

Lieberman also asked the U.S. archivist for information on contacts between federal agencies and Enron dating back to 1992, a period that would cover the Clinton administration.

The Bush administration has acknowledged that Enron officials met six times with

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members of the energy task force, including once with Vice President Dick Cheney, who headed it.

In court papers filed Wednesday seeking a contempt-of-court ruling, the Natural Resources Defense Council accused the Energy Department of delaying the release of the documents in order to engage in "spin" control. The council had sued for access to the papers, which it first sought almost a year ago under the Freedom of Information Act.

In response, Energy Department spokeswoman Jeanne Lopatto said the department met the midnight deadline, adding: "I suspect NRDC may be upset because their photo op was disrupted, but that's not contempt of court."

Judicial Watch, a conservative watchdog group that also sued for access to energy documents, plans to ask a court to force the administration to justify why so much information was deleted from the documents and why 15,000 pages were withheld. The Freedom of Information Act allows the government to withhold information that relates to the government's "deliberative process."

Lieberman's letter and the new court filing were the latest rounds in the legal and political fight over the role played by special interests in shaping the task force's work.

Critics of the administration's policy have seized on documents showing that Energy Secretary Spencer Abraham, a key task force member, held numerous meetings with industry representatives but none with environmental groups while the plan, released in May, was being drafted.

Environmentalists contend that the administration's plan, now before the Democratic-controlled Senate, is tilted toward energy production, while they favor more emphasis on conservation.

"The Bush administration did develop an energy policy that was clearly written by the utility industry and oil and gas companies," said Debbie Sease, the Sierra Club's national legislative director. "The House passed a bill that was just as bad or worse. The Senate started out with a good bill . . . but it's being picked apart, vote by vote, to the point that unless it gets fixed, it's not going to be acceptable energy policy either."

Officials at the Natural Resources Defense Council asserted that the documents released this week show "the oil companies seem to be putting words in our president's mouth," as the environmental group's lawyer, Sharon Buccino, put it.

The council produced a "suggested" presidential executive order written by the American Petroleum Institute on March 20, 2001. API's language--seeking to require federal agencies to assess the effects of proposed regulations on energy supplies--turned up in an executive order issued by President Bush two months later, the environmental group said.

Complaining about the industry's influence, the council also cited a March 2001 e-mail from a lobbyist for the Southern Co., an electric utility, seeking a review of the new source review provision of the Clean Air Act. This requires plants to

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install state-of-the-art pollution control devices when they renovate their plants in a way that increases pollution.

The administration's energy plan later called for a review of the rule.

The administration contends that its energy plan is balanced, including some measures sought by environmentalists and omitting many sought by industry. An Energy Department spokesman said, for example, that API made 25 recommendations, but only four were included in the energy plan.

---- INDEX REFERENCES ----

COMPANY: INTERNORTH INC; ADVANCED PHOTONIX INC; NORTHERN NATURAL GAS CO; AGENCE DE PROMOTION DE L'INDUSTRIE; AMERICAN PETROLEUM INSTITUTE; HNG INTERNORTH; ENRON CORP; BIDDER COMMUNICATIONS INC; SIERRA CLUB; ENERGY AND ENGINE TECHNOLOGY CORP; STRATTON MONTHLY DIVIDEND SHARES INC; SOUTHERN CO (THE)

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Attachment 33

NRDC
THE EARTH'S BEST DEFENSE

NATURAL RESOURCES DEFENSE COUNCIL

Press Release

Main page | Archive

FOR IMMEDIATE RELEASE
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Confidential Papers Show Exxon Hand in White House Move to Oust Top Scientist from International Global Warming Panel

Oil Company Memo Calls for Dr. Watson's Dismissal; Administration Obliges
WASHINGTON (April 3, 2002) – The Bush administration this week moved to oust a top scientific official targeted by ExxonMobil in a confidential memo to the White House. Bold language in the ExxonMobil papers released today by NRDC (the Natural Resources Defense Council) reflects a brazen, behind-the-scenes effort by the oil company and other energy giants to disrupt the principal international science assessment program on global warming.

Dr. Robert Watson, a highly respected atmospheric scientist, has been chair of the Intergovernmental Panel on Climate Change (IPCC) since 1996. Operating under United Nations auspices, the 2500-member expert panel provides policymakers around the world with rigorous, consensus-based assessments generally regarded as the most authoritative word on global warming and its causes.

Without formal announcement, the administration has decided to oppose Watson's appointment to a second term as IPCC chair, seriously damaging his prospects when representatives of more than 100 governments meet in Geneva April 17-20 to elect a new IPCC head.

The memorandum, obtained by NRDC from the White House Council on Environmental Quality under the Freedom of Information Act, shows that ExxonMobil began a secret campaign for Dr. Watson's removal in the first weeks of the Bush administration, and reveals ExxonMobil's intention to replace Watson and other key scientists with contrarians known for disagreeing with the prevailing consensus that man-made pollution is causing global warming.

In meetings this week with State Department officials, lobbyists for the coal industry, electric utilities, and automakers joined ExxonMobil's call to replace Watson.

"It's bad enough that ExxonMobil controls White House energy and climate policies," said Daniel Lashof, science director of the NRDC Climate Center. "Now they want to control the science too."

Under Watson's tenure, the IPCC last year produced its third comprehensive assessment of the state of climate science, concluding that "[t]here is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities," and predicting that average global temperatures will rise between 3 and 10 degrees Fahrenheit by the end of the century -- conclusions reaffirmed last spring at White House request by the National Academy of Sciences.

In a letter yesterday to Undersecretary of State Paula Dobriansky, NRDC's Lashof said: "The industry effort to block the reappointment of Dr. Watson is a thinly veiled attempt to undermine the effectiveness of the IPCC as a body that produces high quality, objective scientific assessments. I urge you to reject this campaign and to give Dr. Watson the United States' strongest possible support."

The Natural Resources Defense Council is a national, non-profit organization of scientists, lawyers and environmental specialists dedicated to protecting public health and the environment. Founded in 1970, NRDC has more than 500,000 members nationwide, served from offices in New York, Washington, Los Angeles and San Francisco.

Additional Downloadable Materials for the Press
ExxonMobil Memorandum in PDF format, 232k.
NRDC letter to State Department in Microsoft Word format, 22k.

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Facsimile Cover Sheet

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Date/Time: 6 Feb 2001, 10:00 a.m.

Pages including Cover: 18

Regarding: *Bush Team for IPCC Negotiations*

Attached is a brief memo outlining the issues related to the on-going IPCC negotiations on the Third Assessment Report. I have also attached other material that may be useful to you.

I will call to discuss the recommendations regarding the team that can better represent the Bush Administration interests until key appointments and re-assessments are made.

Randy

Global Climate Science-Issues for 2001

A. Intergovernmental Panel on Climate Change (IPCC)

1. The IPCC is on schedule to issue in late September 2001 its Third Assessment Report (TAR), composed of three Working Group Reports on the science, impacts and mitigation of climate change and a Synthesis Report. The IPCC is headed by Robert Watson, an American who is also the chief science person at the World Bank (Director, Environment Dept.) Watson was hand picked by Al Gore and served in the Clinton/Gore White House Office of Science and Technology policy. His tenure at the IPCC ends with the completion of the TAR. However, he could be extended at an IPCC session this year or next.

During the Hague meeting in November, Watson presented a sneak preview of the Third Assessment Report with the following caveat " *None of the conclusions presented in this report are taken from the TAR, but are consistent with the draft conclusions, which are subject to change until final government approval and acceptance early next year.*" His statement belied his real intent, which was to get media coverage of his views before there was a chance for the process to challenge his personal agenda.

Issue: Can Watson be replaced now at the request of the U.S.?

The Working Group Reports are prepared by scientists, economists, engineers, and others, including some persons from industry and environmental organizations. **Each report includes a "Summary for Policy Makers" (SPM) that is approved by IPCC governments by consensus in a line-by-line review at a Working Group session** with the underlying report (approx. 1000 pages) accepted by the Group at that session.

In the case of the Working Group I report on science, the Group met in plenary in Shanghai, China on January 17-20, approved the SPM, and accepted the report. The US delegation (Moitke lead) was satisfied to raise no objections on the tone and content of the report. To avoid accountability to the Bush Administration, the meeting actually ran until 1:00 a.m. on January 21 which was exactly January 20, 12:00 noon in the U.S. The U.S. was represented by Clinton/Gore carry-overs with aggressive agendas:

1. State Department: **Jeff Moitke**, Deputy Director, Global Change Office, Oceans and International Environmental and Scientific Affairs (and Deputy Chief of Mission, Lesotho)

2. White House Office of Science and Technology Policy: **Rosina Bierbaum**, Associate Director, Environment,

3. White House U.S. Global Change Research Program: **Michael MacCracken**, Executive Director, National Assessment Coordination Office.

Global Climate Science-Issues for 2001

Bierbaum and MacCracken were both actively involved in the production of the US National Assessment that has been roundly criticized for its political and scientific bias. The National Assessment was driven by a political schedule to help the Gore campaign. Several controlled leaks were used to get maximum media attention since Congressional oversight forced a delay in the release of the report.

***Issue:* Have Bierbaum and MacCracken been removed from their positions of influence?**

***Issue:* What was the U.S. position on the WG1 Report? Did it reflect the comments received?**

While the SPM was written to highlight the "human fingerprint", it also states that: "Further research is required to improve the ability to detect, attribute and understand climate change, to reduce uncertainties, and to project future climate changes."

According to an AP story, Watson, in commenting on the report, which was released by the Group, but which has not yet been accepted by the full IPCC, said:

> "The United States is way off meeting its targets," said Watson. "A country like China has done more, in my opinion, than a country like the United States to move forward in economic development while remaining environmentally sensitive."

China, of course, has no commitments under the Kyoto Protocol and its greenhouse gas emissions are growing and will soon exceed those of the U.S.

2. **Working Group II is scheduled to meet on the "Impacts of Climate Change" in plenary in Geneva, Switzerland, from February 12-16.** Reportedly, the U.S. has submitted comments on the draft report by January 8, which was the deadline. Those comments have not been made public.

***Issue:* Who has reviewed those comments?**

***Issue:* What is the U.S. position on the report?**

***Issue:* Who will represent the U.S. at this meeting?**

3. **Working Group III** is scheduled to meet on "Mitigation of Climate Change" in plenary in **Accra, Ghana, from February 28 to March 3.** Government comments on that draft report/SPM are due to be submitted by January 29.

***Issue:* Who has reviewed those comments?**

***Issue:* What is the U.S. position on the report?**

***Issue:* Who will represent the U.S.? What is U.S. position?**

4. On **April 4-6, 2001**, the full IPCC is scheduled to meet in plenary in **Nairobi, Kenya**, to accept by consensus the results of the three Working Groups.

***Issue:* Will the U.S. revisit the Working Group I comments of the Clinton/Gore representatives?**

***Issue:* Who will represent the U.S. and what will be the U.S. position?**

***Issue:* Can this report be deferred until the US has provided updated input(30-45 days)?**

5. **The last element of the TAR is the Synthesis Report (SR) that is still being drafted under Robert Watson's control.** A draft of the SR, including its SPM, is to be sent out for simultaneous expert and Government review and comment with a deadline of May 29. A second draft is scheduled to be given to Governments only for their review and comment on July 6 with a deadline of August 31. **The IPCC plenary will meet in London from September 24-29 to adopt/approve the Synthesis Report by consensus.**

***Issue:* Can this report be deferred at least 45 days?**

Thereafter the entire TAR will be released(in time for political use at COP-7).

COP-6, held in The Hague last November, ended without finishing its work on implementation of the Kyoto Protocol and with an understanding that it would meet again in 2001, but with no date established. The SBI and SBSTA are scheduled to meet in Bonn, Germany, from May 21-June 1. Some Parties want COP-6 to reconvene during that time. **COP-7 is scheduled to meet October 29-November 9 in Marrakech, Morocco, together with the subsidiary bodies.**

Global Climate Science-Issues for 2001

Recommendations:

1. Restructure the U.S. attendance at upcoming IPCC meetings to assure none of the Clinton/Gore proponents are involved in any decisional activities.

a. Appoint **Dr. John Christy**, University of Alabama-Huntsville(Lead Author-Working Group I) as science lead for the balance of the IPCC process. Phone: 256.961.7763 This replaces Bierbaum and MacCracken.

b. Appoint **Dr. Richard Lindzen**, MIT,(Lead Author-Working Group I) as a co-lead to conduct an immediate review of the comments on the Working Group reports(I, II and III) and to review the US comments to be submitted(II, III). Phone: 617.253.2432

c. Detail **Dr. Joe Friday**, National Research Council-Board on Atmospheric Sciences and Climate(Coordinated the "Research Pathways for the Next Decade" report that the Clinton Admin tried to bury), to work with Christy/Lindzen. Phone: 202.334.3512

d. Detail someone from the State Dept to work under the direction of Christy/Lindzen for the "consensus negotiations". This replaces Moltke.

2. Request that the April 4-6 full IPCC meeting be deferred at least 30 days until a re-assessment of US input can be made.

3. Request that all action related to the Third Assessment Report is deferred until the IPCC process is complete (30-45 days). This must include the Watson release of the draft Synthesis Report.

4. Explore the possibility of asking Speaker Hastert to make Dr. Harlan Watson, Hse Science Committee, available to work with the team. Dr. Watson has been recommended for the Assistant Secretary of State for Oceans position.

Attachment 34

The Nation; Charges Fly Over Science Panel Pick

[HOME EDITION]

Los Angeles Times - Los Angeles, Calif.
Author: ELIZABETH SHOGREN
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The Bush administration is pushing for an engineer from India to take over the helm of an influential international science panel on global warming that is now headed by an American atmospheric chemist who has been criticized by the energy industry.

Energy lobbyists have accused Robert T. Watson, chairman of the Intergovernmental Panel on Climate Change, of promoting his own agenda. In a memo to the White House a year ago, a senior Exxon Mobil Corp. official urged the administration to push him out.

"Can Watson be replaced now at the request of the U.S.?" asks the memo, which was obtained from the White House through a Freedom of Information Act request by the Natural Resources Defense Council, an environmental group.

The council accuses the Bush administration of turning its back on solid science and bending to industry wishes by supporting Watson's challenger, Dr. Rajendra K. Pachauri. In an election later this month, the 100-plus member countries of the climate panel will have one vote each on the chairmanship.

"It's bad enough that Exxon Mobil controls White House energy and climate policies," said Daniel Lashof, science director of the NRDC Climate Center. "Now they want to control the science too."

Also promoting Watson's reelection are leading climate scientists such as Ralph J. Cicerone, chancellor of UC Irvine and chairman of a National Academy of Sciences panel that reviewed global warming issues for the Bush White House.

Bush administration officials said they decided to support Pachauri because his background as an engineer and an economist prepares him to determine the global implications of climate science. They said the administration also believes that a chairman from the developing world would signal that global climate change is a problem for the whole world, not just for wealthy nations.

Environmentalists and Watson say the administration's decision reflects its discomfort with having Watson on a prestigious platform for broadcasting to the world the seriousness of global climate change resulting from the burning of coal, gas, oil and other fossil fuels.

"There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities," the climate change panel concluded last year in its third comprehensive assessment under Watson's chairmanship.

"I've been hearing over the last month or two that a small vocal part of the energy industry has been putting a lot of pressure on the U.S. government not to reelect me," said Watson, who was the associate director for environment in the White House Office of Science and Technology during President Clinton's first term.

Watson said he believes he still has a good chance to win reelection. Officials from many countries have told him they will support his candidacy because of his ability to organize thousands of scientists to review documents and develop coherent analyses of the complicated problem.

Watson said he hopes the Bush administration does not believe energy lobbyists' claims that he advocates tough government regulations of industries that emit carbon dioxide, the major greenhouse gas produced from human activity.

"My advocacy is for truth in science--that we do get the very best scientists from around the world," Watson said. "The argument that I'm an advocate for regulations against the oil industry is incorrect."

President Bush's climate change policy calls on industry to voluntarily reduce carbon dioxide emissions.

White House spokesman Scott McClellan disputed the claim that the Exxon Mobil memo influenced the White House decision on the IPCC chairmanship. The memo "was faxed to an individual who had no involvement with IPCC leadership issues and took no action on the memo," he said.

Neither he nor any official provided by the Bush administration to comment on the issue flatly denied that industry influence played a role in the State Department's decision to side with Pachauri.

Energy industry lobbyists met Tuesday with State Department officials before the decision to support Pachauri was announced. But a Bush administration official said the decision already had been made.

Credit: TIMES STAFF WRITER

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Attachment 35

NATURAL RESOURCES DEFENSE COUNCIL

Arsenic and Old Laws

A Scientific and Public Health Analysis of Arsenic Occurrence in Drinking Water, Its Health Effects, and EPA's Outdated Arsenic Tap Water Standard

This February 2000 report analyzes data collected by water systems in 25 states between 1980 and 1998 and compiled by the U.S. Environmental Protection Agency. The study finds that millions of Americans drink tap water from systems that have been shown to contain arsenic, a known toxin and carcinogen, at average levels that pose unacceptable cancer risks. This report includes a summary of the adverse health effects of arsenic in drinking water by Dr. Paul Mushak, an eminent expert on the subject, based upon a 1999 National Academy of Sciences report. The report also contains detailed recommendations on what the EPA and water systems should do to reduce arsenic in drinking water and safeguard the health of the American public.

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Chapter 2: An Overview of the Scientific and Health Issues Raised by Arsenic Regulation
Chapter 3: Conclusions for Safe Regulation of Drinking Water
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Report Credits and Acknowledgements

Check the map

For an overview of the geographic distribution of arsenic problems in 25 states

Appendix A: List of Public Water Systems in Which Arsenic Was Found in the 25 States Reporting Data
States that reported data: Alabama, Alaska, Arizona, Arkansas, California, Illinois, Indiana, Kentucky, Kansas, Maine, Michigan, Minnesota, Missouri, Montana, Nevada, New Hampshire, New Jersey, New Mexico, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Texas, Utah

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For printed copies of this report, see our Publications List.

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NATURAL RESOURCES DEFENSE COUNCIL

Arsenic and Old Laws

A Scientific and Public Health Analysis of Arsenic Occurrence in Drinking Water, Its Health Effects, and EPA's Outdated Arsenic Tap Water Standard

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EXECUTIVE SUMMARY AND RECOMMENDATIONS

FINDINGS

Arsenic in drinking water poses a significant public health risk in the United States. According to our most conservative analysis of new EPA data covering only 25 states, at least 34 million Americans in over 6,900 communities drank tap water supplied by systems containing arsenic, a known toxin and carcinogen, at average levels that pose unacceptable cancer risks.[1] Our "best" estimate, based on what we believe to be the most reasonable (but less conservative) analytical techniques, indicates that 56 million Americans in over 8,000 communities in those 25 states drank water with arsenic at these risky levels.[2]
These newly public figures are based on more than 100,000 arsenic samples collected from 1980 to 1998 by more than 24,000 public water systems in 25 states, which were then compiled by the U.S. Environmental Protection Agency (EPA). The Natural Resources Defense Council (NRDC) obtained the data under the Freedom of Information Act and analyzed them. While arsenic levels can vary with time, when considering cancer risk, the average levels generally are of primary concern. For this reason, NRDC calculated average arsenic levels in the systems evaluated. Because data were available for only half of the states in the nation, these are likely to be significant underestimates of the total U.S. population exposed to arsenic in tap water.
NRDC also has generated maps for this report showing the geographic distribution of arsenic problems for all 25 reporting states. This marks the first time that EPA□s drinking water database has been publicly analyzed using a Geographic Information System (GIS) to generate maps of drinking water problems.
This report includes a summary of the adverse health effects of arsenic in drinking water by an eminent expert on the subject, based upon a 1999 National Academy of Sciences (NAS) report and a review of peer-reviewed literature. The NAS report and other scientific literature discussed here have concluded that arsenic in drinking water is a known cause of bladder, lung, and skin cancer. In addition, the NAS report and many previous studies have found that arsenic in drinking water may also cause kidney and liver cancer.
Arsenic□s known noncancer toxic effects include toxicity to the central and peripheral nervous systems, heart and blood vessel problems, and various precancerous lesions on the skin, such as hyperkeratosis (a pronounced scaly skin condition) as well as changes in pigmentation. The NAS report and peer-reviewed animal studies have found that arsenic may also cause birth defects and reproductive and other problems, although some of these effects are less documented than arsenic's cancerous, skin, nervous, and cardiovascular effects.
The NAS concluded in 1999 that EPA□s 57 year-old arsenic standard for drinking water of 50 parts per billion (ppb), set in 1942 before arsenic was known to cause cancer, "does not achieve EPA□s goal for public health protection and, therefore, requires downward revision as promptly as possible" (NAS, 1999, p. 9). In fact, the academy said that drinking water at the current EPA standard "could easily" result in a total fatal cancer risk of 1 in 100 -- about a 10,000 times higher cancer risk than EPA would allow for carcinogens in food, for example.

RECOMMENDATIONS

- **EPA must immediately adopt a strict, health-protective standard for arsenic in tap water.** The Safe Drinking Water Act (SDWA) Amendments of 1996 required EPA to propose a revised arsenic standard (to replace the old standard set in 1942) by January 1, 2000, a deadline the agency has missed. This is the third time EPA has violated a statutory mandate to update the arsenic standard. EPA is required to finalize a new standard by January 1, 2001. We conclude – as did NAS – that EPA should expeditiously issue a stricter Maximum Contaminant Level standard for arsenic. EPA must consider that many Americans also have unavoidable exposure to arsenic in their food, so relatively low levels of arsenic in tap water can cause safety levels to be exceeded. A health-protective tap water arsenic standard should allow a maximum lifetime cancer risk no greater than that EPA has traditionally accepted (a level presenting a lifetime cancer risk from 1 in 1,000,000 to at most 1 in 10,000 for vulnerable or highly exposed individuals).

  This would require EPA to set a drinking water standard well below the current 50 ppb standard -- in the range of 1 ppb. Limitations in the analytical techniques widely used for measuring arsenic in water, however, would likely necessitate a standard of 3 ppb, rather than a standard of 1 ppb, because reliably quantifying arsenic at levels below this would be difficult using current standard lab equipment and practices.

said probably overestimate costs, indicate that the cost per household of a 2 ppb standard would be from $5 to $14 per month for the vast majority (87 percent) of affected consumers; users of small systems may have to pay significantly more. EPA□s (admittedly high) estimates also project that nationally an arsenic standard of 2 ppb would cost $2.1 billion per year, and a 5 ppb standard would cost $686 million per year.

- **EPA should reduce its cross-media guidance level for arsenic and should fund improved analytical methods to lower detection limits for arsenic.** Health data indicate that EPA's current guidance level establishing the maximum recommended daily arsenic exposure, called a reference dose (which is unenforceable itself, but is used by EPA in developing enforceable standards in all environmental media, including water), is too high and may not protect vulnerable populations, such as children. To protect children, EPA should reduce this reference dose from 0.3 micrograms per kilogram per day (µg-kg per day) to at most 0.1 µg-kg per day, and should immediately reevaluate the reference dose in light of the 1999 NAS risk estimates, suggesting that the cancer risk at this level would still be unacceptable. In addition, EPA should fund efforts to reduce the level at which arsenic can be reliably detected in drinking water, so that it can be found down to levels at which it may pose a health risk (below 1 ppb).

- **Water systems should be honest with their customers about arsenic contamination and potential health risks.** Only if water systems tell their customers the truth about arsenic contamination in their tap water, and about the health threat it poses, will the public support efforts (including possible rate increases) to remedy the problem.

- **Systems with arsenic problems should work with government officials to clean up their source water.** Some systems may be able to reduce arsenic levels by cleaning up or changing the source of their water. For example, some arsenic contamination results from leaching of arsenic from old waste dumps, mines, or tailings, or from past use of arsenic-containing pesticides. Government officials and water systems should team up with citizens to remedy contamination at these sites so water supplies are not arsenic-contaminated. In addition, recent studies have shown that high groundwater pumping rates have increased arsenic levels in some wells. It should be investigated whether reducing pumping rates or reworking wells can reduce some systems□ arsenic levels.

- **Water systems unable to get cleaner source water should treat to remove arsenic; state and federal funds should be increased to assist smaller Systems in paying for upgrades.** As noted above, there is readily available treatment technology that can remove arsenic from tap water, at a cost of about $5 to $14 per month per household for the vast majority of people (87 percent) served by systems with arsenic problems. Very small systems serving a small fraction of the population drinking arsenic-contaminated water, however, will often be more expensive to clean up per household (due to the lack of economies of scale). For these systems, federal and state assistance to improve treatment is available, and arsenic contamination should be a high priority for these drinking water funds. Additional federal and state funding through State Revolving Fund (SRF), USDA's Rural Utility Service, and other programs may also be needed. The SRF established by the SDWA Amendments of 1996 should be funded at least to the full authorized amount ($1 billion per year) to help smaller systems with arsenic problems.

- **EPA should improve its arsenic and other drinking water databases.** EPA should upgrade its drinking water database, known as the Safe Drinking Water Information System (SDWIS) so that it includes all of these arsenic data, as well as unregulated contaminant data, as required by the Safe Drinking Water Act -- and makes them accessible to the public. The SDWIS database must also be upgraded to include more accurate latitude and longitude ("lat-long") data. The ready availability and low cost of new GPS (global positioning system) units for recording lat-long coordinates -- available for a few hundred dollars -- should drive EPA to require accurate lat-long data for the distribution systems, treatment plants, and intakes of each public water system. Such data will have a wealth of uses for water systems, state and local officials, EPA, and the public in using GIS systems for protecting source water, for developing targeted and well-documented rules, and for other purposes.

Notes

1. The phrase "unacceptable cancer risk" is used here to mean water containing arsenic at a level posing a lifetime risk of dying from cancers in all internal organs -- bladder, kidney, liver, and lung -- of over 1 in 10,000, based on the methodologies, estimates, and cancer risk characterizations described in the National Academy of Sciences□ recent report, *Arsenic in Drinking Water*, at 8, 301 (1999), and based on the standard assumption that a person consumes two liters of water per day. A 1 in 10,000 cancer risk traditionally is the highest cancer risk EPA ever allows in tap water when setting standards, although the agency usually seeks to set standards at a stricter level, posing a lower cancer risk. See Chapters 1 and 2 for details.

2. As discussed in Chapter 1, the 56 million population exposed figure is our best estimate of the average arsenic exposure levels of consumers in the 25 states included in the new EPA database analyzed in this report. While this analysis is conservative (it may underestimate the extent of exposure), an even more conservative analysis would suggest that a minimum of 34 million people in these 25 states drank water posing a significant cancer risk. The latter highly conservative low average estimate assumes, when calculating average arsenic levels, that no arsenic was in the water at times when early crude tests with a high reporting limit of, for example, 10 ppb, found none, even though subsequent more sensitive tests found arsenic. On the other hand, the mid-average approach assumes that arsenic

NATURAL RESOURCES DEFENSE COUNCIL

Arsenic and Old Laws

A Scientific and Public Health Analysis of Arsenic Occurrence in Drinking Water, Its Health Effects, and EPA's Outdated Arsenic Tap Water Standard

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Chapter 1
ARSENIC HAS BEEN FOUND AT LEVELS OF HEALTH CONCERN IN THE TAP WATER OF TENS OF MILLIONS OF AMERICANS IN 25 STATES

NRDC has obtained new data showing that tens of millions of Americans are consuming tap water every day that poses unacceptable cancer risks. This chapter summarizes these new arsenic occurrence data, while subsequent chapters discuss in detail the health implications of arsenic contamination of drinking water and the need for a stricter standard for arsenic in tap water.

The source of these new data is an EPA database not previously made public, obtained by NRDC under the Freedom of Information Act. In preparing to develop an updated standard for arsenic in drinking water, EPA asked all states for data on the occurrence of arsenic in the tap water served by public water systems. Twenty-five states responded (see Figure 1, National Arsenic Occurrence Map), providing over 100,000 arsenic test results taken from 1980 to 1998 from over 23,000 public water systems. These water systems serve a total of about 99.5 million Americans, or 40 percent of the 1990 U.S. population. Because the database does not cover states in which approximately 60 percent of the U.S. population resides, the estimates of population affected by arsenic in their tap water likely are substantial underestimates. NRDC has deleted from consideration, as potentially unreliable, samples that exceeded 1,000 parts per billion.

These new data reveal startling new details about the extent of arsenic contamination in the tap water. Table 1 shows our best estimate is that over 56 million Americans in these 25 states consumed water from systems containing arsenic at levels presenting a potentially fatal cancer risk above the level that is EPA□s highest acceptable cancer risk (1 in 10,000). Even our extremely conservative "low average" analysis approach indicates that at a minimum, over 34 million people in these 25 states drank water posing these elevated cancer risks. Our estimates are based on detailed evaluations of the EPA-collected occurrence data and the National Academy of Sciences (NAS) total cancer risk estimates.[3] Table 2 notes the total potentially fatal cancer risk that would be associated with drinking two liters of water containing arsenic at a given level for a lifetime, based upon the NAS estimates. Chapter 2 includes a further discussion of these data on risks and health effects, and how these estimates were derived.

As is clear from Tables 1 and 2, tens of millions of Americans are consuming tap water every day at levels that may pose a serious potentially fatal cancer risk and other health risks. Appendix A lists each public water system in which arsenic was found in the 25 states reporting data. The national map is intended to show the general areas that are hardest hit by the highest levels of arsenic. However, to determine whether arsenic has been found in a particular public water system, according to EPA□s database, readers should refer to the table of water systems reported in Appendix A. The map cannot be used by itself to identify whether a particular water system has an arsenic problem, because often there are several water systems located immediately adjacent to each other, and the map was generated at a scale that cannot be used to identify precisely which water system contains a given level of arsenic.

Table 1: Arsenic Levels in Tap Water Systems in 25 States -- Low and Best Estimates

Average Arsenic Level (in ppb)	Low Estimate* of Number of Water Systems Affected	Low Estimate* of Total Population Served	Best Estimate** of Number of Water Systems Affected	Best Estimate** of Total Population Served
None detected	15,624	40,619,400	15,624	40,619,400
Detected, <1*	2,068	28,017,372	884	5,925,297
≥ 1 and <3	2,935	19,994,024	3,146	25,711,312
≥ 3 and <5	1,321	7,440,564	1,947	17,494,651
≥ 5 and <10	1,348	5,033,538	1,652	10,611,259
≥ 10 and <15	535	1,451,616	566	2,075,157

≥ 20 and <25	[illegible]	[illegible]	[illegible]	[illegible]
> 25 and <50	280	354,802	283	376,542
≥ 50	66	99,736	66	99,736
TOTAL	**24,599**	**103,523,971**	**24,599**	**103,523,970**
TOTAL at or **above** 1 **ppb** (0.5 ppb presents the highest cancer risk EPA traditionally allows in tap water)	6,907	34,887,199	8,091	56,979,263

*The low estimate is based on the assumption that any nondetect, no matter what the reporting limit, contained no arsenic, even if other samples showed arsenic was present. This highly conservative analysis results in a large number of systems having average concentrations below 1 ppb, because all reported nondetects, no matter what the reporting limit, are averaged as zero. See the discussion in the text for more details on how these averages were calculated.

** The best estimate is the estimated mid-average level of each system, which is the average of the detected levels of arsenic and, for those systems for which there was at least one detect of arsenic, one-half the level of detection for all nondetects. See the discussion in the text for more details on how these averages were calculated.

Table 2: Lifetime Risks of Dying of Cancer from Arsenic in Tap Water

*Based upon the National Academy of Sciences' 1999 Risk Estimates**

Arsenic Level in Tap Water (in parts per billion, or ppb)	Approximate Total Cancer Risk (assuming 2 liters consumed/day)
0.5 ppb	1 in 10,000 (highest cancer risk EPA usually allows in tap water)
1 ppb	1 in 5,000
3 ppb	1 in 1,667
4 ppb	1 in 1,250
5 ppb	1 in 1,000
10 ppb	1 in 500
20 ppb	1 in 250
25 ppb	1 in 200
50 ppb	1 in 100

*See note 3 and Chapter 3 for details on how we calculated total cancer risk based on an extrapolation of NAS's risk estimates, which assumed a linear dose-response and no threshold.

WATER SYSTEMS WITH ELEVATED LEVELS OF ARSENIC AND STATE MAPS SHOWING DISTRIBUTION OF ARSENIC PROBLEMS

Arsenic contamination of tap water is not a problem limited to a few pockets of the nation, nor is it limited in scope to small water systems. Tables 3 through 5 present summary data showing some water systems in which the EPA and state data indicate serious arsenic contamination problems may be found.

In addition, using ArcView Geographic Information System (GIS) software, and the latitude and longitude coordinates for public water systems reported in EPA's Safe Drinking Water Information System (SDWIS), NRDC has developed 25 state maps showing the regional variations in arsenic levels in tap water. The larger the dot, the larger the population served water system. In addition, we used graduated red coloration to show the concentration of arsenic found in the water, from light pink (representing low concentrations of arsenic) to bright red (representing mid-level arsenic levels) to dark red (representing severe arsenic contamination). In addition, NRDC wanted to give readers a picture of where arsenic was being searched for but *not* found. We used separate maps with graduated blue-green coloration to represent nondetects, with light blue-green representing nondetects using low levels of quantification (for example 1 ppb), and darker blue-green representing nondetects using high limits of quantification (for example 10 ppb).

As is clear from these tables and the 25 state maps, although arsenic contamination of tap

risk of fatal cancer).

Note: Only the national map is included in the online version of this report.

How Average Arsenic Levels are Calculated in This Report and in Appendix A

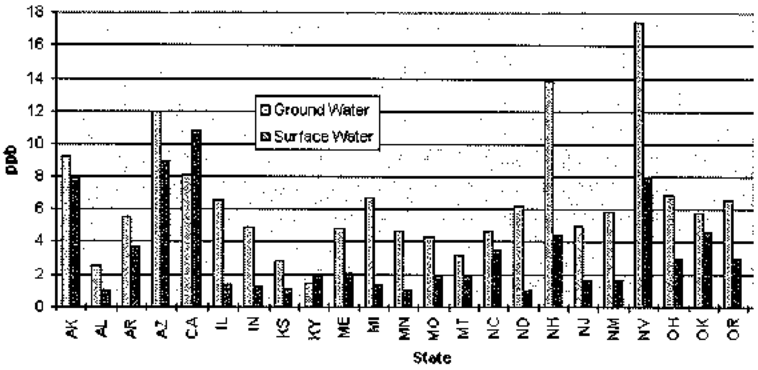
Arsenic levels can vary with time, and old samples often used cruder analytical techniques that could not detect low arsenic levels (below 10 parts per billion). We found that the so-called reporting limits for arsenic (that is, the lowest level of arsenic in the water that states require to be reported) in many states was 5 to 10 ppb in the 1980's and even in the early 1990's. Figure 3 shows that in some states, such as California, many water systems testing their water for arsenic were allowed to report as nondetected any level of arsenic below the state□s relatively high reporting limits.

In many cases, those reporting limits later were lowered, due to improved analytical methods, and arsenic started to be reported in the water of many more communities, as would be expected. This presented a problem for our analysis: when a water system had for years not reported arsenic, and then reported it when the reporting limit dropped, how should we calculate the arsenic level for that system? Additionally, a relatively small number of water systems had very inconsistent reported levels of arsenic over time, and we had to decide how to report their average levels as well. We decided that when a water system conducted multiple tests of its water, we would use two different averaging techniques to estimate the arsenic exposure for consumers of that water:

- **First, we calculated a very conservative low average**, which assumes that when arsenic was not reported as detected, there was absolutely no arsenic in the water at that time, even if the limit of detection was high (for example, 10 ppb), and even if other tests showed that arsenic was present in the water at levels somewhat below the previous reporting limit. For example, if a water system did five tests when the reporting limit was 10 ppb from 1985 to 1990 and found no arsenic, and then tested twice in 1993 to 1995 when the reporting limit was 3 ppb, and it found 8 ppb both of those later times, the low average calculated for that system would be 2.3 ppb (that is, [0 ppb + 0 ppb + 0 ppb + 0 ppb + 0 ppb + 8 ppb + 8ppb] □ 7 measurements = 2.3 ppb).

- **Second, we based our best estimate** on a calculated mid-average, which assumes that if at least some arsenic was detected in a water system at some time, then whenever arsenic was not reported as detected, it was present at a level of one half of the reporting limit. Using the same example, if a water system had five tests when the reporting limit was 10 ppb from 1985 to 1990 and found no arsenic, and then tested twice in 1993 to 1995 when the reporting limit was 3 ppb, and found 8 ppb both of those later times, the mid-average calculated for that system would be 5.8 ppb (that is, [5 ppb + 5 ppb + 5 ppb + 5 ppb + 5 ppb + 8 ppb + 8 ppb] □ 7 measurements = 5.8 ppb).

Figure 2: State Average Arsenic Concentrations for Systems Finding Arsenic



Based on best estimate of average arsenic levels for systems that found arsenic. Systems with all non-detects excluded.

Figure 3: Number of Tap Water Arsenic Samples, and the Lowest Level of Arsenic Required to Be Reported, by State (Reporting Limits)

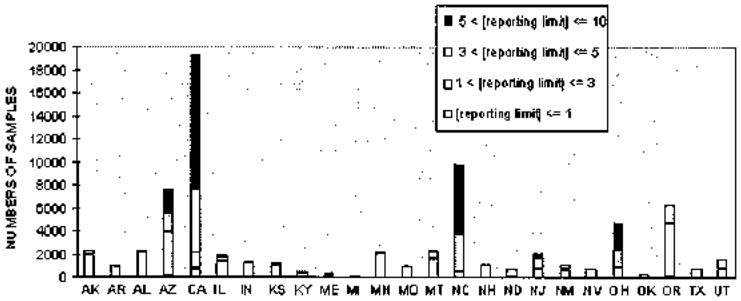


Table 3: 46 Largest Water Systems With Arsenic Levels Over 5 ppb (Ranked by Largest Population First)
Table 4: Highest Average Arsenic Levels in Water Systems Serving Over 10,000 (Ranked by Largest Population First)
Table 5: 50 Public Water Systems of All Sizes With Highest Average of Arsenic Concentrations

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Notes

3. As is discussed in Chapter 3, NAS estimated that, considering lung and bladder cancers death studies, the total cancer risk at the current tap water standard of 50 ppb "could easily" be 1 in 100. NAS, *Arsenic in Drinking Water*, at 8, 301 (1999). The NAS also noted that while there may be some indication that arsenic may not have a linear dose-response relationship at low doses, these data are "inconclusive and do not meet EPA's 1996 stated criteria for departure from the default assumption of linearity." *Ibid* at 7. Thus, as discussed in Chapter 2, we assume, as did NAS, that dose-response is linear with no threshold, and that the total lifetime potentially fatal cancer risk of consuming two liters per day of arsenic-contaminated water poses the risks noted in Table 2. While NAS did not explicitly calculate risks posed by water with arsenic at levels below 50 ppb, its analysis was used to develop Table 2.

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Arsenic and Old Laws

A Scientific and Public Health Analysis of Arsenic Occurrence in Drinking Water, Its Health Effects, and EPA's Outdated Arsenic Tap Water Standard

Top of Report

Chapter 2
AN OVERVIEW OF THE SCIENTIFIC AND HEALTH ISSUES RAISED BY ARSENIC REGULATION

WHAT ARE THE KEY SCIENCE AND HEALTH ISSUES FOR ARSENIC REGULATION IN TAP WATER?

There are several important public health issues raised by the presence of arsenic in America□s tap water, including:

(These issues are discussed in this chapter.)

1. Why should the public care about arsenic in drinking water?
2. What are some of the environmental and biological characteristics of arsenic that are important to human health?
3. What are the adverse health effects of the various chemical forms of arsenic found in U.S drinking water?
4. Who in America is at special risk for adverse health effects from arsenic?

(These issues are discussed in the following chapter.)

5. What can we conclude about the adequacy of the U.S. EPA□s current drinking water standard for arsenic?
6. What can we conclude about the adequacy of other regulatory guidelines or standards for arsenic, for example the EPA reference dose (RfD) for ingested arsenic?
7. What can we conclude about what a health-protective level of arsenic in American drinking water supplies should be to prevent cancer and noncancer effects in American populations?
8. How can we prevent arsenic from getting into drinking water, or remove it from drinking water once it□s there?

ANALYSIS AND DISCUSSION

Why should the public care about arsenic in its drinking water?

Arsenic is an element of the earth's crust that has many economic and industrial uses. However, it also is highly toxic in many of its chemical forms, even at the low concentrations often found in drinking water. Arsenic itself, as the core element in various arsenic compounds, remains unaltered even though it may bind or unbind with other elements or undergo changes in valence, or charge state. This scientific reality has many implications for how the element moves through the human environment and how we can effectively regulate it.

Some drinking water arsenic comes from contamination by human activities. For example, arsenic can be released by industrial or mining waste sites, or can seep from a pesticide dump site into groundwater serving as a community water source. Other drinking water arsenic occurs naturally. Thus, water supplies from wells drilled into groundwater aquifers that can be laced with geochemical arsenic.

In fashioning *remedies* to the problem of arsenic contamination in drinking water, it may be important to consider the origin of the arsenic. But no matter the source of arsenic, public health concerns dictate that the problem be solved promptly. Where the arsenic contamination is from human activity, waste cleanups (such as Superfund cleanups) may solve the problem, while in other cases the only remedy available may be arsenic removal at the drinking water treatment plant. The bottom line is that as a matter of community and preventive medicine, we must seek to minimize or prevent adverse health effects and risks from arsenic in tap water.

What are some of the environmental and biological characteristics of arsenic that are important with respect to its effects on human health?

Tap water is one important way that people are exposed to arsenic, but they may also encounter arsenic in other environmental media, such as food, dust, soil, and ambient air. Toxic forms of arsenic are harmful to people no matter how they get into our bodies. Water can be the predominant source of the toxic forms of arsenic for many Americans, but in order for arsenic to be a health concern, it is not necessary that drinking water be the sole or dominant source of human arsenic intake. In other words, arsenic levels in our blood increase no matter what the source, so more arsenic in toxic forms from tap water or any other source increases our health risk.

This environmental and biological reality prevents our viewing tap water arsenic in isolation. If we chose to quantify health risks only for drinking water arsenic and did not consider suspected or known contributions from other human arsenic intake sources, we might well be underestimating overall or aggregate health risks. That is, our risk numbers would be at

contaminants and associated human exposures than others. This multimedia, integrated risk concept is particularly critical in the case of drinking water arsenic. Tap water arsenic is more easily controlled through centralized regulation, for example, controls on community water supplies, than arsenic in various dispersed sources and pathways, such as arsenic in soils, arsenic in home remedies popular in certain cultures, contaminated garden crops, or localized air arsenic emissions from smelters. Consequently, the regulatory attention given to arsenic in water is especially critical.

One characteristic of drinking water arsenic of special concern to regulators and scientists is the element□s typical occurrence in an especially toxic form, inorganic oxyarsenic. Oxyarsenic occurs in two different charge states (or valences) of importance here: pentavalent, which has five valence electrons (essentially points at which other chemical groups can attach to it), and trivalent, which has three such valence electrons, or attachment points. These forms are associated with a variety of cancer and noncancer toxic effects in humans. A wealth of recent health and scientific data identify trivalent and pentavalent oxyarsenic as equally toxic under the typical long-term, lower-level exposures to these arsenicals sustained by human populations. Earlier, crude studies in which test animals were fed large quantities of either valency form under acute, that is, very short-term, conditions seemed to show some difference in the way the animals□ metabolisms reacted, but we now know that result mainly related to the high-dose, short-time conditions of the studies. These conditions do not apply to long-term exposures of human populations to lower, but still toxic, exposure levels.

Most Americans are adept at recognizing visible or "macro-scale" acute and chronic (continuing) hazards to their health and readily accept the usual characterizations of those hazards by experts. Examples include acute injuries from fire and various chronic diseases linked to smoking. But many people are less aware of environmental contaminants and their toxic potentials. Many toxic contaminants such as arsenic occur in the environment at extremely low concentrations, yet these levels still can be high enough to be of health concern because they can be toxic at trace (part-per-million, ppm) or ultra-trace (part-per-billion, ppb and part-per-trillion, ppt) levels. In some cases, the injuries to human health from exposure to contaminants may only be seen after persistent contact with the contaminant for years or even decades; in other cases, complex medical and laboratory tests must be done to establish their presence.

What are the adverse health effects of arsenic in those chemical forms likely to occur in America□s drinking water?

The public□s perception of arsenic is still largely literary and forensic (stemming from such classics as the Joseph Kesselring play *Arsenic and Old Lace* and the film it inspired), and is most often recognized as the poison of choice for homicide, suicide, and other nefarious activities. This perception of arsenic toxicity represents only its most severe form. Such poisonings are acute, triggered by ingestion of very high amounts of inorganic arsenic (such as oxyarsenic) over a short time. When arsenic is ingested in large amounts deliberately or inadvertently, it produces a constellation of severe and often fatal injuries to the cardiovascular, gastrointestinal and nervous systems. This report examines the less-dramatic (but perhaps more important overall) dose-response and public health implications of widespread lower-level arsenic exposure of populations or their subsets.

We are concerned with arsenic exposures and toxic responses that are long term, occur at relatively much lower doses than those producing acute, fatal poisoning, and affect entire populations or population segments rather than a toxic outcome reported for a specific individual. In fact, we now know that the levels of arsenic and other elements in the environment that are toxic are so low that scientists could not previously have anticipated adverse effects without the growing scientific database of human epidemiological, experimental animal, and toxicological mechanistic studies. This large and evolving database defines significant toxic risks across a wide spectrum of doses or exposures.

The available information on the adverse health effects of arsenic in drinking water and in other media are to be found in various authoritative expert consensus documents listed in this paper□s illustrative bibliography. These include documents of federal agencies such as the EPA, and independent scientific bodies such as the National Academy of Sciences (NAS). These treatises and individual critical reviews and research papers form the foundation of the analyses and conclusions presented in this paper. This analysis and its conclusions about the impact of tap water arsenic on public health are focused on adverse effects associated with the element□s toxicological character. Some experimental animal studies of arsenic□s biological activity in recent years have suggested a potential role for the element as a nutrient in those animal species tested. Nutrient roles at very low intakes and toxic effects at higher intakes are not uncommon with environmental elements and do not, in any way, ease the need for control of excessive exposures. A nutrient role in humans, within the framework of the battery of widely accepted criteria to establish such roles, has not been determined for arsenic.

Indeed, the NAS□s recent report on arsenic in drinking water notes that "studies to date do not provide evidence that arsenic is an essential element in humans or that it is required for any essential biochemical process." (NAS, 1999, p. 259) Any nutrient role would have to be at very low levels, in common with other elements with dual bioactivity. It is highly unlikely that arsenic could ever be regulated to levels so low that any yet-to-be-established human deficiency for the element would occur. This topic was discussed in detail by the author elsewhere (Mushak, 1994).

Arsenic-Induced Skin and Internal Cancers

Long-term exposure of nonoccupational human populations to environmental arsenic is associated with skin cancer and with various internal cancers, such as bladder, kidney, liver, and lung cancer. The NAS□s 1999 report on arsenic in drinking water concluded that arsenic is "known" to cause skin, bladder and lung cancer, and noted that there is substantial evidence that arsenic in drinking water is associated with other cancers, including cancers of the liver and kidney.

Workers encountering airborne arsenic in the workplace are known to be at high risk for lung cancer and possibly other cancers as well. Nonworker populations who have been

drinking water. Consult the bibliography for further details. Among the key references are the 1984 EPA health assessment document for arsenic, the 1988 EPA assessment of some specific issues for arsenic and human health, the EPA 1996 document for arsenic health assessment, and the 1999 NAS detailed report on cancer and other adverse effects, *Arsenic in Drinking Water*.

Some of the most compelling evidence for arsenic as a carcinogenic (cancer-causing) substance is to be found in various studies of a large Taiwanese population exposed to arsenic in their drinking water. Also compelling are data showing elevated cancer rates in people who drank arsenic-contaminated water in Argentina and Chile. The Taiwanese study population was huge, numbering more than 40,000 subjects, and included a large control population with more than 7,000 individuals. Study groups of these sizes in the environmental epidemiology of toxic elements are not very common. The earliest cancers appearing in these Taiwanese and in other groups were skin cancers -- consisting of various histopathological types -- followed later in their lives by cancers of internal organs -- bladder, kidney, liver, lung. Arsenic-associated skin cancers occur in specific body areas not exposed to sunlight: the trunk, soles, and palms. Therefore, arsenic cancer lesions can be distinguished from cancers caused by sun exposure.

Additional strong evidence that arsenic in drinking water causes cancer is from Chile, where a larger population was studied than that in Taiwan -- more than 400,000 people. Researchers evaluating this Chilean population found marked increases in mortality for bladder and lung cancer in particular. Approximately 7 percent of all deaths over age 30 could be attributed to arsenic (Smith AH et al. 1998).

Some regulators and others have argued that the threat to life caused by arsenic-associated cancers differs between skin cancers and cancers of the bladder, kidney, liver, or lung. They argue that the latter cancers collectively offer a higher mortality risk and are therefore more life-threatening. This distinction is hardly reassuring, nor does it counsel neglect of skin cancer as a public health concern. Only some of the arsenic-associated cancers arising in skin and associated with arsenic are benign (the basal cell lesions) while the squamous cell carcinomas may metastasize to other organs. In any event, the findings of internal organ cancers in reports that are more recent than those for skin cancers have significantly reinforced public health and safety concerns associated with arsenic.

While some regulators have suggested that skin cancer should be downgraded as a health concern because it sometimes is not fatal, is inappropriate to consider only fatal cancers in assessing arsenic□s risks to public health. Nonfatal cancers inflict enormous emotional and economic costs to the victims of these cancers, their families, and society as a whole.

Not surprisingly, new findings on arsenic carcinogenesis have generated a number of recent studies, such as ones looking at how representative the Taiwanese population data are for risk analyses in U.S. communities exposed to arsenic in drinking water and other environmental media. Some in industry and their representatives have challenged the Taiwanese data, despite the fact that the Taiwanese data are the most extensive to date, and that rates of cancers associated with drinking water arsenic are proportional, considering varying exposure levels, to those found in other geographically distinct areas, such as Argentina and Chile.

To date, however, no one has successfully challenged the view by U.S. regulators and the NAS that the Taiwanese and Chilean studies provide strong evidence of arsenic□s carcinogenicity in humans. Several appraisals of these challenges merit comment and the author noted these in a 1995 paper (Mushak and Crocetti, 1995).

Some attacks on the Taiwanese data have argued that the nutritional status and metabolic aspects of the study population put it at greater risk for toxicity from arsenic exposures than U.S. communities. However, the results of these studies have not produced any convincing challenges to the scientific validity of the data on nutritional grounds (Mushak and Crocetti, 1995). Impaired nutrition as a factor producing increased arsenic toxicity in Taiwanese, even if it were valid, is hardly an exclusionary criterion for comparisons with Americans. The argument of differential nutrition requires that we assume Americans exposed to drinking water arsenic, unlike the Taiwanese, are all well-nourished and at lower risk for arsenic toxicity. This is simply untrue. Undernutrition is a chronic public health and societal problem in America, including for those in the high-risk arsenic groups, the elderly and young children (see below).

Industry and some others have cited additional factors to argue that one cannot compare the Taiwanese exposures to arsenic to American arsenic exposures. They have claimed that other contaminants, such as alkaloids, in the Taiwanese well water are the culprits or at least co-culprits. Again, this argument is unconvincing. For example, arsenic produces cancers and other arsenic-associated effects in a number of other exposure settings comparable to the Taiwanese situation, but where alkaloidal contaminants are absent. Others have held that the Taiwanese have genetic determinants that alter arsenic metabolism in the body, resulting in a different likelihood of cancers, but genetic predisposition to arsenic-associated cancers also remains an open issue. Some recent studies suggest that there may be genetic polymorphism (that is, many different human genetic types) in the enzyme pathway which is thought to detoxify arsenic in our body ("detoxifying biomethylation"), but such polymorphism has yet to be linked to risk differences for various cancers. Furthermore, we do not know the range of genetic diversity in Americans with respect to these arsenic methylation enzymes. Nor do we have a good handle on the mechanisms of arsenic carcinogenesis, or the metabolic transformations of the element. Research has also suggested that increased arsenic methylation may be linked to a higher cancer risk. This author first hypothesized in 1983 that the body's metabolic diversion of methyl groups away from needed bodily processes to detoxifying arsenic could be a factor in causing arsenic toxicity (Mushak, 1983). Thus, as NAS's 1999 report concluded, there is no basis on which to rest any argument that the solid body of Taiwanese data associating arsenic in tap water with several cancers, or the confirmatory data from Argentina and Chile, should be rejected.

These studies, taken together, paint a compelling picture. They have lead the NAS and many other august bodies to conclude that arsenic in drinking water is known to cause cancer in humans.

including hyperkeratosis, a pronounced scaly skin condition, and changes in pigmentation. These skin changes are so characteristic that the medical literature notes that laypeople could easily identify workers who used arsenic as a sheep-dip pesticide, simply because of their obvious skin lesions.

Ingested inorganic arsenic produces both central and peripheral nervous system effects in exposed humans. Peripheral nervous system effects on both sensory and motor nerve function mainly harm adults, while very young children are more susceptible to central nervous system effects on the brain. The effects of arsenic exposure in children may persist over the long term, based on data described in EPA□s 1984 health assessment document (EPA, 1984). Irreversible toxicity must obviously be viewed much more seriously than reversible effects. Once injury has occurred, simply reducing the exposure does not undo the harm.

Exposures to arsenic in drinking water and other media also cause toxic effects on peripheral blood vessels. In its extreme form, vessel toxicity takes the form of a dry gangrene, called Blackfoot Disease, particularly noted in the more heavily exposed Taiwanese. Lower exposures were linked to a very painful peripheral blood vessel disorder in Chilean children exposed to drinking water arsenic, resembling Raynaud□s Disease. The latter arises from arterial and arteriolar spasm and contractions leading to impaired blood flow and cyanosis (inadequate oxygen reaching the tissues). Studies also have linked arsenic exposure from drinking water to higher rates of diabetes.

Data from the Taiwanese studies and from studies of other populations reveal that there is a dose-response relationship for ingested water arsenic and several non-cancer toxic effects (NAS, 1999; EPA, 1984, 1996). By dose-response relationship, we simply mean that as the arsenic intake increases, both the frequency and the severity of toxic effects increase in the exposed people. This type of dose-response relationship is one of the most important pieces of evidence that health scientists use to determine that a toxic chemical actually causes a particular toxic effect. For example, scientists have documented a dose-response relationship in human populations showing that increased exposure to arsenic in drinking water causes more frequent and more severe skin lesions and serious vascular effects. Arsenic also has been linked to injury to the cardiovascular system, a particular concern in the United States where cardiovascular diseases already are a major public health concern. Elevated arsenic exposures should be considered a potential added risk factor in addition to other widely-recognized risk factors for cardiovascular diseases.

Who in America is at special risk for adverse health effects from environmental arsenic?

Different people respond to exposure to arsenic or other toxins in different ways. The toxic responses can vary greatly, even when people are exposed to the same amount of a contaminant such as arsenic.

There are many reasons for this variability in toxic response, arising from either intrinsic factors or extrinsic causes. Intrinsic factors are those peculiar to the individual, and over which the individual has little control, for example, gender, age, race, stage of development, or group behavioral traits. Extrinsic factors are those outside the individual□s characteristics and include length of exposure to a toxic substance. A general discussion of characteristics that can heavily influence the differential toxicity of toxins to different individuals, in the context of lead, is included in the NAS□s 1993 report on populations sensitive to lead exposure (NAS, 1993a), of which the chief author of this report was a co-author. A second NAS report appearing in 1993 (NAS, 1993b) detailed the increased sensitivity of very young children to pesticides compared to adults. As discussed below, many of the basic principles that may lead to higher risks in children from lead or pesticides (for example, children□s immature detoxification systems and higher exposure to drinking water per unit of body weight) apply to arsenic.

Variability in the human population□s sensitivity to environmental contaminant toxicities is now an accepted principle in scientific, regulatory, and legislative quarters. This acceptance by science is found in numerous documents and individual research papers dealing with environmental contaminants, illustrated in the cited treatises and papers. Agencies such as the EPA regulate environmental metals and other contaminants with an eye to those populations at special risk, not "average" populations. That is, population segments with particular biological sensitivities or enhanced exposures are identified in relevant rulemaking for adequate protection from exposure and associated toxic harm.

In 1996 Congress enacted the Food Quality Protection Act (FQPA), Pub. L. No. 104-170, 110 Stat. 1489 (1996), partly in response to the 1993 NAS report on children and pesticides (NAS, 1993b), *Pesticides in the Diets of Infants and Children*. The FQPA mandates special protection for young children from pesticides, including a general requirement that an added tenfold margin be included to ensure safety for children, unless reliable data show that such an additional safety factor is unnecessary to protect children. Similarly, Congress adopted the "Boxer Amendment" in the 1996 Safe Drinking Water Act Amendments, which requires EPA to consider children, infants, pregnant women, and other especially vulnerable subpopulations in setting drinking water standards. SDWA □□ 1412(b)(1)(C), (b)(3)(C)(5), 1457(a).

We can readily identify two segments of the U.S. population that are at risk. First, older adults who have sustained elevated arsenic exposures over the long term are at special risk. Both cancer and noncancer toxic effects can occur in these individuals as a result of their prolonged exposure.

Second, very young children can be at elevated risk. The very young, especially infants and toddlers, are more likely to come into direct contact with arsenic. For instance, they often put arsenic-contaminated items in their mouths. In addition, pound for pound they consume more arsenic and other contaminants than adults. A higher arsenic intake rate for children per unit of body weight has been shown, as seen for example in the 1999 study of Calderon et al. evaluating American subjects. Additionally, the very young, being less able to defend against toxicants than are older children or adults. In the case of arsenic, we have to take into account that the very young do not detoxify arsenic as efficiently as adults, as shown in recent studies. Data from a study by Concha (1998a) indicate the fraction of toxic inorganic

percent inorganic form, suggesting that children may be less able to detoxify arsenic and therefore may be more susceptible to its toxic effects. Data from a study by Kurttio et al., (1998) indicate that this differential in biomethylation-detoxification may persist over many years. We also must consider that children are more sensitive to the central nervous system effects of arsenic than adults are, and that children who sustain central nervous system injuries from arsenic may have irreversible injury, as noted above (EPA, 1984).

A third high-risk population, not fully characterized, is fetuses, which can be exposed to arsenic by way of maternal exposure. Arsenic, like a number of other environmental contaminants, crosses the placental barrier in pregnant mammals (for example, NAS, 1999). The fetus is even more biologically sensitive than the infant and toddler. Arsenic intoxication of the conceptus (human embryo relatively shortly after conception) can potentially target both organogenesis (the generation of the developing vital organs) in the embryo stage and further development in the later, fetal stage. While no in-utero arsenic effects have been documented for human exposures, we do know that oral intake of arsenic in experimental animal studies produced birth defects, impaired fetal growth, and reduced the survival of fetal and newborn animals (see, for example, NAS 1999). Of particular concern here is the recent finding that arsenic enters the fetal circulation in pregnant women by at least the third trimester, and that the level of arsenic in umbilical cord blood approaches the maternal arsenic level (Concha et al., 1998b).

Because of variations in human sensitivity to arsenic, including indications that children may be more vulnerable to this toxin, the NAS (1999) suggested that "a wider margin of safety might be needed when conducting risk assessments of arsenic because of variations in metabolism and sensitivity among individuals or groups"(p. 5). The next chapter, dealing with conclusions about the regulatory status of drinking water arsenic in America, focuses on these risk groups.

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Arsenic and Old Laws

A Scientific and Public Health Analysis of Arsenic Occurrence in Drinking Water, Its Health Effects, and EPA's Outdated Arsenic Tap Water Standard

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Chapter 3
CONCLUSIONS FOR SAFE REGULATION OF DRINKING WATER

What can we conclude about the adequacy of the U.S. EPA□s current drinking water standard for arsenic?

The present EPA drinking water standard, as an enforceable Maximum Contaminant Level (MCL), is 50 micrograms of arsenic per liter water (50 µg/L, equivalent to 50 parts per billion, or ppb). This value has not changed since 1942, and was promulgated with few scientific underpinnings. There is therefore little scientific support for its regulatory adequacy. This MCL was issued before the accumulation of the large body of scientific and human health data produced over the last 30 to 40 years, a period that included the Taiwanese studies and numerous authoritative treatises on arsenic, including some from the NAS and EPA. As long ago as 1962, the U.S. Public Health Service recommended that water containing more than 10 µg/L (or ppb) of arsenic (one-fifth of the still-current standard) should not be used for domestic supplies.

Congress has directed EPA to update the 1942 arsenic standard three times -- in 1974, 1986, and 1996. A court ordered EPA to complete this task in the early 1990□s, but several extensions were granted. EPA still has not updated the standard. In a legislative mandate in the Safe Drinking Water Act Amendments of 1996, Congress again directed EPA to publicly *propose* an updated arsenic standard based on current evidence by January 1, 2000, a deadline that EPA has now, again, missed. EPA is then required to promulgate the *final* arsenic standard by January 1, 2001.

The current scientific and health risk assessment status of arsenic within that mandate makes it clear that EPA□s current MCL of 50 µg/L is grossly inadequate for protecting public health. The extent of that inadequacy is effectively captured in the NAS report, *Arsenic in Drinking Water* (NAS, 1999). The report focused heavily on risk assessment estimates for human cancer frequencies as a function of drinking water and food arsenic and derived cancer risks for arsenic in environmental media, particularly drinking water. Our analysis concurs strongly with the academy□s findings and recommendations as well as the following conclusion:

> On the basis of its review of epidemiological findings, experimental data on the mode of action of arsenic, and available information on the variations in human susceptibility, it is the subcommittee□s consensus that the current EPA MCL for arsenic in drinking water of 50 µg/L does not achieve EPA□s goal for public-health protection and, therefore, requires downward revision as promptly as possible (NAS, 1999, pp. 8-9).

The NAS report did not recommend a specific MCL below 50 that would be fully health protective. It did, however, provide a series of cancer risk assessments for cancers of the skin and internal organs. This approach for bladder and lung cancers employed the traditional straight-line extrapolation from rates at elevated arsenic exposures. Put differently, the NAS assumed -- as is usually assumed by scientists based on traditional principles of toxicology, unless there is strong evidence to the contrary -- that there is a direct, linear relationship between cancer risk and arsenic exposure. The academy committee members, correctly and conservatively (with respect to the best health protection), noted that low-dose extrapolation models based on available data may *or may not* be "sublinear" compared to linear extrapolation. That is, arsenic at extremely low doses may, or may not, cause relatively less cancer risk per microgram than it does at high doses. However, the NAS experts concluded, the evidence for such "non-linear" models of arsenic-associated cancer risk is not compelling enough to rule out the traditional linear approach, so the health-protective linear approach should be used. The NAS scientists then used studies of people who had been exposed to arsenic in their tap water at elevated levels (for example in Taiwan) to model, or estimate, the risks of people exposed to lower levels.

The 1999 NAS report calculated that arsenic consumption in drinking water at the current EPA MCL would produce a male *fatal bladder* cancer lifetime risk of 1 per 1,000 to 1.5 per 1,000, using a linear extrapolation approach. Factoring in lung cancer risk and its relative robustness compared to bladder cancer (lung cancer risk is about 2.5 times greater than bladder cancer risk), an overall internal cancer risk rate "could easily result in a combined lung cancer risk" of 1 percent, or 1 in 100, according to the NAS□s 1999 report (p. 8). The high level of cancer risk from arsenic ingestion in water at the present MCL does not account for concurrent intakes of carcinogenic arsenic from food or idiosyncratic sources (for example, certain prepared ethnic remedies that contain arsenic). In the past, EPA estimated a lower cancer risk from arsenic in tap water than did NAS in 1999. For example, EPA□s Integrated Risk Information System (EPA, 1998) estimated about a 10-fold lower cancer risk for arsenic than the more recent NAS study (NAS, 1999), apparently in part because EPA evaluated only bladder cancer risks, whereas NAS considered the higher risk of lung cancer as well, based on recent studies. We believe the NAS risk estimates are

generally supported by studies of people drinking relatively low levels of arsenic in their tap water. For example, a recent study from Finland (Kurttio et al., 1999), found that Finns who drank water containing low levels of arsenic (less than 0.1 ppb) had about a 50 percent lower risk of getting bladder cancer than their countrymen who drank water containing somewhat more arsenic (0.1 ppb to 0.5 ppb). Significantly, people who drank more than 0.5 ppb arsenic had more than a 140% increase in bladder cancer rates compared to those who consumed levels less than 0.1 ppb.

The pros and cons of models that characterize cancer risk bring up the role and judgment of risk assessors. The NAS's 1983 seminal document on risk assessment in regulatory agencies and elsewhere in the federal government (NAS, 1983) suggested a four-part paradigm for quantifying health risk that is now widely used in various incarnations by governmental agencies and others. The 1983 report also repeatedly made note of the role of judgment in the risk assessment process, a fact too often ignored by interested parties viewing regulatory risk assessment models. Without a totally clear scientific consensus on the guaranteed best scientific approach, or in the face of equally acceptable approaches, we must opt for the scientific approach that provides the maximum protection for human populations. The linear extrapolation approach adopted by the NAS subcommittee is in full accord with this principle, which should apply to assessment of cancer risks for environmental contaminants.

What can we conclude about the adequacy of other regulatory guidelines or standards for arsenic, for example the EPA reference dose (RfD) for ingested arsenic?

EPA issues guidelines for the intake levels of environmental contaminants that the agency generally considers to be free of toxic risk during long-term, that is, lifetime, exposures. In the case of oral intakes these values are called reference doses, RfDs. They are expressed in milligrams (mg) of contaminant daily intake per unit body weight in kilograms (kg-day). RfDs, being derived for oral intakes, do not usually take account of other routes of intake. Inhalation of contaminants might be a significant exposure route, in which case a reference concentration, RfC, expressed as milligrams per cubic meter of ambient air, may also be used. It is important to note that if more than one exposure route is significant, we must recognize that the RfD is less protective than we would otherwise conclude if we thought that arsenic in drinking water was the sole route of exposure. EPA, in its general description of the RfD approach, notes the need to take account of other intake routes (EPA, 1993).

EPA has set the RfD for ingested inorganic arsenic, the amount viewed as not being linked to any health risk, at 0.0003 mg/kg-day (0.3 µg/kg-day). This value is derived for skin hyperpigmentation and keratosis and potential vascular effects. Analyses in the preparation of this paper, including a review of health effects data for the United States, found no currently valid and convincing reasons to say this value is too low. Thus, no higher RfD is warranted.

EPA's failure to fully consider risks to children in the RfD derivation is of concern. It is true that early childhood is only a fraction of the total lifetime interval considered when deriving an RfD for lifetime effects of arsenic. However, the relatively inefficient detoxification of a potent carcinogen and toxin by children, and the increased sensitivity (and higher exposure per unit of body mass) of children to arsenic-associated central nervous system effects, are serious issues. EPA should revise the current RfD downwards to account for the apparent elevated vulnerability of children; the data certainly do not support any upward revision of the current value.

In addition, EPA has not reconciled the health risks represented by the current RfD value based on noncancer toxic effects with the internal cancer risk estimates calculated for drinking water arsenic in the 1999 NAS report. The current RfD permits a "safe" daily intake by a 70 kg adult male of 21 µg arsenic per day. Risk-characterization estimates in the NAS report for the MCL value permit calculation of a cancer risk for this "safe" 21 µg daily intake that markedly exceeds any acceptable regulatory risk management guideline for cancer. Put differently, the amounts of arsenic intake that may be safe for noncancer risks are unsafe for cancer risks.

To protect children and infants, an RfD at least three-fold lower, 0.1 µg/kg-day, is certainly more defensible and more protective of identifiable at-risk populations in the United States. This adjustment is based upon standard EPA use of "uncertainty" factors for the RfD. The current uncertainty factor of three should be increased 10, the next generally permitted level for such a factor, based on concerns about the special susceptibility of children. Even such a lower RfD, it should be noted, would still present a cancer risk higher than EPA would generally consider acceptable. We recommend that the RfD be reduced to at most this level.

What can we conclude about what a health-protective level of arsenic in U.S. drinking water supplies should be to prevent cancer and noncancer effects in the U.S. population?

According to the data, we need a much lower and more protective EPA standard for drinking water arsenic and a much lower and more protective reference dose guidance level for arsenic.

Given the risk estimates for all internal cancers provided in the NAS's 1999 report, the current EPA MCL for arsenic must be revised downward to no higher than a value at the Practical Quantitation Level (PQL) of 3 ppb. EPA completed a thorough review of laboratory capabilities in 1999, and concluded that the PQL is 3 ppb (Miller, 1999). Thus, a new MCL of 3 ppb is reasonable, based on the newest analytical methodology assessment from EPA (which is more current than the 4 ppb figure cited by NAS, 1999, a level based on earlier studies, see, Eaton et al., 1994; Mushak and Crocetti, 1995).

- Our conclusion that the MCL should be 3 ppb is driven by practicality, that is, one cannot regulate below what one can measure for compliance. This does not say that values lower than the PQL of about 3 ppb pose no cancer risk; it only recognizes that quantification of these lower levels in drinking water is problematic at this time. While many laboratories can reliably detect arsenic at levels below one ppb, reviews of a

immediately seek to reduce the PQL for arsenic by developing and standardizing improved analytical techniques for arsenic. The only alternative to setting an MCL at the PQL would be for EPA to establish a "treatment technique" for arsenic, an approach that seems difficult to justify here since arsenic is reliably detectable down to the low ppb range.

- There is no scientifically sound reason for increasing the noncancer RfD value from 0.3 µg/kg-day to a higher value. To the contrary, as noted above, there is good reason to adjust the value lower. Adults ingesting the "safe" arsenic dose for noncancer effects will simultaneously be at too high a risk for internal organ cancers. While EPA□s risk management guideline for permissible skin cancer risk was changed to 1 in 10,000 in 1988, the guideline for the more dangerous, more often fatal internal cancers should remain at 1 in 1,000,000. One cannot get to anything near this cancer rate guideline with the present RfD value if one assumes significant contribution of carcinogenic inorganic arsenic from food.

- For these reasons, an RfD at least three-fold lower, 0.1 µg/kg-day, is certainly more defensible and more protective of identifiable at-risk populations in the United States.

How can we prevent arsenic from getting into drinking water, or remove it from drinking water once it□s there?

1. Preventing Arsenic From Getting Into Water Supplies.
Arsenic gets into drinking water from a variety of sources. Sources from human activities include:

- **Leaking of arsenic from old industrial waste dumps.** Arsenic is one of the most common contaminants found at Superfund sites, for example.

- **Leaching of arsenic from mines and mine tailings.** Some hard-rock and other mines expose arsenic-bearing rock to the elements, "liberating" the arsenic into the environment, and in some cases causing serious arsenic contamination of ground and surface water.

- **Runoff or leaching of old arsenic-containing pesticides from sites where they were heavily used.** In some cases, the old arsenic-based pesticides remain in the areas where they were applied, manufactured, or disposed of years ago, and can get into water supplies.

- **Heavy groundwater pumping.** Recent studies in Wisconsin and elsewhere have shown that heavy pumping of groundwater has increased arsenic levels in some wells. In some cases heavy pumping appears to have pulled water out of heavily arsenic-contaminated layers of rock that were not the primary aquifer being tapped but had not been sealed off from the well. In other cases, possibly because overpumping appears to have caused groundwater levels to drop, increasing arsenic-bearing rock contact with air and thereby increasing arsenic leaching).

Cleaning up old dumpsites under Superfund and related programs may reduce arsenic contamination in some systems affected by arsenic from industrial sites. Additionally, arsenical pesticide hot spots, and certain mine waste sites, are sometimes covered by Superfund or other cleanup laws and should be addressed in order to reduce water contamination.
Efforts to reduce leaching and drainage from mines and mine tailings by improving reclamation and mining practices should also be undertaken to reduce arsenic loading into many water sources. Furthermore, it is worth investigating whether reworking contaminated wells (for example, using a casing and cement to seal off arsenic-bearing rock layers that may be leaking water into the well) and/or reducing pumping rates may in some cases reduce arsenic levels in systems. Government officials and water systems should work with citizens to remedy these problems so water supplies are not contaminated by arsenic and do not need to be treated for arsenic removal.

2. Readily Available Treatment Technologies Can Remove Arsenic from Drinking Water.
The best way to avoid arsenic contamination from reaching our taps is to prevent it from getting into the environment in the first place. Where prevention is not possible, as when the arsenic occurs naturally, and when no alternative water source is available and the system cannot consolidate with another, cleaner water system, water treatment is readily available. Treatment already in use by some progressive water utilities has been demonstrated to reduce or essentially eliminate arsenic contamination of tap water. Among the effective arsenic treatment options EPA has identified (EPA, 1999; EPA 1994) are:

- **Modifying Existing Coagulation and Filtration.** Large water systems that already have coagulation and filtration technology (as most surface water systems do) can take simple steps to modify these processes to substantially reduce arsenic levels. Changing their use of iron or manganese oxidation, use of ferric chloride or ferric sulfate, and alum coagulation and filtration can reduce arsenic by 80 to 95 percent. These steps are relatively inexpensive.

- **Water Softening with Lime.** Many water systems already use lime to "soften" their water (that is, to reduce water "hardness" by removing the minerals calcium and magnesium). We now know that softening, if optimized, can reduce arsenic levels by 60 to 90 percent. It is about as inexpensive as coagulation and filtration modifications

waters, if the source water has high levels of selenium, fluoride, or sulfate, it is not as effective at arsenic removal.

- **Ion Exchange.** This technology, already used by many water systems, can remove arsenic effectively in most water. Again, however, if levels of certain other chemicals (such as sulfate, selenium, fluoride, or other dissolved solids) are too high, pretreatment using other technologies is needed to assure that adequate levels of arsenic are removed.

- **Electrodialysis Reversal.** Essentially the same process as used to clean blood at dialysis centers, electrodialysis takes advantage of the charge of particles (like arsenic) and a special membrane under the influence of an electric current, and can remove about 80 percent of arsenic from water.

- **Reverse Osmosis and Nanofiltration Membranes.** RO and NF membranes can remove 90 percent to more than 95 percent of arsenic. These membranes can reject substantial amounts of water, and therefore waste-stream recovery or other actions may be necessary in the arid West. Also, particularly if arsenic levels in the raw water are high, treatment or disposal of the concentrated brine created by removing the arsenic from the water can increase costs.

- **Point of Use and Point of Entry Treatment.** Under the 1996 Safe Drinking Water Act Amendments, water suppliers are authorized, under strict conditions, to use point-of-use filters (for example, RO units installed under kitchen sinks) or point of entry filters (for example, treatment devices in the basement at the point water goes into the home) to comply with drinking water standards. EPA studies have shown that these devices can be affordable and effective to treat for arsenic, and may be cheaper for small systems than installing centralized treatment. For this to work in a national rule, EPA would have to clarify utilities□ utility responsibility in assuring the continued operation and maintenance of such devices.

3. Treatment Costs to Remove Arsenic are Modest for Most Consumers.
For several years, EPA has been evaluating the cost of installing treatment to meet various Maximum Contaminant Levels (MCL) for arsenic. EPA's most recent public analysis (Taft, 1998) found that if the standard were lowered from the current 50 ppb down to 5 ppb, it would cost most households (those served by city systems serving 100,000 people or more) about $2 a month, and would cost up to $14 a month for people living in smaller towns (with 10,000 to 100,000 people). Even a standard as low as 2 ppb would cost city dwellers with arsenic problems about $5 a month, and those living in affected towns as small as 10,000 people would pay about $14 a month.
Systems serving over 10,000 people serve the vast majority of people affected by arsenic contamination. Our analysis of EPA□s 25-state arsenic database shows that about 9 out of 10 people (87 percent) who consume arsenic at a significant level in their tap water (over 1 ppb) are served by these systems serving more than 10,000 customers.
For the 13 percent of consumers who get their water from smaller systems, however, treatment costs can be significantly higher than they are for consumers in cities, because of the lack of economies of scale. Thus, EPA estimates that people drinking water from a system serving 3,300 to 10,000 people may have to pay as much as $20 a month, and the smallest systems (assuming the worst case and that no point-of-use or other devices were allowed) could reach $100 a month (Taft, 1998).
Using these figures, EPA has estimated that a 5 ppb arsenic rule would cost about $686 million per year, and a 2 ppb standard would cost $2.1 billion. However, EPA recently admitted (Taft 1998) that both these national cost estimates and the individual household cost estimates are probably overstatements of the true costs of treatment for several reasons:

- Most important, EPA assumed that all systems that exceeded the MCL would install full treatment of all of their water to get it well below the MCL. More recent analysis shows, however, that most water systems would actually treat only some of their water and then would blend it with untreated water, in order to produce water just under the MCL, to keep the costs down.

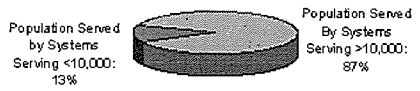
- EPA assumed that if a water system with multiple wells has just one or a few wells exceeding the arsenic MCL, the system will treat all of its wells, including those below the MCL; EPA now understands that this is extremely unlikely.

- EPA's estimates did not account for recent advances in treatment technologies, such as the newly understood ability of the relatively inexpensive ion-exchange treatment to effectively treat all but the highest sulfate waters.

- EPA□s estimates failed to account for improvements in water quality that are expected to be required by other EPA rules, such as the groundwater rule, the Stage 2 Microbial and Disinfection Byproducts rule, and the uranium rule, all of which are expected to drive many water systems to use treatment that will also reduce arsenic.

- The older EPA estimates do not consider the availability of point-of-use and point-of-entry devices now authorized by the 1996 SDWA Amendments, technologies that are substantially less expensive than centralized treatment for many small systems.

- EPA's cost estimates do not account for expected reductions in treatment costs as



* Significant is defined as presenting >1 in 10,000 fatal cancer risk, i.e. over 1 pp

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4. The States and Federal Government Should Assist Small Systems That Cannot Afford Arsenic Treatment.
Even with these reasons to believe EPA is overestimating costs, it is clear that at least some small systems will have to pay relatively high costs per household to have arsenic-safe water. For these smaller systems, federal and state assistance to improve treatment is available, and arsenic contamination should be a high priority for these drinking water funds. Additional federal and state funding through State Revolving Funds (SRF), USDA's Rural Utility Service, and other programs may also be needed. The SRF established by the Safe Drinking Water Act Amendments of 1996, which has not been fully funded since the act's passage, should be funded at least to the full authorized amount ($1 billion per year) to help smaller systems with arsenic problems.
Therefore, even using EPA□s high cost estimates,[4] a strict arsenic standard for tap water would be both sound public health policy and affordable for consumers. It is EPA□s obligation to protect the American public from arsenic contaminated tap water, by issuing a strict MCL of 3 ppb arsenic.

CONCLUSIONS

Americans should be able to turn on their taps and be sure that their drinking water is safe. Arsenic is perhaps the worst example of EPA□s failure to address a serious health risk from a chemical contaminant in drinking water. The agency has had over a quarter century, since the Safe Drinking Water Act passed in 1974, to adopt a modern tap water standard for arsenic, but has failed to do so. The time has come for the agency to act. Specifically, we recommend that:

- **EPA Must Immediately Propose and Finalize by January 1, 2001 a Health-Protective Standard for Arsenic in Tap Water.** The National Academy of Sciences (NAS) has made it clear, and we agree, that EPA should expeditiously issue a stricter Maximum Contaminant Level standard for arsenic. Based on available scientific literature and NAS risk estimates, this standard should be set no higher than 3 ppb -- the lowest level reliably quantifiable, according to EPA. Even an arsenic standard of 3 ppb could pose a fatal cancer risk several times higher than EPA has traditionally accepted in drinking water.

- **EPA Must Revise Downward its Reference Dose for Arsenic.** EPA's current reference dose likely does not protect such vulnerable populations as infants and children. Furthermore, "safe" arsenic intakes in the RfD present unacceptably high cancer risks. To protect children, EPA should reduce this reference dose from 0.3 micrograms per kilogram per day (µg-kg/day) to at most 0.1 µg-kg/day. For concordance with cancer risk numbers, EPA should reevaluate the RfD in more depth as expeditiously as feasible.

- **EPA Should Assure that Improved Analytical Methods Are Widely Available to Lower Detection Limits for Arsenic.** EPA must act to reduce the level at which arsenic can be reliably detected in drinking water, so that it can be reliably quantified by most labs at below 1 ppb, the level at which it may pose a health risk.

- **Water Systems Should be Honest With Consumers about Arsenic Levels and Risks.** It is in public water systems□ best long-term interest to tell their customers about arsenic levels in their tap water and the health implications of this contamination. Only when it is armed with such knowledge can the public be expected to support funding and efforts to remedy the problem.

- **Water Systems Should Seek Government and Citizen Help to Protect Source Water.** Water systems should work with government officials and citizens to prevent their source water from being contaminated with arsenic.

- **Water Systems Should Treat to Remove Arsenic, and Government Funds Should be Increased to Help Smaller Systems Pay for Improvements.** Readily available treatment technology can remove arsenic from tap water, at a cost that is reasonable ($5 to $14 per month per household) for the vast majority of people (87 percent) served by systems with arsenic problems. Very small systems serving a small fraction of the population drinking arsenic-contaminated water, however, will often be more expensive to clean up per household. Assistance to such systems should be a high priority for drinking water funds such as the SRF and USDA's Rural Utility Service programs. The SRF should be funded at at least $1 billion per year to help systems with arsenic problems.

- **EPA Should Improve its Arsenic, Geographic Information, and Drinking Water Databases.** EPA should upgrade its Safe Drinking Water Information System to include and make publicly accessible all of the arsenic and unregulated contaminant

for source water protection, developing targeted and well-documented rules, and for other purposes.

Note

4. The Association of California Water Agencies and the American Water Works Association have charged the EPA has *underestimated* national arsenic treatment costs. However, EPA has responded in detail to these allegations and thoroughly rebutted these arguments.

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Arsenic and Old Laws

A Scientific and Public Health Analysis of Arsenic Occurrence in Drinking Water, Its Health Effects, and EPA's Outdated Arsenic Tap Water Standard

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The bulk of this paper, except the arsenic occurrence data and maps, was prepared by Dr. Paul Mushak as a pro bono professional courtesy to the Natural Resources Defense Council, without remuneration and in the interest of public health. It contains Dr. Mushak's independent analysis of key issues related to drinking water arsenic and human health and its critical conclusions about the inadequacy of current arsenic regulation and the need for the much lower indicated standard. The author gratefully acknowledges the editorial help of Betty Mushak, co-principal, PB Associates. The survey of arsenic levels in the drinking water of Americans and the maps of arsenic occurrence were prepared using EPA's 25-state arsenic database by Dr. Matthew McKinzie of NRDC. Erik Olson assisted in this data analysis, and thanks Anne, Chris, and Luke for their support in completing this project.

This report would not have been possible with the support of NRDC's more than 400,000 members. NRDC also thanks The Henry Philip Kraft Family Memorial Fund of The New York Community Trust, The McKnight Foundation, and Town Creek Foundation, Inc. for supporting our work on drinking water.

About the author

Paul Mushak, Ph.D., is a toxicologist and health risk assessment specialist working in the area of toxic environmental metals. He is a co-principal in PB Associates, Durham, NC, and is a visiting professor of pediatric toxicology and environmental health at the Albert Einstein College of Medicine in New York City. His work examining arsenic and other toxic substances spans almost 33 years. He has authored and co-authored numerous scientific publications in metals and served in numerous advisory roles on the health effects of arsenic and other elements with federal, state, international, and independent scientific agencies. He is a member of many scientific societies, including the Society of Toxicology. He served as a member of several National Academy of Sciences committees on metal contaminants and has testified twice before Congress on child environmental health matters. He was a principal co-author of the Environmental Protection Agency's 1984 health assessment document for arsenic, and a member of the external advisory panel of experts for EPA's 1988 special report on arsenic risk assessment issues. Dr. Mushak also chaired the 1995-1996 peer review panel evaluating EPA's report to Congress on hazardous air pollutants (HAPs) from fossil-fueled power plants. Arsenic was one of the key contaminants for HAP evaluation in that EPA report.

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APPENDIX A
List of Public Water Systems in Which Arsenic Was Found in the 25 States Reporting Data

Important note regarding arsenic levels in individual water systems listed in this report
How to download the chart(s)
How to read the chart(s)
Download chart(s)

Important note regarding arsenic levels in individual water systems listed in this report

The information on arsenic levels in public water systems included in the NRDC report *Arsenic and Old Laws* is derived from the U.S. Environmental Protection Agency's (EPA) 25-state arsenic database, which includes samples taken from 1980 to 1998. NRDC has not independently verified these data, which EPA collected from state drinking water program officials, and compiled into the 25-state arsenic database. Additional sampling may have been completed for some water systems after the EPA database was compiled. To verify information on all sampling completed to date for a public water system, contact your state drinking water program (call EPA's drinking water Hotline at 800 426-4791 for state contacts) or your water system.
Corrections: Because of an error in data reporting by the state of California, in the print version of this report and the earlier online version, Alameda County Water District, City of Antioch Water Department, and City of Santa Clara Water and Sewer Utilities were incorrectly included in charts identifying water systems with high average arsenic levels. NRDC has been informed that the monitoring results reported to the state of California by the City of Milpitas, which the state then reported to US EPA (and ultimately were reported by NRDC based on EPA's database), were for emergency wells not currently in use. This information was not indicated in EPA's database. The City of Milpitas has provided information indicating that the water used by the City of Milpitas has been consistently below 2 parts per billion (ppb).

How to download the chart(s)

Appendix A is posted in downloadable spreadsheet form. We've provided the information as one master chart, and then broken it up into 25 individual state charts.
These charts have been saved as "comma delimited files," a format that can be read by most spreadsheet programs and requires the least possible download time. To download, click on any file. A new browser window will open and display a document with many rows of text and numbers, separated by commas. Under your browser's File menu, select Save As and save the file, retaining the .csv extension. Open the file in your spreadsheet program.
The master chart is also available as a zipped Excel 5.0/95 Workbook file.

How to read the chart(s)

Because of the limitations of this file type, you may need to widen the columns in order to read the chart easily. To do this: When you open the chart some of the column headings will be obscured by text displayed at the top. Click into box A4 to clear the display. Then, with your mouse in the row of gray column labels at the top of the chart (A, B, C, etc.) rest it on the line between any two columns until the cursor becomes a black cross. Double click to expand the column. (Don't expand column A -- lengthy text in the first two rows will make the column too wide.)
Those column headings that may not be self-explanatory are explained below:

D. "Population Served" is the average number of people who drank water from the water system during the time the sampling was done.
E. "Low Est. of Average Arsenic Level (ppb)" is a very conservative (that is, low) estimate of the average arsenic concentration, stated in parts per billion (ppb), in the system's water over the period for which data were collected by the system. EPA collected data for 1980-1998, though data were not available from all systems for this full period. The low estimate assumes that when arsenic was not reported as detected, there was absolutely no arsenic in the water at that time, even if the limit of detection was high (for example, 10 ppb), and even if other tests showed that arsenic was present in the water at levels somewhat below the previous reporting limit.
F. "Best Estimate of Average Arsenic Level (ppb) is what we believe is the most reasonable estimate of the average arsenic level in the system's tap water, based on the

G. "# Samples in Which Arsenic Was Detected" lists the number of tests for arsenic in the system's water that found arsenic, according to the data in EPA's database.
H. "# of Samples in Which Arsenic Was Not Detected" lists the number of tests for arsenic in the system's water that did not find arsenic, according to the data in EPA's database.
I. "Qualifier for Minimum Level" includes two possible qualifiers for the minimum level in the next column: it can include a less than symbol ("<"), in which case the qualifier means that arsenic was not detected, with the stated detection limit. Thus, a "<" symbol in the qualifier column, followed by a 5 in the "Minimum Level Found" column, means that the minimum level of arsenic reported for the system was "less than 5 ppb."
J. "Min. Level Found" means the lowest level of arsenic reported for the system in the EPA database. If the lowest level found was a nondetect, it will be listed as <[the reporting limit]," as noted in the previous definition.
K. "Max. Level Found" means the highest level of arsenic reported for the system in the EPA database.
L. "Date Max. Level Found" means the date that the highest level of arsenic was found in the EPA database.
M. "Most Recent Sample in EPA Database (ppb)" means the level of arsenic found, in parts per billion, in the most recent arsenic test reported for that system in EPA's database.
N. "Date of Most Recent Sample in EPA Database" means the date that the most recent sample reported in the EPA database was taken.

The following information was provided by the EPA and describes its 25-state arsenic database and conventions applied to the database:

Arsenic occurrence and exposure database description (10/19/99)
This database contains arsenic compliance monitoring data from ground and surface water community water systems in 25 States (monitoring conducted to comply with the current 50 ppb arsenic standard). Some States also provided data from non-transient, non-community water systems (NTNCWS). EPA's Office of Ground Water and Drinking Water has received this data from various sources, including States, associations, and other EPA offices. EPA has compiled the data into a single uniform format to support development of national occurrence and exposure distributions of arsenic in public ground water and surface water supplies. Below is the list of the general data conventions that were applied to the data to condition them for EPA's initial analysis. EPA will be applying additional data conventions and further manipulating the data in order to develop the national occurrence and exposure estimates, to support the arsenic in drinking water regulation proposal (January 1, 2000). In addition, these data conventions may change as EPA analyzes the data further.
Data conventions applied to the state data
1. Deleted all observations with dates before 1980, and one observation dated 2010.
2. Deleted observations with no public water supply identifier (PWSID).
3. Deleted observations from purchased water systems or inactive water systems.
4. Arsenic values reported as "zero" or non-detect ("ND") were considered to represent an analytical result below the reporting limit. If the state did not disclose the reporting limits for the samples, reporting limits were assigned based on where the majority of the lowest measured results clustered. This change was made in only two States, Alabama and Oregon.
5. Deleted samples that were non-detects with reporting limits greater than 10 ppb (e.g., <20 ppb, <50 ppb).
6. Matched PWSIDs to EPA's Safe Drinking Water Information System (SDWIS) for population served, system type, source type, system name, etc. If State had provided this information and there was a discrepancy with SDWIS, used SDWIS information for consistency.
7. Missouri reported only "detect" results to EPA. EPA's contractor contacted the Missouri Department of Health, which provided PWSIDs for all systems that monitored but had no arsenic detects for the same time period of arsenic data submitted (1/12/95-9/3/97). For each of these systems, EPA added a "non-detect" observation at the reporting limit of 1 ppb. These data were combined with the MO positive results.

For additional information on the data and how it was collected and compiled, the health risks related to arsenic in drinking water, how NRDC analyzed the data and calculated our estimates, and our conclusions and recommendations, refer to the text of this report.

Download chart(s)

Appendix A master file
Comma delimited file (751K)
Zipped Excel 5.0/95 Workbook file (543K)

Individual charts for the 25 states that reported data

Alabama	Montana
Alaska	Nevada
Arizona	New Hampshire
Arkansas	New Jersey
California	New Mexico
Illinois	North Carolina
Indiana	North Dakota

Kansas
Maine
Michigan
Minnesota
Missouri
Oklahoma
Oregon
Texas
Utah

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Table 3
46 Largest Water Systems with Average Arsenic Levels Over 5 ppb (Ranked by Largest Population First)

Note: To print portions of this chart, in the Print dialogue box choose Properties and Paper and set to Legal and Landscape and click OK; under Print Range choose "from 1 to 1" and click OK (this will print one page and lock in settings); then use Print Preview to determine which page(s) to print.

Natural Resources Defense Council, February 2000.
Based on EPA's 25-State Arsenic Database of Samples Taken and Reported to States from
Contact Your Water System or State for All Sample Results.

Rank	Water System Name	State	County	Population Served	Low Est. of Average Arsenic Level (ppb)	Best Est. of Average Arsenic Level (ppb)	# Samples in Which Arsenic Was Detected	# S i A V D
1	LOS ANGELES-CITY, DEPT. OF WATER & POWER	CA	LOS ANGELES	3600000	4.2	6.9	92	
2	PHOENIX MUNIC WATER SYS	AZ	MARICOPA	1000000	4.6	5.0	312	
3	EL PASO WATER UTILITIES-PUB SERV B	TX	EL PASO	620000	6.6	6.8	42	
4	SOUTHERN NEVADA WATER SYSTEM	NV	CLARK	500000	5.0	5.0	1	
5	ALBUQUERQUE WATER SYSTEM	NM	BERNALILLO	417279	14.1	14.2	188	
6	MESA, MUNIC WATER DEPT.	AZ	MARICOPA	350000	7.0	9.5	94	
7	CORPUS CHRISTI CITY OF	TX	NUECES	270000	6.5	6.5	5	
8	STOCKTON EAST WATER DISTRICT	CA	SAN JOAQUIN	250000	2.2	6.1	4	
9	RIVERSIDE, CITY OF	CA	RIVERSIDE	245000	2.3	5.4	49	
10	SCOTTSDALE, MUNIC WATER	AZ	MARICOPA	174170	10.0	11.1	149	
11	GLENDALE MUNIC WATER CC	AZ	MARICOPA	150000	5.1	5.9	45	
12	KALAMAZOO	MI	KALAMAZOO	150000	5.5	5.5	13	
13	SAN BERNARDINO CITY	CA	SAN BERNARDIN	137738	3.1	6.2	11	
14	CHANDLER, MUNIC WTR DEPT	AZ	MARICOPA	132353	5.6	7.6	121	
15	DESERT WATER	CA	RIVERSIDE	125000	1.9	5.3	13	

	DEPARTMENT						
17	CWS - SALINAS	CA	MONTEREY	100300	2.0	**5.6**	16
18	DOMINGUEZ WATER CORP	CA	LOS ANGELES	100000	1.7	**6.0**	1
19	MIDLAND CITY OF	TX	MIDLAND	97458	10.8	**11.1**	7
20	LOS ANGELES CO WW DIST 4 & 34-LANCASTER	CA	LOS ANGELES	96073	12.0	**14.5**	82
21	NORMAN	OK	OK	80000	36.3	**36.3**	25
22	PEORIA, CITY OF	AZ	MARICOPA	74000	4.1	**6.3**	44
23	HOUSTON-GREENSPOINT	TX	HARRIS	72027	7.9	**4**	0
24	YORBA LINDA WATER DISTRICT	CA	ORANGE	70000	3.0	**5.9**	20
25	VICTORIA CITY OF	TX	VICTORIA	67353	11.2	**11.6**	3
26	GILBERT, TOWN OF	AZ	MARICOPA	67000	8.8	**9.3**	43
27	WATERFORD TOWNSHIP	MI	OAKLAND	66692	7.8	**7.8**	2
28	CITY OF LAKEWOOD	CA	LOS ANGELES	66000	13.9	**15.1**	39
29	ELSINORE VALLEY MWD	CA	RIVERSIDE	66000	2.2	**5.7**	15
30	BAKERSFIELD, CITY OF	CA	KERN	60720	1.5	**5.3**	14
31	MONTEREY PARK-CITY, WATER DEPT.	CA	LOS ANGELES	59000	5.3	**6.9**	15
32	GREAT FALLS CITY OF	MT	CASCADE	55097	7.8	**7.8**	11
33	CITY OF CERRITOS	CA	LOS ANGELES	53300	4.6	**6.2**	20
34	RANCHO CALIFORNIA WATER DIST	CA	RIVERSIDE	51672	1.7	**5.1**	41
35	CITY OF RIO RANCHO SEWER AND WASTEWATER SERV	NM	SANDOVAL	49999	12.1	**12.4**	39
36	PETALUMA, CITY OF	CA	SONOMA	49957	1.4	**5.0**	1
37	TURLOCK, CITY OF	CA	STANISLAUS	49500	5.1	**7.7**	36
38	CITY OF CHINO HILLS	CA	SAN BERNARDIN	49000	28.2	**30.2**	30
39	WEST SACRAMENTO, CITY OF	CA	YOLO	45000	5.5	**7.1**	29
40	MANTECA, CITY OF	CA	SAN JOAQUIN	44500	7.0	**9.6**	23
41	TRACY, CITY OF	CA	SAN JOAQUIN	44500	2.8	**6.5**	11
42	PORTSMOUTH, CITY OF	OH	SCIOTO	44004	1.6	**6.2**	1
43	FLAGSTAFF MUNICIPAL WATER	AZ	COCONINO	41200	3.6	**6.8**	15
44	MOORE	OK	OK	40300	12.3	**12.6**	59
45	SUN CITY WEST	AZ	MARICOPA	40000	14.4	**16.0**	19
46	ST. GEORGE CITY	UT	WASHINGTO	40000	8.0	**8.5**	41

*** Important note regarding arsenic levels in individual water systems listed in this rep**
public water systems included in the NRDC report *Arsenic and Old Laws* is derived from the
(EPA) 25-state arsenic database, which includes samples taken from 1980 to 1998. NRDC

for state contacts) or your water system.

Corrections: Because of an error in data reporting by the state of California, in the print ver version, Alameda County Water District, City of Antioch Water Department, and City of San incorrectly included in charts identifying water systems with high average arsenic levels.

NRDC has been informed that the monitoring results reported to the state of California by th reported to US EPA (and ultimately were reported by NRDC based on EPA's database), we This information was not indicated in EPA's database. The City of Milpitas has provided infc City of Milpitas has been consistently below 2 parts per billion (ppb).

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Table 4
Highest Average Arsenic Levels in Water Systems Serving over 10,000 People (Ranked by Largest Population First)

Natural Resources Defense Council, February 2000.
Based on EPA's 25-State Arsenic Database of Samples Taken and Reported to States from
Contact Your Water System or State for All Sample Results.

Rank	Water System Name	State	County	Population Served	Low Est. of Average Arsenic Level (ppb)	Best Est. of Average Arsenic Level (ppb)	# Sam in W Arse Was Dete
1	OKLAHOMA UNIVERSITY	OK	OK	22738	78	78	
2	HANFORD, CITY OF	CA	KINGS	37000	51	51	
3	NORMAN	OK	OK	80000	36	36	
4	ANDREWS CITY OF	TX	ANDREWS	11061	35	35	
5	YUKON	OK	OK	20000	35	35	
6	CITY OF CHINO HILLS	CA	SAN BERNARDIN	49000	28	30	
7	ARVIN COMMUNITY SERVICES DIST	CA	KERN	10700	30	30	
8	WEATHERFORD	OK	OK	10400	29	29	
9	CALIFORNIA MENS COLONY	CA	SAN LUIS OBIS	15000	23	26	
10	US ARMY FORT IRWIN	CA	SAN BERNARDIN	17000	24	25	
11	CORCORAN, CITY OF	CA	KINGS	17560	23	23	
12	DELANO, CITY OF	CA	KERN	31235	22	23	
13	INDIAN WELLS VALLEY W.D.	CA	KERN	32630	21	23	
14	NELLIS AIR FORCE BASE AREA I	NV	CLARK	18100	21	21	
15	LEMOORE, CITY OF	CA	KINGS	15806	21	21	
16	M.D.O.T-GRAYLING REST 1&2,R403	MI	CRAWFORD	12000	20	20	
17	AZ WATER CO-APACHE JCT S	AZ	PINAL	34900	16	17	
18	AZ WATER CO-CASA GRANDE	AZ	PINAL	36500	16	17	
19	SUN CITY WEST	AZ	MARICOPA	40000	14	16	
20	NEW MEXICO UTILITIES, INC.	NM	BERNALILLO	14000	15	15	
21	CITY OF LAKEWOOD	CA	LOS ANGELES	66000	14	15	
22	AVONDALE, CITY PUBLIC WO	AZ	MARICOPA	22000	13	15	
23	LOS ANGELES CO WW DIST 4 & 34-LANCASTER	CA	LOS ANGELES	96073	12	15	
24	ALBUQUERQUE WATER SYSTEM	NM	BERNALILLO	417279	14	14	
25	HILLCREST WATER COMPANY 1,2,3,4	CA	SUTTER	10062	13	13	
26	SCWC - ARTESIA	CA	LOS ANGELES	35731	11	13	

28	MOORE	OK	OK	40300	12	13	
29	ELK GROVE WATER WORKS	CA	SACRAMENTO	23000	12	13	
30	MOUNDS VIEW	MN	RAMSEY	12700	12	13	
31	CITY OF RIO RANCHO SEWER AND WASTEWATER SERV	NM	SANDOVAL	49999	12	12	
32	PARADISE V WATER CO-AM W	AZ	MARICOPA	12000	12	12	
33	CITY OF ELKO	NV	ELKO	10000	12	12	
34	EAST NILES CSD	CA	KERN	21500	11	12	
35	VICTORIA CITY OF	TX	VICTORIA	67353	11	12	
36	SCWMD LAGUNA/VINEYARD	CA	SACRAMENTO	20259	11	12	
37	HCO MUD NO 53	TX	HARRIS	19227	12	12	
38	WOODBURN, CITY OF	OR	MARION	15225	11	11	
39	SCOTTSDALE, MUNIC WATER	AZ	MARICOPA	174170	10	11	
40	MIDLAND CITY OF	TX	MIDLAND	97458	11	11	
41	TRUCKEE-DONNER PUD, MAIN	CA	NEVADA	14200	9	11	
42	BELLFLOWER - SOMERSET MWC	CA	LOS ANGELES	24000	8	11	
43	GALT, CITY OF	CA	SACRAMENTO	12000	9	11	
44	JEFFERSON CO CONS PWSD C1	MO	MOJEFFERSON	30000	10	10	
45	BEALE AIR FORCE BASE	CA	YUBA	10000	5	10	
46	MANTECA, CITY OF	CA	SAN JOAQUIN	44500	7	10	
47	MESA, MUNIC WATER DEPT.	AZ	MARICOPA	350000	7	10	

*** Important note regarding arsenic levels in individual water systems listed in this rep**
systems included in the NRDC report *Arsenic and Old Laws* is derived from the U.S. Enviro
database, which includes samples taken from 1980 to 1998. NRDC has not independently v
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Figure 1
NATIONAL ARSENIC OCCURRENCE MAP

This map is intended to show the general areas that are hardest hit by the highest levels of arsenic. However, to determine whether arsenic has been found in a particular public water system, according to data reported to the U.S. Environmental Protection Agency, refer to the table of water systems reported in Appendix A. The map cannot be used by itself to identify whether a particular water system has an arsenic problem, because often there are several water systems located immediately adjacent to each other, and the map was generated at a scale that cannot be used to identify precisely which water system contains a given level of arsenic.

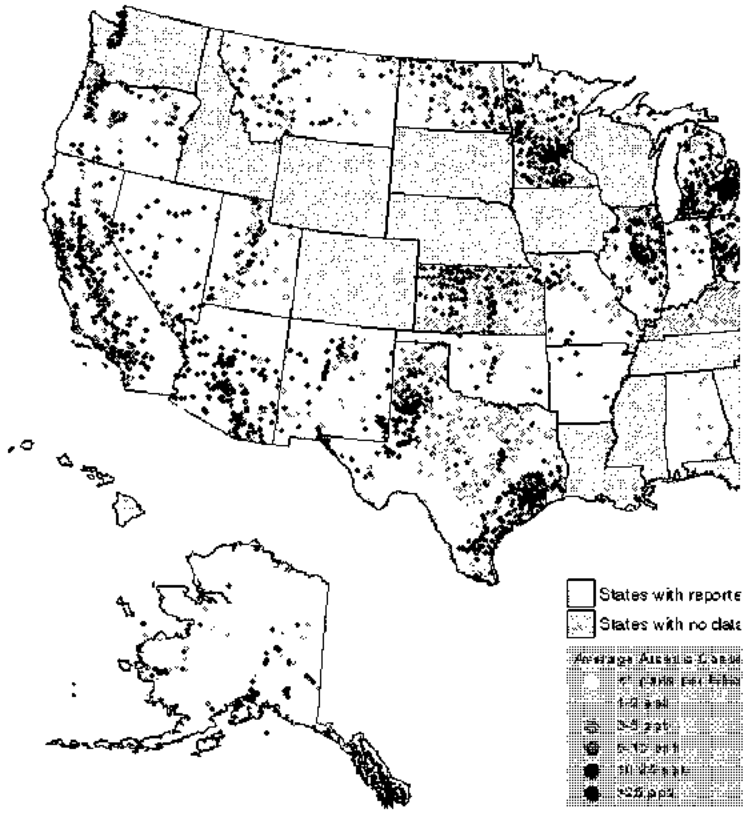

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Table 5
50 Public Water Systems Of Any Size With Highest Average Arsenic Levels (Ranked by Best Estimate of Average Concentration)

Note: To print portions of this chart, in the Print dialogue box choose Properties and Paper and set to Legal and Landscape and click OK; under Print Range choose "from 1 to 1" and click OK (this will print one page and lock in settings); then use Print Preview to determine which page(s) to print.

Natural Resources Defense Council, February 2000.
Based on EPA's 25-State Arsenic Database of Samples Taken and Reported to States fror
Contact Your Water System or State for All Sample Results.

Rank	Water System Name	State	Population Served	Low Est. of Average Arsenic Level (ppb)	Best Est. of Average Arsenic Level (ppb)	# Samples in Which Arsenic Was Detected	# o Sar in \ Ars Wa Det
1	PAUG VIK, INC. INLET SALMON	AK	25	220.0	220.0	1	
2	J TRAILER PARK	CA	25	210.0	210.0	2	
3	DATELAND VINEYARD LABOR	AZ	75	195.0	195.0	4	
4	SOUTHWEST SPORTS PLEX	TX	300	162.0	162.0	1	
5	TOLAS PARK	NV	109	150.0	150.0	1	
6	SAN YSIDRO WATER SUPPLY SYSTEM	NM	300	140.3	140.3	7	
7	HCO FACILITY & PROPERTY MANAGEMENT	TX	3000	138.0	138.0	1	
8	MONTGOMERY MOBILE HOME PARK	NV	150	130.0	130.0	1	
9	DSET LABORATORIES WATER	AZ	56	125.3	125.3	3	
10	ALASKA RAINBOW LODGE	AK	26	120.0	120.0	1	
11	VISTA HERMOSA MHP	AZ	180	118.2	118.2	27	
12	MOUNTAIN HOME ESTATES ASSN	NH	500	107.9	107.9	10	
13	ROOSEVELT LAKE RV PARK	AZ	200	93.2	93.7	18	
14	LKSD NAPAKIAK HS & ELEM	AK	124	93.3	93.3	3	
15	WYNRIDGE CONDOMINIUM	NH	58	92.3	93.2	2	

17	MOUNT WESKE ESTATES MUTUAL WATER COMPANY	CA	71	89.4	89.4	5
18	WESTHAVEN MOBILE COURT	MI	193	89.0	**89.0**	1
19	FALLON NAVAL AIR STATION	NV	4850	85.0	**85.0**	1
20	WHY UTILITY CORP	AZ	960	80.8	**81.4**	14
21	LKSD NAPASKIAK Z J WILLIAMS SC	AK	121	79.7	**79.7**	8
22	OKLAHOMA UNIVERSITY	OK	22738	78.5	**78.5**	20
23	NAPASKIAK WATER SYSTEM	AK	367	77.5	**78.0**	4
24	SABROSA WATER CO NEW RIV	AZ	270	77.4	**77.6**	24
25	SEVENTH DAY ADVENTIST SCHOOL	MI	50	76.0	**76.0**	1
26	MITCHELL'S CORNER WATER SYSTEM	CA	32	73.0	**73.0**	1
27	FLYING A TRAILER PARK	NV	25	73.0	**73.0**	1
28	BREEZY PINES WATER INC-L	AZ	50	71.5	**71.5**	2
29	OLIVET ELEMENTARY SCHOOL	CA	450	71.1	**71.1**	11
30	CAROLINA FOREST S/D	NC	360	69.4	**69.6**	6
31	FOUNTAIN TRAILER PARK WATER	CA	40	69.0	**69.0**	1
32	PRAIRIE VIEW ESTATES MHP	IL	120	67.1	**67.1**	12
33	BADGER DEN	AK	150	66.1	**66.1**	7
34	KOUNTRY MANOR MOBILE HOME PARK	MN	75	65.8	**65.8**	18
35	CITY OF CHENEY	KS	1560	65.1	**65.1**	6
36	BRUNI RURAL WATER SUPPLY CORP	TX	363	65.0	**65.0**	2
37	CORAL GABLES MOTEL	MI	25	64.0	**64.0**	1
38	WINDEMERE POINT S/D	NC	25	63.0	**63.4**	3
39	CAVE CREEK WATER	AZ	1300	63.0	**63.3**	38
40	PHILADELPHIA WATER SYSTEM	AZ	75	62.3	**62.3**	3
41	CAMP VERDE WTR SYSTEM	AZ	1500	58.3	**58.5**	27
42	LKSD TUNTUTULIAK ANGAPAK SC	AK	101	58.2	**58.3**	8

44	BYRON WOODS SBDV	IL	210	56.0	56.0	13	
45	FERNLEY UTILITIES	NV	5950	56.0	56.0	1	
46	LKSD KWETHLUK HS & ELEM	AK	225	55.5	55.5	7	
47	LAMCREST ENTERPRISES	AZ	40	55.2	55.2	17	
48	KENAI WILDERNESS LODGE	AK	25	54.0	54.0	1	
49	SOUTH MAINE ADULT MHP	NV	168	54.0	54.0	1	
50	CEDAR LODGE MOTEL/SUPERIOR TRL	NV	100	53.5	53.5	2	

*** Important note regarding arsenic levels in individual water systems listed in this re**
water systems included in the NRDC report *Arsenic and Old Laws* is derived from the U.S.
state arsenic database, which includes samples taken from 1980 to 1998. NRDC has not ir
collected from state drinking water program officials, and compiled into the 25-state arsenic
completed for some water systems after the EPA database was compiled. To verify inform:
public water system, contact your state drinking water program (call EPA's drinking water H
water system.

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Attachment 36

EPA aims to cut levels of arsenic in well water

[1 3 Edition]

The San Diego Union - Tribune - San Diego, Calif.
Author: Steve LaRue
Date: Jun 5, 2000
Start Page: B.1
Section: LOCAL
Text Word Count: 1549

Document Text

For text of mac-produced charts, see microfilm.

Residents of several outlying areas in San Diego County and across the nation may be paying an unseen price for their rural lifestyles - - increased cancer risk -- health experts say.

The cause: the classic poison arsenic, a metal present in deep rocks, particularly in desert and mining areas. Underground water in these areas dissolves the poison and delivers low levels of it into humans who drink it.

The federal Environmental Protection Agency is proposing to shrink the limit on arsenic in drinking water to one-tenth the current limit, to five parts per billion from 50.

That would mean more stringent water testing requirements at a dozen water systems in this region that rely at least partly on well water and serve communities such as Borrego Springs, Camp Pendleton, Escondido, Jacumba, Poway, La Mesa and El Cajon.

Larger systems, such as the La Mesa-based Helix Water District, already have treatment plants that remove this and other contaminants. If arsenic levels are found to exceed the new health standard in smaller water districts, the cost to users to build treatment works could be considerable because it would be spread among relatively few customers.

The EPA says the proposed health standard could lower cancer risks for 22.5 million Americans, but could require customers of 2,000 to 2,500 small water districts in California, mostly in Southern California, to endure higher water rates to finance new treatment systems.

Nationwide, customers of 6,000 to 7,000 small water systems could face higher costs, the EPA says.

"A lot of systems that use wells are going to have to look more closely for arsenic than they have before," said Bruce Macler, chief drinking water toxicologist for the EPA's western regional office in San Francisco.

"I wouldn't be surprised if 30 to 40 percent of these systems have to do something," he said. "I am sure some of the systems in San Diego County will be impacted."

One part per billion, or ppb, is equivalent to about one drop of water in a large high school swimming pool, or one second in about 32 years.

The EPA's move to tighten the arsenic standard follows a 1999 study by the National Research Council. The existing standard is based on a level set in the early 1940s before arsenic was known to cause cancer. The EPA says it could pose long-term cancer risks in some areas of greater than one case of cancer per 100 people who drink water containing the maximum arsenic levels.

That is, one of every 100 people who drink water with 50 ppb of arsenic would be expected to develop one type of cancer during his or her life.

This is a much higher risk level than the one-per-million the EPA tolerates as a maximum for other drinking water contaminants.

The report concludes: "The current (standard) for arsenic in drinking water does not achieve the EPA's goals for public health protection and, therefore, requires downward revision as promptly as possible."

Water industry trade groups say a less strict standard, such as 10 parts per billion, might be more appropriate, and also a lot less expensive.

"We definitely agree that the standard has to come down, but we are a little apprehensive about what the number should be," said Krista Clark, regulatory specialist for the 442-member Association of California Water Agencies.

Costs could reach $100 per household per year in rural areas, she said, and should not be imposed until there is more scientific consensus on what the standard should be.

These charges, she warned, would reflect the high costs of building and maintaining water treatment works in rural areas where there are not many water customers to share those costs.

Meanwhile, a key environmental group is urging the EPA to make the new arsenic standard even more strict.

"We have called on the EPA to adopt a standard no higher than 3 ppb," said Erik Olson, senior attorney for the Natural Resources Defense Council, or NRDC.

"Clearly, it would be a substantial improvement to go from 50 ppb down to 5 ppb, but the total cancer risk at 5 ppb is still one in 1,000, which is far higher than EPA ever accepts (from other contaminants) in drinking water," he said.

Drinking arsenic-laced ground water over decades has been observed in other countries to increase the incidence of cancers that attack a variety of organs, from the bladder to the lungs, and to contribute to heart illness, federal officials say.

Studies of parts of India where arsenic levels approach 500 ppb indicate that 10 percent of the people who drink the water for long periods develop cancer, said the EPA's Macler.

How many San Diego County residents, or other Americans, may be at risk? Without standardized tests and monitoring procedures, experts say this is difficult to determine. For example, some testing procedures register a "not detectable" reading when the arsenic level is lower than 10 ppb or 20 ppb, experts say.

The vast majority of Southern California's 17 million water consumers, including most urban and suburban dwellers in San Diego County, will not be affected because most of their water comes from mountain snowpacks and rainfall captured as it flows down distant rivers.

Even when some of the wells in these large "surface water" systems contain high arsenic levels, their water is vastly diluted, then treated to remove this and other contaminants.

"The highest arsenic value we have seen in the last year is slightly over 2 ppb, so we are slightly over half of the proposed limit," said John Chaffin, the city of San Diego's water quality superintendent.

The city does draw water from a single well, in El Cajon, where arsenic levels were recorded at 10.2 ppb in 1994. But the water is treated to remove the arsenic and then greatly diluted before it is delivered to customers, Chaffin said.

The existing arsenic standard applies to so-called community water systems and larger systems. A community system is one with at least 15 service connections that supplies at least 25 people throughout the year.

The EPA is proposing to extend the new arsenic standard to include systems that regularly serve 25 or more people at least six months out of the year.

These could be small water companies or special water districts. Neither the existing nor the proposed arsenic standard would apply to so-called "transient" systems, which people do not use continually, such as wells supplying water for rural restaurants or gas stations. Private wells supplying farms and rural homes would not fall under the standard, either.

Private well owners can have their water tested for arsenic and can remove it by using filters containing iron oxide or aluminum oxide.

The San Diego County Department of Health Services monitors arsenic testing at community water systems but refused to disclose which of them has tested above 5 ppb for arsenic. A spokesman said the reason is that the

proposed standard has not been approved, and specific testing procedures have not been identified by the State Department of Health Services.

"We are expecting some kind of guidance from the state as to how to implement the new standard," but there is little doubt that several systems in San Diego County will exceed it, said Frank Gabrian, supervising environmental health specialist.

Counties submit well test results to the states, and states report them to the federal government. Some of these results were obtained under the Freedom of Information Act by the NRDC and posted on the group's Web site (http://www.nrdc.org).

But the results may not tell the whole story.

They suggest, for example, that 1,200 or more residents of Borrego Springs consumed well water in 1997 that contained an average level of 5.6 ppb of arsenic, and that well arsenic concentrations there reached a peak of 10.2 ppb in 1988.

But Linden Burzell, chief engineer for the Borrego Water District, said he is not familiar with such test results.

"We measured the wells in 1998 and have taken hundreds of different samples, and we will be doing this again next year," Burzell said. "All of our 12 wells show that arsenic is undetectable except for one well, where it is at 2 ppb, so arsenic levels in the Borrego Valley aquifer are very low."

The NRDC data also indicate arsenic levels that might exceed the new standard in wells in Jacumba and at Camp Pendleton.

State and county officials said new compliance and testing rules will be needed to tell which water districts comply with the new arsenic standard. The state would be expected to issue these rules about 18 months after a new federal standard is approved.

Credit: STAFF WRITER

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Abstract (Document Summary)

The EPA's move to tighten the arsenic standard follows a 1999 study by the National Research Council. The existing standard is based on a level set in the early 1940s before arsenic was known to cause cancer. The EPA says it could pose long-term cancer risks in some areas of greater than one case of cancer per 100 people who drink water containing the maximum arsenic levels.

They suggest, for example, that 1,200 or more residents of Borrego Springs consumed well water in 1997 that contained an average level of 5.6 ppb of arsenic, and that well arsenic concentrations there reached a peak of 10.2 ppb in 1988.

1 PIC | 3 CHARTS | 1 DIAGRAM; Caption: 1. Marc Hall, a San Diego Water Department chemist, diluted a sample from Otay Lakes. The EPA has proposed lowering the limit on arsenic in drinking water. 2,3,4,5. Arsenic in drinking water (B-3) 2. The element arsenic occurs naturally in the soil. In many areas, it dissolves into the public water supply. (B-3) 3,4. Long-term exposure hazards (B-3) 5. Web sites for more information (B-3); Credit: 1. Earnie Grafton/ Union-Tribune 2,3,4,5. SOURCES: U.S. Environmental Protection Agency; California Department for Health Services; Natural Resources Defense Fund; Knight Ridder/Tribune | UNION-TRIBUNE

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Attachment 37

The New York Times
nytimes.com

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January 11, 2005

Science Panel Issues Report on Exposure to Pollutant

By FELICITY BARRINGER

WASHINGTON, Jan. 10 - In an eagerly awaited report on perchlorate, one of the most controversi unregulated toxic pollutants in the country's drinking water and food supplies, the National Acac Sciences said Monday that people would be safe if exposed to daily doses 20 times those under consider the Environmental Protection Agency.

Depending on how federal and state regulators interpret the academy's recommendation, the Defense De its contractors and other federal agencies responsible for contamination from perchlorate, a component c rocket fuel, could avoid cleanup costs of hundreds of millions of dollars.

The environmental agency and the states of California and Massachusetts have already taken the initial s the regulatory process, with the E.P.A. and Massachusetts both suggesting a maximum safe level of one billion, and California setting a goal of six parts per billion. Thus far, no regulation on the maximum saf perchlorate in drinking water has been made final.

Large doses of the chemical, in widespread use by the Defense Department since the 1950's, have been s inhibit the thyroid gland's ability to take up iodide from a person's diet. Insufficient iodide has been linke impaired neurological development, but the report said that the evidence the panel examined "is inadequ determine whether or not there is a causal association between perchlorate exposure and adverse neurodevelopmental outcomes in children."

The scientists on the National Academy panel avoided arriving at a figure for safe drinking water levels, that was not their charge, recommending instead a safe level based on body weight. Some state regulato representatives of environmental groups, doing their own extrapolations from the panel's report, said it w support a drinking water standard of 20 parts per billion. Others said the conclusions could support maxi levels of less than three parts per billion.

Pentagon scientists, using the same human studies that underpinned the academy's report, had concluded maximum safe level of perchlorate in drinking water supplies was 200 parts per billion.

Groundwater around the country has been found to contain trace levels of perchlorate. The chemical has detected in the Colorado River, a water source for 15 million people in the Southwest. The town of Bou Cape Cod closed some wells because of high perchlorate levels.

But perchlorate's toxicity is hotly disputed, as are safe exposure levels. The debate led four federal agenc including the Defense Department, to ask the academy to assess perchlorate's adverse health effects.

In its report, the 15-member panel, led by Dr. Richard B. Johnston Jr. of the University of Colorado Sch Medicine, said that risk assessments should be based on human studies that indicate when the thyroid's u iodide is inhibited. The E.P.A.'s 2002 risk assessment had relied in part on studies of rats that indicated c

some brain structures after perchlorate exposure.

Scientists from environmental groups like the Natural Resources Defense Council and the Environmental Working Group pointed out that the main human study involved only seven healthy adults who ingested scaled amounts of perchlorate for 14 days.

Regulators in both California and Massachusetts said Monday that they would review the report and, if necessary, adjust their preliminary findings on perchlorate. Allan Hirsch, a spokesman for the Office of Health and Hazard Assessment in California, said that changes might not be necessary, adding that the National Academy dose recommendation "is highly consistent with the calculations we made."

In an earlier call with reporters, officials of the Natural Resources group said that the evidence considered by the panel had been unfairly weighted on the side of industry and the Defense Department, which, along with the White House had an undue influence on the process. They cited evidence they obtained under the Freedom of Information Act, which showed extensive e-mail communication among high-ranking administration members about the charge given to the academy panel.

Richard Canaday, a representative of the White House Office of Science and Technology Policy, responded in a telephone interview: "There is no basis for that claim. This is an attempt to distort the science by attacking the process." The academy, Mr. Canaday added, is the "gold standard of independent scientific review."

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Attachment 38

The New York Times
nytimes.com

August 22, 2003

DRAFT OF AIR RULE IS SAID TO EXEMPT MANY OLD PLANTS

By KATHARINE Q. SEELYE

After more than two years of internal deliberation and intense pressure from industry, the Bush administration has settled on a regulation that would allow thousands of older power plants, oil refineries and industrial units to make extensive upgrades without having to install new anti-pollution devices, according to those involved in the deliberations.

The new rule, a draft of which was made available to The New York Times by the Natural Resources Defense Council, an environmental group, would constitute a sweeping and cost-saving victory for industries, exempting thousands of indus trial plants and refineries from part of the Clean Air Act. The acting administrator of the Environmental Protection Agency could sign the new rule as soon as next week, administration officials have told utility representatives.

The exemption would let industrial plants continue to emit hundreds of thousands of tons of pollutants into the atmosphere and could save the companies millions, if not billions, of dollars in pollution equipment costs, even if they increase the amounts of pollutants they emit.

The action could also spare Gov. Michael O. Leavitt of Utah, if he is confirmed as the new E.P.A. administrator, from having to make a decision on a highly contentious issue.

The current rule requires plant owners to install pollution-control devices if they undertake anything more than "routine maintenance" on their plants. Industries have long argued that the standard is too vague and hinders substantial investment in cleaner, more efficient equipment.

The new rule says that as much as 20 percent of the cost of replacing a plant's essential production equipment -- a boiler, generator or turbine -- could be spent and the owner would still be exempt from installing any pollution controls, according to people involved in the deliberations.

Together, such equipment can cost hundreds of millions of dollars, sometimes more than $1 billion, to replace. A utility or factory could thus make tens of millions of dollars worth of improvements without being required to install pollution controls.

At the end of last year, the administration proposed that the current standards be eased, saying that the threshhold for requiring pollution control devices could be anywhere from nothing to 50 percent of the cost of replacing major equipment. Members of Congress protested that the public could not meaningfully comment on such a range, and 225,000 people objected to the rule before the comment period ended on May 31, according to John Walke of the Natural Resources Defense Council.

Only in the last few weeks have officials settled on the 20 percent figure, which had been a closely held secret within the administration. The draft of the new rule, in fact, describes the point at which pollution-control devices must be installed only as "X percent," but officials and several others in contact with those who wrote the rule said that the level was 20 percent, though they warned that the percentage could change before being made final.

Officials said that Marianne Horinko, the acting administrator of the Environmental Protection Agency, would probably sign the rule before Labor Day. It would go into effect shortly thereafter, without further review or public comment.

The only way to stop it would be through court action, which critics of the new rule are threatening.

Eliot Spitzer, the attorney general of New York, said he would file a challenge to the new rule as soon as it was signed.

"A rule that creates a 20 percent threshold eviscerates the statute," he said of the Clean Air Act. "This makes it patently clear that the Bush administration has meant all along to repeal the Clean Air Act by administrative fiat."

Administration officials, including Ms. Horinko, declined to comment. Jarrod Agen, a spokesman for the E.P.A., said that officials could not comment because the matter was still under review. "But I can say that we are working on this final rule," he said, adding that it would "encourage facilities to improve their efficiency, reliability and safety."

Spokesmen for industry groups reacted positively to the new rule. Scott Segal, executive director of the Electric Reliability Coordinating Council, representing utilities, said that industries would appreciate having a "bright line." He said that the 20 percent, though he did not know precisely how it would be calculated, "is not an unreasonable number."

Mr. Walke of the Natural Resources Defense Council called the 20 percent standard "a grotesque accounting gimmick" that would "let companies completely overhaul their plants over time and spew even more pollution than now."

Clarifying the rule -- and making it more lenient -- has been a central goal of industry for more than a decade, and the administration has been reviewing it since President Bush came into office more than two years ago.

While industry -- and many of Mr. Bush's political and financial backers -- have supported a broad exemption like 20 percent, many state and local officials, including Governor Leavitt's director of air quality in Utah, have strongly opposed the concept.

Governor Leavitt is still likely to encounter harsh criticism on the matter during his confirmation hearings, which are expected to begin shortly after Congress returns from its summer recess on Sept. 2. Democrats have indicated they plan to challenge him to defend the rule, which would put him in opposition to his own state's air experts.

Determining when a plant must install pollution-control devices has been one of the thorniest and most controversial environmental decisions facing the Bush administration.

The new rule also appears to run counter to the stance the administration has taken in several lawsuits against polluters across the country, trying to enforce more rigorous standards under the Clean Air Act.

The Justice Department during the Clinton administration initiated lawsuits against dozens of oil refineries and about 50 coal-fired power plants for their failures to install pollution controls under the requirement of routine maintenance.

The Justice Department during the Bush administration has continued to prosecute those cases, but only after an internal dispute.

Oil, coal and electric companies had lobbied the administration to drop the suits; Christie Whitman, the former E.P.A. administrator, resisted. As a result, Vice President Dick Cheney's energy task force directed the Justice Department to analyze whether to continue the suits. In January 2002, the department decided to do so.

And in a striking counterpoint to the administration's new rule, the department won a landmark victory two weeks ago in federal court against an Ohio Edison plant in Jefferson County, Ohio.

That decision, which found that Ohio Edison violated the Clean Air Act when it failed to install pollution controls, could set a precedent for the other cases and puts the administration on a collision course with itself because of its new rule.

Senator James M. Jeffords, the Vermont independent who is the ranking minority member of the Environment and Public Works Committee, called the new rule "just one more flagrant violation of the Clean Air Act and every court's opinion on this matter." He added: "Its publication will amount to malfeasance."

Mr. Cheney's energy task force also directed the E.P.A. to review the regulations regarding routine maintenance and report to Mr. Bush within 90 days. That deadline slipped repeatedly as the administration mulled how to respond.

The current trigger point of "routine maintenance" was set by Congress in a 1977 amendment to the Clean Air Act. The idea was to avoid shutting at once all plants that might be in violation of the Clean Air Act.

Instead, Congress said, when old plants were refurbished, they had to add the best available air-pollution control equipment. The amendment became known as "new source review" because it required review when a plant added new power sources that could raise emissions.

During the preparation of its report on energy policy, Mr. Cheney's task force was visited often by officials from several industry groups and companies seeking to alter the new source provisions.

According to documents obtained through the Freedom of Information Act by the Natural Resources Defense Council, those visitors included officials from the Edison Electric Institute, the North American Electric Reliability Council, the National Mining Association, the American Petroleum Institute and the Southern Company.

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Attachment 39

The New York Times
nytimes.com

April 27, 2002

E-Mail Suggests Energy Official Encouraged Lobbyist on Policy

By DON VAN NATTA JR.

In an e-mail message sent last year while the Bush administration was formulating a national energy policy, a senior Energy Department official posed this question to a lobbyist for a major natural gas interest: "If you were king, or Il Duce, what would you include in a national energy policy, especially with respect to natural gas issues?"

The message was sent by Joseph Kelliher, who was a political appointee in the Energy Department. Last spring, Mr. Kelliher was a major contributor to Vice President Dick Cheney's energy task force.

Mr. Kelliher's invitation for input was seized by the lobbyist, Dana Contratto, who responded with an array of pro-industry proposals.

The e-mail exchange was released on Thursday night by the Energy Department in response to Freedom of Information Act lawsuits brought by Judicial Watch and the Natural Resources Defense Council. Both groups had sued the Bush administration for records about White House energy policy.

Jeanne Lopatto, a spokeswoman for the Energy Department, described Mr. Contratto as an expert on natural gas issues.

"He has a fine reputation for independent thinking," Ms. Lopatto said. "The administration had two basic choices on how to develop a national energy policy: it could close its doors and shut its ears and turn off its phones and write a national energy policy in isolation, or it could consult with experts, listen to the public and incorporate the good ideas and reject the bad ideas.

Mr. Contratto, a partner with the law and lobbying firm Crowell & Moring, suggested several new initiatives, including that the administration endorse an increase in the gas transmission operating pressures.

"With higher pressures, more gas moves," Mr. Contratto wrote in the March 22, 2001, message. "Obviously, some pipelines could not handle such higher pressures, but new pipelines could be built to move more gas at such higher pressures."

Ms. Lopatto said that none of Mr. Contratto's suggestions were incorporated in the national energy report. The memorandums with the reference to Mr. Kelliher's request for information had been released several weeks ago, but at that time Mr. Kelliher's invitation for suggestions had been whited out.

"Of course, I'm glad that the Energy Department corrected their previous error," said Sharon Buccino, a senior lawyer at the Natural Resources Defense Council. "I wish that they had done it right the first time, in compliance with the judge's order and before the Senate passed its energy bill."

Ms. Lopatto said Mr. Kelliher's e-mail messages "had been inadvertently redacted by the Justice Department."

A federal judge had ordered the Departments of Commerce, Energy and Transportation to release the documents earlier this year. The messages were part of the batch of 400 pages of documents that were released late Thursday by the Energy Department.

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Attachment 40

Department of Energy
Washington, DC 20585

February 10, 2011

Mr. Joshua Berman
Natural Resources Defense Council
1200 New York Avenue, NW, Suite 400
Washington, DC 20005

Re: HQ-2011-00601-F

Dear Mr. Berman:

This is an interim response to the request for information that you sent to the Department of Energy (DOE) under the Freedom of Information Act (FOIA), 5 U.S.C. 552. You asked for records that reflect communications between the DOE and the Federal Housing Finance Agency and/or the Office of the Comptroller of the Currency regarding Property Assessed Clean Energy (PACE) energy efficiency retrofit programs, and any responses or attachments.

The request has been assigned to the Office of Energy Efficiency and Renewable Energy to conduct a search of its files for responsive records. Upon completion of the search and the review of any records located, you will be provided a response.

In your letter, you agreed to pay up to $100.00 for fees associated with the processing of the request. You also requested a waiver of processing fees, and stated that disclosure of the information will help to inform the public about the DOE's change of position regarding the PACE program.

For purposes of assessment of fees, you have been categorized under the DOE regulation at Title 10, Code of Federal Regulations, Section 1004.9(b)(3), as a "news media" requester. Requesters in this category are charged fees for duplication only and are provided 100 pages at no cost.

I have reviewed the information that you provided with your letter to support the request for a fee waiver or reduction and determined that the information satisfies the criteria considered for a waiver of fees. A waiver, therefore, is appropriate for fees that may be incurred because the subject of the request relates to a government activity, and information about the activity could lead to greater public understanding about the matter.

The above referenced number has been assigned to the request and you should refer to it in correspondence with the DOE about this matter. If you have questions about processing the request, please contact Ms. Ruth Mosby in the Office of Energy Efficiency and Renewable Energy at EE-12/Forrestal Building, 1000 Independence Avenue, SW, Washington, DC 20585. She also can be contacted on (202) 586-8757.

I appreciate the opportunity to assist you. You may contact Ms. Joan Ogbazghi in this office on (202) 586-3595 with any questions about this letter.

Sincerely,

Joan Ogbazghi
for Alexander C. Morris
FOIA Officer
Office of Information Resources

Printed with soy ink on recycled paper