UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

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OFFICE OF WATER

MEMORANDUM

SUBJECT: Integrated Reporting and Listing Decisions Related to Ocean Acidification

FROM: Denise Keehner, Director
Office of Wetlands, Oceans and Watersheds

TO: Water Division Directors, Regions 1 - 10

The purpose of this Memorandum is to provide information to assist the Regions and States in preparing and reviewing Integrated Reports related to ocean acidification (OA) impacts under Sections 303(d), 305(b), and 314 of the Clean Water Act (CWA). You may recall that EPA settled a lawsuit in which the Center for Biological Diversity (CBD) challenged EPA's approval of Washington State's 2008 CWA 303(d) list, arguing failure to include coastal waters as impaired for marine pH [*CBD v. EPA*, No. 2:09-cv-00670-JCC (W. D. Wash.)]. One of the conditions of the settlement agreement was that EPA would issue this Memorandum by November 15, 2010, describing how EPA will proceed with regard to the interplay between OA and the 303(d) program. This Memorandum recognizes the seriousness of aquatic life impacts associated with OA and describes how States can move forward, where OA information exists, to address OA during the 2012 listing cycle using the current 303(d) Integrated Reporting (IR) framework. At the same time, this Memorandum also acknowledges and recognizes that in the case of OA, information is largely absent or limited at this point in time to support the listing of waters for OA in many States.

I. Background

Ocean acidification refers to the decrease in the pH of the Earth's oceans caused by the uptake of carbon dioxide, a greenhouse gas (GHG), from the atmosphere. Ocean acidification, like climate change, is primarily caused by increasing carbon dioxide (CO_2) concentrations in the atmosphere. As a result of absorbing large quantities of human-made CO_2 emissions, ocean chemistry is changing, which is likely to negatively affect important marine ecosystems and species including coral reefs, shellfish, and fisheries. In addition, OA could cause these ecosystems to become even more vulnerable to other environmental impacts, especially those from climate change, such as increases in sea surface temperatures (NRC 2010; Ridgwell and Schmidt 2010; US EPA 2009b, 2010c; NOAA 2008; Hoegh-Guldberg et al. 2007).

EPA's actions under the Clean Air Act (CAA) to better understand and address the environmental impacts associated with greenhouse gas (GHG) emissions, including OA and climate change, currently show the greatest promise in addressing these serious environmental

challenges. For example, under the CAA, EPA finalized the Mandatory Reporting of Greenhouse Gases rule, thereby creating a GHG reporting program to collect comprehensive, nationwide emissions data; issued the Endangerment and Cause or Contribute Findings for Greenhouse Gases under Section 202(a) of the CAA; and developed several GHG mitigation regulations for light-, medium-, and heavy-duty vehicles and for new and existing industrial facilities that substantially increase GHG emissions. At the same time, EPA also recognizes that the 303(d) program under the CWA has the potential to complement and aid in these efforts by ensuring that, over time, we continue to identify and track waters that are impaired due to OA.

II. Summary of Federal Register Notice and Comments Received

EPA published a Federal Register (FR) notice on March 22, 2010, requesting public comment on what considerations EPA should take into account when deciding how to address the listing of waters as threatened or impaired by OA under the CWA section 303(d) program, including how to develop Total Maximum Daily Loads (TMDLs) for such listed waters. The 60-day comment period on the FR notice ended on May 21, 2010, and resulted in approximately 30,000 responses, the majority of which were form letters expressing general support for EPA to take immediate action regarding OA (EPA Docket ID No. OW–2010–0175, at http://www.regulations.gov). About 35 individual responses (from State Agencies, environmental non-governmental organizations, academia, industry, and representatives from Congress) provided the Agency with detailed comments and recommendations on OA and the 303(d) program. Many commenters indicated their support for EPA to take both short and long-term action to address OA under the CWA. Several commenters indicated that the natural daily and seasonal variability of marine pH makes it difficult to implement the criteria. Other commenters suggested using modeling methods to identify a baseline for marine pH and recommended that States consider monitoring for other OA parameters besides marine pH (e.g., dissolved inorganic carbon [DIC], partial pressure of CO_2 [pCO_2], and/or total alkalinity [TA]) to better reflect OA impacts.

A number of commenters stated that although evaluating OA impacts is challenging, some monitoring technologies do exist and are available through other programs and academic institutions. Several commenters indicated that States need detailed guidance and resources to develop and implement consistent and comprehensive State monitoring and assessment programs for marine pH criteria and other biological endpoints that reflect adverse OA impacts. A number of commenters stated that warm water coral reefs were particularly vulnerable to OA, and that some technical methods exist to help States develop coral reef biological criteria as another way to protect coastal waters from OA impacts. Other commenters suggested that States can coordinate and leverage existing Federal and other water sampling programs as they develop their OA monitoring and assessment methodologies. Several commenters indicated that EPA should not address OA at all under the CWA, but defer to the CAA to identify and manage CO_2 emissions that lead to OA. A few commenters stated that even if waters were listed for OA impairment, it would be extremely difficult to develop OA-related carbon TMDLs because of the lack of available methods and data.

III. Additional Information on Ocean Acidification

After the FR notice comment period closed, EPA evaluated additional information, programs, and resources to consider how to approach OA under the 303(d) program, which are briefly described below:

(1) National Research Council (NRC) Report: At the request of the U.S. Congress, the NRC published a report titled, "Ocean Acidification: A National Strategy to Meet the Challenges of a Changing Ocean", the goal of which was to review the current state of knowledge and identify key gaps in information to help Federal agencies develop a program to improve OA understanding and address the consequences of OA (NRC 2010). Overall, the report concludes that OA science is complex and in its early stages, but that there is evidence that it is a growing problem which will intensify with continued CO_2 emissions, and will adversely affect marine ecosystems such as marine fisheries, shellfish harvests, and coral reefs. The report states that a national comprehensive monitoring and assessment network does not exist to establish baselines for OA parameters (including marine pH) needed to adequately evaluate OA effects, but a number of current sites and surveys are available to serve as a backbone for a national OA observational network. The report also states that chemical parameters and methods for OA are well-established, but not for biological metrics. In addition, the report indicates that existing knowledge of natural baselines for marine pH is limited because many data sets lack sufficient monitoring details to be useful in estimating trends. The NRC also suggests other chemical parameters be monitored along with marine pH to more accurately reflect OA impacts (e.g., pCO_2, DIC, TA). Finally, the NRC recommends that the Federal government establish a National OA Program for understanding and responding to OA.

(2) Future Federal Action: Ocean Acidification has emerged as a top priority within various Federal efforts. The following are two key actions addressing scientific and technical OA issues, and in turn, should provide useful OA information for the 303(d) program:

(a) The National Ocean Council (NOC): On July 19, 2010, President Obama issued Executive Order (EO) 13547 that establishes the Nation's first comprehensive National Ocean Policy for the stewardship of the ocean, our coasts, and the Great Lakes (Obama 2010). The EO created an interagency National Ocean Council with the intent to strengthen ocean governance and provide sustained, high-level focus on the national priority action objectives to advance the National Policy (available at http://www.whitehouse.gov/administration/eop/oceans). The NOC is charged with developing Strategy Action Plans for nine priority objectives, including "Climate Change Adaptation and Ocean Acidification". Upon approval by the NOC, these 2011 action plans will guide Federal government-wide implementation of ocean policy-related activities and budgets, including development of a flexible framework for effective coastal and marine spatial monitoring and planning.

(b) The Interagency Working Group on Ocean Acidification: The Federal Ocean Acidification Research and Monitoring (FOARAM) Act of 2009 directed the Joint Subcommittee on Science and Technology (JSOST) to create an Interagency Working Group on Ocean Acidification (IWG-OA) to coordinate OA activities across Federal agencies. This Interagency Committee, in which EPA participates, is responsible for organizing and expanding research programs with the

following goals: to enhance understanding of the role of OA on marine ecosystems, identify marine ecosystem conservation measures, facilitate information exchange on OA methods, and investigate the socioeconomic impacts of OA. The IWG-OA is drafting a strategic research plan for OA, to be completed in 2011. An initial report on the plan's progress, including a summary of existing Federally-funded OA research and monitoring activities, including their budgets, was recently completed (IWG-OA 2010).

(3) OA Criteria: Currently all 23 coastal States and five Territories (hereafter referred to as "States") have marine pH water quality criteria (WQC) in place that are similar to EPA's CWA 304(a)(1) recommended national criterion: "pH range of 6.5 to 8.5 for marine aquatic life, but not varying more than 0.2 units outside of the normally occurring range." In addition, more than half the States have coastal monitoring programs. Although EPA recently approved Puerto Rico's 2010 303(d) list that included five waters impaired by marine pH, the majority of the States do not have detailed monitoring protocols, assessment methods, or the high-resolution equipment needed to measure and implement the marine pH criteria. In particular, in most coastal regions data are not readily available to characterize short-term marine pH diurnal and seasonal variability, or to quantify a normally occurring pH "baseline" necessary to identify variation from natural and any long term trends (NRC 2010). After reviewing a wide range of information received in response to a Notice of Data Availability (NODA) on Ocean Acidification and Marine pH Water Quality Criteria (US EPA 2009c), EPA decided against revising the national marine pH criterion for aquatic life due to insufficient data (US EPA 2010b). Finally, only a handful of States have WQC for other OA parameters (e.g., dissolved gases, including CO_2), and most are not actively monitoring for these parameters. A few States have narrative or numeric biocriteria for marine waters with coral reefs that could reflect OA impacts. States will need to continue to use their current marine pH criteria as a basis for 303(d) listing until additional OA criteria are adopted.

IV. Decision Regarding OA and 303(d) Program

EPA has carefully reviewed and considered information received from public comments, other Federal OA programs, and additional scientific information available on this issue in deciding how to approach OA under the 303(d) program. EPA has concluded that States should list waters not meeting water quality standards, including marine pH WQC, on their 2012 303(d) lists, and should also solicit existing and readily available information on OA using the current 303(d) listing program framework. This Memorandum does not elevate in priority the assessment and listing of waters for OA, but simply recognizes that waters should be listed for OA when data are available. EPA recognizes that information is absent or limited for OA parameters and impacts at this point in time and, therefore, listings for OA may be absent or limited in many States.

EPA will provide additional 303(d) guidance to the States when future OA research efforts provide the basis for improved monitoring and assessment methods, including approaches being developed under two significant Federal efforts (NOC and IWG-OA, described above) that will begin in early 2011. This future OA guidance may be in the form of stand-alone OA IR guidance, or as part of EPA's routine, biennial IR update. EPA also encourages States to focus their efforts on OA-vulnerable waters (e.g., waters with coral reefs, marine fisheries, shellfish

resources) that already are listed for other pollutants (e.g., nutrients) in order to promote ecological restoration.

V. Closing Information

Thank you for your continued hard work and dedication working with our States to develop Integrated Reports. This Memorandum and Attachment are consistent with previous IR guidance, and the current statutory framework under CWA Sections 303(d), 305(b), and 314. They are not regulations, do not impose legally binding requirements on EPA or the States, and do not require States to develop any new 303(d) program related to OA. If you have any questions or comments concerning this Memorandum, please contact me or have your staff contact John Goodin at 202-566-1373 (goodin.john@epa.gov) or Christine Ruf at 202-566-1220 (ruf.christine@epa.gov) in the Office of Wetlands, Oceans and Watersheds.

Attachment

cc: US EPA Regional Section 303(d) Coordinators
US EPA Regional Monitoring Coordinators
Brian McLean, Director, Office of Atmospheric Programs, OAR
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ATTACHMENT: INFORMATION CONCERNING 2012 CLEAN WATER ACT SECTIONS 303(d), 305(b), AND 314 INTEGRATED REPORTING AND LISTING DECISIONS RELATED TO OCEAN ACIDIFICATION

This Attachment describes how States can move forward to address ocean acidification (OA) during the 2012 listing cycle using the current 303(d) Integrated Reporting (IR) framework. EPA reaffirms that States must list waters not meeting water quality standards where data and assessment methods are available, including marine pH, but recognizes that information is absent or limited for OA parameters and impacts at this point in time in many States. EPA will provide additional 303(d) guidance to the States when future OA research efforts provide the basis for improved monitoring and assessment methods, including approaches being developed under significant Federal efforts that will begin in early 2011. This future OA guidance may be in the form of stand-alone OA IR guidance, or as part of EPA's routine, biennial IR update. The information in this Attachment is consistent with previous IR Guidance, the current statutory and regulatory framework under CWA Sections 303(d), 305(b), and 314, and implementing regulations at 40 CFR 130.7, 130.2, and 130.8. This Attachment is not a regulation, does not impose legally binding requirements on EPA or the States, and does not require States to develop any new 303(d) program related to OA.

EPA recommends that States address OA during the 2012 303(d) listing cycle by using key components from the existing IR Guidance, described below.

1. Data Solicitation Related to Ocean Acidification

EPA recommends that States with marine waters include as part of their routine IR data request, a provision that solicits existing and readily available water quality-related data and information, including modeling and other non-site-specific data, for marine pH and natural background conditions (see below). Scientific guidance documents on methods for monitoring OA have been published over the last five years. States should refer to NRC's 2010 Report on OA, which provides technical and scientific information on these methods. In addition, States should consider requesting data and information on other OA-related parameters recommended by the NRC, including measurements of temperature, salinity, oxygen, nutrients critical to primary production, and at least two of the following four carbon parameters: dissolved inorganic carbon (DIC), partial pressure of carbon dioxide (pCO_2), total alkalinity (TA), and pH (NRC 2010). Several coastal States currently are monitoring for some of these recommended parameters even in the absence of associated water quality criteria (WQC).

EPA also recommends States specifically solicit existing and readily available biological data that could be used to make OA attainment decisions based on narrative or numeric biocriteria, including biological information related to resources that are particularly vulnerable to OA, such as waters with coral reefs (see section 4, below), marine fisheries, or shellfish resources. EPA acknowledges that existing and readily available chemical and biological data and information may be limited to fully assess coastal waterbody impairment due to OA, but the Agency expects additional data and information will become available in the future. States should refer to Section IV of EPA's 2006 IR Guidance, "Issues Concerning the Development and Use of an Assessment Methodology" (US EPA 2005), for specific recommendations regarding overall data

solicitation and development of assessment methodologies to support State 303(d) attainment decisions.

Listed below are some monitoring programs that include data that may be useful to States as they assess coastal waters for marine pH impairment:

A. NOAA- National Estuarine Research Reserve System (NERRS): Website contains real-time and archived weather and water data. States can use the Google Map feature to locate stations within their waters. To view what type of data the station collects click on the station marker. Majority of the stations collect pH data.
http://cdmo.baruch.sc.edu/QueryPages/googlemap.cfm

B. NOAA National Data Buoy Center: Website contains data from all active NOAA and other registered buoys. EPA recommends States use this website's Google Map feature to locate buoys in their coastal waters and check for stations that monitor pH (also includes NERRS stations).
http://www.ndbc.noaa.gov/

C. Chesapeake Bay Interpretive Buoy System (CBIBS): Website contains weather and water data from sampling stations in Chesapeake Bay. Gooses Reef Buoy records pH data.
http://www.buoybay.org/site/public/

2. Assessment Related to Ocean Acidification

EPA encourages coastal States to start developing assessment methods for evaluating marine waters based on OA impacts using their existing marine pH and biological (narrative and numeric) WQC. EPA reaffirms that States must list waters not meeting water quality standards, including marine pH, based on existing and readily available water quality-related data and information. Consistent with existing IR guidance, EPA also supports the use of predictive modeling and other non-site-specific data such as remote sensing data, land use analysis, and knowledge about pollutant sources and loadings, to make assessment decisions (2006 IR Guidance, Section IV, part C [US EPA 2005]). Several coastal States specifically include a provision in their IR for modeling to be used for listing purposes for all pollutants, although most States do not include this as part of their assessment methodologies. Some States have listed waters based on statewide advisories, or the presumption that the pollutant source (particularly atmospheric deposition, such as mercury) is uniformly affecting segments in large geographic areas. EPA supports the use of these methods for making attainment decisions related to OA where appropriate.

Described below are several programs and articles that currently have useful information and data on OA. EPA recommends States explore these sources to aid in developing strategies for assessing OA impacts.

A. Ocean Carbon and Biogeochemistry (OCB) Program, http://www.whoi.edu/OCB-OA/: This website provides a clearinghouse of OA news, information, and data resources to

support the scientific research community. EPA recommends that States review these websites and documents, especially the "Research Aids" section, to locate relevant information and monitoring projects that can be used to support OA assessment.

Below are some key sections and documents found within OCB's website:

i. "Ocean Acidification - Recommended Strategy for a U.S. National Research Program" (OCB 2009a): The Whitepaper includes a list of additional sources, reports and reviews on OA.
http://www.us-ocb.org/publications/OCB_OA_Whitepaper.pdf

ii. "Response to the EPA's call for Notice of Data Availability (NODA) on Ocean Acidification and Marine pH Water Quality Criteria" (OCB 2009b):
http://www.whoi.edu/fileserver.do?id=62903&pt=2&p=73670

iii. "Response to the EPA's call for public comment on ocean acidification and the 303(d) program" (OCB 2010):
http://www.whoi.edu/fileserver.do?id=62903&pt=2&p=73670

iv. "Research Projects" section under "Research Aids": Includes list of programs and projects that monitor ocean chemistry, explore OA effects on marine ecosystems, and develop ocean chemistry models.
http://www.whoi.edu/OCB-OA/page.do?pid=32492

v. "Data Tools and Resources" section under "Research Aids": Includes links to ocean carbon data, coral reef data, time-series and moorings data from Ocean Sites and the Carbon Dioxide Information Analysis Center (CDIAC), satellite data, and ocean carbon modeling information.
http://www.whoi.edu/OCB-OA/page.do?pid=32493

B. NOAA-Pacific Marine Environmental Laboratory (PMEL) Carbon Dioxide Program, http://www.pmel.noaa.gov/co2/: Conducts ocean carbon cycle research from ships and moorings in all of the major ocean basins in collaboration with the Atlantic Oceanographic and Meteorological Laboratory (AOML) CO_2 Program and the US Climate Variability and Predictability (CLIVAR) CO_2 Repeat Hydrography Program. PMEL monitoring programs include:

i. Air-Sea CO_2 Exchange: Collects fugacity of carbon dioxide (fCO_2) in air and seawater, sea surface temperature (SST), and salinity data
ii. CO_2 Time Series: Collects pCO_2 in air and seawater, and SST
iii. Global Inventory Changes: Includes inorganic carbon measurements

C. NOAA-PMEL Station Papa: Monitors ocean-atmosphere interactions, carbon uptake, and OA. http://www.pmel.noaa.gov/stnP/index.html

D. Integrated Ocean Observing System (IOOS):
Includes a data catalog where you can search by parameter, date, program, and data providers. Note: Internet Explorer is slow to display the data catalog. Firefox, Safari, and Chrome browsers work well. http://www.ioos.gov/

E. Publications by Fabry et al. (2008), Feely et al. (2009), and Riebesell et al. (2010) identify vulnerable ecosystems, measurement requirements, and other details for developing an OA observational network (e.g., planned or deployed open-ocean and coastal OA monitoring sites).

Natural Condition

As discussed previously, currently all 23 coastal States and five Territories have marine pH WQC in place, and more than half of States' criteria contain a natural condition provision (e.g., "pH can range between 6.5 to 8.5, but not varying more than 0.2 units outside of the normally occurring range.") However, most coastal States do not have detailed monitoring protocols, assessment methods, or high-resolution equipment needed to quantify natural conditions within their coastal waters, which is needed to implement such criteria. This absence is due to the fact that marine pH concentrations can vary by depth, time of day, season, and location, making it difficult to monitor accurately. Additionally, historical pH datasets typically lack the necessary detail needed for States to establish accurate baselines. While most States are not determining natural condition for marine pH, a few States do address natural conditions in their assessment methodologies (e.g., modeling can be used to determine natural background). In addition, researchers are developing approaches to estimate historic marine pH values to draw conclusions concerning OA impacts. For example, Feely et al. (2010) uses a CO2SYS computer program developed by Lewis and Wallace (1998) to estimate pre-industrial pH and current pH from measured TA and DIC values. Therefore, to improve implementation of the marine pH criteria, EPA suggests States begin requesting information on, and developing methods for, interpreting their marine pH water quality standards related to natural condition.

Other 303(d)-Related Information

Consistent with EPA's 303(d) regulations and previous IR Guidance, EPA recommends that States include in their IR methodology a description of how they consider available OA data and information for assessment decisions, including statistical approaches and the QA/QC criteria used to evaluate such data and information. Also, EPA reminds States that if a designated use is not supported and the segment is impaired or threatened, the fact that the specific pollutant is not known does not provide a basis for excluding the segment from being listed as impaired. Therefore, if marine pH exceeds the State's criterion, but the source-stressor is unknown (e.g., carbon deposition, nutrient enrichment, industrial discharge, natural background), then EPA expects the segment to be listed. In addition, to promote the identification of the pollutant(s) causing the impairment, EPA recommends that States include other information that could contribute to identifying the specific pollutant.

EPA also recommends that States consider using IR Category 3 for segments where there is insufficient available data and/or information to make a determination related to OA. It is possible that States have information from other sources regarding OA impacts and could then identify those segments that are higher and lower priority for follow-up monitoring in the future, using predicative tools such as probability surveys or landscape models. Category 3 provides

States with the flexibility to monitor these segments in a manner consistent with their overall monitoring strategy and schedule. (See page 5-6 of EPA's 2010 IR guidance [2009a] for more detail on Category 3).

Separate IR section for Marine Water Segments

EPA recommends that States consider including a separate assessment and listing section in their IR report for information related to marine water segments (e.g., coastal waters, estuaries) and all parameters separate from their freshwater segments, where practical. For example, Puerto Rico in their 2010 Integrated Report has separate sections for their segmentation criteria and assessment units of inland waters (rivers, streams, lakes, and estuaries) and coastal shoreline. Location and size of segments are documented in separate tables. In addition, Puerto Rico separates the listing of impaired waters into the following five tables: 1) rivers and streams, 2) estuaries, 3) lagoons, 4) lakes, and 5) coastal shoreline. This separate marine/coastal section may make it easier for States and the public to evaluate, review, and update methods and data related to marine impairments, including OA.

3. Future Federal Efforts Related to Ocean Acidification

States are encouraged to track two key Federal efforts that should help them in developing monitoring and assessment methods and protocols for use in developing future 303(d) lists. First, on July 19, 2010, President Obama issued Executive Order (EO) 13547 that establishes the Nation's first comprehensive National Ocean Policy for the stewardship of the ocean, our coasts, and the Great Lakes (Obama 2010). The EO created an interagency National Ocean Council (NOC) with the intent to strengthen ocean governance and provide sustained, high-level focus on the national priority action objectives to advance the National Policy (available at http://www.whitehouse.gov/administration/eop/oceans). The NOC is charged with developing Strategy Action Plans for nine priority objectives, including "Climate Change Adaptation and Ocean Acidification". Upon approval by the NOC, these 2011 action plans will guide Federal government-wide implementation of ocean policy-related activities and budgets, including development of a flexible framework for effective coastal and marine spatial monitoring and planning.

Second, the FOARAM Act of 2009 directed the Joint Subcommittee on Science and Technology (JSOST) to create an Interagency Working Group on Ocean Acidification (IWG-OA) to coordinate OA activities across Federal agencies. This Interagency Committee, in which EPA participates, is responsible for organizing and expanding research programs with the following goals: to enhance understanding of the role of OA on marine ecosystems, identify marine ecosystem conservation measures, facilitate information exchange on OA methods, and investigate the socioeconomic impacts of OA. The IWG-OA is drafting a strategic research plan for OA, to be completed in 2011. An initial report on the plan's progress, including a summary of existing Federally-funded OA research and monitoring activities, including their budgets, was recently completed (IWG-OA 2010).

4. Biological Assessment, including Coral Reefs, Related to Ocean Acidification

EPA's current policy is that States should designate aquatic life uses for their waters that appropriately address biological integrity and adopt biological criteria necessary to protect those uses (US EPA 1991). To date, about half of the States now have narrative biological criteria and a handful of States have numeric biological criteria in their water quality standards. Nearly one-third of all States have written procedures describing how to use biological information to help make aquatic life use attainment decisions (Russo 2009), but the majority of these measures and methods apply to freshwater, not marine, systems. Species-specific assessments of biological responses to chemical changes representative of OA have been performed (OCB 2009b), but the NRC (2010) concluded that standardized, appropriate parameters for monitoring the biological effects of OA generally cannot be determined until more is known concerning the physiological responses and population consequences of OA across a wide range of taxa. However, where more detailed information on specific aquatic resources (e.g., coral reefs, marine fisheries, or shellfish resources) does exist, EPA encourages States to consider developing bioassessment methods and/or biocriteria to reflect OA impacts.

EPA has detailed information on developing biocriteria and assessment methods at the following website:
http://water.epa.gov/scitech/swguidance/waterquality/standards/criteria/aqlife/biocriteria/biocriteria_index.cfm and within the documents, "Estuarine and Coastal Marine Waters: Bioassessment and Biocriteria Technical Guidance" (US EPA 2000) and "Stony Coral Rapid Bioassessment Protocol" (US EPA 2007). Additionally, States are referred to EPA's recent publication, "Coral Reef Biological Criteria: Using the Clean Water Act to Protect a National Treasure" (US EPA 2010d) for detailed information on different planning, assessment, and management steps necessary for the development of coral reef biocriteria. Also, EPA's website for Biological Indicators of Watershed Health includes more documents that States can use to assist in developing bioassessments (http://www.epa.gov/bioiweb1/)

One data source that States can use to help them prioritize where to monitor and assess in the future for OA impacts is EPA's National Coastal Condition Reports (NCCR) (http://water.epa.gov/type/oceb/assessmonitor/nccr/index.cfm). These Reports assess the Nation's coastal condition by evaluating five indicators of condition (water quality, sediment quality, benthic community condition, coastal habitat loss, and fish tissue contaminants) in each region of the U.S. (Northeast Coast, Southeast Coast, Gulf Coast, West Coast, Great Lakes, Alaska, Hawaii, and Puerto Rico). Although these reports typically cannot be used to make site-specific 303(d) listing decisions, they can be useful to States in identifying which coastal waters have poor conditions, and therefore help States prioritize locations for future monitoring efforts related to OA impacts. The most current NCCR Report was published in 2008 (US EPA 2008b) and EPA is expecting to publish the next updated NCCR Report in late 2012.

Listed below are other resources that may be of use to States in their efforts to develop bioassessments related to OA impacts:

A. Kleypas et al. (2006), "Impacts of Ocean Acidification on Coral Reefs and Other Marine Calcifiers: A Guide for Future Research": This Workshop paper summarizes existing

knowledge on OA impacts of marine calcifiers, presents a consensus on what the most pressing scientific issues are, and identifies future research strategies for addressing these issues. The report is intended to guide program managers and researchers toward designing research projects with the details and references needed to address the major scientific issues that should be pursued in the next 5-10 years.

B. Fabry et al. (2008), "Present and Future Impacts of Ocean Acidification on Marine Ecosystems and Biogeochemical Cycles": This Workshop report summarizes information from nearly 100 scientists and presents a comprehensive research strategy for four critical ecosystems affected by OA: warm-water coral reefs, coastal margins, subtropical/tropical pelagic regions, and high latitude regions.

C. Buddemeier et al. (2008), Coral Mortality and Bleaching Output (COMBO) Model12: Projects CO_2 and high temperature bleaching event impacts to coral reefs. Developers used coral reefs in Hawaii and US Virgin Islands to test importance of stressors and priority areas for conservation.

D. Bradley et al. (2009), "Development and Implementation of Coral Reef Biocriteria in U.S. Jurisdictions": This article references different coral reef monitoring programs within U.S. coastal waters.

E. NOAA National Environmental Satellite, Data and Information Service (NESDIS)/ Coral Reef Watch (CRW): Experimental Ocean Acidification Product Suite (OAPS) that provides a synthesis of satellite and modeled environmental datasets to provide a synoptic estimate of sea surface carbonate chemistry in the Greater Caribbean Region (includes coastal waters along FL and PR). http://coralreefwatch.noaa.gov/satellite/oa/index.html

5. Prioritization and TMDL Schedule Related to Ocean Acidification

States that list coastal waters for marine pH and other OA-related impairments have the discretion to prioritize their TMDL development schedule. CWA Section 303(d) and implementing regulations at 40 C.F.R. §130.7 do not specify a timeframe for States to develop TMDLs. However, EPA's current policy is that States can choose to rank the development of TMDLs for listed waters in line with advancing technical and scientific methods, and generally have between 8 to 13 years to develop TMDLs. Currently, EPA believes that not enough information is available to develop OA-related carbon TMDLs, and is deferring development of TMDL guidance related to OA listings until more information becomes available in the future. States may want to take this information into account in setting the priority ranking for TMDL development for any waters identified due to OA. However, States could address OA impacts immediately by evaluating marine waters that are currently listed for other pollutants and that are considered vulnerable to OA (e.g., waters with coral reefs, marine fisheries, shellfish resources). For example, researchers have demonstrated that nutrient enrichment can also lead to decreases in marine pH due to natural respiration processes and remineralizing dead organic matter back to CO_2 (Feely et al. 2010). States could focus their efforts on these OA-vulnerable waters to promote ecological restoration.

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