Narragansett Bay as a Sentinel Estuary

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I ask you to consider two main points as we go forward:

History

Morphology

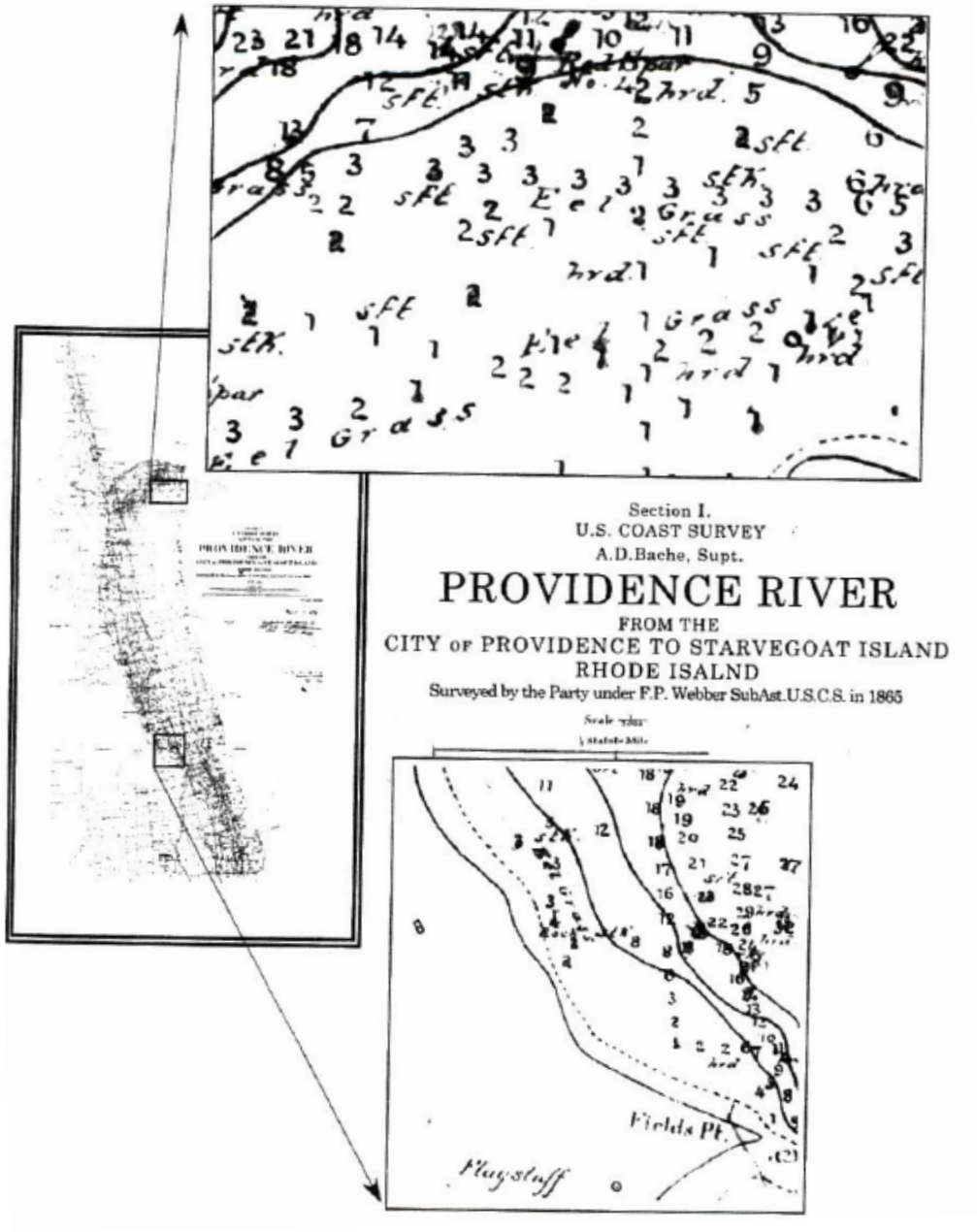
https://commons.wikimedia.org/wiki/File:Providence,_Rhode_Island,_1858.jpg

Opening the drain

1790s—First water powered textile mill on the Blackstone, beginning of the Industrial Revolution

1865—Eelgrass in the Providence River Estuary

1901—"…the beaches within a quarter of a mile of the sewer outfall are usually covered with foul-smelling slime and collections of sewage refuse…. Before the Fields Point sewage station was put into operation this shoal was a famous natural oyster bed, but it has been abandoned for a number of years." (Fuller 1905)



https://books.google.com/books?id=3Zo9AAAAYAAJ&lpg=PA198&ots=6bGEw9JT-U&dq=providence%20river%2C%20sewage%2C%20history&pg=PA187#v=onepage&q&f=false

Also, clear cutting and deforestation

1850—80% of RI was classified as farmland

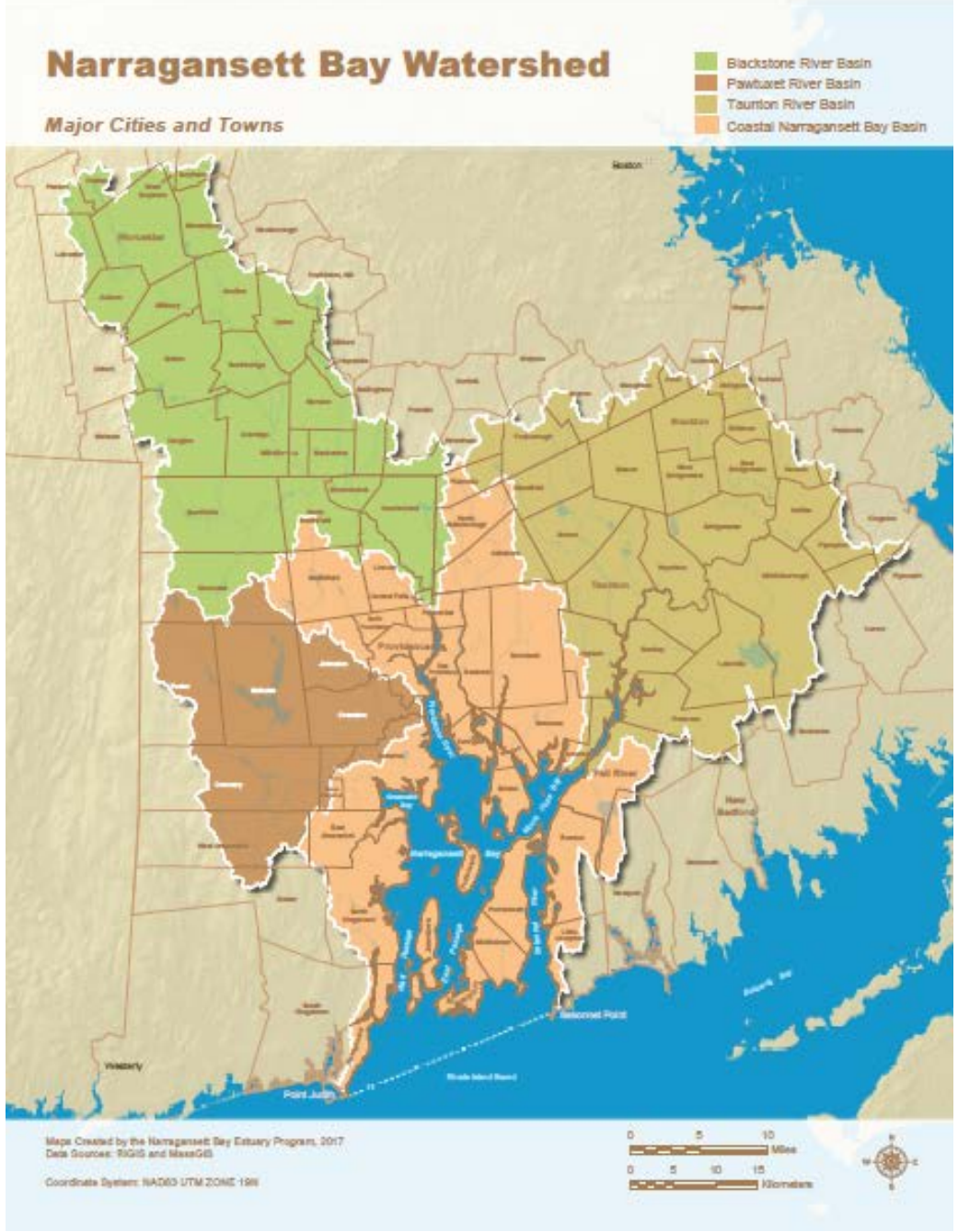
Today, RI is about 10% farmland & 56% forested

(Watershed is 40% forested)

http://www.preservation.ri.gov/conference/past_confs/past_2009.php, Hooker & Compton 2003, Census of Agriculture

60 % of the Narragansett Bay Watershed is in MA,

With the remaining 40% in RI



NBEP Technical Report, Fine Art America

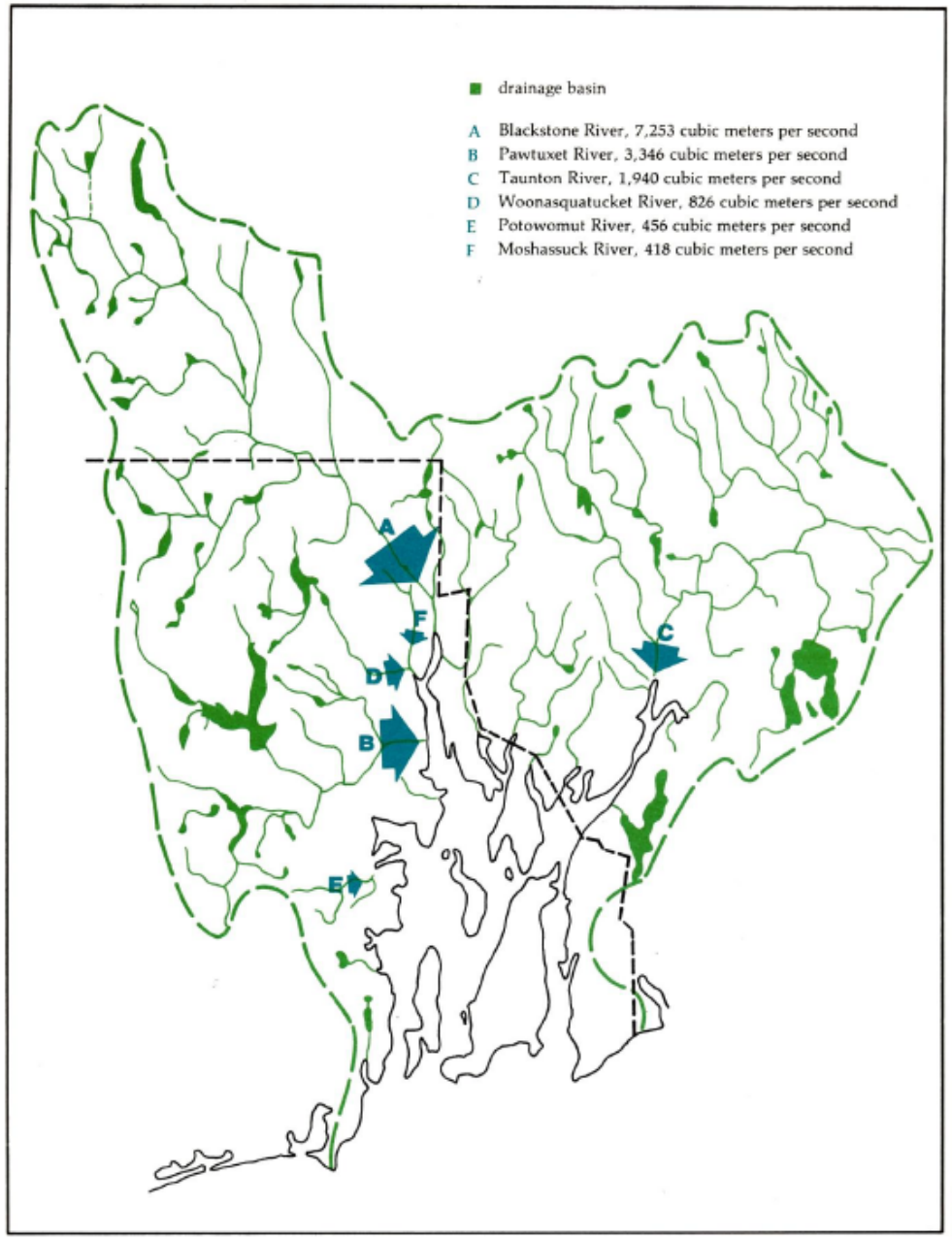
Overall, watershed contributions (via rivers) are fairly small.

But, River flow and precipitation are linked to dissolved oxygen, chlorophyll, and water clarity.

Wet years, poorer water quality in Narragansett Bay.

Source	Annual Total Nitrogen Loading (1,000 lbs/year)			
	Nixon et al. 1995 1982–1983[1]	Nixon et al. 2008 2000–2004[2]	Krumholz 2012 2007–2010[3]	Estuary Program 2013–2015[4]
	Direct Discharge to the Bay			
Atmospheric Deposition*	924	924	924	924
WWTF Discharge[5]	5,636	5,253	4,420	2,777
Urban Run-Off *	1,140	1,140	1,910	1,910
Groundwater Discharge*	-	-	123	123
Rivers[5]	12,290	10,421	7,678	4,668
Total	**20,020**	**17,738**	**15,030**	**9,019**

Figure 10. The Narragansett Bay drainage basin and the average annual flows of principal rivers. *Drafted from data compiled by New England River Basins Commission, 1954.*



Olsen et al. 1980

Closing the drain

Wastewater Treatment Plants

- 50% reduction target met in 2012
- Since then
  - 55% decline in TN
  - 45% decline in TP

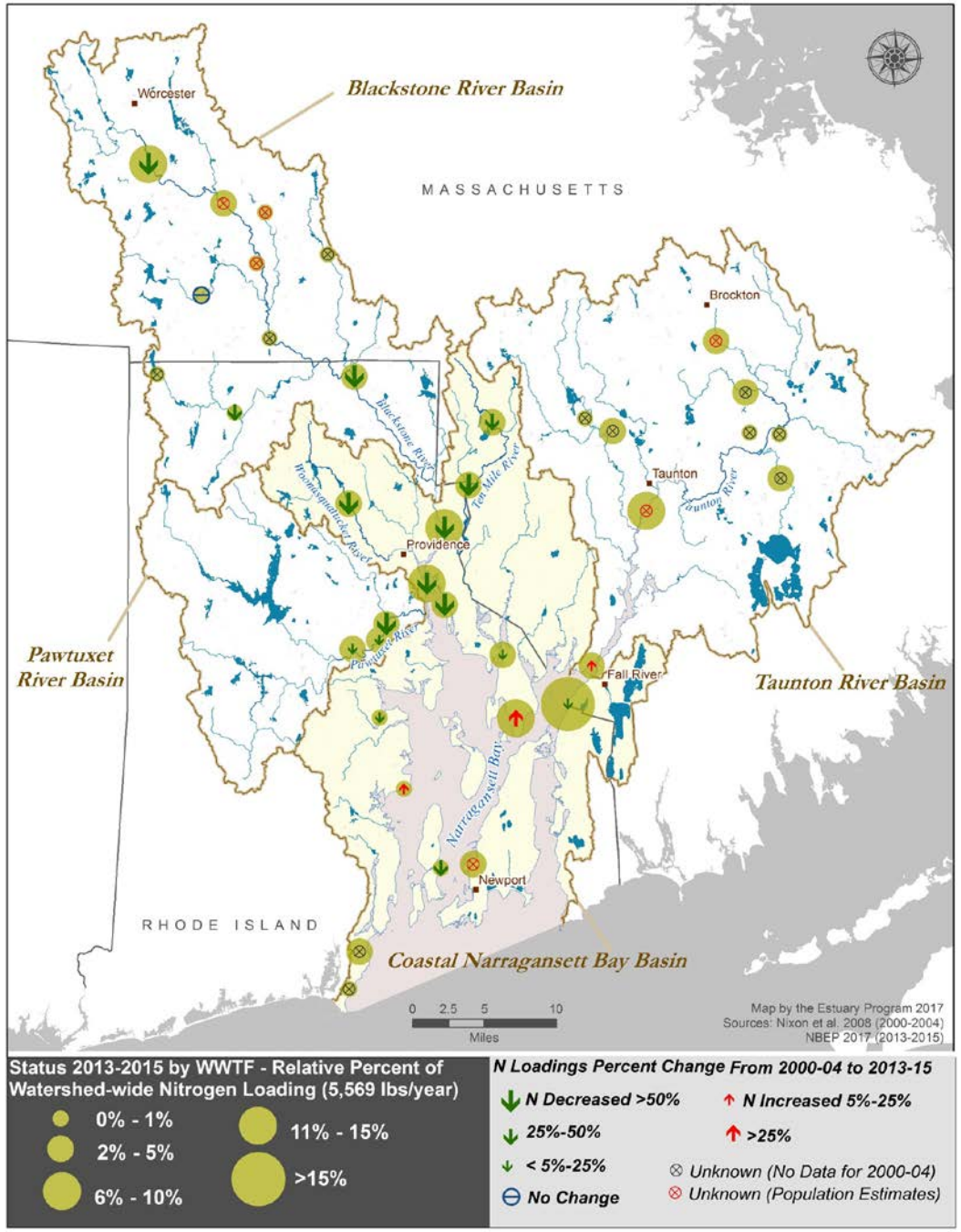
Rivers are similar (flow dependent)

Table 12. Wastewater discharge directly to the Bay with population-estimated data removed. All units are thousand pounds per year.

	Nixon et al. 1995 1982–1983[1]	Nixon et al. 2008 2000–2004	Krumholz 2012 2007–2010	Estuary Program 2013–2015
		Nitrogen		
WWTF Discharge	5,636	4,853	3,397	2,777
		Phosphorus		
WWTF Discharge	924	1,666	1,649	334

[1] The 1982–1983 budget cannot be altered because Nixon and colleagues (1995) did not indicate if they used population estimates for any data.

But what about emerging contaminants?



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1900s	1980s	Today

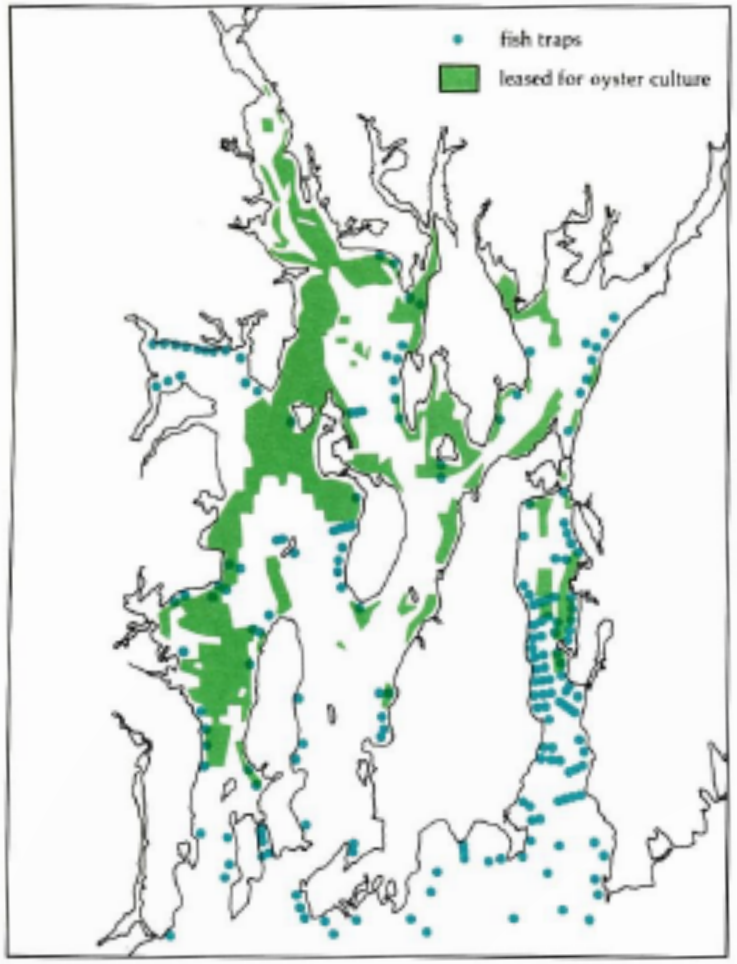
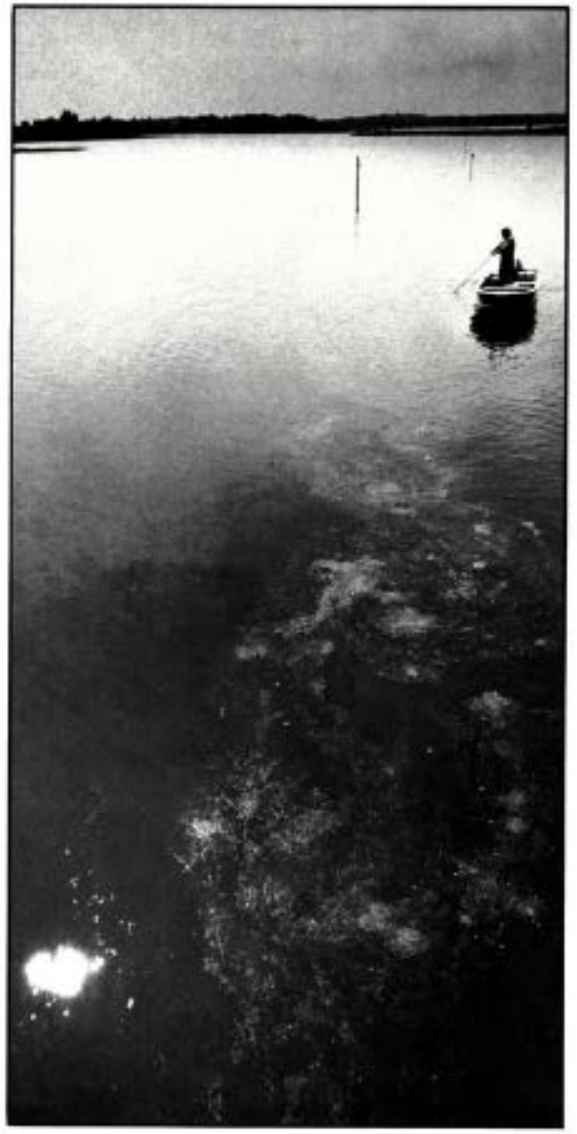


Figure 25. Locations of fish traps in 1910 and grounds leased for oyster culture in 1914. *Adapted from Alexander, 1966, and Holmsen, 1973.*



85% of estuarine water and almost 80% of lake areas were ok for swimming and boating. (>60% of freshwater streams were not)

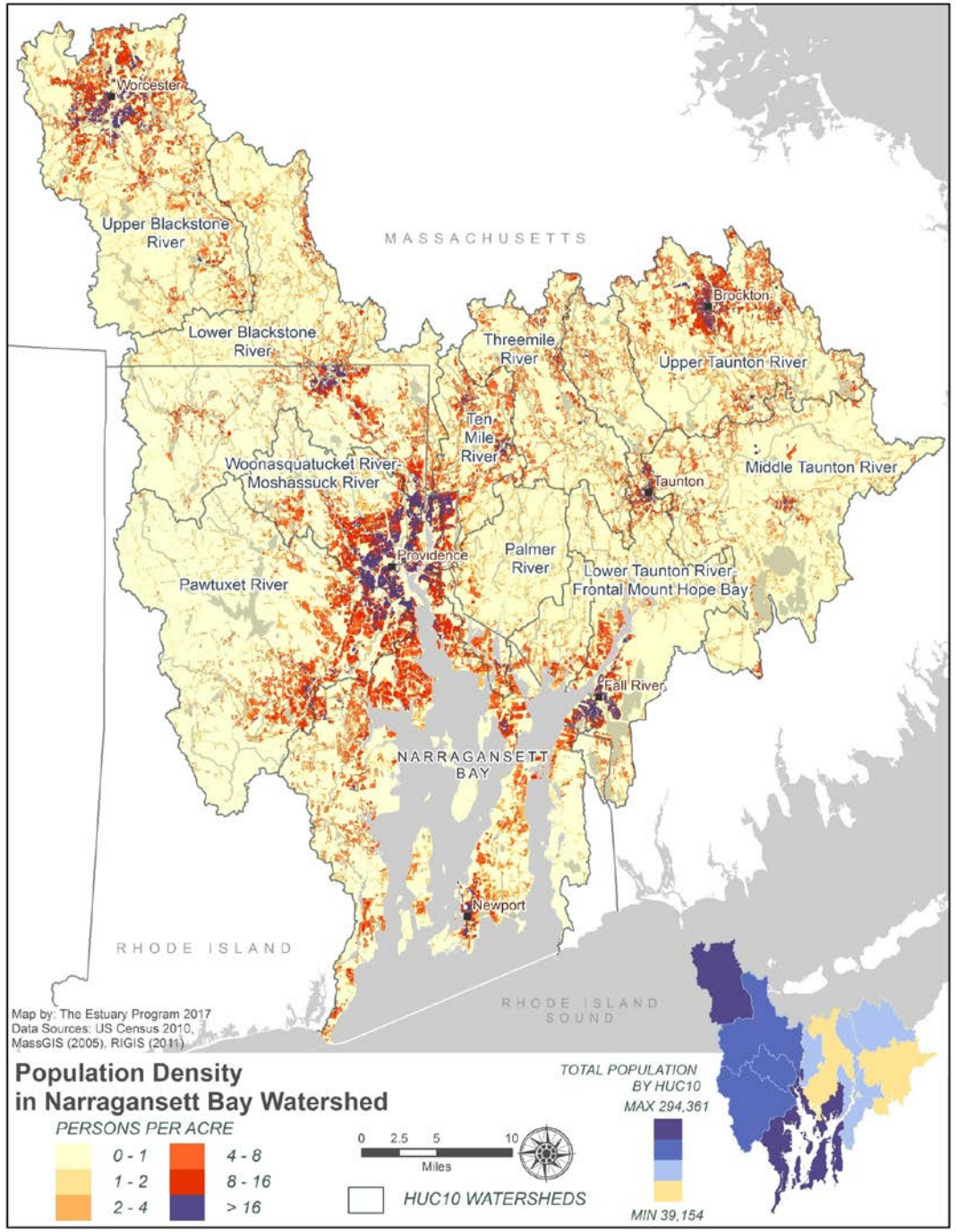
In 2015, 63% of bay was open to shellfishing, without restrictions

More seagrasses, including in Greenwich Bay

Hale 1980, Olsen et al. 1980

The Bay of Gradients

- **An urban gradient**
- Metals in sediments
- Benthic diversity
- Contaminants of emerging concern
- Nutrients
- Chlorophyll
- DO



NBEP Technical Report

Narragansett Bay as a study site

- The salinity gradient from Conimicut Pt to the mouth ranges from 29 to 32
- Generally considered vertically well-mixed
- Sewage is the largest single source of nutrients to the bay
- Sewage enters at the head of the bay and dilutes over its length.

Ayla Fox, from the NBEP Technical Report

Narragansett Bay is one of the most well-studied in the world.

Given our history, the estuary's characteristics, and the nature of the stressors, we are a sentinel for other coastal systems.

Let us leverage our knowledge and expertise to take advantage of the opportunity presented:

to observe the net impacts of enhanced wastewater treatment and a changing climate.

https://landsat.gsfc.nasa.gov/landsat-8-shows-forest-cover-in-rhode-island-with-gypsy-moth-damage/

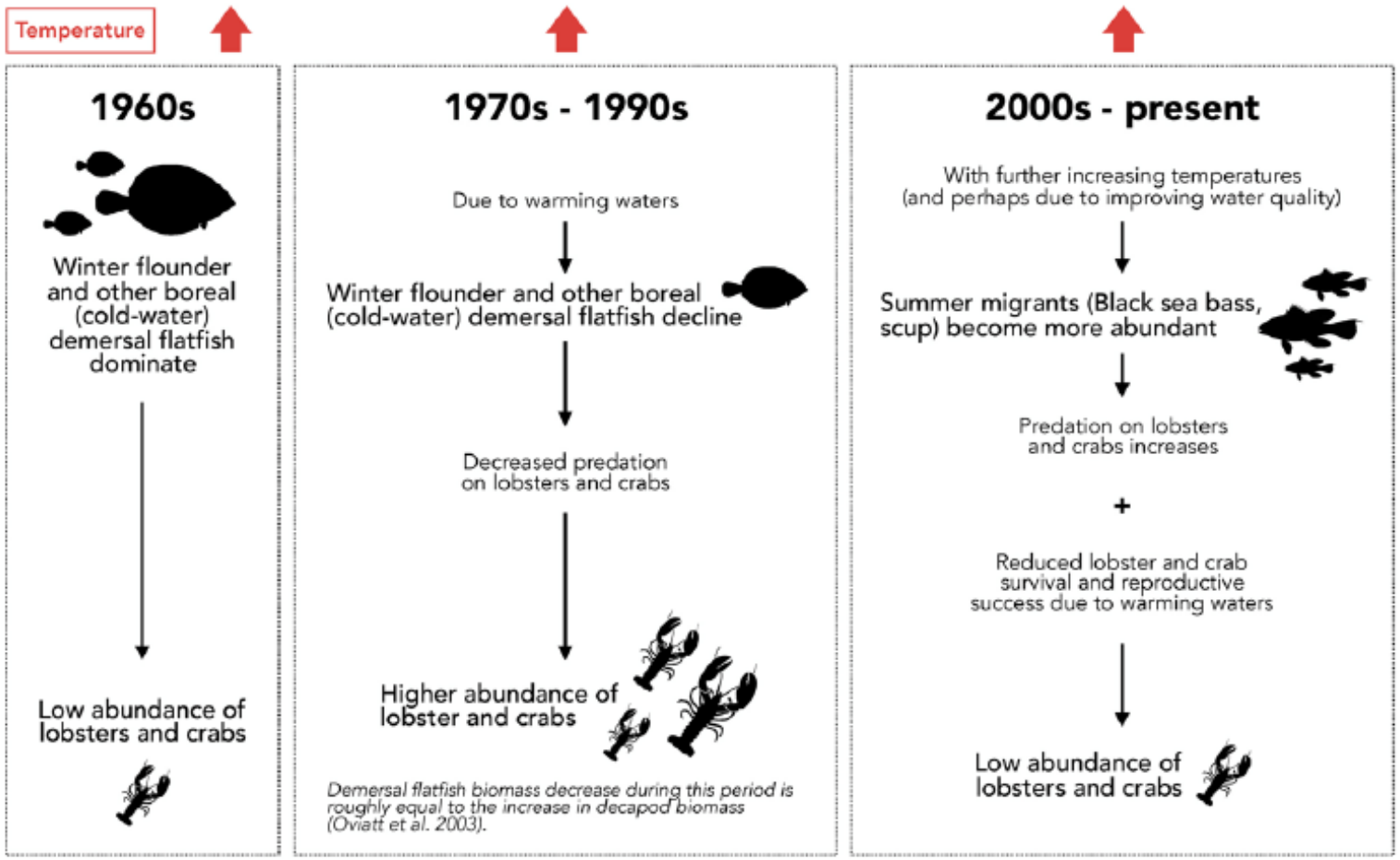


Figure 5. A timeline and description of changes to the Narragansett Bay fish community due to changing abundances of cold-water demersal species such as winter flounder, lobsters, and crabs, and summer migrants like black sea bass and scup, all linked with increases in temperature and shifts in predation.

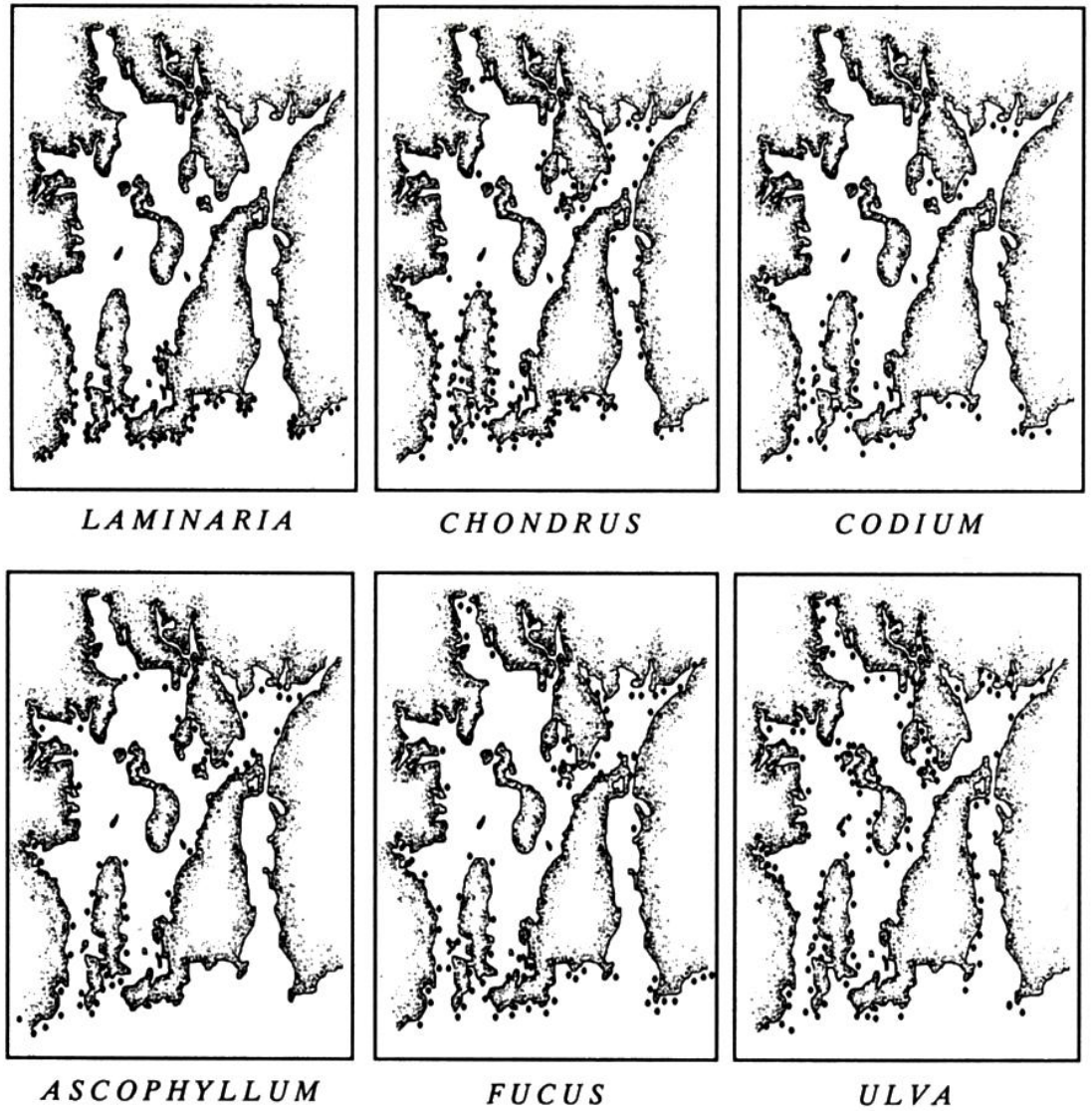
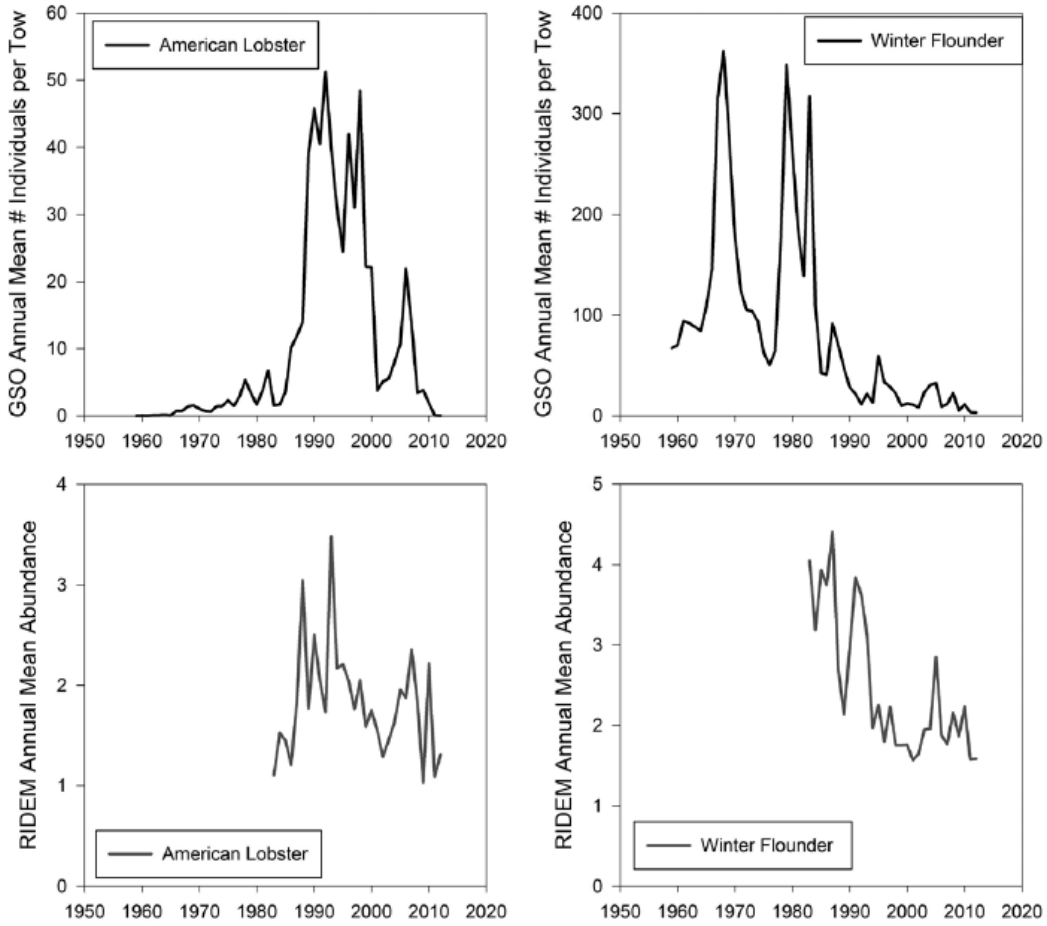
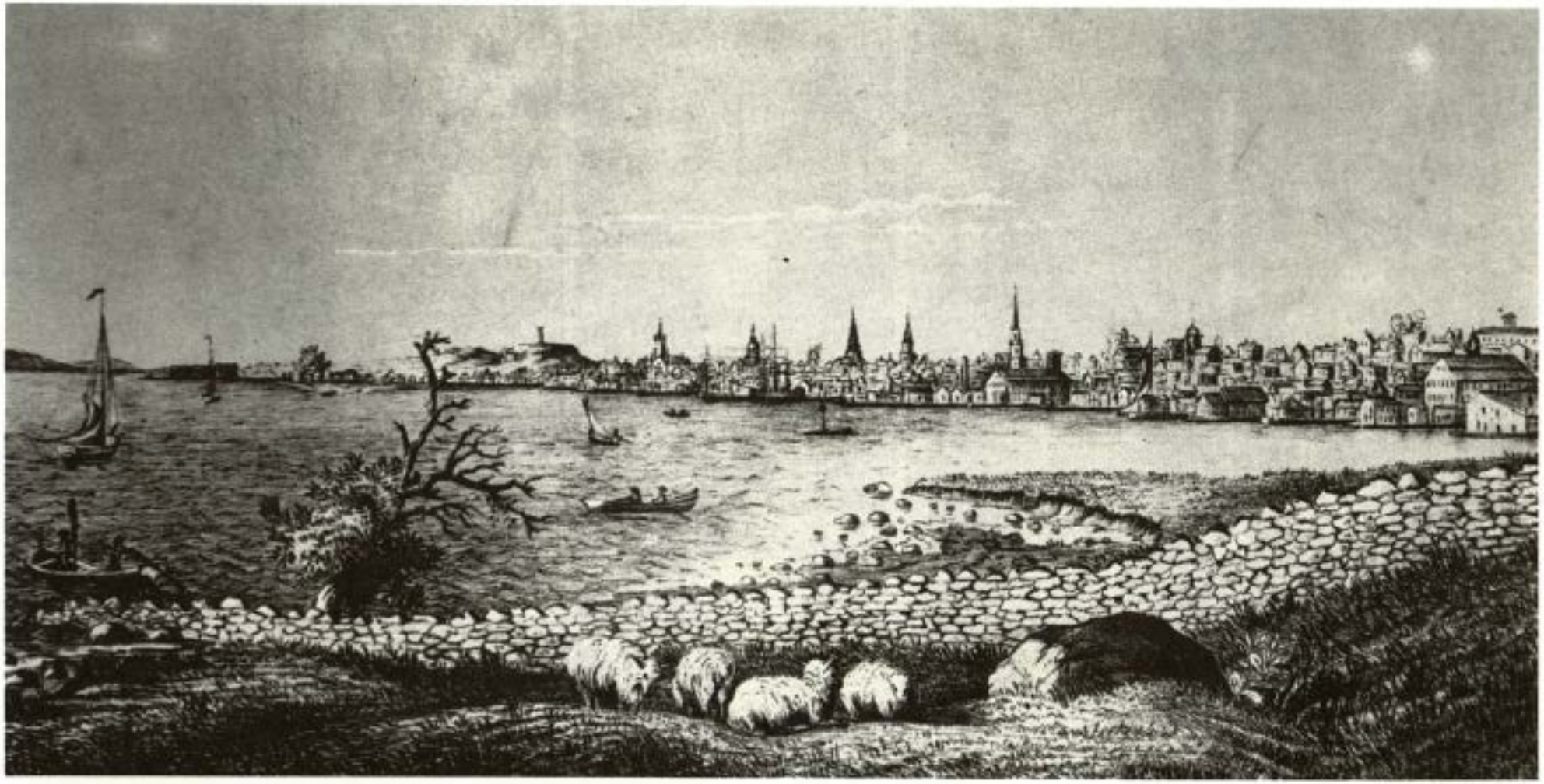


Figure 12.5. Patterns of distribution of six common marine macroalgal genera (from unpublished data of Villalard-Bohnsack and Harlin). A. *Laminaria* spp. are restricted to the mouth of Narragansett Bay. B. *Chondrus crispus*, C. *Codium fragile* and D. *Ascophyllum nodosum* are found throughout the Bay. E. *Ulva lactuca* and F. *Fucus* spp. are widely scattered in the Bay and extend into tributaries.



From Sheath & Harlin 1988
Freshwater and Marine Plants
of Rhode Island



View of Newport from Fort Dunham. Print made by George C. Mason in 1848.