EcoSystem Indicator Partnership

Information on change in the Gulf of Maine

Aquatic Habitats in the Gulf of Maine

Habitat has traditionally been described as "the place where an organism lives." More recently, habitat is often taken to mean a unique combination of physical, geological, and chemical features. Together they provide a preferred living space for a characteristic group of living things. Habitats are generally defined by their dominant physical and biological characteristics, for example: seagrass, sand shoal, salt marsh, mudflat, and tidal flats.

Ecologically, habitats provide spawning grounds, nurseries, refuges, feeding areas, and pathways for migration. When various habitats function together they create an ecosystem of complex biological interactions and biogeochemical processes. A healthy ecosystem is vital to the survival of its living resources. It also provides us with spectacular scenery and natural beauty.

Why use indicators?
Simply put, indicators are one of the best tools for understanding the complexities of the Gulf of Maine/ Bay of Fundy. Like lights on the dashboard of a car, indicators can work in concert with each other to provide an essential look at the larger system. They can be combined into complex calculations or be relatively simple. Simple indicators are often driven by complicated pressures and responses. The three indicators that ESIP has chosen for habitat assessment in the Gulf of Maine are:

1. Extent of salt marsh
2. Extent of eelgrass
3. Number of tidal restrictions

Salt Marshes

Salt marshes in the Gulf of Maine are enormously important. They serve as key nursery habitats for fish and crustaceans. Salt marsh grasses contribute a stable, lasting source of organic matter that decomposes slowly over time, providing food and energy for countless marine and terrestrial creatures throughout the year. Together with other coastal wetlands, salt marshes dampen wave action, reducing flooding and erosion while processing water from storms and hurricanes.

Seagrasses

Seagrass beds are another vital coastal habitat in the Gulf of Maine. In New England, the dominant seagrass is eelgrass (*Zostera marina*). Eelgrass is a perennial flowering plant, very different from the macroalgae (seaweeds) of the New England shore. Eelgrass has roots, rhizomes, and a specialized vascular system to move water, food, and oxygen throughout the plant. It also produces seeds as one of the ways it propogates. Eelgrass can be found in clear water in dense beds called seagrass meadows. It can also extend over large areas of the shallows from the low tide line down to 15 feet (4.5 m) or deeper where the seafloor is soft.

Eelgrass habitat is considered one of the most crucial high-quality marine habitats found on the coast. Its growth forms an extremely diverse and productive habitat providing refuge from predators. It also supplies food for the young of a large number of invertebrate and vertebrate (fish) species. The volume of hiding and living space in eelgrass beds is over 27 times greater than in non-vegetated areas.

Eelgrass meadows are considered prime nursery areas for species such as bay scallops (*Argopecten irradians*), juvenile lobster (*Homarus americanus*), juvenile flatfish like winter flounder (*Pseudopleuronectes americanus*), and a large number of crab and shrimp-like species.

Like salt marshes, eelgrass beds provide important habitat for many species, especially waterfowl that feed on the marine organisms found within the eelgrass as wells as the plants themselves.

Photo: Robert Buchsbaum

Spartina patens

In 2006 the Gulf of Maine Council on the Marine Environment formed a partnership to assess the ecological integrity of the Gulf of Maine through the use of indicators. The EcoSystem Indicator Partnership (ESIP) formed as a direct result of the recognized need to understand ecosystem status and trends in the Gulf of Maine. The Council has many efforts to improve the health of the Gulf of Maine through monitoring and restoration. ESIP brings together information from these and other efforts in the region.

Salt Marsh

Indicator 1

The current estimate of salt marsh area in the Gulf of Maine is about 100,000 acres (40,000 hectares). Slightly over one third of the total area is in the Bay of Fundy with the remainder in the three New England states that border the Gulf of Maine. This estimate is based on aerial photographs that were interpreted, digitized, and then analyzed by geographic information systems (GIS). There is no comprehensive Gulf of Maine survey of salt marshes, hence data were taken from wetland inventories for the individual states and provinces. Slight differences in methodology among jurisdictions do not significantly influence the results.

Over the past 25 years, our ability to identify and delineate smaller salt marshes – those of 0.5 acres (0.2 hectare) or less – has substantially improved. This has enabled us to determine the position and extent of salt marshes with much greater accuracy.

In the late 1970s, wetland inventories indicated that there were approximately 39,000 acres (15,782 hectares) of salt marsh in and around the gulf. Despite increases in recent decades, practitioners in the region believe that salt marsh acreage has sustained significant losses since the time of European settlement. These losses are a result of processes such as filling, draining and diking marsh areas, hardening shorelines, and impacts from upland runoff.

Photo: Robert Buchsbaum

State or Province	Sources for GIS	Acres of Salt Marsh	Hectares of Salt Marsh
Nova Scotia (Bay of Fundy only)	Aerial photography from 1980s and 1990s	27,380	11,080
New Brunswick (Bay of Fundy only)	Aerial photography from 1999–2004	11,172	4,521
Maine	Aerial photography from the 1960s	19,216	7,776
New Hampshire	Aerial photography from 2004	5,660	2,291
Massachusetts (Gulf of Maine only)	Aerial photography from 1993	34,464	13,947
Total Gulf of Maine		**97,892**	**39,615**

Sources: Nova Scotia Department of Natural Resources, New Brunswick Department of Natural Resources, Maine Geological Survey, New Hampshire Coastal Program, and Massachusetts Department of Environmental Protection.

Photo: Reginald Newell

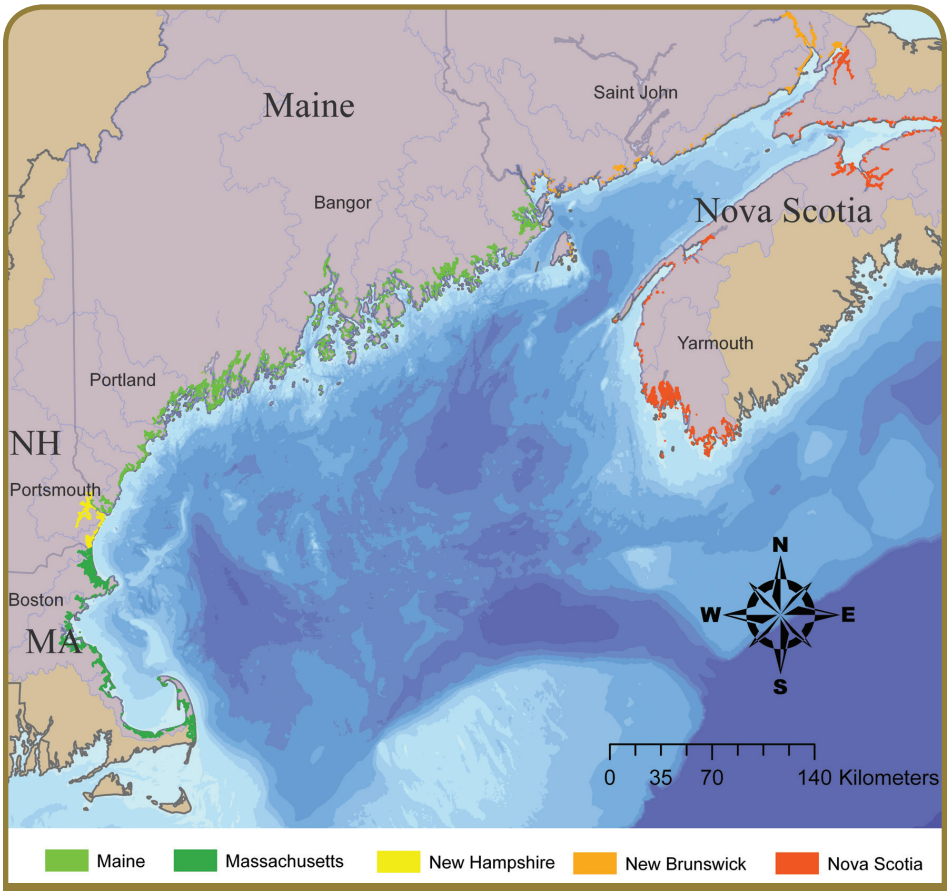


Figure 1: Salt marsh extent in the Gulf of Maine
Increased accuracy of methods is just one factor that influences the estimates of total salt marsh area. While it is desirable to use the most recent aerial photography, the current areas for two of the states and one province are based on aerial photos taken prior to 2000. Moreover, the extent of marsh in a region is always in flux due to natural and human influences.
Source: see table above.

Eelgrass

Indicator 2

Eelgrass in the Gulf of Maine is determined by surveying the sea floor and ocean surface. Local residents, boaters, and fishers have noted the location of specific eelgrass beds for generations, but systematic quantitative measurements of total area covered have only recently become feasible. Although expensive, these measurements are possible with the availability of aerial photography and computerized image processing. However, the cost of surveying hundreds of miles of coastline has limited the scope and frequency of monitoring in the Gulf of Maine.

Figure 2 shows the locations of eelgrass beds in Massachusetts, New Hampshire, and Maine from the most recent analyses available. No significant eelgrass beds are present in the Bay of Fundy portion of the Gulf of Maine, mostly because natural conditions such as the large tidal range are not favorable for eelgrass growth. In the U.S., state-wide monitoring programs for eelgrass provide a baseline and periodic assessment. In addition, local monitoring programs allow communities to track the health of their estuaries and bays over time.

Figure 3 shows a marked decline in eelgrass extent for both Massachusetts and New Hampshire between surveys in 1995 and later years. Time series data are not available for Maine. Hopefully the status of eelgrass data will improve over the coming years. Newer technologies, such as satellite imaging, should allow more frequent assessment of gains and losses in extent of eelgrass along the Gulf of Maine coasts.

Loss of eelgrass can be caused by many things, including light limitation, smothering, disease, catastrophic storms, green crab grazing, ice damage, and impacts from recreational and commercial boats. However, the majority of eelgrass loss in the late 20th and early 21st centuries seems to be most closely linked to effects from excess nutrients (see focus box).

Photo: Courtnay Janiak

Nitrogen pollution in the Gulf of Maine watersheds and estuaries comes from many sources, such as:

- sewage, either through treated wastewater discharges or ground water carrying nutrients from high densities of septic systems (which do not remove all nutrients)
- upland runoff (which often includes fertilizer) from urban, residential, and agricultural development
- other sources including atmospheric deposition.

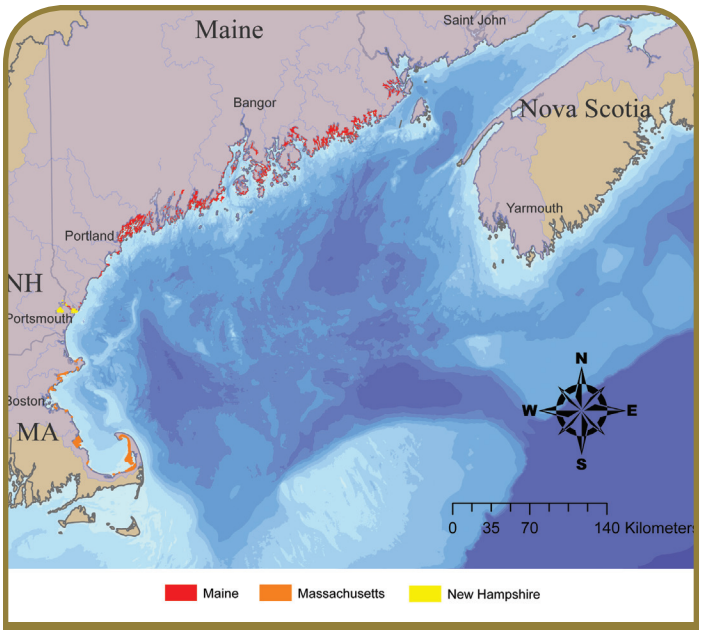


Figure 2: Presence of eelgrass along the US portion of the Gulf of Maine
Sources: Maine Department of Marine Resources, University of New Hampshire, and Massachusetts Office of Geographic Information

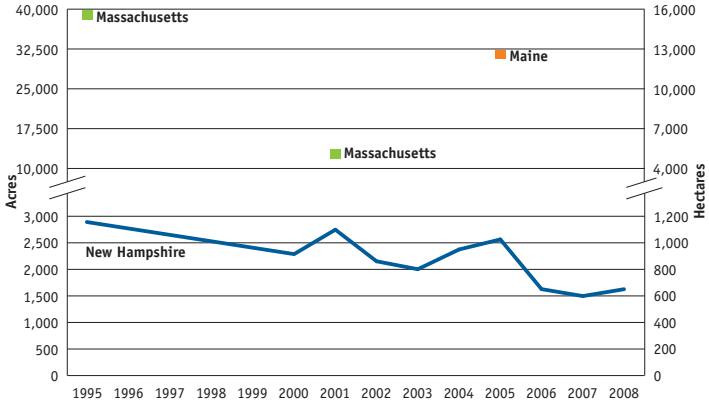


Figure 3: Eelgrass extent for Maine, New Hampshire, and Massachusetts
Sources: Maine Department of Marine Resources, University of New Hampshire, and Massachusetts Office of Geographic Information

Link Between Eutrophication and Eelgrass Coverage

Excess nitrogen has long been linked to the loss of eelgrass. The major reason for decline is thought to be light limitation – caused by planktonic, macro-algal, or epiphytic shading. Waves, currents, and tides also affect the distribution of seagrasses. High organic loading from excess nitrogen may cause water column hypoxia and sediment sulfide production, which has been shown to affect seagrass health. While light limitation is considered the major proximate cause of eelgrass decline, the ultimate cause is generally considered to be excess nitrogen.

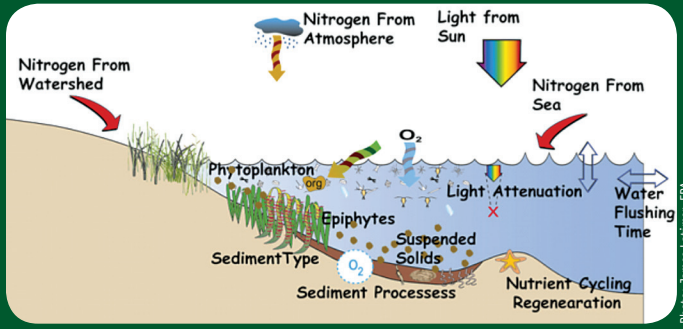


Photo: James Latimer, EPA

Tidal Restrictions and Obstructions

Indicator 3

Throughout the Gulf of Maine, estuaries and tidal marshes have been hydrologically fragmented over the centuries by the construction of dikes and causeways to support agriculture and transportation. These restrictions to tidal flow vary from complete obstruction of tidal exchange via one-way flap gates (allowing only freshwater drainage), to channel restrictions by undersized culverts surrounded by fill. In addition, causeways and dikes that cross tidal marshes alter the normal flooding and draining of the marsh during higher tides and reduce the tidal range.

Problems associated with tidal restrictions are:

- reduced salinities
- poor drainage
- freshwater flooding
- subsidence of the marsh platform
- replacement of salt marsh plants by less salt-tolerant species
- dominance by invasive plants
- interference with normal movements of fish
- limitations of estuarine energy exchange with the Gulf of Maine.

The impact of tidal restrictions can be better understood by looking at how many restrictions occur along a certain length of coastline.

State or Province	Number of Tidal Restrictions
Nova Scotia (Bay of Fundy only)	148
New Brunswick (Bay of Fundy only)	174
Maine	229
New Hampshire	106
Massachusetts (Gulf of Maine only)	113
Total Gulf of Maine	**770**

Sources as for Figure 4. Data for Maine and Massachusetts is considered cursory and field work is needed to obtain values that can be used with confidence.

The greatest number of tidal restrictions (estimates only) are located in Maine (~229) and the fewest in New Hampshire (~106). But Maine's coastline is much longer than New Hamphire's. So when the number of restrictions is divided by coastline length, the concentration of tidal restrictions on the New Hampshire coastline is actually greater. New Hampshire has roughly eight tidal restrictions per statute mile as opposed to Maine that has roughly one restriction per statute mile.

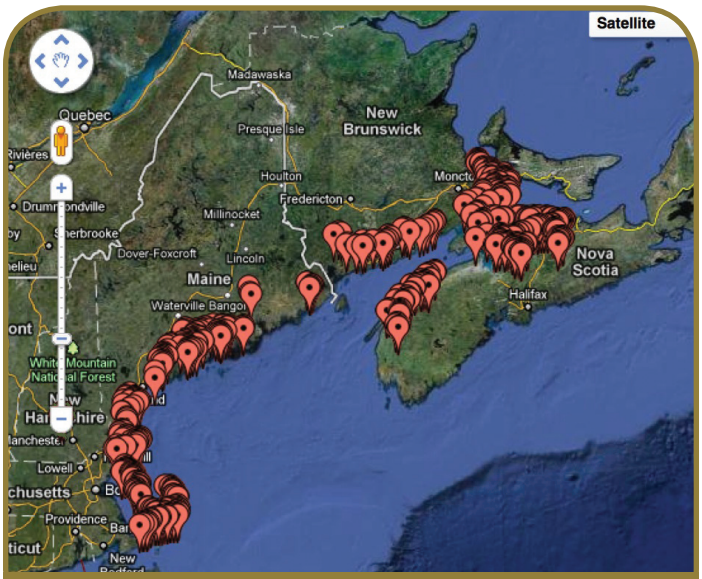


Figure 4: Tidal marsh restrictions in the Gulf of Maine. Estimates for the total number and locations of tidal restrictions in the Gulf of Maine are based on separate surveys conducted by the three states and two provinces.
Sources: Numerous sources were utilized to create the tidal restriction database. For details please go to ESIP's Indicator Reporting Tool (www2.gulfofmaine.org/esip/reporting) and click on About Site Data.

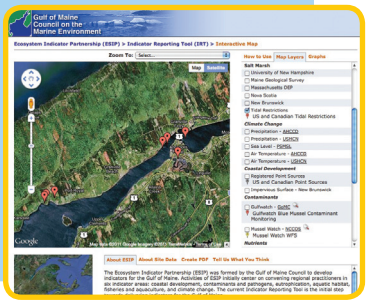
Field surveys and ground truthing of data are extremely important and would improve detail and help identify potential sites for restoration.

During the past two decades, many previously impounded tidal marsh fragments have been reconnected to their estuaries. These tidal exchange achievements were made by removal of tide gates, widening of culverts, and breaching of dikes. Ongoing monitoring is required to follow the path to restoration, and so far has revealed positive responses for hydrology and vegetation. Some studies have shown that natural fish populations have also returned to salt marshes following tidal restoration. More data will be required to determine responses by the full suite of fish species that utilize the Gulf of Maine estuaries.

Indicator Reporting Tool

All data used for the three indicators discussed in this fact sheet are available through ESIP's Indicator Reporting Tool. The tool (www2.gulfofmaine.org/esip/reporting) uses familiar mapping platforms to enable users to locate aquatic habitat data in the region. The snapshots produced by the tool can provide critical information in a timely fashion for those faced with making decisions quickly. Questions such as the following can be answered using the tool:

- How many known tidal restrictions are there in my watershed?
- Is there high nitrogen loading in an embayment under consideration for eelgrass restoration?



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www2.gulfofmaine.org/esip

For more information on any of the ESIP products, please visit our website at www2.gulfofmaine.org/esip.

You may also contact the ESIP Program Manager at ESIPmail@gulfofmaine.org.

We always welcome new members to our work.

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Gulf of Maine Council on the Marine Environment

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