EcoSystem Indicator Partnership

Information on change in the Gulf of Maine

Coastal Development in the Gulf of Maine

The Gulf of Maine's beauty and rich natural resources have drawn people to the region for centuries. Indeed, the Gulf of Maine and Bay of Fundy continue to play a vital role for sectors such as fishing, harvesting of natural resources, shipbuilding, marine trade, energy and mining resources, construction, and tourism and recreation. In 2011, over 9 million people lived in the states and provinces that compose the Gulf of Maine watershed, with over two-thirds located along the coastline. The current trend of migration from rural to urban centers, which are typically on the coast, is expected to continue and be accompanied by demand for new development. Moreover, many of the region's coastal communities also experience a significant influx of seasonal visitors each year.

This concentration of development at the coast can lead to conflicting uses of space and resources and affect the health of the ecosystem. Unless planned and managed in a sustainable way, coastal development can have negative impacts including increased runoff and flooding, decreased water quality, and a decline in suitable wildlife through fragmentation or habitat loss. In addition, coastal communities are faced with a need to adapt development patterns as climate change alters patterns in precipitation, flooding, and sea level.

Understanding the current status and trends in coastal development within the coastal counties of the Gulf of Maine is important for decision makers. With this understanding, coastal development can be planned and managed in such a way as to minimize negative impacts and to maintain the beauty and natural resources that support the people and economy of the Gulf of Maine.

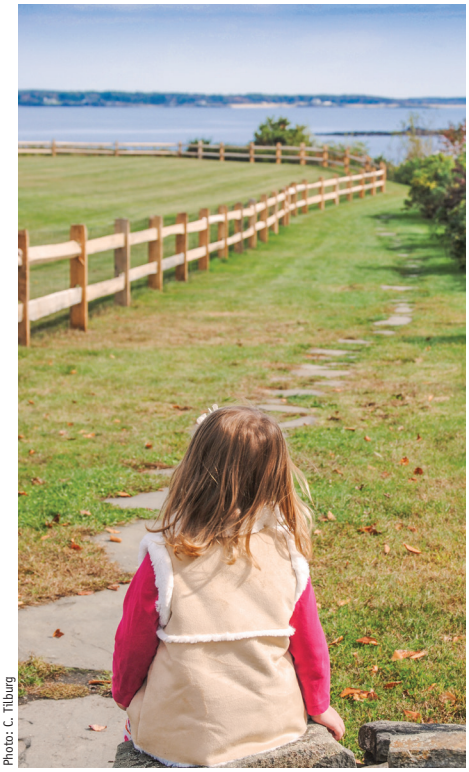


Photo: C. Tilburg

Why use indicators?

Indicators help monitor conditions in the Gulf of Maine and are one of the best tools for understanding and characterizing ecosystem changes. Like warning lights on a car's dashboard, 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. The EcoSystem Indicator Partnership (ESIP) has chosen three indicators to assess coastal development in the Gulf of Maine:

1. **Population**
2. **Impervious Surface**
3. **Point Sources**

Photo: P. Guyton

Portland, Maine

The Gulf of Maine (GOM) is a physical body of water that stretches from Cape Cod, Massachusetts, to Yarmouth, Nova Scotia. In addition, our work also encompasses the GOM watershed, which includes the GOM and the Bay of Fundy water bodies, the rivers and watersheds that drain into them along with the associated coastal counties.

Population

Indicator 1

The Gulf of Maine watershed supports a long history of human activity. Early indigenous people used the waters and land for sustenance and cultural needs. Europeans began arriving in the early 1600s. As more people settled within the region of the Gulf of Maine, their presence and activities had increasing influence on the natural environment and resources around them. Through these activities, the population has become woven into the region's ecosystem.

Population density is an important indicator as, generally, the greater and denser the population, the more impacts that can be expected to the ecosystem. As of 2011, over 9 million people lived in the counties that compose the Gulf of Maine watershed. However, the population is not distributed evenly between the two countries, with more people living in the US portion of the Gulf of Maine than in the Canadian. In 1900, the number of individuals in the US portion of the Gulf of Maine watershed (Maine, New Hampshire, and Massachusetts) totaled a little more than 3 million. As of 2011, the population was over 7 million. For the Canadian portion of the Gulf of Maine (the Bay of Fundy region of New Brunswick and Nova Scotia), the population in 1901 was around 590,000. As of 2011, that population was over 1.3 million. In the last 40 years alone, the population for all of the counties in the Gulf of Maine watershed increased by more than 1.8 million people.

Figure 1 shows the overall population in 2010 as well as changes in population for the past 40 years. It is clear in the figure that population for the US is highest in the counties surrounding the Gulf of Maine. In addition, the figure also shows that the most significant population increases have been on the coasts of Massachusetts and New Hampshire, as well as around Saint John, New Brunswick. This highlights the trend of rural populations moving towards urban areas of the coast. These dense populations often coincide with major rivers, further impacting the quantity and quality of waters of the Gulf of Maine.

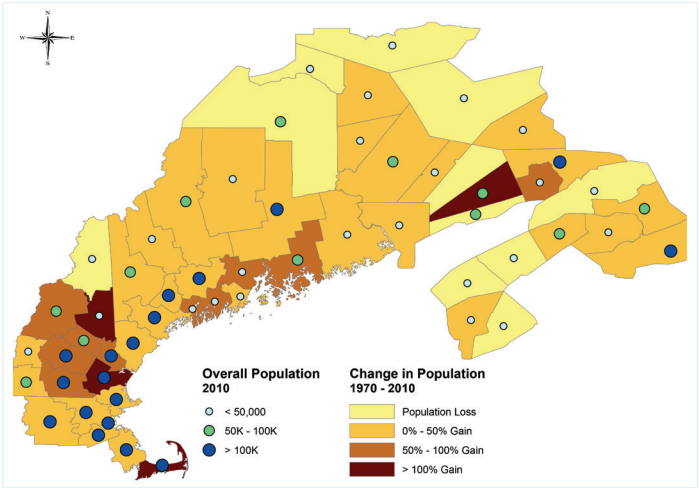


Figure 1: Population in the Gulf of Maine

Population change for each county from 1970 to 2010 is represented by county color gradient (browns to yellows). Overall population in each country in 2010 is represented by blue markers. US information from www.census.gov and Canadian information from www.statcan.gc.ca.

Photo: P. Guyton

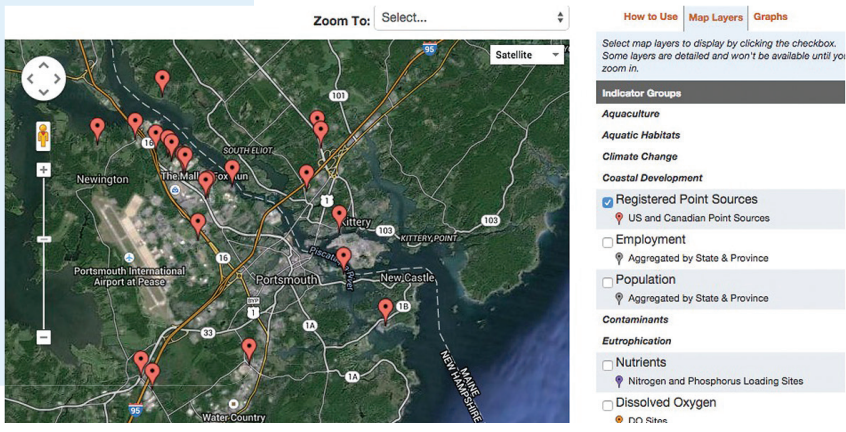
View from Cadillac Mountain, Maine

Obtaining Data: Indicator Reporting Tool

All of the data used for the three indicators presented in this fact sheet (Population, Impervious Surface, and Point Sources) are available online through ESIP's Indicator Reporting Tool (www.gulfofmaine.org/esip/reporting). The tool uses familiar mapping platforms to enable users to locate coastal development data in the region. The data snapshots that users produce with the tool can provide critical information in a timely fashion for those making policy and operational decisions.

The tool can help to answer questions such as:

1. What areas have seen the most population growth?
2. Where might impervious surface be an issue in my county?
3. Are there watersheds with a lot of pollutant point sources in my state or province?



Impervious surface

Indicator 2

An impervious surface is an area with a hard surface that prevents water from seeping into the soil. These impenetrable, or impervious, surfaces include human structures, like roads, parking lots, rooftops, and even large cemeteries, as well as natural structures, such as bedrock outcroppings. All of these can alter the ability and rate at which the land can absorb or filter water. Increases in the spatial extent and distribution of impervious surfaces, or imperviousness, can increase the frequency and intensity of runoff and the transport of sediment, nutrients, and contaminants during rainfall and melting events, which, in turn, can impact water quality and ecosystem health in nearby water bodies. Studies have shown that stream quality begins to degrade when impervious surface in a watershed exceeds 10 percent. At the coast, increased imperviousness can result in more significant nutrient loading to estuaries, or can increase sediment amounts thereby reducing water clarity, fueling algal blooms, and smothering or infilling fragile coastal ecosystems, such as eelgrass beds and coastal marshes. Consequently, measuring and monitoring the imperviousness within the Gulf of Maine watershed provides an important indicator of where coastal and watershed development may impact water quality and the health of the aquatic ecosystems. By understanding the extent and distribution of impervious surfaces, planners, managers, and policy makers can make informed development decisions to prevent or reduce these impacts.

In 2006, impervious surface within the US portion of the Gulf of Maine watershed ranged from 16.5 percent in Massachusetts to less than 1 percent in Maine. However, these state averages mask the extent of impervious surface in urban areas. The greater Boston area; the I-93 corridor to Concord, New Hampshire; and the coastal cities of Portsmouth, New Hampshire; Portland, Maine; and Bangor, Maine have greater than 30 percent imperviousness (Figure 2). A closer view of Boston, Massachusetts, from 2001 is provided as an example (Figure 3). In Canada, information on imperviousness was identified as a significant gap. In 2013, efforts began to map and analyze imperviousness in Nova Scotia, and the results of this work were recently released (see focus box). As development continues to increase in the Gulf of Maine region, particularly in coastal urban centers and up river reaches, employing strategies to minimize human-made impervious surfaces are critical to mitigating negative impacts on runoff and subsequent impacts to water quality and ecosystem degradation.

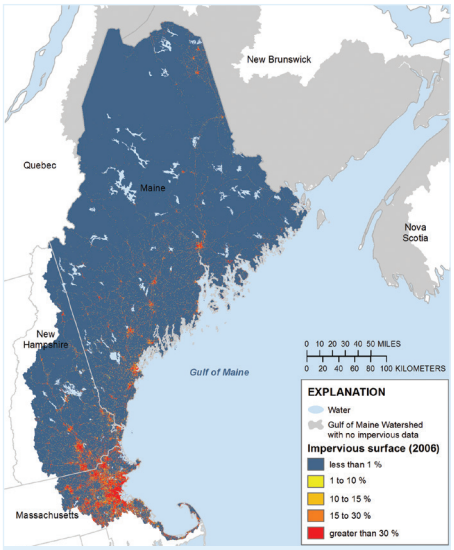


Figure 2: Percent impervious surface

While most of the landmass draining into the Gulf of Maine has less than 1% imperviousness, many urban areas not only exceed 10% imperviousness, but have imperviousness greater than 30%. Many of these urban areas are on the coast, compounding coastal impacts.

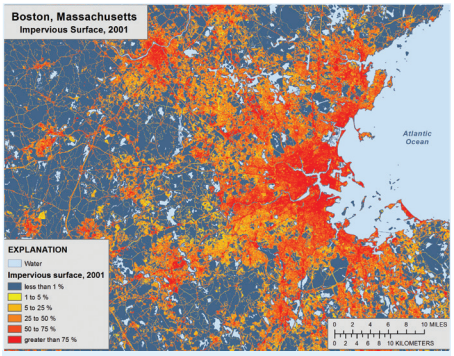
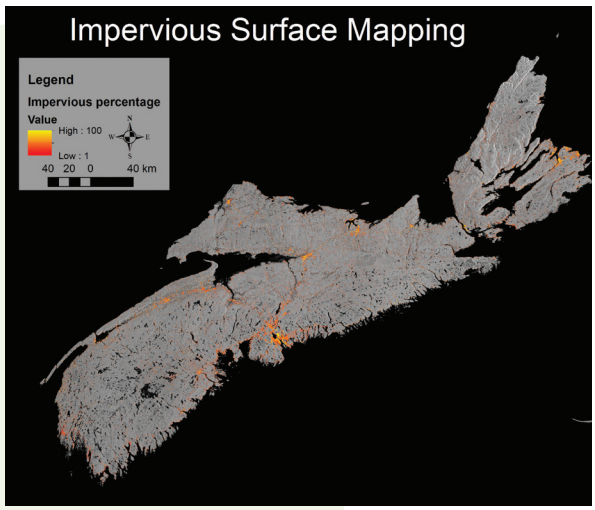


Figure 3: Percent impervious surface for Boston, Massachusetts, 2001

Nova Scotia Impervious Surface

In 2014, Nova Scotia researchers published the first comprehensive report on impervious surfaces throughout the province. This information came too late to fully include within the dataset discussed above, but is available in the For More Information list of the ESIP webpage (**www.gulfofmaine.org/esip**). Using these preliminary data, comparison of impervious surface in 2005 to satellite imagery for 2013 revealed that a significant amount of development in the area has occurred, particularly with respect to the expansion of subdivisions. Interested individuals are encouraged to read the full report available on the ESIP webpage. Data processed by the Applied Geomatics Research Group, Nova Scotia Community College. Data can be downloaded at **http://agrg.cogs.nscc.ca/data_for_download/impervious_surfaces_nova_scotia**.



Focus on Natural Imperviousness

Photo: Peter S. Guyton

Imperviousness is not only human-made, it also occurs naturally. Natural imperviousness includes compacted, high-clay, saturated, and frozen soils. With the last two, imperviousness and hydrological activity are usually seasonal or temporary. This is in marked contrast to urbanized areas which typically contain land developed for commercial, industrial, transportation, and medium- to high-density use areas which are permanently impervious.

Municipalities need access to information regarding the location and types of natural imperviousness in their areas. Municipal bylaws or ordinances should also be adapted to include these types of overlay mapping in order to give the developers and municipalities the best approaches for development or redevelopment in communities. More studies and mapping are necessary to better equip communities, especially in light of the effects of climate change. For example, the City of Moncton, New Brunswick, uses information on natural imperviousness when considering development. In addition, the city requires the submission of an erosion and sediment control plan for all construction sites within the municipality, in an effort to reduce the negative impacts of erosion and sedimentation on the environment.

Point sources

Indicator 3

Point sources of pollution are any identifiable source from which pollutants are discharged, such as pipes, industrial plants, or sewage outfalls. Point sources differ from nonpoint sources in that the discharge point is specific and locatable. Nonpoint sources of pollution also come from human activities but are spread over large areas without specific input sites. A discussion of certain types of nonpoint pollution is available in the ESIP Eutrophication Fact Sheet (available at **www.gulfofmaine.org/esip**).

Locating point sources of pollution can help to identify and monitor areas where human activities may be negatively impacting the quality and health of the ecosystem. This, in turn, can provide managers and residents with information to take action and address these impacts.

Point sources in the Gulf of Maine are monitored by federal, state, and provincial government agencies. These agencies are charged with monitoring and ensuring that water quality meets scientifically determined quality and safety guidelines for different water uses (e.g. drinking water, swimming, fish and shellfish consumption).

Individual point sources may have little impact on an ecosystem. However, as the number of point sources increase, there is potential for these impacts or the various pollutants that are discharged to combine or accumulate, making the impacts to the ecosystem more pronounced. These cumulative effects can have implications to water quality, aquatic life, human health, fisheries, and aesthetics of the waters. ESIP's Contaminants Fact Sheet provides a more indepth look at pollutants and contaminants in the region (available at **www.gulfofmaine.org/esip**). As of 2010, there were more than 250 registered point sources in the Canadian portions of the Gulf of Maine. This figure includes industrial point sources along with wastewater inputs. In the US there were more than 1100 registered point sources as of 2011 including industrial and wastewater. Many of the point sources in the Gulf of Maine region are located along rivers, which means the pollution they discharge may also be transported downstream toward the coast where they may combine or accumulate. As population and development in the Gulf of Maine continues to increase, it is likely that sources of waste and pollution and the resulting pressures on the ecosystem will also increase.

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The EcoSystem Indicator Partnership (ESIP) is part of the **Gulf of Maine Council on the Marine Environment (GOMC)**. In 2006, the GOMC created ESIP to assess the ecological integrity of the Gulf of Maine through the use of indicators. This fact sheet is one outcome supporting this goal. Funding, in part, was provided by the Department of the Interior and Environment Canada.

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

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