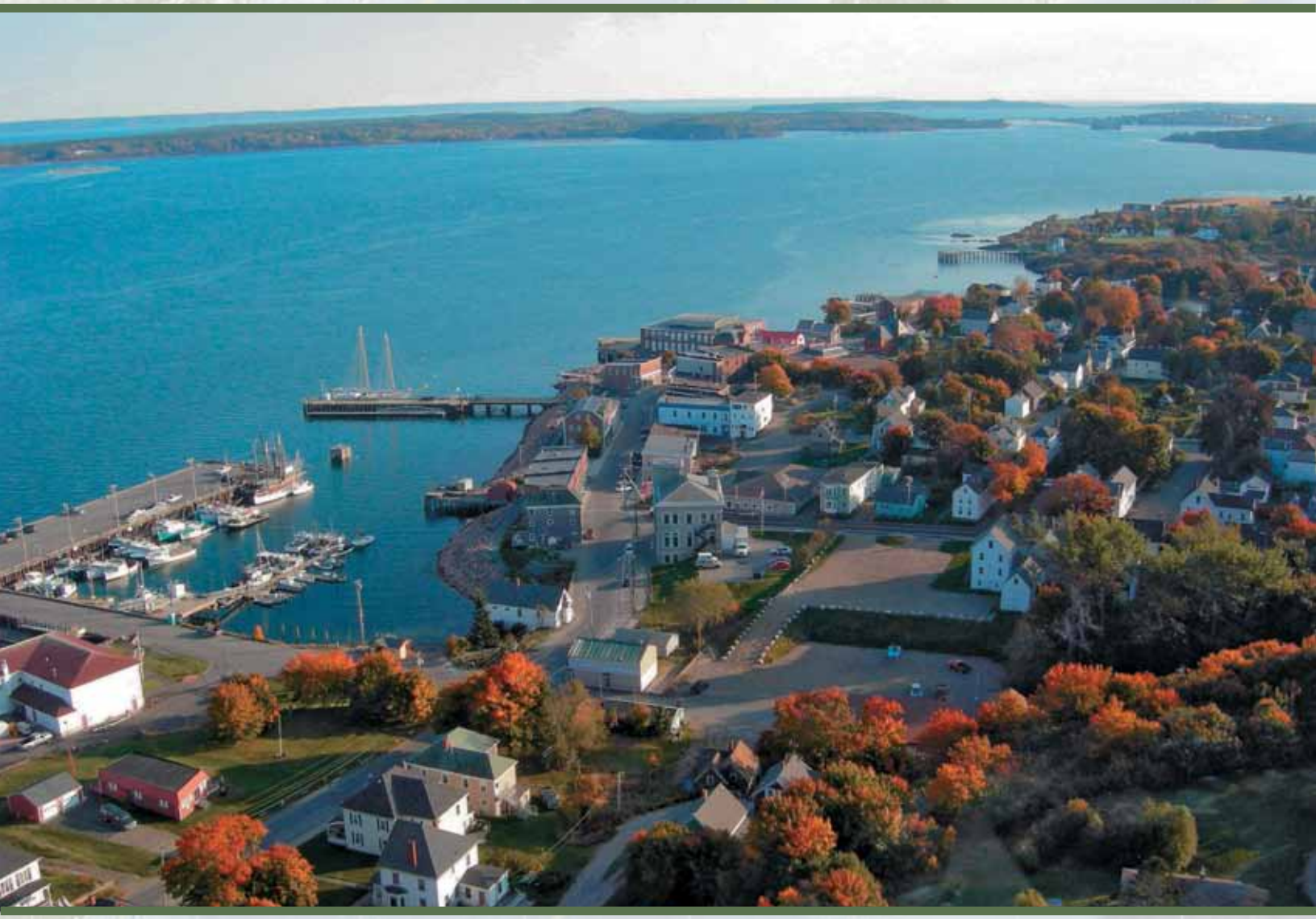
COASTAL LAND USE AND DEVELOPMENT

STATE OF THE GULF OF MAINE REPORT



Gulf of Maine
Council on the
Marine Environment

June 2013

COASTAL LAND USE AND DEVELOPMENT

STATE OF THE GULF OF MAINE REPORT

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Gulf of Maine Council on the Marine Environment

Environment Canada Environnement Canada

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The Gulf of Maine Council on the Marine Environment was established in 1989 by the Governments of Nova Scotia, New Brunswick, Maine, New Hampshire and Massachusetts to foster cooperative actions within the Gulf watershed. Its mission is to maintain and enhance environmental quality in the Gulf of Maine to allow for sustainable resource use by existing and future generations.

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1. Issue in Brief

Attracted by opportunities for employment and recreation, more than half of those who reside in the Gulf of Maine region live and work in the coastal zone. By 2007, 10.8 million people lived year-round in the Gulf of Maine region, with a projected increase of 600,000 more residents by 2025 (Pesch and Wells 2004). Adding to the growth in year-round residents, many coastal communities are experiencing an influx of seasonal visitors.

This paper focuses on land use changes and land development—human settlements, structures, and economic activitiy—in municipalities immediately bordering the Gulf of Maine. This area stretches from Cape Cod north and east along coastal Massachusetts, New Hampshire and Maine and encompasses the Bay of Fundy shoreline of New Brunswick and Nova Scotia to Cape Sable Island. Along the length of this coastline, pressures on lands are growing as population numbers climb, development spreads, and climate change transforms coastal ecosystems.

While projected population growth for the region is modest and portions of the coastline may see declines, land development is still expanding markedly. In 1997, the coastal watersheds of New England were the second most developed region in the United States, with 17 percent of the land area developed. If current rates of development continue, that figure may rise to 25-30 percent by 2025 (Beach 2002).

Development has both direct impacts, such as fragmentation of undeveloped lands and increased impervious surfaces, and many indirect effects, such as diminished water quality (Figure 1). Even low-density development can compromise the ecosystem services that healthy coastal habitats provide—such as water filtration, carbon sequestration, and flood protection. Poor land-use decisions can fragment habitats, reduce biodiversity, hasten the spread of invasive species, cut off shore access, contribute to greenhouse gas emissions, and damage the long-term health of local economies. A Massachusetts study spanning the years 1971-2005 found that indirect impacts of development (such as disruption of wildlife and introduction of invasive species) were at least three times greater than direct impacts (such as the runoff from new construction and paving) (DeNormandie et al. 2009).

> The current economic downturn is akin to the eye of a storm. This is an important opportunity to make changes in how we develop, conserve, and manage land. As the economy recovers, the pressures of sprawling development will likely continue to move across the landscape.
>
> James DeNormandie
> *Losing Ground*

LINKAGES

This theme paper also links to the following theme papers:

- Climate Change and Its Effects on Humans
- Climate Change and its Effects on Ecosystems, Habitats and Biota
- Watershed Status
- Coastal Ecosystems and Habitats
- Microbial Pathogens and Toxins
- Eutrophication

Coastal communities along the Gulf of Maine that seek to sustain healthy ecosystems and economies will need new planning, management, modeling, and monitoring tools. Many actions are underway to address coastal management needs in the Gulf region, but better coordination and additional incentives are needed to achieve best land management practices.

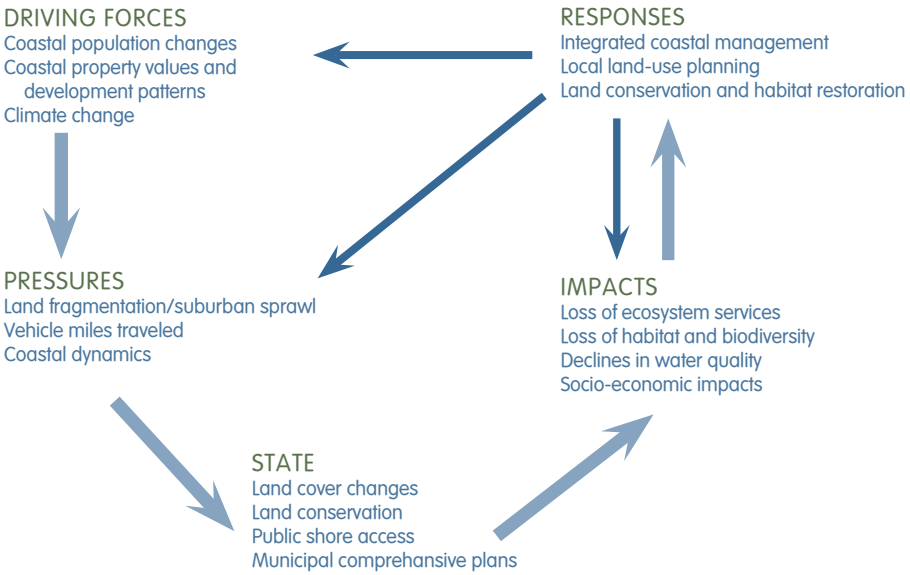

Figure 1: Driving forces, pressures, state, impacts, and responses (DPSIR) to coastal land use and development around the Gulf of Maine. In general, the DPSIR framework provides an overview of the relation between different aspects of the environment, including humans and their activities. According to this reporting framework, social and economic developments and natural conditions (driving forces) exert pressures on the environment and as a consequence, the state of the environment changes. This leads to impacts on human health, ecosystems, and materials, which may lead to societal or government responses that feed back on all the other elements.

2. Driving Forces and Pressures

2.1 COASTAL POPULATION CHANGES

Population growth has been modest along much of the Gulf of Maine coastline in recent decades (with marked declines in a few counties). U.S. counties experienced an average increase of 27 percent over three decades, with an 18 percent increase in the overall coastal population (Table 1). The change in population varied greatly among the provincial coastal counties, with an overall increase of 6 percent (Table 2). Much of the increase in Canada can be attributed to suburban development near the urban centers of Halifax and Moncton.

Even in areas with slow growth, coastal counties remain far more densely populated than inland areas. Approximately 70 percent of Massachusetts' population lives in coastal counties, all of which (save for islands) have population densities of at least 500 people per square mile, according to 2010 U.S. Census data. New Hampshire's coastal counties fall in the density range of 88–499 people per square mile. In Maine, the coastal zone (all those municipalities bordering coastal or tidal waters) represents only 15 percent of the state's land area yet contains 46 percent of its developed land and 44 percent of its residents (MCHT 2012). In New Brunswick, nearly 60 percent of the provincial population lives within 31 miles of the coast, and in Nova Scotia about 70 percent of the provincial population lives in coastal communities (provincial figures include coasts beyond the Bay of Fundy).

Table 1: Population change in U.S. Gulf of Maine coastal counties, 1980-2010 (data from NOAA 2013b).

COUNTIES BORDERING THE GULF OF MAINE	1980 POP.	2010 POP.	% CHANGE
Rockingham County, NH	190,345	295,223	55.1
Barnstable County, MA	147,925	215,888	45.94
Strafford County, NH	85,408	123,143	44.18
York County, ME	139,666	197,131	41.14
Waldo County, ME	28,414	38,786	36.5
Lincoln County, ME	25,691	34,457	34.12
Cumberland County, ME	215,789	281,674	30.53
Hancock County, ME	41,781	54,418	30.24
Sagadahoc County, ME	28,795	35,293	22.56
Plymouth County, MA	405,437	494,919	22.07
Knox County, ME	32,941	39,736	22
Essex County, MA	633,632	743,159	17.28
Suffolk County, MA	650,142	722,023	11.06
Norfolk County, MA	606,587	670,850	10.59
Middlesex County, MA	1,367,034	1,503,085	9.9
Washington County, ME	34,963	32,856	–6.03

Table 2: Percent population change in Canadian Gulf of Maine coastal counties, 1981-2011 (data from Statistics Canada 2013b).

COUNTIES BORDERING THE GULF OF MAINE	1981 POP.	2011 POP.	% CHANGE
Westmorland County, NB	107,640	144,158	33.93
Hants County, NS	33,121	42,304	27.73
Albert County, NB	23,632	28,846	22.06
Kings County, NS	49,739	60,589	21.81
Colchester County, NS	43,224	50,968	17.92
Charlotte County, NB	26,571	26,549	–0.08
Yarmouth County, NS	26,290	25,275	–3.86
Annapolis County, NS	22,522	20,756	–7.84
Cumberland County, NS	35,231	31,353	–11.01
Saint John County, NB	86,161	76,550	–11.15
Shelburne County, NS	17,328	14,496	–16.34
Digby County, NS	21,689	18,036	–16.84

More rural and remote coastal locations are losing population as people migrate to urban areas for job opportunities (PNS 2009). In New Brunswick, for example, population grew 2.9 percent province-wide between 2006 and 2011, while the Moncton area saw marked population increases—25.6 percent in Dieppe, 6.3 percent in Moncton, and 7.3 percent in Riverview (data from Statistics Canada 2013b).

Those migrating to urban centers for jobs are not necessarily settling within city limits. Some buy or build homes in the surrounding countryside, contributing to sprawl (uncontrolled development and land fragmentation in a widening arc around urban centers). In Cumberland County, Maine, for example, roughly 60 percent of housing units built between 2000 and 2005 occurred outside the county's seven traditional population centers (Brookings 2006). This pattern likely contributed to increased vehicular use: between 2000 and 2010, vehicle registrations in Cumberland County outpaced population by 41 percent (Casco Bay Estuary Partnership 2010).

Although population has been increasing in coastal urban centers, development is far outpacing it. Between 1982 and 1997, for example, the amount of farm and forest land converted to urban uses in Portland, Maine increased by 108 percent, while its population grew by only 17 percent. In southeastern Massachusetts, the amount of developed land is increasing at three times the rate of population growth, and models show that by 2030 between 50 and 63 percent of the region's land may be developed (Stone et al. 2006). Some coastal resort communities along the Gulf shoreline have seen particularly dramatic change in both population and development. Cape Cod, Massachusetts, experienced a 400 percent increase in population between 1951 and 2005, transforming the character of its communities and integrity of its natural ecosystems (Figure 2).

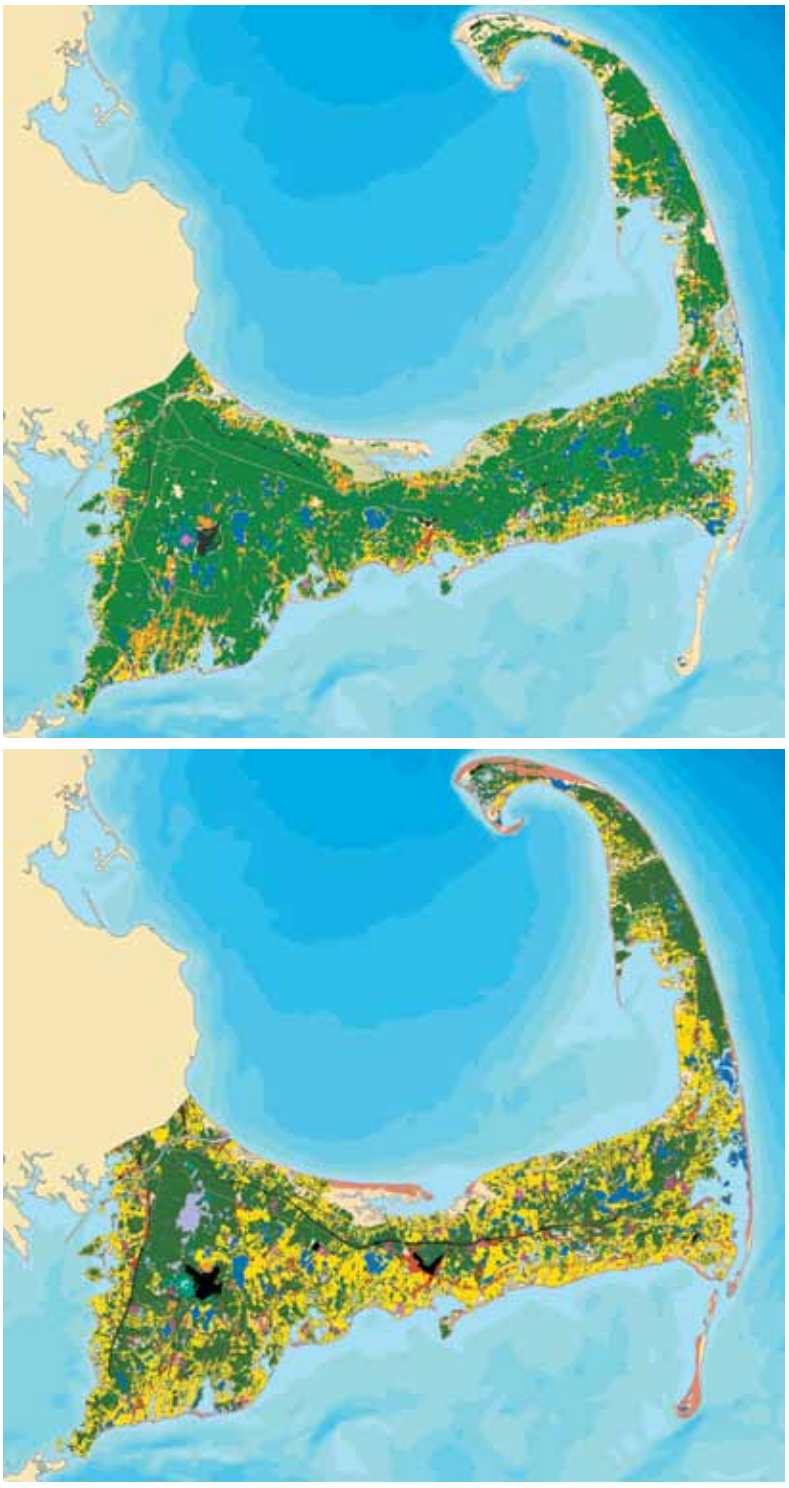

Figure 2: Land cover on Cape Cod, Massachusetts, 1951 (top) and 2005 (bottom). Cape Cod's year-round population reached 229,000 in 2003, up roughly 400 percent from 1951. Seasonal visitors swell the summer population further, sometimes exceeding 500,000. The dark green areas depict forest lands and the orange agricultural, while yellow shows residential development and red commercial development (Woods Hole Research Center, 2012, http://www.whrc.org/mapping/capecod/index.html).

2.2 COASTAL PROPERTY VALUES AND DEVELOPMENT PATTERNS

Industrial and coastal-dependent uses are declining in many Gulf of Maine coastal communities (given depletion of fisheries stocks, changes in technology and shipping, and other market forces), and residential and commercial development are taking over former working waterfronts. Market demand for waterfront property drives up property values, speeding the conversion of traditional working harbors into condominiums, homes or restaurants, which can close off public shore access. A 2005 study of Maine's coastal municipalities found both high real estate appreciation and a proliferation of high-priced houses—trends that typically raise taxes and drive out long-time owners, irreversibly altering land use and community traditions (Brookings 2006). Over the decade spanning from 2003 to 2013, property assessments in Nova Scotia's Gulf of Maine coastal counties rose between 70 and 114 percent (S. Lemmon, Property Valuation Services Corporation, pers. comm.).

Much of the new development occurring along the Gulf of Maine coastline is dispersed along the shoreline, rather than concentrated in existing town and village centers. Differences in property values (with outlying communities having lower-priced lots and lower taxes); municipal zoning (which often favors minimum lot sizes to provide for adequate septic fields or prevent dense developments); and consumer desire (for space, quiet and, most especially, water views) can all drive a dispersed pattern of development (DeNormandie et al. 2009).

Sprawl has far-reaching effects on land use. Dispersed, large-lot development consumes more land per capita and fragments the large tracts critical for many wildlife species. Creation of additional roads and parking lots can lead to incremental filling of wetlands and degradation of wildlife habitat (USEPA ND). Estimates of wetland loss since European settlement among the five Gulf jurisdictions, attributable to sprawling development and agricultural conversion, vary greatly. For example, salt marsh loss is estimated to range from 18 to 50 percent in New Hampshire, 25 to 50 percent in Maine, 40 to 50 percent in Massachusetts, and 75 percent in Nova Scotia and New Brunswick, with the highest levels along the Bay of Fundy (Bromberg and Bertness 2005; Dionne et al. 1998; Reed and Smith 1972).

Increases in impervious surface area typically generate more contaminated runoff (nonpoint source pollution) to coastal waterways and wetlands. New road construction also drives up vehicle miles traveled (VMT), through a combination of increased driving by current residents, heightened commercial transportation activity, and inmigration of new residents (Duranton and Turner 2009). Added vehicular traffic exacerbates air pollution, greenhouse gas emissions, and nonpoint source pollution. While VMT per capita in states bordering the Gulf appeared to peak around 2005 (see Table 3) (no data could be found for the provinces), levels remained high through 2010 due to the dispersed population, recreational travel and long work commutes.

Table 3: Vehicle Miles Traveled (VMT) per capita, U.S. Gulf of Maine states.

	1999	2005	2010
Maine	11,288	11,379	10,961
Massachusetts	8,392	8,594	8,293
New Hampshire	9,901	10,319	9,922

Coastal development along the Gulf of Maine shoreline is fueled by a large influx of tourists and seasonal residents. Because seasonal (second) homes and retirement homes need not be within commuting distance of employment centers, they can contribute to dispersed development patterns. According to 2010 U.S. Census data, Maine has the nation's highest percentage of second homes (with more than 118,000 seasonal residences representing 16.4 percent of the housing stock) and New Hampshire has the third highest percentage at 10.4 percent (63,910 seasonal residences). These data do not break out coastal residences.

Nova Scotia experienced dramatic growth in residential lots over the past half-century (Figure 3). The recent dip in the upward trajectory may be due to the most choice lands already being subdivided (PNS 2009). Much of the subdivision was not concentrated near major urban centers, but was widespread throughout

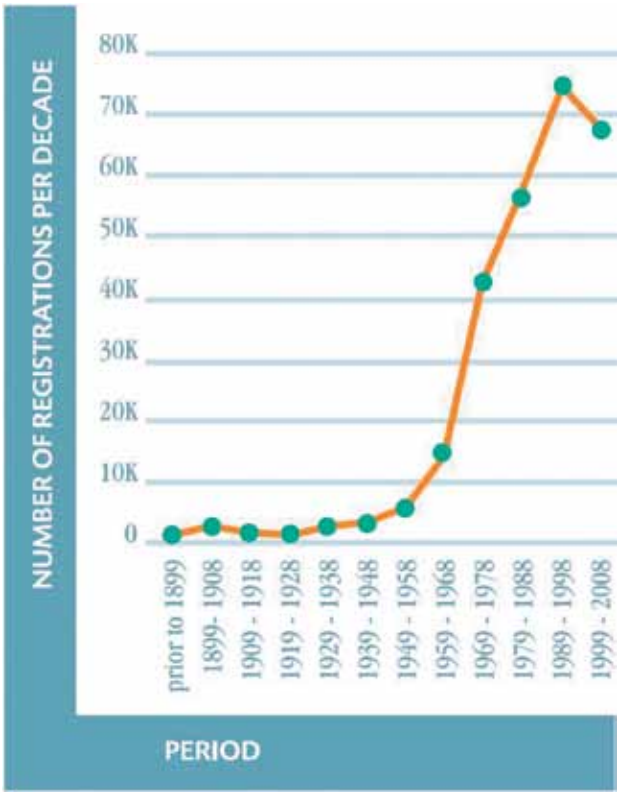

Figure 3: Increase in Nova Scotia residential lots within 1.2 miles of the coastline from the 1950s through 2008 (PNS 2009).

the province—suggesting that a high portion may be for seasonal residences (PNS 2009). Census data supports this: in Nova Scotia, population in Gulf of Maine coastal counties declined slightly (0.66 percent) from 2006 to 2011, yet the number of personal residences in those counties rose by 3.38 percent (data from Statistics Canada 2013a, 2013b). Similar patterns are evident in the United States: growth projections indicate that nearly half of Maine's coastline will qualify as suburban by 2050 (Brookings 2006).

Residential construction appears to be the dominant driver of development along the Gulf of Maine coastline—reflecting the region's shift from a resource-based economy to one dependent on tourism and recreation. Available province-wide data in Nova Scotia, for example, indicate that the predominant type of development is residential (76 percent) with industrial (8.7 percent) and commercial (5.7 percent) far less significant (PNS 2009).

The cumulative impact of construction of single-family dwellings is significant—particularly as individual house footprints increase. The average size of new homes constructed in Massachusetts rose steadily over recent decades to more than 2,700 square feet in 2006. These larger residences involve more impermeable surface area, more potential habitat disruption, and more hydrological changes (both above and below ground) (DeNormandie et al. 2009). This impact can be particularly severe in coastal areas with abundant wetlands and in shorefront settings subject to storm surge and flooding.

Industrial development tends to be concentrated, highly regulated, and routinely monitored, but residential projects are often dispersed and minimally regulated, with no follow-up environmental monitoring (PNS 2009). Along portions of the Gulf of Maine coastline where lands are increasingly built out, new development is migrating inland along what some planners call a "sprawl frontier."

As coastal residences escalate in size and value, landowners can become more protective of their substantial shorefront investments—closing off traditional public access and taking measures to armor the shore against storm damage. Sandy beaches represent less than 40 miles of Maine's 5,300-mile coastline, and about half of these are hardened with structures like seawalls that limit formation of beaches and dunes (Maine Sea Grant 2011). Since shore armoring techniques can foster erosion and disrupt coastal ecosystems (see Section 4, Impacts), private property interests are often pitted against the health of coastal ecosystems and interests of the larger community. The region is seeing increased conflict and litigation over both shoreline hardening and traditional beach access (Woodard 2012), trends that may accelerate as climate change begins affecting more coastal properties.

2.3 COASTAL DYNAMICS

Coastal developers aspire for permanence, yet shorelines are inherently dynamic—eroding and depositing material continually. This constant movement is critical for coasts to provide many of the "ecosystem services" they offer such as storm buffering, flood control, water filtration, and nursery habitat for fish and shellfish. As the Gulf of Maine shoreline becomes more built-up, communities have less capacity to accommodate moving shorelines.

Land-use conflicts along the immediate Gulf shoreline could intensify as sea level rises and other effects of climate change become more evident. Possible hazards include:

- Accelerated rates of coastal erosion;
- Increased storm frequency;
- More intense storms and higher storm surge;
- Saltwater intrusion into freshwater wells and aquifers in the coastal zone; and
- Flooding and inundation of low-lying areas.

In a survey of Maine beachfront owners, one-third reported that natural forces already had affected their properties adversely—primarily due to erosion (White et al. 2010).

Recent research points to a global sea level rise of 20-75 inches from 1990 to 2100 (Walmsley 2010; see Climate Change and its Effects on Humans). A Canadian study found that a third of the national coastline was moderately or highly sensitive to sea-level rise, including 80 percent of the Nova Scotia and New Brunswick coasts (National Round Table 2011). A 3.28-foot rise in sea level along the coast of Maine could consume 20,000 acres of real estate, not accounting for storm surge flooding or erosion (Natural Resources Council ND).

The risks include both episodic hazards (such as storm surge flooding or extreme wave action) and chronic vulnerability (due to low-lying topography, coastal subsidence, or soils prone to erosion) (PNS 2009). The high rate of historic wetland loss within the Gulf of Maine region (see Table 4) has increased the region's vulnerability to storm surge and erosion, with fewer coastal wetlands left to buffer upland areas.

Severe storms typically drive up both construction costs regionally (and even nationally) and can make it harder for individuals to afford or obtain property insurance. Insurance and mortgage lending guidelines may begin limiting development in the most vulnerable coastal settings (Brennan 2012).

3. Status and Trends

3.1 LAND COVER CHANGES

As of 2006, land cover in the U.S. counties bordering the Gulf of Maine was dominated by forests (43 percent) and open water (30 percent), with significant wetlands (10 percent) and development (9 percent), according to data compiled by NOAA's Coastal Services Center (NOAA 2013a). Agriculture, scrub, grass and barren collectively made up less than 10 percent of the total land area. Between 1996 and 2006, the region saw just over 2 percent change in land cover—with scrub experiencing the largest net increase (93 square miles) and forests the largest loss (213 square miles, just less than 3 percent net loss) (Figure 4). Less than 1 percent of the total wetland area (3.52 square miles) changed during that decade—gaining areas formerly mapped as open water. Agricultural land cover experienced a small net gain over the decade (despite losses to development), representing 4 percent of the coastal counties in 2006.

Developed lands grew 3 percent between 1996 and 2006 in the U.S. Gulf of Maine coastal counties, with most new development occurring in previously forested areas. That increase added 46 square miles to the total developed area, the equivalent of a football field every 9.75 hours throughout the decade (N. Herold, NOAA Coastal Service Center/C-CAP Program, pers. comm.).

In the Canadian Maritimes, Statistics Canada analyzed land cover in the Annapolis-Minas Lowlands along the eastern coast of the Bay of Fundy. Coniferous forests made up 43 percent of the land area, with cropland/pasture covering 23.4 percent, mixed forests 9.9 percent, and deciduous forests 4.6 percent (Mustapha 2012). Between 2001 and 2006, the number of farms declined 6.1 percent and the area with tree fruit and berries declined 18.7 percent.

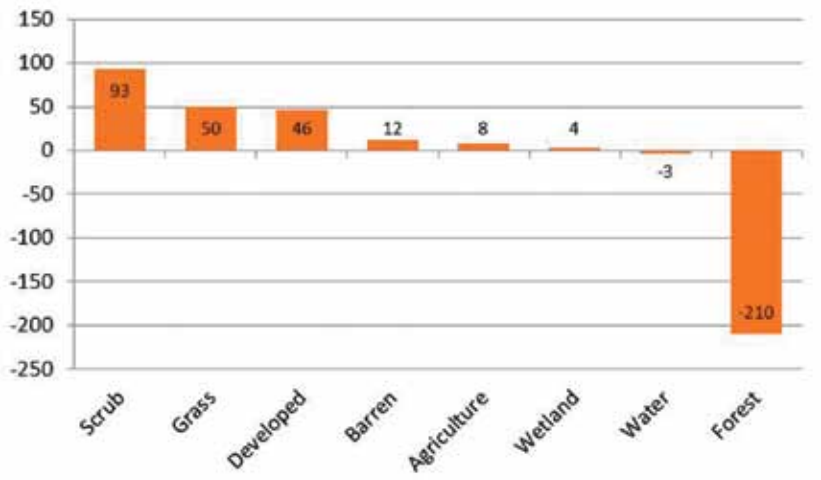

Figure 4: Distribution of net land cover change from 1996 to 2006 in U.S. counties bordering the Gulf of Maine (shown in square miles) (N. Herold, NOAA Coastal Service Center/C-CAP Program, pers. comm.).

U.S. states bordering the Gulf of Maine experienced 150 years of reforestation following the clearing done by European settlers, but now their forest cover is declining due largely to residential and commercial development and fragmentation by roads (Foster et al. 2010). Maine and New Hampshire contains three of the top 15 watersheds in the United States predicted to have the most change in housing density on forest land between 2000 and 2030 (MCHT 2012). If current trends continue, models indicate that some coastal counties could have up to 63 percent of private forestland developed by 2030 (Figure 5). Unlike the relatively transient form of land-use conversion that occurred historically (where land cleared for farming readily reverted to forest), the current conversion to structures and parking lots is much more enduring (Foster et al. 2010).

As development has overtaken forests and farmlands in coastal counties along the Gulf, the percentages of impervious surfaces have increased. From 2001-2006, impervious surface area rose 3.73 percent in Massachusetts, 15.23 percent in New Hampshire, and 1.42 percent in Maine (Xian 2011). Many studies have recorded damage to natural ecosystems when impervious surface cover climbs above 10 percent of the total area. In more urbanized areas of the Gulf of Maine region, percentages already reach 35-40 percent. Future projections to 2100 demonstrate the dramatic increase in impervious surface area expected for the U.S. northeast if present development trends continue (Figures 6a and 6b).

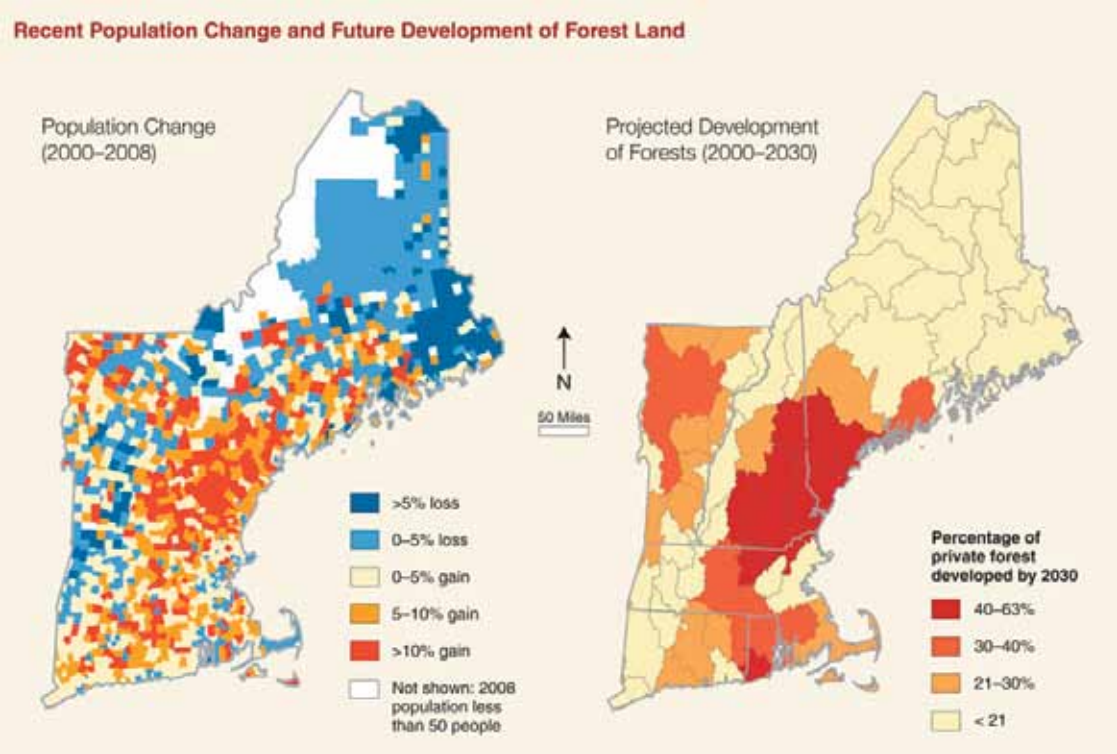

Figure 5: Population changes and projected development of forested lands in New England (Foster et al. 2010).

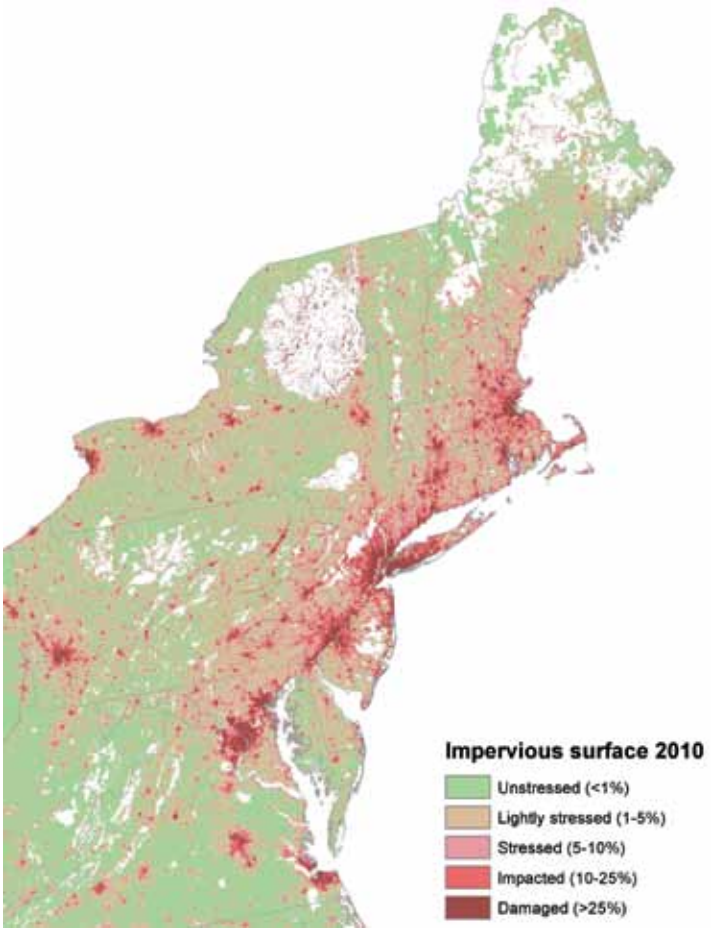

Figure 6a: Impervious surface cover in the U.S. Northeast—2010 (Theobald et al. 2009).

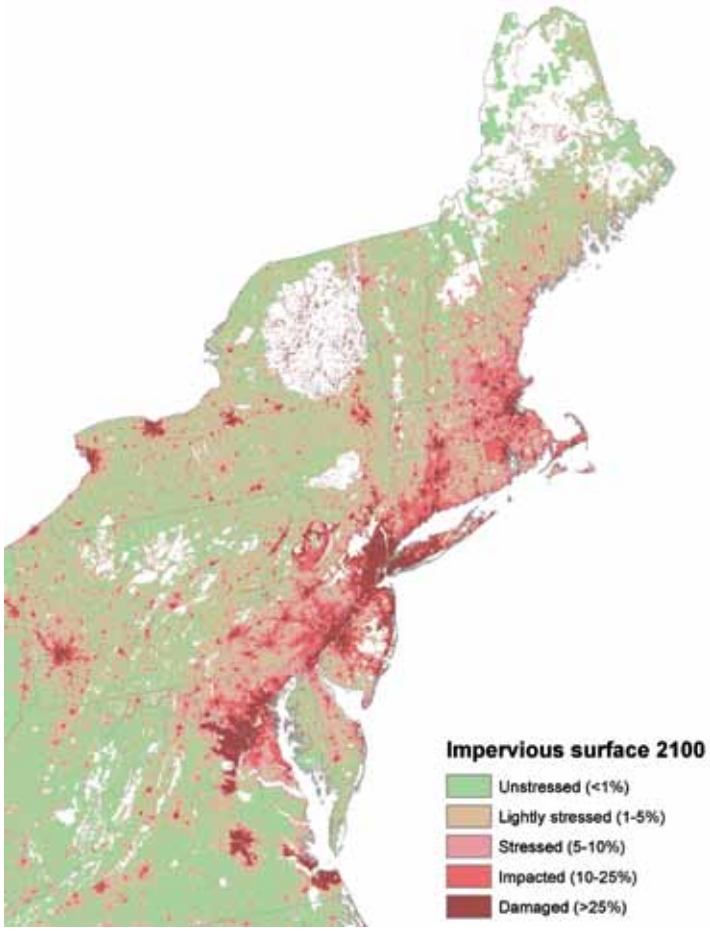

Figure 6b: Projected impervious surface cover in the U.S. Northeast—2100 (Theobald et al. 2009).

Several watersheds along the Gulf of Maine coastline have conducted detailed analyses of impervious surface cover. The Casco Bay Estuary Partnership, tracing impervious surface area in Maine's most urban watershed, found that between 2005 and 2010, the percentage of impervious surfaces remained at 6 percent (Casco Bay Estuary Partnership 2010). Another relatively urban watershed surrounding the Piscataqua River (including Portsmouth, New Hampshire) reported in 2010 that impervious surface cover represented 9.6 percent of the land area. The amount of impervious surfaces there increased by 120 percent over two decades, six times the rate of population increase. The rate of new impervious surfaces nearly doubled in the period between 2005 and 2010, relative to the period from 1990 to 2005 (PREP 2013).

3.2 LAND CONSERVATION

In most of the Gulf of Maine region, land conservation has accelerated in recent decades. Between 1999 and 2005, Massachusetts protected twice as much land as was developed and as of 2009, more than a fifth of Massachusetts' land area was permanently protected wildlife habitat (up from 17.3 percent in 1997) (DeNormandie et al. 2009). Within the Massachusetts counties bordering the Gulf of Maine, there are currently 399,576 permanently conserved acres (73 percent of which are known to provide legal public access)—but no trend data specific to coastal counties is available (B. Smith, Massachusetts Executive Office of Energy and Environmental Affairs, pers. comm.).

As of 2006, 10 percent of lands within Maine's coastal zone had permanent protection (compared to 17 percent statewide, up from a statewide figure of less than 5 percent prior to 1987) (MCHT 2012). Most of the state's marked gains in conservation occurred in northern, eastern, and western regions of Maine—not in the most populous coastal counties (Cronan et al. 2010). Along the southern half of Maine's coast, conserved tracts tend to be smaller and more scattered due to high land values and the extent of existing development. Conservation gains along the coast of Massachusetts and Maine are due largely to the expanded work of land trusts, community-based nonprofits that rely heavily on use of donated and purchased conservation easements.

The New Hampshire Coastal Program and the New Hampshire Estuaries Project, in partnership with non-governmental organizations, developed a comprehensive land conservation plan for coastal watersheds (Zankel et al. 2006). The plan identified about one-third of coastal watersheds as Conservation Focus Areas, some of which already had conservation measures in place. To date, 13.5 percent of lands within New Hampshire's coastal watersheds have been conserved (PREP 2013).

Nova Scotia has set a goal of protecting 12 percent of its provincial land base by 2015, while New Brunswick intends to increase protected areas from 3 to 5 percent of its total land base (PNS 2013; PNB 2013). The Canadian Council on Ecological Areas reports that governmentally protected areas represented 3.1 percent of the provincial land base in New Brunswick at the end of 2011. The Eastern Habitat Joint Venture, a habitat conservation partnership, is working to implement the North American Waterfowl Management Plan through protection of coastal and wetland habitats. The partners in this effort (Nature Conservancy of Canada, Ducks Unlimited Canada, Nature Trust of New Brunswick, the Province of New Brunswick and the federal government of Canada) have protected 12,472 acres to date in the four New Brunswick counties bordering the Gulf of Maine.

As of September 2012, Nova Scotia had 9.4 percent of its land base province-wide legally protected, including land trust and non-governmental holdings (PNS 2013). Along the immediate coastline, about 15 percent of lands are publicly owned but less than 5 percent of coastal lands are protected through a mixture of conservation easement properties, non-government organization holdings, and Crown protected areas. The Bay of Fundy shoreline, due to its long history of settlement and subdivision, may have an even lower percentage of protected lands (D. Garratt, Nova Scotia Nature Trust, pers. comm.). Nova Scotia recently proposed a Parks and Protected Areas plan that would raise the percentage of legally protected lands to 13 percent and would protect 437 additional miles of coastline province-wide including 163 beaches, 64 salt marshes and 25 estuarine flats. Of the proposed additions, more than 247,000 acres are in counties bordering the Bay of Fundy (PNS 2013).

3.3 PUBLIC SHORE ACCESS

Coastal communities bordering the Gulf of Maine rely heavily on shore access for recreation, harvesting, and other traditional maritime uses. Maintaining access is a growing concern in the face of increasing coastal development, rising property values and taxes (which can restrict access for lower-income residents), changes in land ownership, lack of enforcement and planning, growing costs of infrastructure maintenance, and declines in fisheries/maritime industries (Springuel 2007).

Massachusetts and Maine are among the few U.S. states that do not own the intertidal zone between high and low water marks. Due to colonial-era ordinances, public access in this portion of the shore is confined to "fishing, fowling, and navigating"—prompting concerns (and legal action in places) over the public's right to broader recreational use. New Hampshire owns up to the mean high water mark and in Canada, the provinces generally own the intertidal zone except for some colonial-era land grants that included the intertidal zone as part of private property holdings.

The Gulf jurisdictions vary greatly in the relevant data they have on shore access sites, and no jurisdiction has data tracking changes to access points over time. Much of the knowledge about access is local and the changes in permitted uses shift gradually—making the status of sites hard to track. Tourism New Brunswick promotes 11 accessible saltwater beaches along its Fundy shoreline, but no data could be located on the percentage of shoreline that is publicly owned or publicly accessible. Nova Scotia has no province-wide inventory or database of access sites, and the provincial government reported in 2009 that it did not have adequate information to determine the area or length of the Nova Scotia coast that is reachable by the public (PNS 2009). Roughly 15 percent of the Nova Scotia coast is publicly owned, but not all of that is accessible and the majority lies outside the Bay of Fundy shoreline.

Since 1995, the Canadian Department of Fisheries and Oceans (DFO) has been divesting recreational harbors and harbors where there has been little or no fishing activity (Fisheries and Oceans 2011). This trend may have reduced shore access in some harbor settings. Most of the New Brunswick and Nova Scotia property divestitures to date occurred prior to 2007, with ownership of 22 sites transferred to the provinces, 27 to municipalities, and most of the remainder to local not-for-profit organizations. Because the terms of divestiture specify that public access need only be maintained for a minimum of five years, DFO does not have records of which sites still provide public access (S. Gaudet, DFO, pers. comm.). Access can be lost in cases where harbor infrastructure is demolished in the property transfer process or is not adequately maintained under new ownership.

About 5 percent of the total land area within Maine's coastal zone (those municipalities bordering coastal and tidal waters) is publicly owned, and the Maine Coastal Program recently completed an inventory of all governmentally owned sites (totaling 547), along with 142 private sites (the vast majority of them owned by land trusts or other conservation nonprofits) (M. Nixon, Maine Coastal Program, pers. comm.). A nonprofit completed an in-depth mapping analysis of working waterfront access, which found that only 20 miles of Maine's 5,300-mile shoreline continues to offer working access. More than half of these sites are privately owned so could be subject to conversion. In that study, 15 percent of Maine's coastal towns reported having no public access to the shore (Island Institute 2010). In 2005, Maine voters gave strong support to a state referendum allocating $2 million in bond funds toward protection of working waterfront lands (Springuel 2007).

New Hampshire's Coastal Program published a map with 23 public access sites identified along its 18-mile coastline (NHCP 2007). It plans to launch an online coastal atlas that provides information about all New Hampshire coastal access sites (K. Lucey, New Hampshire Coastal program, pers. comm.). Massachusetts has worked to increase and inventory coastal access sites along its 1,500-mile shoreline. The state has purchased more than 100 miles of shoreline and now has 375 miles in public ownership (D. Janik, Massachusetts Office of Coastal Zone Management, pers. comm.). In 2006, the Massachusetts Office of Coastal Zone Management established a GIS database that serves as a state register of protected coastal access sites. It also created an online access locator (http://www.mass.gov/eea/agencies/czm/program-areas/public-access-and-coast-guide/coast-guide/coast-guide-online.html) that provides site-specific information for more than 1,000 shore access points along its coast. Massachusetts has 11 Designated Port Areas (protected for marine industrial development), and helps secure public access within developed ports and harbors by regulating coastal development under its Public Waterfront Act.

3.4 MUNICIPAL COMPREHENSIVE PLANS

Since municipalities make many coastal land-use decisions on both sides of the border, the extent of local comprehensive planning can indicate whether communities are working toward sustainable future growth, although adequate resources are not always available for implementation. Planning at the municipal level does not guarantee that adequate planning is occurring at the regional or watershed scales, or that planning decisions afford sufficient protection to sensitive coastal ecosystems. Yet careful local planning is a first step in guiding many communities toward better land-use decisions.

A growing number of municipalities in the region are working to create climate adaptation plans as well, with federal and provincial incentives in New Brunswick and Nova Scotia (http://atlanticadaptation.ca). These plans consider the potential impact of projected sea-level rise and storm surges, and the need to site new infrastructure outside flood-prone areas. At least a dozen coastal communities in both Massachusetts and New Brunswick have begun work on adaptation plans. In Massachusetts, communities receive help preparing to manage storm damage and sea-level rise through the state's Storm Smart Coast Program. More information on adaptation plans can be found in the Gulf of Maine Council's theme paper, Climate Change and Its Effect on Ecosystems, Habitats and Biota.

Because Massachusetts is a home rule state, municipal comprehensive plans are not required, and the only data on their status are maintained by Regional Planning Associations. Only one such association provided data for this paper (see box in section 5 on Cape Cod), so the status of comprehensive planning among the state's coastal communities is uncertain. Massachusetts does require towns to develop and regularly update municipal open space plans in order to qualify for any state funding for conservation, recreation, and open space funding, but there is no state tracking of these plans.

Nearly all of New Hampshire's coastal cities and towns have adopted a town plan, a comprehensive plan, or a master plan, and almost all of those include natural resource chapters (Sowers 2010; J. LaBranche, Rockingham Planning Commission, pers. comm.). While none of the plans currently have separate sections on coastal planning and management, there is a bill pending in the state legislature that would enable creation of separate chapters on coastal planning and management in municipal master plans (J. LaBranche, Rockingham Planning Commission, pers. comm.). Seacoast New Hampshire had two recent planning

initiatives focused on coastal resilience: the Portsmouth Coastal Resilience Initiative and Climate Ready Estuaries.

A detailed survey completed by the Piscataqua Regional Estuary Partnership found the strengths and limitations in the planning efforts of 52 towns and four regional councils in its watershed (in seacoast New Hampshire and southernmost Maine). Most towns had plans that identified natural resource protection goals and strategies, as well as approved open space protection plans and active conservation commissions. However, many towns lacked natural resource inventories with current data and maps on wildlife habitat, and there were inconsistent environmental standards in regards to wetland and shoreland buffers, development setback requirements, stormwater management regulations, erosion and sediment control requirements, and impervious surface area limits (Sowers 2010).

Maine, also a home rule state, does not require comprehensive plans. However, plans for communities in the coastal zone must meet minimum requirements relative to coastal issues to be found consistent with the state's *Comprehensive Planning and Land-Use Regulation Act*. As of March 2013, 85 of Maine's 148 coastal communities had adopted plans consistent with the state Act.

Local planning in New Brunswick's municipalities is guided by the *Community Planning Act*. This Act also guides development in unincorporated areas (which include just less than half of the provincial population). A number of municipalities have developed green plans and integrated sustainability plans in addition to having their own municipal or rural plans. In January 2013, twelve Regional Service Commissions (RSC) were created to provide a forum for communication, planning, policing, solid waste management, and regional economic development. Regional planning through the new RSC model is expected to foster greater collaboration among various levels of governance in New Brunswick (J. Glynn, NB Department of Environment and Local Government, pers. comm.)

Municipal governments in Nova Scotia have direct control over regulations for most land uses (Figure 7), but relatively few along the southern and Bay of Fundy coasts deal directly with planning for watercourses and coastal buffers (D. Smith, Service Nova Scotia-Municipal Relations, pers. comm.). A few regions have taken on ambitious planning initiatives, such as Kings County and Cumberland County (which put together an award-winning Strategic Environmental Planning Framework). Canada's federal government currently provides a portion of

federal gas sales tax revenues to municipalities that have completed an Integrated Community Sustainability Plan (ICSP) for "green projects." This incentive has helped foster rural environmental planning and municipal consideration of environmental issues from a land-use planning perspective (D. Smith, Service Nova Scotia and Municipal Relations, pers. comm.)

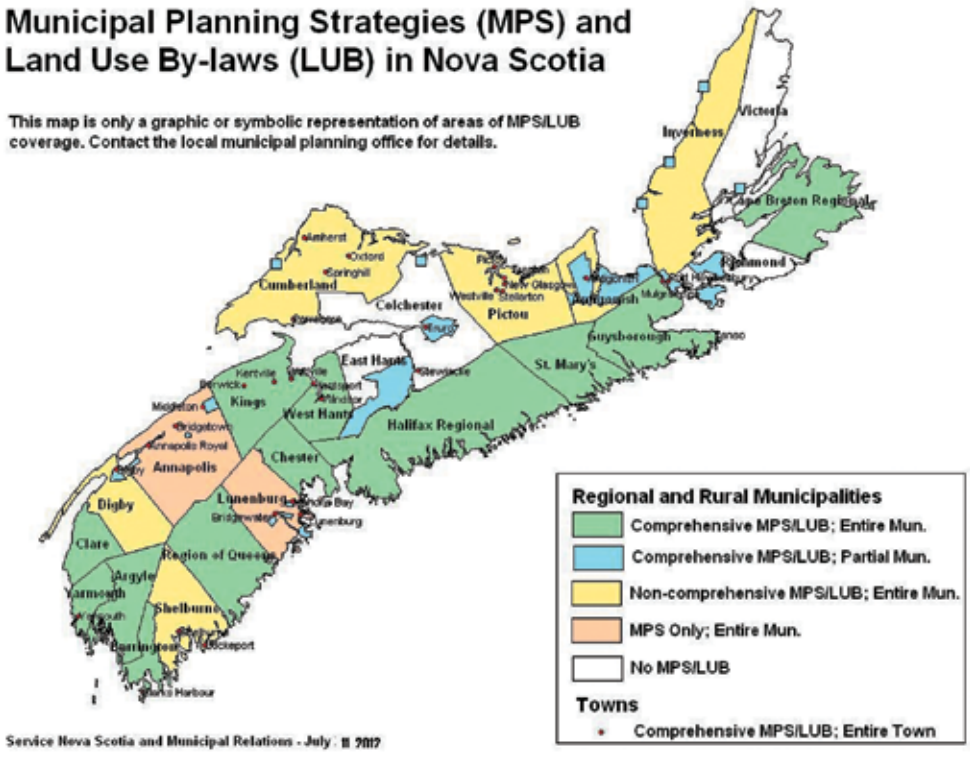

Figure 7: State of municipal planning strategies and land-use bylaws in Nova Scotia municipalities.

4. Impacts

Poorly planned and dispersed development has had a profound impact on coastal land use along the Gulf of Maine shoreline. The ecological, sociological and economic transformations wrought by coastal development in the region have not been fully documented so the true scale of impacts is difficult to assess.

From an ecological perspective, development can erode the array of "ecosystem services" provided by intact natural communities including soil formation, water filtration, beach replenishment, wildlife habitat, waste decomposition, pollination, carbon sequestration (helping mitigate climate change), air purification, groundwater recharge and storm protection. By fragmenting the landscape (reducing the intact natural areas), development creates smaller and smaller patches of nature that cannot provide the ecosystem services that larger tracts formerly did. Wildlife often suffers in this process, failing to thrive or even survive (Yale 2004).

Assigning economic measures to a region's "natural capital" is one tool for quantifying the significant value of healthy ecosystems. Preliminary estimates reveal impressive values from well-functioning systems. A recent analysis of Maine's natural capital found that each year the state receives an equivalent value of more than $14 billion (more than a quarter of its 2011 GDP) in services from its natural environment (Troy 2012). In Nova Scotia, GPI Atlantic estimates that wetlands alone provide $7.9 billion worth of ecosystem services. Yet no existing studies tally the true costs that cumulative coastal development has had on the region. Table 4 depicts some of those ecological, social and economic impacts.

Figure 8: A freight train passing along a dyke near Sackville, New Brunswick illustrates how vulnerable some coastal infrastructure is due to poor planning and disruption of natural wetland ecosystems. A storm surge at highest high tide in this setting would reach halfway up the freight cars. (Photo courtesy of E. Desplanque, Atlantic Canada Climate Adaptation Poster, Natural Resources Canada 2001, http://www.nrcan.gc.ca/earth-sciences/climate-change/community-adaptation/poster/732).

Table 4: Cumulative impacts of poorly planned development (with regional examples).

IMPACTS	EXAMPLES FROM THE GULF OF MAINE
Ecological Impacts	
Decreased protection from erosion and storm surge	• Where dykes have disrupted the natural capacity of wetlands to absorb storm surge and floodwaters, in settings such as the tidal isthmus near Sackville, New Brunswick, there is increased risk of flooding and damage to coastal infrastructure (Figure 8).
Loss of mature forests that provide carbon sequestration	• Research over a 25-year period in New England demonstrates that many forests do not stop or slow their storage of carbon as they mature and age: in fact carbon uptake actually increases (Foster et al. 2010).
Loss of wetlands and nursery areas for juvenile fish/shellfish	• Among the five Gulf jurisdictions, wetland loss ranges from a low of 25-50 percent in Maine; to 50 percent in Massachusetts and New Hampshire; to 65-85 percent in Nova Scotia and New Brunswick, with the highest levels along the Bay of Fundy (Gustavson 2010). Work is underway throughout the region to halt and reverse this trend (see box, "Moving toward No Net Wetland Loss").
Fragmentation of wildlife habitat and declines in threatened species	• Some of Maine's most rare plant communities have already been lost or altered by development in coastal counties of southern Maine (Stone 2011). • The World Wildlife Fund (ND) reports that 5 percent or less of the New England-Acadian forests covering the region remain intact in pre-settlement condition.
Loss of sandy beaches (degrading the economic potential of the habitat with highest "natural capital" value) (Troy 2012)	• Roughly 30 percent of Massachusetts' south shore has shoreline protection structures that have contributed to extensive loss of recreational beaches and alteration of marine habitats (Figure 9) (O'Connell 2010). In southeastern New Brunswick, beach and dune habitat at five study sites declined between 8 and 40 percent between 1941 and 2001 (Gustavson 2010).
Decline in water quality with more runoff from impervious surfaces and less filtration by coastal wetlands	• A one-acre parking lot produces about 16 times the volume of runoff that comes from a one-acre meadow (Beach 2002). • Shellfish harvesting is prohibited in 37 percent of the surveyed areas in the Maritimes due to nonpoint source pollution, primarily fecal coliform bacteria from urban and agricultural areas (Stewart et al. 2003). • Excess nitrogen and algal blooms (see Gulf of Maine Council Eutrophication fact sheet and Eutrophication theme paper). • Concentrations of suspended sediment at one site in Great Bay, New Hampshire, increased 122 percent between 1976 and 2011 (PREP 2013). • Groundwater contamination (see Gulf of Maine Council theme paper on Microbial Pathogens and Toxins). • In Maine, only one-third of municipal water supplies lie within conservation areas; the balance are vulnerable to contamination from increased development (Cronan et al. 2010).

(continued on next page)

Table 4 *(Continued)*: Cumulative impacts of poorly planned development (with regional examples).

IMPACTS	EXAMPLES FROM THE GULF OF MAINE
Socio-Economic Impacts	
Loss of forest land	• Loss of natural-resource based industries and associated value-added production (e.g., furniture construction) can weaken the regional economy. Before European settlement, an estimated 70-90 percent of New England's northern hardwood forests were old growth, whereas young forests represented 1-3 percent of forest land. Now that figure is reversed (Foster et al. 2010).
Loss of productive agricultural lands	• Loss of farmland and the necessary infrastructure for farming can increase regional food vulnerability. Many communities in the Gulf of Maine region have only a 3- to 4-day supply of food in the regional distribution system, as a 2008 ice storm demonstrated (New England Governors 2009).
Loss of affordable housing and workforce	• Coastal development and seasonal home purchases can drive up property values and taxes, forcing long-time residents and businesses inland. In some Cape Cod, Massachusetts communities, seasonal homes represent more than half the housing stock (Shemkus 2011)
Decline in the vibrancy of communities	• A rise in the percentage of housing stock held by seasonal owners can leave communities struggling to sustain year-round viability One Cape Cod realtor noted that there are numerous neighborhoods in Dennis, Massachusetts where nearly no lights are visible during winter months (Shemkus 2011).
Increased long-term cost of municipal services	• Several studies in Maine (and numerous others in the United States) have shown that while residential development does increase a community's tax base, those revenues are outweighed over time by the additional cost of municipal services.
Increased energy expenditures and greenhouse gas emissions	• Increases in annual Vehicle Miles Traveled correlate with patterns of dispersed development, generating more vehicular emissions. Between 2000 and 2010, the county bordering Casco Bay, Maine saw vehicle registrations outpace population growth by 41 percent (Casco Bay Estuary Partnership 2010).
Loss of recreational opportunities	• Unplanned development can diminish a community's scenic and recreational assets, and eliminate traditional access to beaches and trails. Maine ranked second among U.S. states for proportional share of lost rural lands in the 1990s (Brookings 2006).
Diminished character of place	• Poorly planned and managed land use can make communities less desirable for long-time residents and less appealing to tourists and seasonal visitors: "The spread of anonymous suburban development threatens to gradually (or not so gradually) degrade Maine's quality of place at a time when quality of place means more and more" (Brookings, 2006, p. 49).

Moving toward No Net Wetland Loss

As noted in Table 4, the jurisdictions surrounding the Gulf of Maine have experienced a dramatic loss in wetlands, particularly in coastal regions where development pressures historically have been most intense. Infilling for development, agricultural conversion (including cranberry production), and tidal restrictions (from dams, culverts and causeways) have diminished the number and degraded the health of many coastal wetlands.

To help reverse this trend, all five jurisdictions bordering the Gulf have committed to policies and regulations that will prevent wetland loss. Massachusetts has pioneered a system that helps address losses outside the regulatory system as well. Realizing in 2004 that roughly 59 percent of its wetland loss was due to illegal fill, the Massachusetts Department of Environmental Protection launched a "Wetland Loss Mapping Project" that has reduced wetland loss by two-thirds since the project began (USEPA ND). Along portions of the Gulf coastline, communities are working to restore historic wetlands as well (e.g., removing dams and dykes).

Further information on state and provincial approaches to wetlands conservation can be found in the following resources:

- Massachusetts Wetland Program Plan
- New Hampshire Wetland Program Plan
- Maine Wetland Program Plan
- New Brunswick Wetlands Conservation Policy
- Nova Scotia Wetland Conservation Policy

Figure 9: Loss of beach at Ocean Bluff, Massachusetts. A postcard from the early 1900s depicts this sandy shore environment before shoreline armoring. The second image, taken in 2005, demonstrates how source sediment impoundment and passive erosion have completely eroded the fronting beach (J. O'Connell, Coastal Erosion Advisory Services, http://jimoconnell28.wordpress.com).

5. Actions and Responses

As the preceding Impacts section makes clear, poor land-use decisions and the cumulative impacts of development can be costly in ecological, social, and economic terms. Too often, those costs are not evident until after development has occurred. Coordinated management and careful planning are critical in directing growth in ways that minimize ecosystem degradation and sustain the well-being of coastal communities.

> The situation in the Gulf of Maine is further complicated because the region is controlled by hundreds of municipalities, dozens of counties and metropolitan regions in two countries. To say that authority is fragmented understates the enormity of the challenge to creating a coherent land-use policy.
>
> Gerald G. Pesch and Peter G. Wells
> *Tides of Change across the Gulf*

5.1 INTEGRATED COASTAL MANAGEMENT

Sound land-use management along the coast requires coordination among many levels of government, integration of policies with legislation and regulations, clear lines of responsibility and accountability, adequate funding, and measures to assess progress (PNS 2009). For decades, integrated coastal management has been a priority for many governmental entities in the region (Coastal Coalition of Nova Scotia 2008). It remains an elusive goal though, as jurisdictions struggle to integrate scientific findings into the planning process, inform and support local decision-makers, increase coordination and communication among different levels and agencies of government, sort out multiple layers of coastal legislation (numbering at least 45 in a single jurisdiction), make permitting and environmental compliance more user-friendly, and secure the funding and other resources necessary to foster coastal planning (Reid 2004; PNS 2009; McCloskey et al. 2011).

Numerous documents in recent years have mapped out potential steps toward more integrated coastal management in the Gulf of Maine region—ranging from centralized databases of relevant information (e.g., resource and land-use information, satellite and GIS maps, model ordinances, infrastructure changes and improvements and development indicators, and smart growth strategies) to technical assistance and funding mechanisms for regional and municipal planning (Pesch and Wells 2004; DeNormandie et al. 2009; PNS 2009; McCloskey et al. 2011).

> Ultimately, land-use education is a challenge of making linkages between causes and effects that appear unrelated, between constituencies that believe they have little in common, and between places that seem to be far apart.
>
> Dana Beach
> *Coastal Sprawl*

All three of the U.S. states bordering the Gulf of Maine have federally funded Coastal Programs (matched by state contributions) that support economic growth and natural resource protection in the coastal zone and help integrate management among different governmental agencies. Massachusetts has an Ocean Management Plan, adopted in 2009, that sets forth the state's goals and siting priorities, and sets standards for allowed uses, activities, and facilities in state waters. The plan translates policy direction and specific requirements of the underlying legislation (Massachusetts *Ocean Act*) into a comprehensive management approach that can be implemented through existing state programs and regulations (A. Donovan, Massachusetts Office of Coastal Zone Management, pers. comm.). New Hampshire's efforts to advance integrated

coastal management are occurring primarily through the work of the Northeast Regional Ocean Council.

In 2002, New Brunswick created a Coastal Area Protection Policy that has helped limit development within 100 feet of coastal wetlands, tidally affected lands, and other vulnerable locations—helping ensure a resilient natural shoreline that in turn protects infrastructure and properties. Nova Scotia is working toward addressing coastal land-use issues in a more integrated manner, a need clearly outlined in its 2009 State of Nova Scotia's Coast Summary Report.

5.2 LOCAL LAND-USE PLANNING

Along the Gulf of Maine coastline, municipalities make many of the most critical land-use decisions—determining the siting of development, setting and enforcing (or not) shoreline and wetland buffers, and laying the groundwork to guide future growth and development (PNS 2009). Relying on volunteer planning boards and town staff with multiple responsibilities, few local governments are well-positioned to take on the breadth of coastal management and planning duties accorded them (CCNS 2008).

With help from federal, provincial and state programs, regional planning entities, and watershed councils, many municipalities are trying to institute a range of "best management practices" (BMPs). BMPs can help direct development to appropriate settings, preventing infrastructure damage and supporting the continued health of coastal ecosystems. These practices include:

- Minimizing impervious surface cover with new and existing development;
- Encouraging low-impact development approaches like porous paving materials, green roofs, and rain gardens to reduce stormwater runoff and nonpoint source pollution;
- Using smart-growth strategies to direct new development into more urban areas, keeping rural lands available for agriculture, forestry, and open space;
- Establishing or strengthening regional planning commissions that can coordinate among municipalities (see box, "Cape Cod, Massachusetts: Managing Growth");
- Employing Transfer of Development Rights (TDRs), a market-based planning tool that channels development from rural to higher density areas;
- Setting and enforcing generous buffer zones around sensitive ecosystems (e.g., New Brunswick's Coastal Area Protection Policy);
- Encouraging compact development and cluster or density zoning (where development density is based on a specified area rather than lot-by-lot,

allowing for more concentrated units with larger open space areas set aside);

- Completing natural resource inventories and wetlands evaluations;
- Participating in initiatives led by non-government organizations, such as Integrated Habitat Conservation Planning (see box), to direct land securement, protected areas planning, and stewardship activities (e.g., South West Nova Integrated Conservation Strategy, Chignecto Bay Integrated Habitat Conservation Strategy);
- Ensuring adequate directives and enforcement for wetland protection, stormwater management, erosion/sediment control, and floodplain management (PREP 2013);
- Using zoning to support water-dependent uses and requiring waterfront developers to provide access;
- Pairing new regulations and standards with developer incentives to keep them fiscally neutral (e.g., density bonuses, one-stop permitting, expedited zoning procedures and permitting, fee reductions and waivers, and reduced parking requirements (APA 2011); and
- Creating innovative tools to help guide development (such as New Hampshire's interactive Cost of Sprawl Impact model that allows municipalities to assess the impact of different development scenarios) and to help assess the impacts of development (such as the Conservation Assessment and Prioritization System [CAPS] model employed in the Massachusetts Losing Ground analysis).

There is ample guidance on recommended actions (see box on Smart Growth); the challenge is to find the time, technical guidance, and financial resources to implement recommended measures.

Integrated Habitat Conservation Planning (Nova Scotia, New Brunswick)

The overarching goal of this multi-species, multi-partner approach to conservation planning in Atlantic Canada is the conservation of habitat, wildlife, and overall biodiversity. This planning occurs within discrete ecological units (watersheds and watershed composites) at scales that reflect requirements for effective implementation. Proposed outcomes include shareable strategic information (i.e., map tools) for various habitat conservation actions founded on consensus-based goals, as well as species/ecosystem targets (i.e., focal species, habitats) as identified among stakeholders and partners (A. Hanson, Environment Canada, pers. comm.).

Cape Cod, Massachusetts: Managing Growth

Cape Cod, a unique geologic feature along the Gulf of Maine coast (with a substrate entirely of sand and gravel), represents one of the region's most extreme examples of land-use change. In the half-century between 1951 and 2003, the Cape's year-round population grew 400 percent, reaching 229,000 (Woods Hole Research Center 2012).

Exponential population growth has wrought irreversible changes on Cape Cod (Figure 2). The vast majority of the Cape's prime agricultural lands have been developed, primarily as residential subdivisions, leaving less than 3,000 acres (mostly fragmented in small parcels) (Beauchamp et al. 2011). Despite rampant residential development, workforce housing is a concern since 32 percent of the housing stock Cape-wide is held by seasonal visitors (according to 2010 U.S. Census data).

Concerned by loss of open space, increasing road congestion and threats to water quality, residents of the 15 Cape towns voted in 1990 to transform their regional planning agency into the Cape Cod Commission, giving it power to regulate "developments of regional impact" and impose limited moratoria within "districts of critical planning concern" to allow for planning and development of targeted regulations. These powers give the Commission critical input into how and whether proposed developments happen (H. McElroy, Cape Cod Commission, pers. comm.).

Nearly all Cape municipalities have a local comprehensive plan and a more comprehensive Open Space and Recreation Plan. While the Commission regulates subdivision plans over 30 acres, most residential development is regulated at the municipal level, where performance standards are typically less restrictive. The Commission invites local municipalities to participate in far-sighted regional planning efforts such as a land use vision map; a Regional Ocean Management Plan (which addresses offshore renewable energy and sand and gravel mining for beach nourishment); a Regional Wastewater Management Plan (which addresses both treatment system options and green infrastructure); and a Regional Multi-hazard Mitigation Plan (H. McElroy, Cape Cod Commission, pers. comm.).

The Commission's work is complemented by the efforts of a community-based nonprofit, the Association to Preserve Cape Cod. This group supports land use planning and natural resource protection zoning; advocates for smart growth; monitors salt marshes, herring runs and marine invasive species; and recently completed a farmland assessment and a study of the effects of sea-level rise on aquifers.

Having contended with the side effects of rapid growth, many area residents now value the role that regional land-use planning can play in sustaining the Cape's ecological and economic future.

As the Gulf of Maine experiences more pronounced effects of climate change, communities will need to reduce their vulnerability and plan for both short-term responses and long-term recovery. Measures to ensure coastal resilience in the face of climate change may include:

- Gathering relevant scientific data for decision-making;
- Conducting risk assessments;
- Controlling erosion and revegetating areas;
- Protecting land and restoring habitats;
- Instituting risk-based land-use planning;
- Changing building practices/codes; and
- Reviewing emergency preparedness (The Heinz Center 2009; White et al. 2010).

Smart Growth—Coastal and Waterfront Elements (NOAA 2012)

1. Mix land uses, including water-dependent uses.
2. Take advantage of compact community design that enhances, preserves, and provides access to waterfront resources.
3. Provide a range of housing opportunities and choices to meet the needs of both seasonal and permanent residents.
4. Create walkable communities with physical and visual access to and along the waterfront for public use.
5. Foster distinctive, attractive communities with a strong sense of place that capitalizes on the waterfront's heritage.
6. Preserve open space, farmland, natural beauty, and the critical environmental areas that characterize and support coastal and waterfront communities.
7. Strengthen and direct development toward existing communities, and encourage waterfront revitalization.
8. Provide a variety of land- and water-based transportation options.
9. Make development decisions predictable, fair, and cost-effective through consistent policies and coordinated permitting processes.
10. Encourage community and stakeholder collaboration in development decisions, ensuring that public interests in and rights of access to the waterfront and coastal waters are upheld.

5.3 LAND CONSERVATION AND HABITAT RESTORATION

While land conservation efforts are gaining momentum along the Gulf of Maine coastline, they will need to become better coordinated, concentrating on land linkages and contiguous parcels—particularly in more populous regions (Cronan et al. 2010). In addition to commonly employed devices such as conservation easements, communities may want to consider using tools that compensate landowners for protected resources while directing development to higher density areas (such as transfer of development rights) (Cronan et al. 2010).

Conservation work in the Gulf of Maine coastal region is increasingly focused on collaborative conservation initiatives that protect vital ecosystem processes in areas defined more by biophysical traits than jurisdictional boundaries. These initiatives, many of which build on the state, provincial and federal coastal protection efforts described in section 3, seek to conserve critical tracts of the region's natural infrastructure, helping to sustain its resilience in the face of a warming climate and changing land uses (Foster et al. 2010). Some organizations in the Gulf of Maine region participate in the North Atlantic Landscape Conservation Cooperative, a partnership that aims to address land use pressures and widespread resource threats and uncertainties amplified by a rapidly changing climate.

A growing number of regional initiatives—at the watershed scale—are linked to an ambitious 50-year vision articulated by researchers at Harvard Forest in Massachusetts, outlined in the Wildlands and Woodlands report. They seek to build public support for an unparalleled conservation effort that would retain 70 percent of New England in forestland, permanently free from development. Ninety percent of these would be managed for forest products, water supply, wildlife habitat, recreation and aesthetics while the remaining 10 percent would be large-landscape wildland preserves with minimal human impact (Foster et al. 2010). There are currently six regional conservation partners in this effort along the US Gulf of Maine shoreline: Taunton River Coalition; Great Bay Resource Protection Partnership; Mount Agamenticus to the Sea Conservation Initiative; Portland North Land Trust Collaborative; River Link; and Twelve Rivers Collaborative.

Habitat restoration is important to improve the function and provision of ecosystem goods and services from previously degraded habitats. A wide range of activities have been undertaken, many of them supported by the Gulf of Maine Council on the Marine Environment (see http://restoration.gulfofmaine.org/)—one example of which is highlighted in the salt marsh restoration box.

Community-Based Salt Marsh Restoration in Nova Scotia

Salt marshes are critical coastal habitats in the Gulf of Maine, providing important ecological and economic services. While there are widespread efforts to protect undisturbed marshes, portions of the Gulf coastline have few of those left. In the upper Bay of Fundy, up to 85 percent of the salt marshes that were present historically have been lost or damaged (Commission for Environmental Cooperation 2013).

The Ecology Action Centre, based in Halifax, coordinated a community-based pilot project at Cheverie Creek in Hants County that may help stimulate other salt marsh restoration projects in the region by helping fill knowledge gaps about how best to organize, fund, and implement such a project. The collaborative effort engaged the local community and drew financial and technical support from one federal agency, three provincial agencies, two universities, and the Nova Scotia Museum of Natural History. A habitat restoration grant from the Gulf of Maine Council on the Marine Environment helped the group implement its plan for tidal restoration at a culvert that crosses the creek.

6. Indicator Summary

INDICATOR	DPSIR FRAMEWORK	STATUS	TREND
Coastal Population Density	Pressure	Fair—Many coastal communities contend with increased congestion and other negative impacts from year-round residents and seasonal visitors.	Worsening and Improving—Population density is increasing along much of the southern Gulf coast, but is stable or decreasing in some coastal counties.
Population dispersal and spread of suburban sprawl	Pressure	Fair—While an economic downturn has slowed this trend temporarily, the region is still suffering from sprawling growth and its negative impacts.	Worsening—Development is outpacing population growth, and projections indicate sprawl will keep spreading unless marked changes in planning/ zoning occur.
Changes in per capita annual Vehicle Miles Traveled	Pressure	Fair—Available U.S. data indicate miles are declining slightly, but remain high due to dispersed population and long work commutes.	Improving—While transportation alternatives are still inadequate and per capita rates are still high, VMTs are declining slightly.
Change in impervious surface cover	Pressure	Fair—Impervious surface cover percentages are still relatively low but locally high percentages are problematic in some settings.	Worsening—Land-use cover data (where it exists) indicate steady growth in impervious surface cover.
Storm intensity and frequency	Pressure	Fair—Some evidence of increased number and intensity of storms.	Worsening—Storm frequency and intensity are increasing, damaging infrastructure (particularly in low-lying and beach areas).
Flooding/erosion due to sea-level rise	Pressure	Fair—Vulnerable communities are contending with some effects to date and coastal municipalities are increasingly concerned with coastal resilience and mitigation.	Worsening—Frequency of flooding and erosion is increasing in vulnerable areas.
Loss of productive working landscapes	State	Fair—Agricultural and forest lands are getting developed—primarily for residential use—at a rate that far exceeds population growth.	Worsening—Projections are that this trend will increase, particularly in populous coastal counties.
Changes in acreage of permanently conserved land	State	Fair—Many parts of the Gulf of Maine region have seen significant conservation gains, but fewer and smaller parcels are being protected in congested, coastal areas.	Improving—A renewed commitment to land protection is increasing acreages and percentages, but land values near the coast make conservation expensive.
Public access to the shore	State	Fair—Increasing shoreline development threatens some traditional access across private lands, but efforts are underway to inventory, publicize, and protect access points.	Unknown—Much shore access is informal and not all jurisdictions have inventoried sites so trend data are not available.
Municipal comprehensive plans	State	Unknown—Most land-use decisions along the Gulf shoreline rest with municipalities which have widely divergent capacity for planning and for implementation of plans.	Unknown—Many municipalities lack the financial resources or technical support to do more comprehensive planning.
Provincial/state coastal policies or strategies	Response	Fair—Ongoing efforts are underway to create both comprehensive policies and ones that address priority issues.	Unknown—There are few means of tracking the effectiveness of current efforts (formal evaluations are rare and not readily accessible).

Categories for Status: Unknown, Poor, Fair, Good.
Categories for Trend: Unknown, No trend, Worsening, Improving.

Data Confidence

- There is widespread scientific support for the ecological contributions provided by relatively undisturbed natural ecosystems along the Gulf of Maine coast.
- Census data provide a fairly reliable gauge of human population changes and population density.
- Numerous scientific studies confirm the increasing intensity and frequency of coastal storms in the North Atlantic.
- While percentages vary slightly based on calculation methods, numerous data sets confirm the acreage changes in lands conserved and lands converted to development.

Data Gaps

- Many land-use and development impacts are local in scope and not traced or recorded in governmental records (making cumulative impacts on a regional scale hard to gauge).
- There are limited analyses to date of the economic value of coastal ecosystem services and even fewer specific to the Gulf of Maine region.
- Many data sets regarding land use and development are not differentiated by coastal counties which would allow for a more accurate measure of changes along the coast.
- Every jurisdiction bordering the Gulf of Maine lacks trend data on changes in the number of public access sites.
- With home rule dominant in much of the region, detailed information on the status of municipal planning efforts is rarely centralized or accessible.
- Data on development and land-use trends since the recent recession (beginning in 2007) could not be located so the impact of this economic downturn could not be determined.

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