



A Climate Change Impact Assessment for Sagadahoc Co. and Merrymeeting Bay Region

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Highlighted Sectors: Agriculture, Development & Habitat Conservation

Geographic boundaries: The 13-town Sagadahoc and Merrymeeting Bay region includes Sagadahoc Co. plus the towns of Brunswick, Harpswell, and Dresden and is over 370 mi².

Description: The Androscoggin and Kennebec Rivers dominate the region and here they meet to form Merrymeeting Bay, a great source of regional biological diversity. The region remains heavily forested with developable lands and large blocks of agricultural areas. The region is 75% forested, 8% farmland, and 16% developed (McWilliams et al. 2003, USDA Agricultural Census 1974-1997). The region's under-protected freshwater streams provide important aquatic habitats, and their health is essential to the region's drinking water supplies and shellfish resources. Rich alluvial soils sustain a growing agriculture cluster comprised of farmers, farmers' markets and value-added organic food producers. Over 90% of the land is held by private landowners.

The largest threat to the highlighted sectors is unmanaged development. Coastal Maine (including Sagadahoc Co.) is one of the areas in the United States most threatened by sprawl: over 20% of the developable land base has been developed in the last 20 years and up to another 20% is predicted to be lost in the next 20 years (Stein et al. 2005). Hence, the US Forest Service lists the Lower Kennebec as one of the fifteen US watersheds expected to see the greatest increase in housing density on private forests by 2030 (White & Mazza 2008). From 2000 to 2005, over 50% of the people moving to the Sagadahoc Co. region moved to rural towns. High housing costs in Portland, the nearby hub of Maine's economy, continue to draw prospective home buyers to the Sagadahoc region, where housing is still relatively cheap and taxes relatively low. This has resulted in significant change and placed enormous pressures on local communities.

Organizations that could contribute to climate change adaptation:

Municipalities with potential climate change adaptation capacity: Bath, Bowdoinham, Brunswick, and Topsham

Regional Planning Organizations: ME IFW Beginning with Habitat, Kennebec Valley Council of Governments, Mid-Coast Regional Planning Commission, Sagadahoc Regional Rural Resources Initiative (voluntary local planning coordination); New Meadows River Watershed Partnership; DOT's Gateway 1

Land Conservation Organizations: Brunswick-Topsham Land Trust, Kennebec Estuary Land Trust, Maine Audubon Society, Maine Coast Heritage Trust, The Nature Conservancy- Maine Chapter, New England Forestry Foundation, the Pemaquid Watershed Association, Twelve Rivers, Sheepscot Valley Conservation Association, Trust for Public Land, Phippsburg Land Trust, Ducks Unlimited

Other Conservation Organizations: Friends of Merrymeeting Bay, the Chewonki Foundation, Maine Audubon Society-Merrymeeting Chapter, Maine Rivers, Casco Bay Estuary Partnership, Trout Unlimited

Major Forest Landowners: Maine Bureau of Parks and Lands, Maine Department of Inland Fisheries and Wildlife

Recreational Organizations: Four snowmobile clubs, one ATV club, and Bath Trails (a local trail group).

Educational Institutions: Bowdoin College, Bates College (Morse Mountain), the Cathance River Education Alliance, the Holt Research Forest, and University of Maine at Orono

Other: Mid-Coast Redevelopment Authority, Small Woodland Owners Association of Maine

Select Sector Attributes and Considerations:

Agriculture: This region of Maine has experienced a unique resurgence of local agriculture (Sagadahoc Region Rural Resources Initiative 2010). The number of farms and farm acreage has increased from the early 1970s so that the region now has 188 farms and over 14,700 acres of farmland almost evenly split between cropland and hay/pasture (ME Department of Agriculture, Food and Rural Resources 2003). Sagadahoc County has about 44,476 acres of prime farmland and 91,416 acres of soils of statewide significance. About 40% of gross receipts come from dairy, 40% from crops, and 20% from nursery businesses. Only about 500 acres of farmland are permanently protected in the region. Local communities, especially Bowdoinham and Dresden, have shown a great interest in maintaining agricultural areas. New markets (e.g., trends supporting local and organic food) have been essential to the resurgence in local agriculture.

Development: Planned and unplanned development pose a threat to the natural resources of the region (Sagadahoc Region Rural Resources Initiative 2010). Most development between 1900 and 1970 occurred in town centers and along Route 1. Since the 1980's, residential growth has primarily occurred along secondary roads, away from town centers, altering previously roadless, undeveloped land. Regional service center communities now only absorb about 18 percent of new residents, with the remainder scattered throughout rural areas. A key challenge to sustainable development is to provide affordable housing, a regional challenge that now affects both middle-income as well as low-income families. An often sought solution is to seek housing where land costs make housing affordable (i.e., in undeveloped rural areas) which exacerbates the threat of sprawl. This trend of decentralized rural development increases town costs associated with road maintenance, services, and school busing. Over 60% of the towns have comprehensive land use plans. The Mid-Coast Redevelopment Authority overseeing the economic redevelopment of the former Brunswick Naval Air Station will strongly affect economic development across much of the region.

Habitat Conservation:

Unique Features: The region has a high concentration of rare, threatened, and endangered species and habitat types. Merrymeeting Bay, the largest freshwater tidal bay in Sagadahoc, Lincoln, and Cumberland counties, is the wildlife habitat centerpiece of this region and the Kennebec Estuary Focal Conservation Area. For the U.S. east coast, the fall migrant waterfowl numbers at Merrymeeting Bay are second only to Chesapeake Bay, holding up to 40,000 waterfowl at one time during migration.

This region includes two ME Inland Fisheries and Wildlife Beginning with Habitat focal conservation areas: Maquoit and Middle Bay (in part) and the Kennebec Estuary. The latter includes >20% percent of Maine's tidal marshes and 25,000 acres of prime waterfowl habitat as well as a number of rare exemplary natural communities, rare plant species, and critical habitat for several endangered and threatened animal species. Its coastal bays support highly productive shellfish flats and lobster grounds. In Sagadahoc County, about 30% of the forestland is in northern hardwood, 8% is in spruce-fir forest types, 33% in oak and/or pine forest types, and the balance is in miscellaneous forest types. About 40% of the forest is pole timber and 40% is sawtimber with a balance in seedlings/saplings.

Conservation groups have obtained high levels of support and have made significant efforts to conserve key areas. Local communities have a high interest in conserving open space for access and trails. The level of land use planning ranges from low to high across local communities. Forest and wetland exotic plant species (e.g., exotic honeysuckle spp., barberry, Japanese knotweed, purple loosestrife) and the hemlock wooly adelgid have only recently begun to threaten habitats in this region. Because the Androscoggin and Kennebec Rivers dominate the wetland complexes of the region and drain about one-third of Maine, changes in upstream land use and industrial expansion could potentially threaten these habitats. Excessive and poorly planned shoreline development likely threaten water quality and impact wetland and marine habitats (Maine Natural Areas Program 2008). Residential development pressures are increasing and are likely to degrade existing shoreline buffers, fragment wildlife habitat, lower water quality, and allow invasive species to expand (Beginning with Habitat 2009). Industrial contaminants are still abundant in the bay's fine-grained sediments and affect bald eagles and perhaps other wildlife species.

Conservation Lands: Less than 10% of the region is under permanent conservation ownership or easement.

Federal Lands: Pond Island NWR (10 acres of marine, shore, and seabird habitats)

State lands: The region has several key conservation areas including: Caesar Pond WMA (500 acres of forest and freshwater wetlands), Earle R. Kelly WMA (800 acres of forest and freshwater wetlands), Kennebec River Estuary WMA (over 200 acres of upland and brackish wetlands), Merrymeeting Bay WMA (over 150 acres of upland and brackish wetlands), Muddy River WMA (170 acres, riparian and emergent wetlands), Popham Beach State Park (about 600 acres of coastal beach, dune, salt marsh, and upland forest), Reid State Park (about 766 acres of coastal beach, dune, salt marsh, and upland forest), and Swan Island WMA (1,755 acres of upland forest and tidal freshwater marsh).

NGO lands: Brunswick-Topsham Land Trust (>1,500 acres), Kennebec Estuary Land Trust (700 acres), The Nature Conservancy-ME (2,500 acres).

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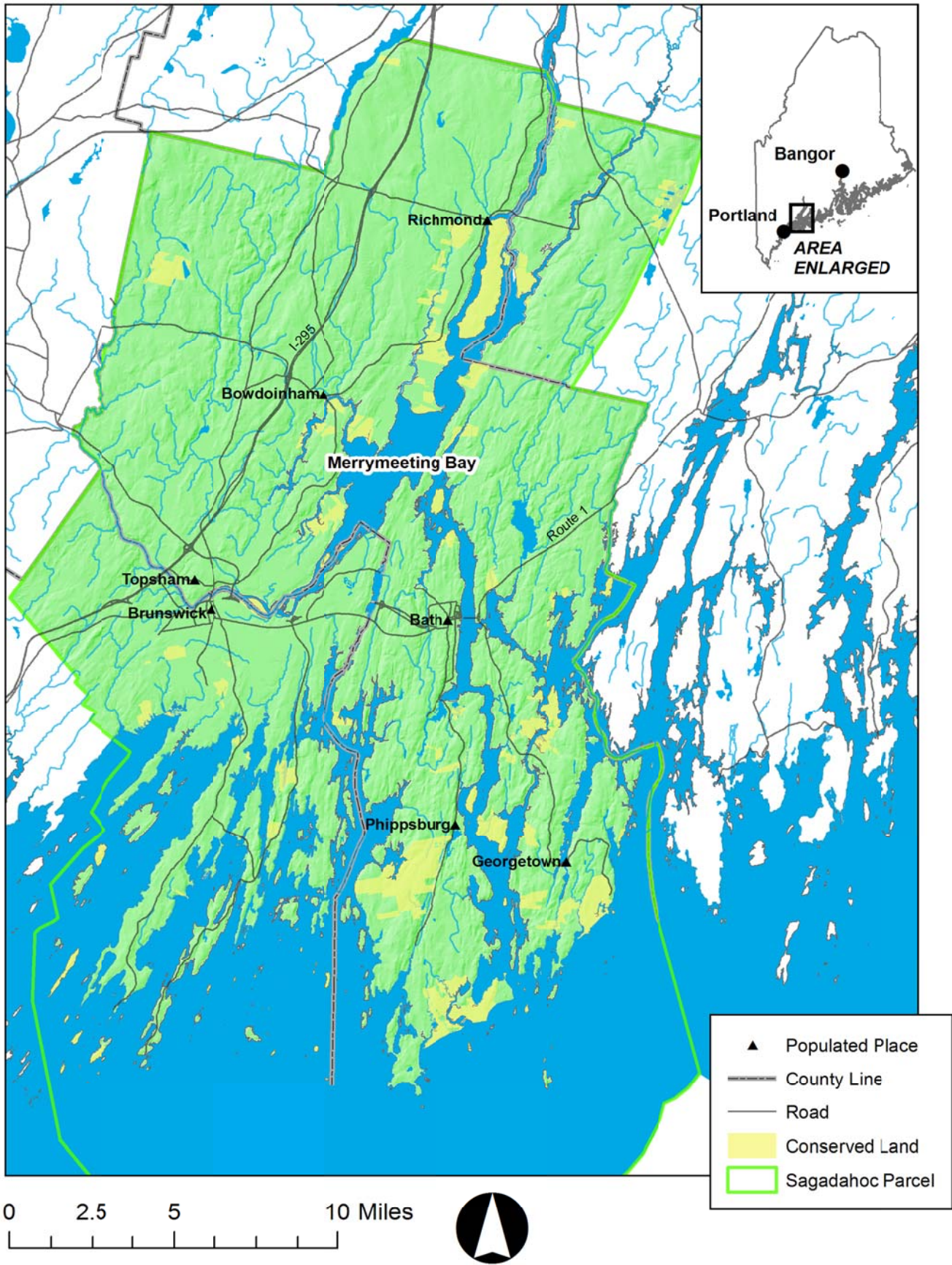
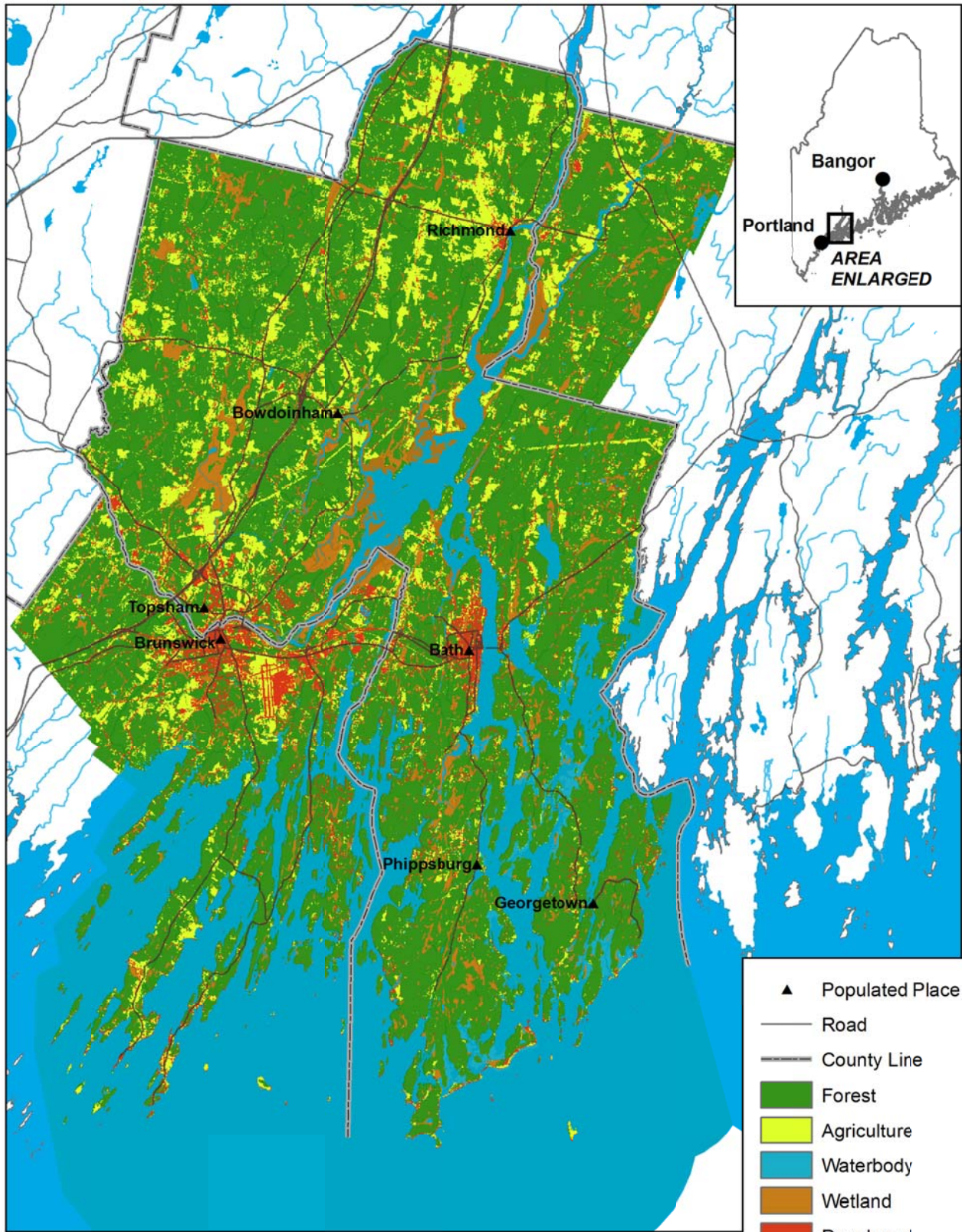


Fig. 1: Map of Sagadahoc Region.



Projected Impacts and Strategies for Agriculture, Habitat Conservation, and Development

Agriculture

Major Agricultural Sector - Projected climate changes	Potential Impact on agricultural sectors	Level & Likelihood of Potential Impact without action		Possible Actions:	What type of actor can best implement the action?*	Other sectors to be engaged:
Livestock (meat & dairy)		2010-2040	2041-2100			
- warmer temperatures	- reduction in winter feed costs - reduction in summer productivity	Low	Moderate			
	- increase in mastitis as more of year is muddy due to unfrozen ground	Low	Moderate			
- more frequent extreme heat events	- reduction in milk and meat production efficiency	Low	Moderate			
- more frequent drought	- reduced water availability for livestock and increased production costs	Low	Low			
- longer growing season	- longer opportunity to use pasture-based systems	Moderate	High			
Cropping (forages, vegetables, and orchard)						
- warmer temperatures	- greater production for some forage, vegetable, and fruit varieties due to warmer growing season	Moderate	High			
	- reduced production for other forage, vegetable, and fruit varieties due to warmer growing season	Moderate	High			
	- increase in new crop pest and number of generations of current insect pests	High	High			
- warmer winters - less snowfall	- crop losses due winter deacclimatization and winter bud kill of some varieties of forages, blueberries, and fruit trees	Moderate	Moderate			
- more frequent extreme heat events	- more frequent problematic moisture stress to crops	Low	Moderate			
- more frequent drought	- reduction in crop productivity due to lower water availability	Low	Moderate			
- more frequent late growing season drought	- reduced productivity late in season	Low	Moderate			
- longer growing seasons	- more opportunities for additional harvests of forage - more opportunities for growing new, more productive crop and fruit varieties	Moderate	High			
- more frequent extreme rainfall events	- increased difficulty in accessing fields - increased soil erosion - more frequent weather-related crop losses	Moderate	Moderate			
- more variable first frost date	- more frequent weather-related crop losses due to increased flower/fruit mortality from irregular first frost	Low	Low			
- increased CO2 fertilization	- greater crop productivity	Moderate	Moderate			

Major Agricultural Sector - Projected climate changes	Potential Impact on agricultural sectors	Level & Likelihood of Potential Impact without action		Possible Actions:	What type of actor can best implement the action?*	Other sectors to be engaged:

* e.g., landowner, local/regional government, NGO, state government, and/or federal government.

Habitat Conservation

Biodiversity Component - Projected climate changes	Potential Impact	Level & likelihood of Potential Impact without Action		Possible Actions:	What type of actor can best implement the action?*	Other sectors to be engaged:
		2010-2040	2041-2100			
Landscape Elements						
Large Blocks of Habitat & Habitat connectivity - warmer temperatures - more frequent drought	- more frequent forest fires and forest pest outbreaks reduce block size by resulting in younger forest and/or open forest types	Low	Low			
Enduring features (e.g., soils, aspect etc.) - more frequent late-growing season drought - more frequent drought	- more frequent forest fire increasing soil erosion	Low	Low			
Habitat						
Northern hardwood forest & northern coniferous forest communities - warmer temperatures - more frequent late-growing season drought - more frequent drought	- loss in extent of northern hardwood forest and spruce-fir forests due to less tree regeneration and increase mortality	Moderate	High			
	- increase spread of hemlock woolly adelgid and reduction in hemlock dominated forest	High	High			
Oak and pine forest communities - warmer temperatures - more frequent late-growing season drought - more frequent drought	- increase in extent of oak and pine forests - increase levels of chronic stress due to greater populations of forest pests, pathogens, invasive spp., levels of O3, and white-tailed deer populations. - more frequent forest fire burning pitch pine forest	Low	Moderate			
Freshwater wetlands (plant communities & waterbodies) - more frequent drought - greater variation in rainfall - more frequent extreme rainfall events	- habitat area may decline in drought years - more frequent stream scouring and sedimentation events from storms - greater levels of eutrophication from farmland and lawns	Moderate	Moderate			
Freshwater tidal wetlands - sea level rise - salt water intrusion	- upstream shift of tidal shore habitats - decline in extent of tidal habitats	Low	Low			
Species						
Northern species at southern edge of range (e.g., northern warbler spp., red spruce, balsam fir) - warmer temperatures	- habitat loss - reductions in population size	Low	Moderate			

Biodiversity Component - Projected climate changes	Potential Impact	Level & likelihood of Potential Impact without Action		Possible Actions:	What type of actor can best implement the	Other sectors to be
		Moderate	High			
Southern species at northern edge of range (e.g., possum, gray fox, southern flying squirrel) - warmer temperatures - less severe winters	- increased population size, expanded range of spp.	Moderate	High			
Wetland and Aquatic Species - greater winter rain flooding and reduced spring flows - more frequent drought - more frequent extreme rainfall events	- reduction in populations of wetland species (e.g., wetland plants, low nesting marsh birds) due to stress from more variable hydrology - increased stream sedimentation from storms	Low	Moderate			
Wildlife Health - warmer temperatures	- increased tick infestations and frequency of extreme heat reduces moose populations	Moderate	High			

Development

Components of Developed Areas - Projected climate changes	Potential Impact	Size & likelihood of Potential Impact without action		Possible Actions	What type of actor can best implement the action?*	Other sectors to be engaged:
		2010-2040	2041-210			
Buildings - more frequent extreme rainfall events - more frequent flooding - more frequent winter thaws/rains - more frequent extreme heat events	- flooded septic systems - more frequent flooding of low lying buildings - water damage to sites and buildings - hotter buildings increase energy costs	Moderate	Moderate			
Transportation Infrastructure - more frequent extreme rainfall events - more frequent winter thaws - more frequent extreme heat events	- "blown out" of stream crossing structures (e.g., culverts) - road are damaged by extreme heat and rainfall events - closed roads	High	High			
Utilities (telecommunications & electricity) - more frequent extreme rainfall and ice storm events	- ice storm damage to telecommunications infrastructure	High	Moderate			
Water Management Storm water - more frequent extreme rainfall events	- storm water infrastructure overwhelmed - "blown out" stream crossing structures (e.g., culverts)	High	High			
Wastewater - more frequent extreme flooding	- flooding of low lying treatments plants - system infrastructure overwhelmed if combined with	Moderate	Moderate			

Components of Developed Areas - Projected climate changes	Potential Impact	Size & likelihood of Potential Impact without action		Possible Actions	What type of actor can best implement the action?*	Other sectors to be engaged:
		2010-2040	2041-210			
	storm water and contaminating surface waters					
Drinking water - more frequent drought - more frequent extreme water fluctuations - more frequent extreme rainfall events - warmer temps.	- greater levels of sedimentation due to increased surface runoff - more widespread eutrophication due to increased urban/residential runoff of pet feces, fertilizers, etc.	Moderate	High			
Green infrastructure (e.g., urban forests) - more frequent drought and late-growing season drought - more frequent extreme weather events	- greater levels of insect pest damage and abundance of invasive species - more frequent storm damage to urban forest - loss of urban forest leads exacerbates problems arising from storm water runoff, extreme heat, and drought impacts on vegetation	Moderate	Moderate			