



**Facilitators:** Jim Gooch, Trust for Public Land  
Alan Hutchinson, Forest Society of Maine

**Highlighted Sectors:** Forestry, Nature-based Recreation, and Development

**Geographic boundaries:** The lower Penobscot River watershed between Mattawamkeag and Bucksport, Maine.

**Description:** Penobscot County is about 78% forested and so the forest products industry remains an important element of this region's economy. However, the service sector (including education, health services, and retail and wholesale trade) dominates the southern half of the region. About 14% of the southern half has been developed; the northern half is much less developed. The US Forest Service lists the Lower Penobscot watershed as two of the fifteen US watersheds predicted to experience the greatest increase in housing density on private forests by 2030 (White & Mazza, 2008). Some less developed towns are projected to experience population increases >30% in the next 20 years while some developed towns may experience declines (U.S. Census Bureau and Maine State Planning Office 2006). There are four major conservation efforts going on in the watershed:

1. The Penobscot Valley Community Greenprint is a collaborative effort lead by the Trust for Public Land to foster regional planning to maintain regional quality of place (Trust for Public Land, 2009).
2. The Penobscot River Restoration Project, managed by Penobscot River Restoration Trust, is a collaboration between a hydro-power company, the Penobscot Indian Nation, seven conservation groups, and state and federal agencies. Their goal is to restore 11 species of sea-run fish to the Penobscot River and maintain energy production.
3. The Lower Penobscot River Coalition is a collaboration of thirteen local land trusts "working together for ecosystem health" in the communities and watershed of the Lower Penobscot River.
4. The Lower Penobscot Forest Project is a partnership between The Nature Conservancy and Forest Society of Maine that aims to conserve over 42,000 acres.

**Some Key Organizations:**

Municipalities with climate change planning capacity: Bangor, Bradley, Brewer, Bucksport, Eddington, Hampden, Hermon, Holden, Lincoln, Milford, Old Town, Orono, Orrington, Penobscot Indian Nation (Indian Island), and Veazie.

Regional Planning Organizations: Eastern Maine Development Corporation, Maine Land Use Regulation Commission, Penobscot Valley Council of Governments, Northern Maine Development Commission.

Land Conservation Organizations: Bangor Land Trust, Brewer Land Trust, Forest Society of Maine, Holden Land Trust, Landmark Heritage Trust, Lower Penobscot River Coalition, Maine Audubon, Maine Coast Heritage Trust, Maine Farmland Trust, The Nature Conservancy – Maine Chapter, New England Forestry Foundation, Northeast Wilderness Trust, Penobscot River Restoration Trust, Orono Land Trust, Small Woodland Owners Association of Maine, and The Trust for Public Land.

Other Conservation Organizations: Natural Resources Council of Maine, Penobscot County Soil and Water Conservation District, Penobscot Riverkeepers 2000, Friends of the Sunhaze Meadows NWR.

Major Forest Landowners: Maine Bureau of Parks and Lands, Penobscot Indian Nation.

Recreational Organizations: Over 14 snowmobile clubs, 8 ATV club, Penobscot Conservation Club.

Educational Institutions: University of Maine at Orono.

### **Select Natural Resource Attributes:**

Forestry: The timber industry is a mainstay of the economy and by far the dominant land use in the region. In Penobscot County, about 35% of the forestland is in northern hardwood, 32% is in spruce-fir forest types, 8% in oak and/or pine forest types, and the balance is in miscellaneous forest types. About 40% of the forest is pole timber and 25% is sawtimber with a balance in seedlings/saplings. Pulp and paper mills (in Woodland, Bucksport, Lincoln, and Old Town), over a dozen sawmills (e.g., Chester), and several biomass plants are essential markets for wood fiber from this region and lie at the periphery of the region. About 0.5 million acres of forest have been certified (about one-third FSC certified, two-thirds SFI certified). Small, nonindustrial landowners dominate the southern and central areas and large ownerships (>10,000 acres) become more common in the north and east. Development-driven parcelization of large land parcels in the southern areas may be attracting new forest landowners uninterested in timber harvesting. Weak global markets threaten viability of the forest products sector though outside investors have recently capitalized forest products plants. This has reduced paper manufacturing but not pulp production in this region.

Development: The region is heavily settled in the south and sparsely settled in the north with the Bangor area being a major service center for eastern and northern Maine. It relies on a significant airport, I-95, rail, and nearby seaports to connect with the national and global marketplace. I-95 is an essential travel corridor for the region that extends through the middle of the region. Bucksport, Old Town/Orono, and Lincoln are minor service centers. Towns in the south and east of the region have seen population growth rates >10% in the last several years. Most towns in the Bangor area have comprehensive land use plans but less settled towns elsewhere lack resources and may not. The area's extensive wetlands (22.5% of the southern half) and poorly draining soils pose some limits on development. A key challenge to sustainable development is to provide affordable housing, a challenge in Penobscot Valley that now affects both middle-income families 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. Traffic congestion is locally problematic in communities in the greater Bangor area.

Nature-based Recreation: Extensive public roads provide access in the southern portion of the region. The private commercial forest has a logging road network that provides good access to the north. It has over 200 miles of snowmobile trail (including four ITS [Interconnected Trail System] trails), and over 150 miles of ATV trail. There are 35 boat launches in Penobscot County. The Penobscot River and its tributaries provide many easily-accessed boating day trips, including seasonal (spring runoff) whitewater boating. Local hiking trail networks can be found in the developed communities in the southern portion and at Sunhaze NWR and scattered public conservation lands. Hiking trails can also be found in the hills in the eastern areas. Local snowmobile trails can be found throughout the region. Many streams and larger lakes have public boating access.

White-tailed deer and bear numbers are high in this region, especially in the agricultural areas of western Penobscot County. Moose are abundant throughout the region. Ruffed grouse, woodcock, and snowshoe hare hunting is good and best in the agricultural areas of western Penobscot County. Posting on private lands is an increasing threat to public access and outdoor recreation. Wetlands along the Penobscot River are renowned for waterfowl hunting for black ducks, wood ducks, hooded mergansers and goldeneye ducks. Access is easy as public boat launch sites are spaced every few miles along the river. The Penobscot River is home to many fish: native brook trout, landlocked salmon, smallmouth bass, white perch and chain pickerel are prevalent resident species. Sea-run species include Atlantic salmon, alewives, American shad, American eel, sea lamprey, striped bass, tomcod, rainbow smelt and occasional Atlantic sturgeon. The Penobscot River is the largest Atlantic salmon run remaining in the United States (1,000-4,000 adults in recent decades). A variety of lakes provide habitat for warm-water and cold-water fisheries. The Penobscot River and adjacent tributaries provide habitat for warm-water fisheries whereas smaller streams provide quality habitat for cold-water fisheries. Over 50% of the stream crossings in the lower Penobscot drainage had severe barriers to fish passage (Abbot 2007). Exotic wetland plant species (e.g., purple loose strife) and alterations in hydrology due to development may threaten fish habitats.

## References

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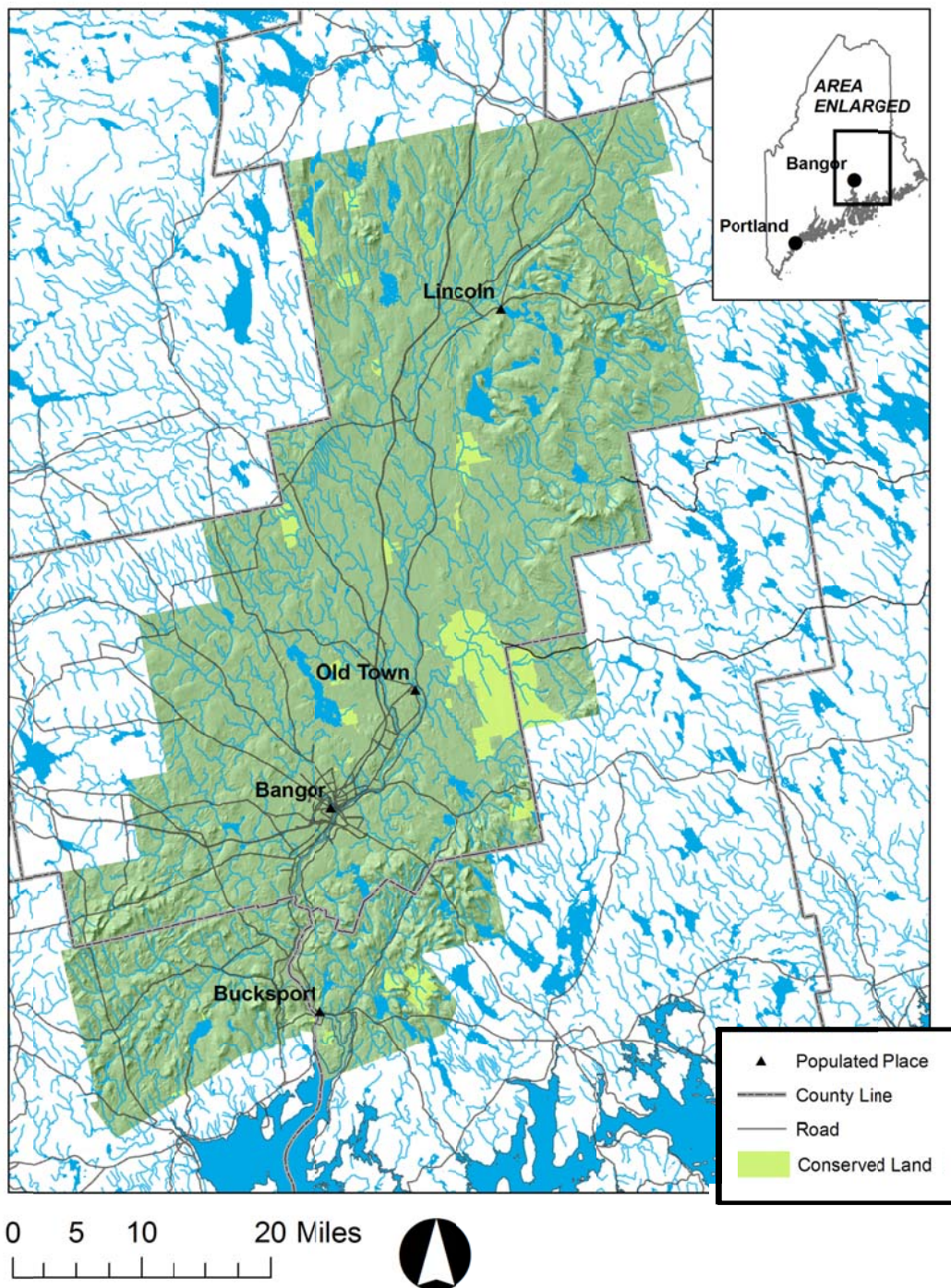
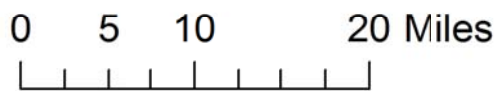
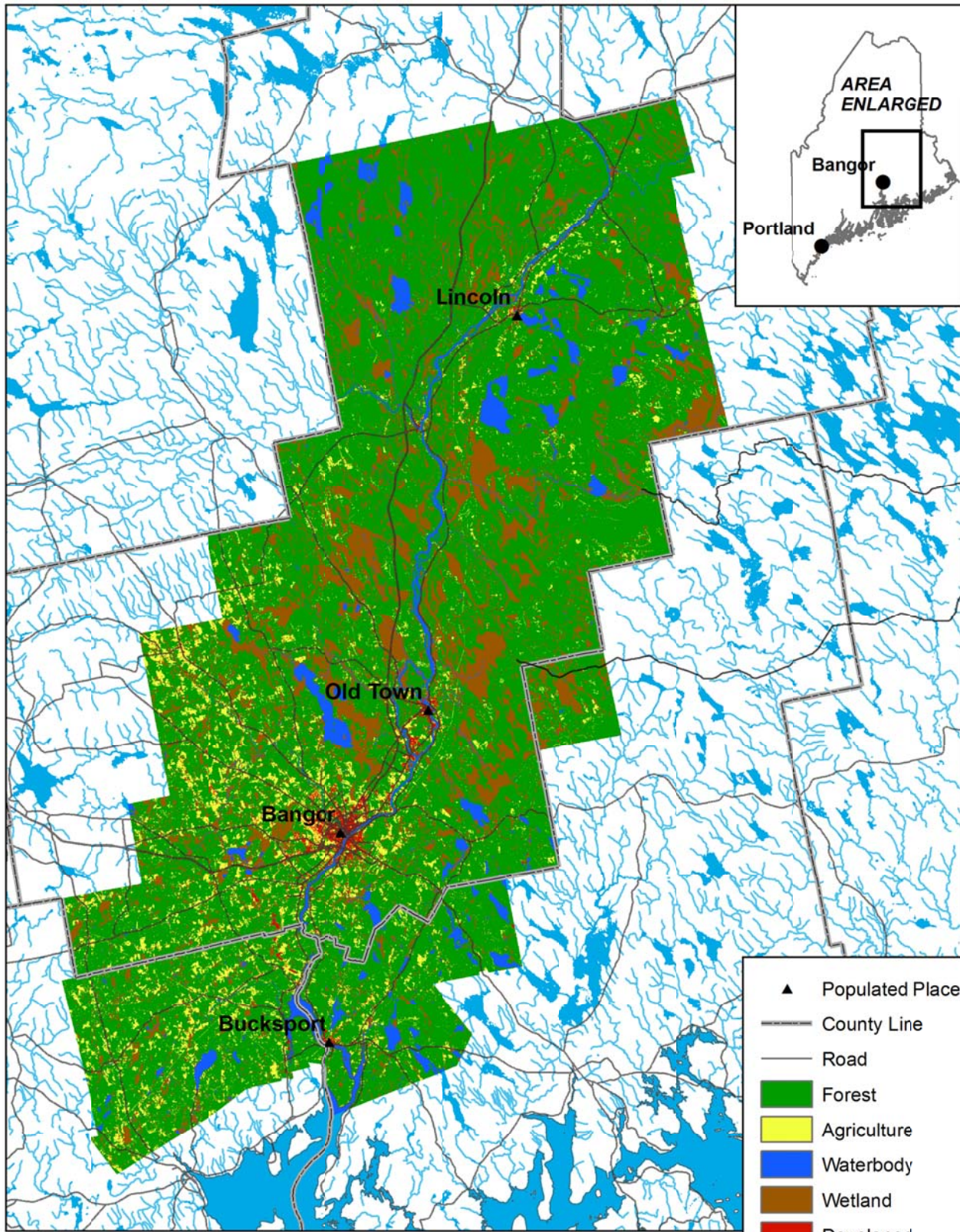


Fig. 1: The Lower Penobscot Valley Region



## Projected Impacts and Strategies for Forestry, Nature-based Recreation and Development

### Forestry

Component of Managed Forest System - Climate factors	Potential Impact	Size & likelihood of impact w/o action		Possible Actions	Who can do it?	What other sectors should be engaged?
		2010-2040	2041-2100			
<b>Logging Systems</b>						
• <b>Logging Operation</b>						
- slightly more frequent extreme rainfall events - more frequent winter thaws/rains	- additional infrequent saturated and/or unfrozen soil conditions that limit logging operations - shorter winter logging season - possible temporary wood shortages	Moderate	High			
- slightly more frequent drought	- more harvesting of forested wetlands	Low	Moderate			
• <b>Haul Roads</b>						
- slightly more extreme rainfall events - more frequent winter thaws	- more frequent stream crossing "bow outs" - more frequent haul road closings due to unfrozen or saturated soil	High	High			
<b>Forest Health</b>						
<b>Pests, pathogens, and invasive species</b>						
- warmer temps. lead to increase of populations of tree pests & pathogens	- greater tree mortality	Low	Moderate			
- warmer temps. Increases populations of invasive plant species	- reduced tree recruitment	Low	Low			
<b>Extreme weather events (including ozone)</b>						
- Extreme heat increases O3 concentration and damages trees	- reduced tree growth and recruitment	Low	Low			
- increased frequency of droughts & flooding	- reduced tree growth and recruitment - greater tree mortality - greater frequency of forest fire	Low	Low			
- slightly more frequent extended winter thaws	- dieback in spruce, birch, and other hardwood spp.	Moderate	Moderate			
<b>Productivity (CO2 fertilization)</b>						
- increases in CO2 levels	- increased tree growth for aspen spp	Low	Moderate			
<b>Forest tree species</b>						
• <b>North hardwood and Conifer species</b>						
- warmer temp. - more frequent late growing season drought	- shift north of spp. distribution - reduction in regeneration of northern hardwood and northern conifer spp. - slightly greater mortality of northern hardwood and northern conifer spp. - reduction in abundance of northern hardwood and northern conifers	Low	Moderate			

Component of Managed Forest System - Climate factors	Potential Impact	Size & likelihood of impact w/o action		Possible Actions	Who can do it?	What other sectors should be engaged?
		2010-2040	2041-2100			
• Southern tree species (Oak and Pine)	- increase in abundance of oak and pine	Low	Moderate			

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

## Development

Components of Developed Areas - Climate factors	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			
<b>Buildings</b>						
- more frequent extreme rainfall events - more frequent flooding - more frequent winter thaws/rains	- flooded septic systems - more frequent flooding of low lying buildings - water damage to sites and buildings	Moderate	Moderate			
<b>Transportation Infrastructure</b>						
- 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			
<b>Utilities (telecommunications &amp; electricity)</b>						
- more frequent extreme rainfall events	- ice storm damage to telecommunications infrastructure	High	Moderate			
<b>Water Management</b>						
<b>Storm water</b> - more frequent extreme rainfall events	- storm water infrastructure overwhelmed - “blown out” stream crossing structures (e.g., culverts)	High	High			
<b>Wastewater</b> - more frequent extreme flooding	- flooding of low lying treatments plants - system infrastructure overwhelmed if combined with storm water and contaminating surface waters	Moderate	Moderate			
<b>Drinking water</b> - more frequent drought - more frequent extreme water fluctuations - more frequent extreme rainfall events - warmer temps.	- greater levels of sedimentation due to surface runoff - more widespread eutrophication	Moderate	High			
<b>Green infrastructure (e.g., urban forests)</b> - more frequent drought and late-growing season drought - more frequent extreme weather events	- greater levels of insect pest damage 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			

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

## Nature-based Recreation

Recreation Activities - Climate factors	Potential Impact	Size & likelihood of Potential Impact		Possible Actions:	What type of actor can best implement the action?*	Other sectors to be engaged:
		2010-2040	2041-2100			
<b>Water Recreation</b>						
<b>• Fishing</b>						
- warmer temps. - more frequent extreme heat events - more frequent extreme rainfall events	- increased cold water fish mortality & decline in cold water fisheries - increase in warm water fisheries - greater eutrophication due development & agriculture with negative impacts on fisheries	Moderate	High			
- shorter season with ice	- shorter ice fishing season - longer open water fishing season	High	High			
<b>• Boating</b>						
- more frequent drought	- boat launches may become seasonally high/dry and limit water access	Moderate	Moderate			
- warmer temperatures - more frequent extreme heat events	- longer boating season - increased boating	High	High			
<b>• Whitewater Boating</b>						
- more frequent winter thaws - shorter season with ice	- more opportunities for winter whitewater boating	Moderate	Moderate			
- more frequent drought - less snow and lower/earlier spring runoff	- reduced spring whitewater conditions - less water for dam releases for summer season whitewater boating	Moderate	Moderate			
- more frequent extreme rainfall events	- unpredictable opportunities for white water boating during summer	High	High			
<b>Land-based Recreation</b>						
<b>Winter trail sports (snowmobiling, snowshoeing, and X-country skiing)</b>						
- warmer winters - more frequent winter thaws	- Shorter season for winter trail sports - Less snow on trails/reduced trail quality for winter sports	Moderate	High			
- more frequent extreme rainfall events	- more frequent "blow outs" of constructed trail stream crossings	Moderate	Moderate			
<b>Trail sports (ATVing, hiking, mtn. biking, horseback riding)</b>						
- warmer temperatures	- longer trail sport season	High	High			
- more frequent extreme rainfall events	- more frequent "blow outs" of trail stream crossings	Moderate	Moderate			
- warmer summer temperatures - more frequent summer extreme heat events	- hiking and mountain biking less popular in middle of summer	Low	Moderate			
<b>• Camping</b>						
- warmer summer temperatures	- mid-summer camping becomes less	Low	Moderate			

Recreation Activities - Climate factors	Potential Impact	Size & likelihood of Potential Impact		Possible Actions:	What type of actor can best implement the action?*	Other sectors to be engaged:
		2010-2040	2041-2100			
- more frequent summer extreme heat events	popular					
<b>• Hunting</b>						
- prolonged warm weather in fall period - warmer temperature	- best hunting times shift to later in year - increases in deer and turkey populations	Low	High			
<b>• Wildlife Viewing</b>						
- warmer temperatures - more frequent extreme heat events	*- northward range shifts of charismatic species (e.g., moose, loons) and iconic boreal bird communities, and reduction in their populations *- decline in moose viewing due to pop. decline from tick infestations & heat stress *- more deer viewing opportunities due to population increase	Moderate	High			
<b>• Fall foliage viewing</b>						
- warmer temperatures	- declining in "leaf peeping" due to decline in abundance and extent of "leaf peeping" forest types (northern hardwood, birch, and aspen) with dramatic fall colors	Low	Moderate			
- prolonged warm weather in fall period	- declining fall leaf color intensity of northern hardwood, birch, & aspen spp. - extended fall tourism season	Moderate	High			

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