



## A Climate Change Impact Assessment for Downeast Maine

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**Highlighted Sectors:** Forestry, Habitat Conservation, and Nature-based Recreation

**Geographic boundaries:** Washington County north of Route 9 and a small portion of northern Hancock County and eastern Penobscot County.

**Description:** The Downeast Lakes Region is 96% forested and serves as the primary wood basket for a diverse forest products economy of mills along the periphery of the region. Forestry and wood manufacturing jobs provide about 10% of the jobs in Washington County. Most of the region lacks local municipal government and so land use planning and decision making is under the jurisdiction of the Maine Land Use Regulation Commission (LURC) in these areas. Although the human population changes slowly, there has been a 7% increase in human population and a 21% increase in housing units from 1990 to 2000 in the LURC jurisdiction of Washington County (Bell 2007) which includes this region. Washington County has the highest poverty and unemployment rate in the State.

The region is distinctive for its large lake and wetland systems which support outstanding nature-based recreation ranging from the world-class fishing opportunities at Grand Lake Stream to five backcountry canoe routes. It includes the headwaters of Downeast coastal river watersheds, the U.S. portion of the St. Croix International Waterway, and the eastern headwaters of the Penobscot River. Included among these water resources are the headwaters of four undammed federally-designated Atlantic salmon rivers, along with significant brook trout and landlocked salmon fisheries. The area features New England's greatest diversity of peatlands and 17 Beginning with Habitat Wildlife Focus Areas, which are of statewide wildlife significance.

**Organizations that could contribute to climate change adaptation:**

Municipalities with climate change adaptation capacity: Passamaquoddy Tribe, Indian Township

Regional Planning Organizations: Maine Land Use Regulation Commission, Down East Resource Conservation and Development Council, Washington County Council of Governments, St. Croix International Waterway Commission, and Sunrise County Economic Council

Land Conservation Organizations: Downeast Lakes Land Trust, Downeast Rivers Land Trust, Forest Society of Maine, New England Forestry Foundation, The Nature Conservancy – Maine Chapter, and Woodie Wheaton Land Trust

Other Conservation Organizations: Washington County Soil and Water Conservation District, Project SHARE (Salmon Habitat And River Enhancement), Downeast Salmon Federation, Pleasant River Watershed Council, Narraguagus River Watershed Council, Machias River Watershed Council, East Machias River Watershed Council, Eastern Brook Trout Joint Venture.

Major Forest Landowners: Baskahegan Corp., Maine Bureau of Parks and Lands, Robbins Lumber, Wagner Forest Management, Typhoon LLC, Penobscot Indian Nation (49,000 acres), and Passamaquoddy Tribe (69,000 acres).

Recreational Organizations: Five snowmobile clubs and one ATV club

Educational Institutions: University of Maine Cooperative Extension Washington County Office, University of Maine at Machias, and University of Maine at Orono

Other: DownEast & Acadia Regional Tourism, the Grand Lake Stream Area Chamber of Commerce, Grand Lake Stream Guides Association.

### **Some Key Sector Attributes:**

**Forestry:** The timber industry is a mainstay of the economy and by far the dominant land use in the region. 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 42% is in spruce-fir forest types, 25% of the forestland is in northern hardwood, about 12% in oak and/or pine forest types, and the balance is in miscellaneous forest types. In Washington County, 34% of the forest is pole timber and 22% is sawtimber with a balance in seedlings/saplings. About 0.5 million acres of forest have been certified (about one-third FSC certified, two-thirds SFI certified). Weak global markets threaten the viability of the forest products sector though outside investors have recently re-capitalized nearby mills. This has reduced paper manufacturing but not pulp production in this region.

**Nature-based Recreation:** The remote nature of this area both adds to its allure for recreationists and is a challenge to attracting recreationists for multi-day experiences. The region is sparsely settled and remote with the small towns of Danforth, Grand Lake Stream, Princeton, Topsfield, and Springfield being the major settlements. Grand Lake Stream has a vibrant cluster of Maine Guides and additional guiding services are available throughout the region. The private commercial forest has a logging road network that provides extensive access to the region. The region has about 600 miles of snowmobile trail (including three ITS [Interconnected Trail System] trails), 700 miles of ATV trail, and over a dozen commercial sporting camps for hunting, fishing, and other types of outdoor recreation. It includes significant parcels of lands with guaranteed public access (listed under habitat conservation) and large private landowners traditionally allow access. There are 57 boat launches in Washington County. The region has the headwaters of five rivers that provide outstanding multi-day backcountry canoe trips. Bear and moose are the primary big game species hunted in this region. Deer hunting remains popular but populations are low. Woodcock and ruffed grouse are found in areas of regenerating clearcuts.

### **Habitat Conservation:**

#### ***Unique Features:***

Private working forests contribute much of the wildlife habitat in the region but may threaten species requiring large (>1000 acre) blocks of mature forest (e.g., pine marten) and old forest species. Exotic and invasive species are not yet a threat to upland habitats though exotic wetland plant species (including purple loosestrife) are present, and non-native fish species (e.g., bait fish, small mouth bass) may pose local threats to native cold water species.

**Conservation Lands:** About one-quarter of the region is under permanent conservation ownership or easement.

**Federal Lands:** None, but Moosehorn National Wildlife Refuge lies to the southeast, and Sunkhaze National Wildlife Refuge to the west.

**State lands:** The region has several key conservation areas including Duck Lake Public Reserved Land (25,220 acres of managed forest and includes Duck Lake Ecological Reserve, 6700 acres of old growth, peatlands, mature forest, and lake shore), the Machias River Corridor (nearly 25,000 acres primarily of working forest easement, including 210 miles of protected river frontage), Niatous Lake Conservation Area (22,120 acres of working forest easement).

**NGO lands:** Farm Cove Community Forest, Downeast Lakes Land Trust (34,000 acres) and Sunrise Easement (312,000 acres)

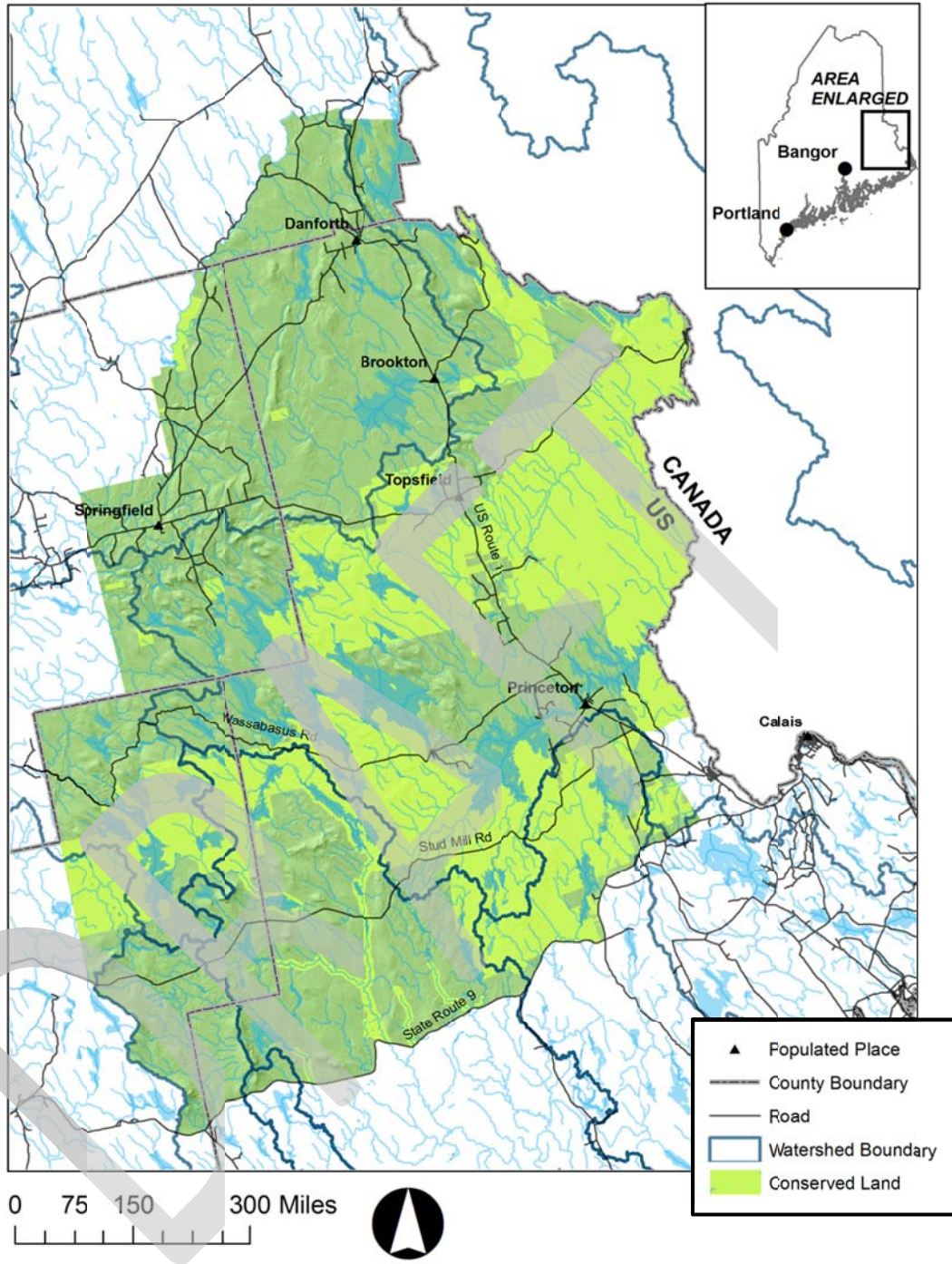
**Other High-value Areas (some lack permanent protection):** Baskahegan Stream Uplands and Wetlands (55,000 acres), Fourth Machias Lake (26,000 acres, protected), Maine River Wetland Complex (25,000 acres, in part under easement), Niatous Lake (26,000 acres), Sawtelle Heath (930-acre level bog ecosystem), and Mattawamkeag River Bogs and Fens (in part, 5,000 acres).

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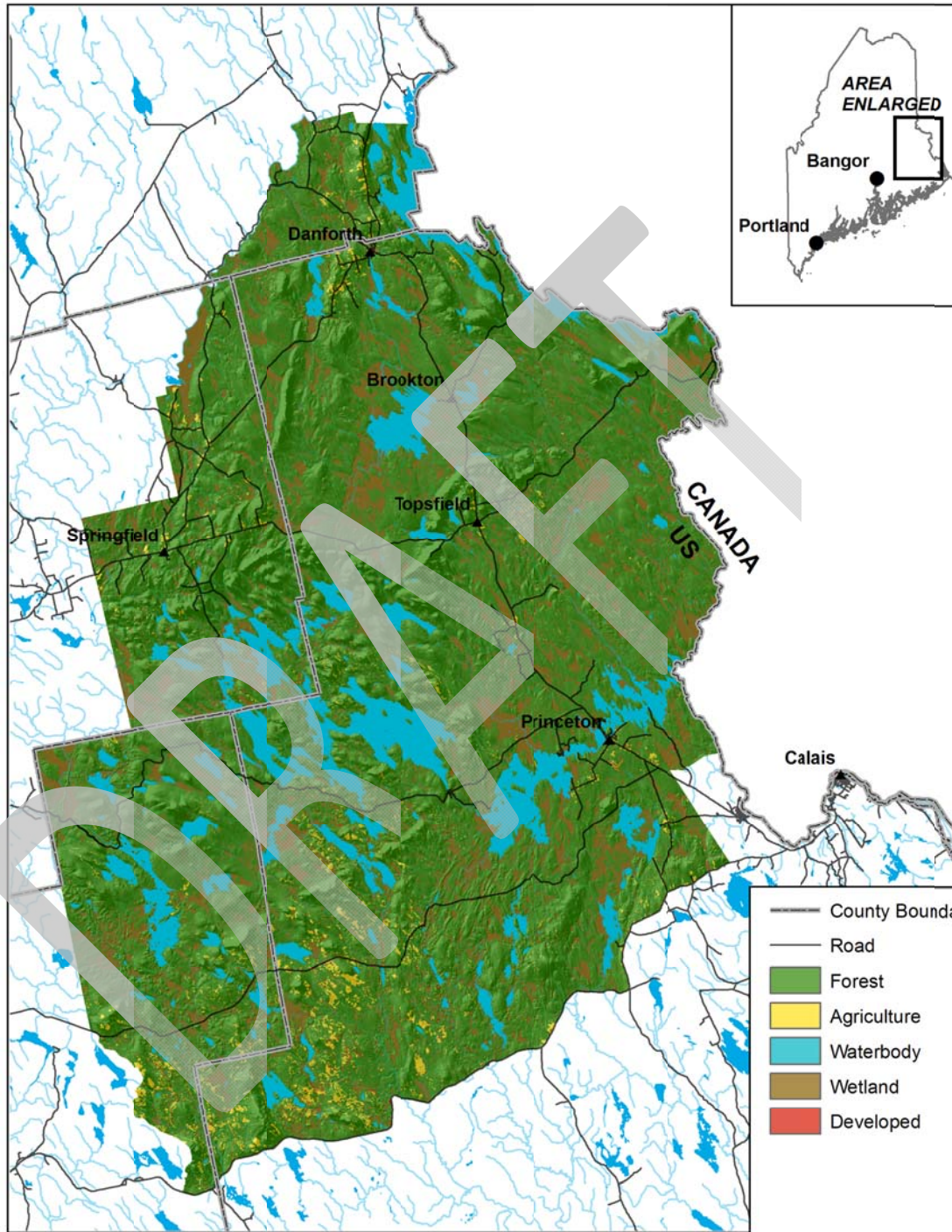
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Fig. 1: Map of Downeast Lakes Region (ME).



**Projected Impacts and Strategies for Forestry, Nature-base Recreation, and Habitat Conservation**

Climate Changes	Habitat Conservation	Forestry	Nature-based Recreation
<ul style="list-style-type: none"> <li>• Summer</li> <li>- warmer temperatures</li> <li>- more frequent late-season drought</li> <li>- more frequent extreme heat events</li> </ul>	<ul style="list-style-type: none"> <li>- increased fire danger and impact to forest habitats and streams</li> <li>- low water level impacts on aquatic and wetland species</li> <li>- greater mortality in cold water aquatic spp. (e.g., brook trout)</li> <li>- reduced fledging success of low nesting marsh birds and loons</li> <li>- lower spawning levels of warm water fish</li> </ul> <p>Moderate likelihood &amp; impact</p>	<ul style="list-style-type: none"> <li>- greater growth/yield</li> <li>- late season drought leading to reduced productivity and increased fire danger in some years</li> <li>- reduced red spruce seedling establishment</li> </ul> <p>Moderate likelihood &amp; impact</p>	<ul style="list-style-type: none"> <li>- reduced populations of brook trout and other cold water fisheries</li> <li>- increased population of warm water fish</li> <li>- reduced river flows may limit traditional canoe trips</li> <li>- region may have summer weather that is most favorable for nature-based recreation in e. U.S</li> </ul> <p>Moderate likelihood &amp; impact</p>
Possible Strategies			
What type of actor(s) can best implement the strategies?*			
Other sectors to be engaged:			

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

Climate Changes	Habitat Conservation	Forestry	Nature-based Recreation
<ul style="list-style-type: none"> <li>• Fall</li> </ul>			
<ul style="list-style-type: none"> <li>- extended season of mild weather</li> <li>- slightly greater</li> </ul>		<ul style="list-style-type: none"> <li>- longer period of “summer” logging</li> <li>- more frequent interruptions of good logging conditions due more frequent rainfall</li> </ul> <p>High likelihood &amp; impact</p>	<ul style="list-style-type: none"> <li>- best hunting times shift to later in year</li> <li>- inferior fall foliage for “leaf peeping”</li> <li>- longer “summer” recreation season</li> </ul> <p>High likelihood &amp; impact</p>
Possible Strategies			
What type of actor(s) can best implement the strategies?*			
Other sectors to be engaged:			

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

Climate Changes	Habitat Conservation	Forestry	Nature-based Recreation
<ul style="list-style-type: none"> <li>• Winter</li> </ul>			
<ul style="list-style-type: none"> <li>- warmer temperatures</li> <li>- reduced snow fall</li> <li>- more frequent winter thaws</li> <li>- declining ice thickness</li> <li>- winter (instead of spring) peak flows</li> </ul>	<ul style="list-style-type: none"> <li>- increases in white-tailed deer population and wild turkey</li> <li>- more ticks leads to greater moose mortality</li> <li>- increase in ice scour impacts on riparian communities</li> </ul> <p>High likelihood &amp; impact</p>	<ul style="list-style-type: none"> <li>- increases in white-tailed deer population reduces tree regeneration (offset by moose decline?)</li> <li>- thaw damage on some tree species</li> <li>- more frequent interruptions of winter harvest operations due to unfrozen ground</li> <li>- later start &amp; earlier end of winter logging</li> </ul> <p>Moderate likelihood &amp; impact</p>	<ul style="list-style-type: none"> <li>- increases in white-tailed deer population</li> <li>- more ticks may increase Lyme disease concern</li> <li>- shorter season and potentially loss of season for winter recreation (ice fishing, snowmobiling, skiing, etc.)</li> <li>- more ticks lead to greater moose mortality</li> </ul> <p>High likelihood &amp; impact</p>
Possible Strategies			
What type of actor(s) can best implement the strategies?*			
Other sectors to be engaged:			

Climate Changes	Habitat Conservation	Forestry	Nature-based Recreation
<ul style="list-style-type: none"> <li>• Spring</li> </ul>			
<ul style="list-style-type: none"> <li>- warmer temperatures</li> <li>- earlier snowmelt</li> <li>- increased variability in spring frost</li> </ul>	<ul style="list-style-type: none"> <li>- reduced and earlier peak spring flows which detrimentally affect aquatic species, including vernal pool specialists</li> <li>- lack of synchrony between long-distant migrant birds and food for nestlings</li> </ul> <p>High likelihood &amp; impact</p>	<ul style="list-style-type: none"> <li>- earlier start on "summer" logging</li> </ul> <p>High likelihood &amp; impact</p>	<ul style="list-style-type: none"> <li>- earlier start of mild season recreation</li> <li>- winter peak flows may reduce opportunities for spring whitewater river trips</li> </ul> <p>High likelihood &amp; impact</p>
Possible Strategies			
What type of actor(s) can best implement the strategies?*			
Other sectors to be engaged:			

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

Climate Changes	Habitat Conservation	Forestry	Nature-based Recreation
Year round			
- extreme rainfall events	- increased levels of stream sedimentation  High likelihood & impact	- more frequent logging road washouts  Moderate likelihood & impact	- more frequent road and trail wash outs  Moderate likelihood & impact
- warmer temperatures	- changes in plant communities including the increase of oak and pine forest community types and decline in northern forest community types - northward range shift of northern species and southern species  High likelihood & impact	- increased growth and yield for temperate tree species (e.g., maple, oak, pine, etc.) - reduced growth and yield for northern species (e.g., birch, spruce, fir, aspen) - greater spread of hemlock woolly adelgid - decline in abundance of northern hardwood and conifer tree species  High likelihood & impact	- increased ability for year-round recreation - increased incidence of insect born diseases (e.g., Lyme's disease, West Nile virus, etc.)  High likelihood & impact
- more frequent drought	- mortality in aquatic species - slight reduction in extent of wetlands - slightly greater frequency of forest fire  Moderate likelihood & impact	- reduced productivity in some years - slightly greater frequency of forest fires  Moderate likelihood & impact	- fire permit & trail restrictions due to fire danger - drier trails - greater mortality in cold –water fisheries  Low likelihood & impact
Possible Strategies			
What type of actor(s) can best implement the strategies?*			
Other sectors to be engaged:			

\* 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 Strategies:	What type of actor can best implement strategies?*	Other sectors to be engaged:
		2010-2040	2041-2100			
<b>Water Recreation</b>						
<b>• Fishing</b>						
- warmer temps. - more frequent extreme heat events	- increased cold water fish mortality & decline in cold water fisheries - increase in warm water fisheries - greater eutrophication with negative impacts on fisheries	Moderate	High			
- shorter season with ice	- shorter ice fishing season or loss of 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	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 - more frequent summer extreme heat events	- mid-summer camping becomes less popular	Low	Moderate			
<b>• Hunting</b>						

Recreation Activities - Climate factors	Potential Impact	Size & likelihood of Potential Impact		Possible Strategies:	What type of actor can best implement strategies?*	Other sectors to be engaged:
		2010-2040	2041-2100			
- prolonged warm weather in fall period	- best hunting times shift to later in year	Low	Moderate			
- warmer temperature	- increases deer population	Low	Moderate			
<b>• Wildlife Viewing</b>						
- warmer temperatures - more frequent extreme heat events	*- northward range shifts of charismatic species (e.g., moose, loons, puffins) and iconic boreal bird communities, and reduction in their populations *- decline in moose viewing due to pop. decline from tick infestations & heat stress *- more white-tailed deer viewing 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.

## Habitat Conservation

Biodiversity Component - Climate factors	Potential Impact	Size & likelihood of Potential Impact without Action		Possible Strategies:	What type of actor can best implement strategies?*	Other sectors to be engaged:
		2010-2040	2041-2100			
<b>Landscape Elements</b>						
<b>Large Blocks of Habitat</b> - warmer temperatures - more frequent drought (general & late-growing season)	- more frequent forest fire reducing block size - more frequent widespread forest pest outbreaks reducing block size	Low	Low			
<b>Habitat connectivity</b> - more frequent late-growing season drought - more frequent drought	- more frequent forest fire reducing connectivity - more frequent widespread forest pest outbreaks reducing connectivity	Low	Low			
<b>Enduring features (e.g., soils, aspect etc.)</b> - more frequent drought (general & late-growing season)	- more frequent forest fire increasing soil erosion	Low	Low			
<b>Habitat</b>						
<b>Northern hardwood forest &amp; northern coniferous forest communities</b> - warmer temperatures - more frequent late-growing season drought - more frequent drought	- reduction in extent of northern hardwood forest and northern conifer forests due to less tree regeneration and increase mortality - northward shift of distribution of forest types	Low	Moderate			
	- more frequent forest fire burning northern conifers - increase spread of hemlock woolly adelgid and reduction in hemlock dominated forest	Low	Low			
<b>Oak and pine forest communities</b> - 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, and invasive spp., levels of O3, and populations of white-tailed deer	Low	Moderate			
<b>Freshwater wetlands, stream/river shore plant communities, and waterbodies</b> - drought - increase fluctuations in water levels - more frequent extreme rainfall events	- habitat area may decline in drought years - more frequent stream scouring and sedimentation events from storms - increased eutrophication due to runoff from storms	Moderate	Moderate			
<b>Species</b>						
<b>Northern species at southern edge of range (e.g., Canada lynx, American marten, Blackpoll warbler)</b> - warmer temperatures	- reduced population size	Low	Moderate			
<b>Southern species at northern edge of range (e.g., white tailed deer, gray fox)</b> - warmer temperatures - less severe winters	- increased population size, expanded range of spp.	Moderate	High			
<b>Wetland and Aquatic Species</b> - winter rain flooding - reduced spring flows - more frequent drought - warmer temperatures - more frequent extreme rainfall events	- reduced populations of cold-water species (e.g., salmonids, some macroinvertebrates) due to increased temperature-related mortality - 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			

Biodiversity Component - Climate factors	Potential Impact	Size & likelihood of Potential Impact without Action		Possible Strategies:	What type of actor can best implement strategies?*	Other sectors to be engaged:
Wildlife Health - warmer temperatures	- increases in population size of deer - increased tick loads & extreme heat reduces moose pops	Low	Moderate			

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## Forestry

Component of Forest System - Climate factors	Potential Impact	Size & likelihood of Potential Impact without action		Possible Strategies:	What type of actor can best implement strategies?*	Other sectors to be engaged:
		2010-2040	2041-2100			
<b>Logging Systems</b>						
• Logging Operation						
- 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			
- more frequent drought	- more harvesting of forested wetlands	Low	Moderate			
• Haul Roads						
- more frequent 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>						
• Pests, pathogens, & invasive species						
- warmer temperatures	- increase of populations of tree pests & pathogens leads to greater tree mortality	Low	Moderate			
	- Increased populations of invasive plant species reduces tree recruitment	Low	Low			
	- increased white-tailed deer populations reduce regen.	Low	Moderate			
• Extreme weather (including O3)						
- more frequent extreme heat events	- increased tree damage from O3 which reduces growth & recruitment	Low	Low			
- more frequent of droughts & flooding	- reduced tree growth and recruitment - greater tree mortality - greater frequency of forest fire	Low	Low			
- extended winter thaw	- 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>						
• Northern hardwoods and Conifers						
- warmer temperatures - more frequent late-growing season drought	- shift north of spp. distributions - reduction in tree regeneration - increased growth rates for some spp.	Low	Moderate			
	- reduction in abundance	Low	Moderate			
- warmer winters	- earlier period for maple syrup	Low	Low			
• Southern tree species (Oak and Pine)						
- warmer temperatures - more frequent late-growing season drought	- increase in regeneration & growth rates - shift north of spp. distributions	Low	Moderate			

Component of Forest System - Climate factors	Potential Impact	Size & likelihood of Potential Impact without action		Possible Strategies:	What type of actor can best implement strategies?*	Other sectors to be engaged:
		2010- 2040	2041- 2100			
	- increase in abundance	Low	Moderate			

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

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