POTENTIAL EFFECTS OF CLIMATE CHANGE ON FIRE-DEPENDENT FORESTS OF NORTHERN MINNESOTA

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The Quetico-Superior Ecosystem in central North America has the potential to undergo dramatic changes due to climate change. Within this fire-dependent, boreal ecosystem, the magnitude of climate change is predicted to be above the global mean. Threats to boreal forest in the Quetico-Superior Ecosystem are reviewed here using the Boundary Waters Canoe Area Wilderness (BWCAW) as a case study to look at potential mitigation measures, management actions, and issues in policy.

Fire, global warming, invasive species, and deer browse are all expected to drive change within boreal forests in northern Minnesota. Since 1910, the fire return interval (FRI) in this region has lengthened from 50-100 years to over 700 years. A warming climate at the end of the Little Ice Age, fragmentation of lands adjacent to the BWCAW, and fire suppression may all have contributed to longer intervals, and as a result coniferous forests will likely lose dominance without a major reintroduction of fire on the landscape. Coniferous forests in this area have also been threatened by large-scale windthrow events, such as the "Big Blowdown" of 1999, followed by fire consuming the once canopy-stored seedbank. Large blowdowns like these are expected to increase with a warmer climate, and salvage logging efforts to mitigate fire hazard will likely be necessary. Warming temperatures are expected to shift boreal forests to a savanna ecosystem, in part because many tree species in northeastern Minnesota are at the edge of their ranges. Future projections of forests in the BWCAW have many possibilities with a predicted warmer and wetter climate (Table 1). Species at the southern edge of their ranges are expected to decline significantly, and those that extend farther south may remain but in reduced numbers. Species currently in low abundance due to limitations of more northern climates are expected to expand, and species just south of, but not currently within the BWCAW, may migrate in. Invasive species such as European earthworms (*Lumbricus rubellus*) and the emerald ash borer (*Agrilus planipennis*) are expected to have impacts on these systems as well in the coming decades. Even native insects such as the mountain pine beetle (*Dendroctonus ponderosae*) may become invasive in a warmer climate.

Impacts of these combined factors may play out according to several scenarios (Table 2). Many management actions could conflict with wilderness law including: chemical or biocontrol treatments for disease and pests, reintroductions of previously extirpated native species, and


Photo Credit Superior National Forest Staff

MANAGEMENT IMPLICATIONS

1) Fire-dependent boreal forests within the Quetico-Superior Ecosystem will likely undergo a shift in vegetation as the climate changes.

2) Wilderness Areas previously thought to be capable of maintaining themselves without active management may be threatened by a changing climate when the species they are composed of are at the edge of their ranges and not allowed the time to adapt to a new climate via natural selection.

3) Managing the BWCAW to mitigate the effects of climate change presents challenges for policy when considering the use of chemical or bio-control treatments for disease and pests, reintroductions of previously extirpated native species, and assisted migration of species.

Want to learn more?

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Frelich, L. E., and P. B. Reich. Wilderness conservation in an era of global warming and invasive species: a case study from Minnesota's Boundary Waters Canoe Area Wilderness. Natural Areas Journal 29:385-393

assisted migration of species expected to be present in the future. Two issues that have been dealt with in the BWCAW are the removal of invasive species and prescribed fire. Both of these actions have taken place within the Wilderness Area in the past and these efforts would likely need to increase as climate change progresses.

Table 1. Tree species native to BWCAW grouped by response to a warm/wet climate scenario.

Groups	Species	Potential Problems
1- species likely to largely disappear with a warmer climate	Balsam fir (*Abies balsamea*)	Balsam wooly adelgid, heat, drought
	Black spruce (*Picea mariana*)	Heat, drought
	White spruce (*Picea glauca*)	Heat, drought
	Jack pine (*Pinus banksiana*)	Heat, blowdown/fire combo, lack of fire, mountain pine beetle
	Red pine (*Pinus resinosa*)	Heat, drought, blowdown/fire combo, lack of fire, mountain pine beetle
	Balsam poplar (*Populus balsamifera*)	Asian long-horned beetle, heat, drought
2- abundant species likely to remain with a warmer climate (*possibly with reduced abundance)	*Paper birch (*Betula papyrifera*)	Asian long-horned beetle, soil warming
	*Quaking aspen (*Populus tremuloides*)	Asian long-horned beetle, heat, drought
	*Big-tooth aspen (*Populus grandidentata*)	Asian long-horned beetle, heat, drought
	Black ash (*Fraxinus nigra*)	Emerald ash borer
	*Tamarack (*Larix laricina*)	Eastern larch beetle, heat drought
	Northern white cedar (*Thuja occidentalis*)	Deer
	Eastern white pine (*Pinus strobus*)	Deer, blowdown/fire combo
3- species at low abundance likely to increase with warmer climate	American basswood (*Tilia americana*)	
	Northern red oak (*Quercus rubra*)	Deer, sudden oak death
	Bur oak (*Quercus macrocarpa*)	
	Northern pin oak (*Quercus ellipsoidalis*)	Deer, sudden oak death
	Green ash (*Fraxinus pennsylvanica*)	Emerald ash borer
	American elm (*Ulmus americana*)	Dutch elm disease, Asian long-horned beetle
	Red maple (*Acer rubrum*)	Asian long-horned beetle
	Silver maple (*Acer saccharinum*)	Asian long-horned beetle
	Yellow birch (*Betula alleghaniensis*)	Deer, Asian long-horned beetle, mismatched soils
	White oak (*Quercus alba*)	
4- species likely to migrate in with a warmer climate	Sugar maple (*Acer saccharum*)	Drought, earthworm invasion, fire
	Black cherry (*Prunus serotina*)	Drought, mismatched soils
	Cottonwood (*Populus deltoides*)	
	Boxelder (*Acer negundo*)	Asian long-horned beetle
	Black willow (*Salix nigra*)	Asian long-horned beetle

Table 2. Impact scenarios intended to encompass the range of possibilities for future BWCAW forests by the late 21st century.

Scenario	Climate	IPPC[1] emission scenario	Change in precipitation	Expected outcome for vegetation	Change in fire regime	Potential mitigation measures
1	Very warm and dry	High	Large decrease	Transition to oak savanna.	Large-scale severity fires at first, then more frequent, lower intensity fires as savanna replaces forest.	Assisted migration of native savanna species to keep out non-native species will likely be necessary.
2	Warm and dry	Low	Some decrease	Transition to a mosaic of savanna and stands of hardwoods.	Similar to Scenario 1 with some moderate to high intensity fires continuing.	Assisted migration more complicated.
3	Very warm and wet	High	No change	Mixture of central hardwoods with some savannas.	Period of high-severity fires; large-scale windthrows from derechos and associated fire danger increases.	Assisted migration complex. Different sets of invasive species may move in. Fire management with salvage logging necessary.
4	Warm and wet	Low	No change	Adaptation of existing tree species to new climate. Hardwood/boreal mixture.	Little change likely.	Assisted migration not very important. Use of prescribed fire to allow natural selection in pine.

[1]IPPC=Intergovernmental Panel on Climate Change