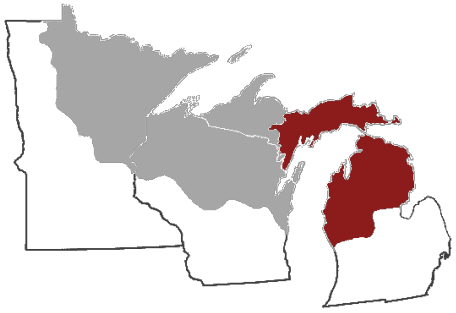
CLIMATE CHANGE PROJECTIONS FOR INDIVIDUAL TREE SPECIES
NORTHERN MICHIGAN



This region's forests will be affected by a changing climate and other stressors during this century. A team of managers and researchers created an assessment that describes the vulnerability of forests in Michigan (Handler et al. 2014). This report includes information on observed and future climate trends, and also summarizes key vulnerabilities for forested natural communities. The Landscape Change Research Group recently updated the Climate Change Tree Atlas, and this handout summarizes that information. Full Tree Atlas results are available online at www.fs.fed.us/nrs/atlas/. Two climate scenarios are presented to "bracket" a range of possible futures. These future climate projections (2070 to 2099) provide information about how individual tree species may respond to a changing climate. Results for "low" and "high" emissions scenarios can be compared on the reverse side of this handout.

The updated Tree Atlas presents additional information helpful to interpret tree species changes:

- Suitable habitat - calculated based on 39 variables that explain where optimum conditions exist for a species, including soils, landforms, and climate variables.
- Adaptability - based on life-history traits that might increase or decrease tolerance of expected changes, such as the ability to withstand different forms of disturbance.
- Capability - a rating of the species' ability to cope or persist with climate change in this region based on suitable habitat change (statistical modeling), adaptability (literature review and expert opinion), and abundance (FIA data). The capability rating is modified by abundance information; ratings are downgraded for rare species and upgraded for abundant species.
- Migration Potential Model - when combined with habitat suitability, an estimate of a species' colonization likelihood for new habitats. This rating can be helpful for assisted migration or focused management (see the table section: "New Habitat with Migration Potential").

Remember that models are just tools, and they're not perfect. Model projections can't account for all factors that influence future species success. If a species is rare or confined to a small area, model results may be less reliable. These factors, and others, could cause a particular species to perform better or worse than a model projects. Human choices will also continue to influence forest distribution, especially for tree species that are projected to increase. Planting programs may assist the movement of future-adapted species, but this will depend on management decisions. Despite these limits, models provide useful information about future expectations. It's perhaps best to think of these projections as indicators of possibility and potential change.

SOURCE: *This handout summarizes the full model results for the Northern Michigan region, available at* www.fs.fed.us/nrs/atlas/combined/resources/summaries. *More information on vulnerability and adaptation in the Northwoods region can be found at* www.forestadaptation.org/northwoods. *A full description of the models and variables are provided in Iverson et al. 2019 (*www.nrs.fs.fed.us/pubs/57857 *and* www.nrs.fs.fed.us/pubs/59105*) and Peters et al. 2019 (*www.nrs.fs.fed.us/pubs/58353*).*

CLIMATE CHANGE CAPABILITY

POOR CAPABILITY	
American hornbeam	Mountain maple
American mountain-ash	Pin cherry
Balsam fir	Serviceberry
Balsam poplar	Slippery elm
Bigtooth aspen	Striped maple
Black spruce	Tamarack (native)
Eastern hemlock	White spruce
Flowering dogwood	
FAIR CAPABILITY	
Eastern white pine	Red pine
Northern white-cedar	White ash
Paper birch	Yellow birch
Pin oak	
GOOD CAPABILITY	
American basswood	Green ash
American beech	Jack pine
American elm	Northern pin oak
Black cherry	Northern red oak
Black locust	Red maple
Black oak	Sassafras
Blackgum	Shagbark hickory
Boxelder	Silver maple
Bur oak	Sugar maple
Eastern cottonwood	Swamp white oak
Eastern redcedar	
MIXED RESULTS	
Bitternut hickory	Ironwood
Black ash	Quaking aspen
Black willow	
NEW HABITAT WITH MIGRATION POTENTIAL	
Bigleaf magnolia	Osage-orange
Black hickory	Pignut hickory
Black walnut	Post oak
Blackjack oak	Red mulberry
Chestnut oak	Scarlet oak
Common persimmon	Shortleaf pine
Eastern redbud	Sweet birch
Hackberry	Sweetgum
Honey locust	Sycamore
Live oak	Virginia pine
Mockernut hickory	Yellow-poplar

ADAPTABILITY: Life-history factors, such as the ability to respond favorably to disturbance, that are not included in the Tree Atlas model and may make a species more or less able to adapt to future stressors.

- \+ HIGH *Species may perform better than modeled*
- • MEDIUM
- – LOW *Species may perform worse than modeled*

HABITAT CHANGE: Projected change in suitable habitat between current and potential future conditions.

- ▲ INCREASE *Projected increase of >20% by 2100*
- ● NO CHANGE *Projected change of <20% by 2100*
- ▼ DECREASE *Projected decrease of >20% by 2100*
- ★ NEW HABITAT *Tree Atlas projects new habitat for species not currently present*

ABUNDANCE: Based on Forest Inventory Analysis (FIA) summed Importance Value data, calibrated to a standard geographic area.

- \+ ABUNDANT
- • COMMON
- – RARE

CAPABILITY: An overall rating that describes a species' ability to cope or persist with climate change based on suitable habitat change class (statistical modeling), adaptability (literature review and expert opinion), and abundance within this region.

- △ GOOD *Increasing suitable habitat, medium or high adaptability, and common or abundant*
- ○ FAIR *Mixed combinations, such as a rare species with increasing suitable habitat and medium adaptability*
- ▽ POOR *Decreasing suitable habitat, medium or low adaptability, and uncommon or rare*

SPECIES	ADAPT	ABUN	LOW CLIMATE CHANGE (RCP 4.5) HABITAT CHANGE	LOW CLIMATE CHANGE (RCP 4.5) CAPABILITY	HIGH CLIMATE CHANGE (RCP 8.5) HABITAT CHANGE	HIGH CLIMATE CHANGE (RCP 8.5) CAPABILITY
American basswood	•	•	▲	△	▲	△
American beech	•	•	▲	△	▲	△
American elm	•	•	▲	△	▲	△
American hornbeam*	•	–	▼	▽	▼	▽
American mountain-ash*	–	–	▼	▽	▼	▽
Balsam fir	–	+	▼	▽	▼	▽
Balsam poplar	•	•	▼	▽	▼	▽
Bigtooth aspen	•	•	▼	▽	▼	▽
Bitternut hickory*	+	–	●	○	▲	△
Black ash	–	•	▲	○	●	▽
Black cherry	–	•	▲	△	▲	△
Black hickory	•		★		★	
Black locust*	•	–	▲	△	▲	△
Black oak	•	•	▲	△	▲	△
Black spruce	•	•	▼	▽	▼	▽
Black walnut*	•		★		★	
Black willow*	–	–	●	▽	▲	○
Blackgum	+	–	▲	△	▲	△
Blackjack oak	+		★		★	
Boxelder*	+	–	▲	△	▲	△
Bur oak	+	–	▲	△	▲	△
Chestnut oak	+		★		★	
Common persimmon*	+		★		★	
Eastern cottonwood*	•	–	▲	△	▲	△
Eastern hemlock	–	•	●	▽	▼	▽
Eastern redbud*	•		★		★	
Eastern redcedar	•	–	▲	△	▲	△
Eastern white pine	–	+	●	○	▼	○
Flowering dogwood	•	–	▼	▽	●	▽
Green ash*	•	•	▲	△	▲	△
Hackberry	+		★		★	
Honeylocust*	+		★		★	
Ironwood*	+	•	●	△	▼	○
Jack pine	+	+	▼	△	▼	△
Live oak	•		★		★	

SPECIES	ADAPT	ABUN	LOW CLIMATE CHANGE (RCP 4.5) HABITAT CHANGE	LOW CLIMATE CHANGE (RCP 4.5) CAPABILITY	HIGH CLIMATE CHANGE (RCP 8.5) HABITAT CHANGE	HIGH CLIMATE CHANGE (RCP 8.5) CAPABILITY
Mockernut hickory	+		★		★	
Mountain maple*	+	–	▼	▽	▼	▽
Northern pin oak	+	•	●	△	●	△
Northern red oak	+	•	▲	△	▲	△
Northern white-cedar	•	+	▼	○	▼	○
Osage-orange	+		★		★	
Paper birch	•	•	●	○	●	○
Pignut hickory	•		★		★	
Pin cherry*	•	–	▼	▽	▼	▽
Pin oak*	–	–	▲	○	▲	○
Post oak	+		★		★	
Quaking aspen	•	+	●	△	▼	○
Red maple	+	+	●	△	●	△
Red mulberry*	•		★		★	
Red pine	–	+	▼	○	▼	○
Sassafras*	•	–	▲	△	▲	△
Scarlet oak	•		★		★	
Serviceberry*	•	–	▼	▽	▼	▽
Shagbark hickory	•	–	▲	△	▲	△
Shortleaf pine	•		★		★	
Silver maple*	+	•	▲	△	▲	△
Slippery elm*	•	–	▼	▽	●	▽
Striped maple	•	–	▼	▽	▼	▽
Sugar maple	+	+	▼	△	▼	△
Swamp white oak*	•	–	▲	△	▲	△
Sweetgum	•		★		★	
Sycamore*	•		★		★	
Tamarack (native)	–	•	●	▽	●	▽
Virginia pine	•		★		★	
White ash	–	•	▲	○	▲	○
White oak	+	•	▲	△	▲	△
White spruce	•	•	▼	▽	▼	▽
Sweet birch	–		★		★	
Yellow birch	•	•	●	○	●	○
Yellow-poplar	+		★		★	

**Species with low model reliability based on five statistical metrics of the habitat models that affect change class. See maps and tables for more information (www.fs.fed.us/nrs/atlas/combined/resources/summaries).*

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