Outline

• Climate change in the northeast

• Changes to habitat

• Fish species response

• Climate-adaptive management
  – Identification of coldwater climate change refugia
Climate Change Effects to Date

Temperatures +
Droughts +
Rain:snow +
Flows +/-

Hayhoe et al. 2006 and references therein; Hayhoe et al. 2008; Ucsusa.ogr; Primack et al 2009
Rate of Change

Northeastern US warming faster than other parts of the world

Karmalkar and Bradley 2017
Changes to streams along a gradient

Most altered habitats = novel ecosystems (transformed)
Coldwater fish responses to date

- Faster growth (only sometimes)
- Decreased survival
- Earlier upstream migration of fishes
- Earlier spawning

Hayhoe et al. 2006 and references therein; Primack et al. 2009; Xu et al. 2010
Fish assemblage response along a gradient
Figure 1.1. Climate-smart conservation cycle. This generalized framework for adaptation planning and implementation mirrors many existing conservation planning and adaptive management approaches and can be used either as a stand-alone planning process, or to inform the incorporation of climate considerations into existing planning and decision-making processes.
Resilient habitat = climate change refugia

- Elevation
- Deep snow
- Valleys
- Canopy cover
- Groundwater
- Deep lakes

Adapted from Morelli et al. 2016

Fisheries & Wildlife Board meeting presentation; July 14, 2020
Brook Trout occupancy models

Interactive Catchment Explorer part of the Spatial Hydro-Ecological Decision System

What is ICE?

The Interactive Catchment Explorer (ICE) is a dynamic visualization interface for exploring catchment characteristics and environmental model predictions.

ICE was created for resource managers and researchers to explore complex, multivariate environmental datasets and model results, to identify spatial patterns related to ecological conditions, and to prioritize locations for restoration or further study.

ICE is part of the Spatial Hydro-Ecological Decision System (SHEDS).
Management scale?

SHEDS: INTERACTIVE CATCHMENT EXPLORER

**Controls**
- About
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**Aggregation Level**
- HUC12 (Region 1)

**State Filter**
- Massachusetts

**Map Variable**
- Occupancy Prob with 2 C Incr. in July Tem
Fisheries surveys since 2000:

Purple = lakes and ponds
Red = warmwater rivers
Blue = coldwater streams
Black = fishless samples
Blue: 2017 coldwater fisheries resource (CFR) survey points

Coldwater streams are potential coldwater climate change refugia
With a 2°C increase in July air temperatures, 42% of coldwater streams (now in red) are likely too warm to support Brook Trout in summer.
With a 4°C increase in July air temperatures, an additional 28% of coldwater streams (now in red) are likely too warm to support Brook Trout in summer.
With a 6° C increase in July air temperatures, an additional 45% of coldwater streams (now in red) are likely too warm to support Brook Trout in summer.
Coldwater streams (blue dots) that also provided habitat during the 2016 drought are climate change refugia from both increasing temperatures and drought conditions.
Refugia are created through a network of refuges.
Developing Collaborations

[Logos of various organizations related to fisheries and wildlife conservation]
Thank you