MASSWILDLIFE

Coldwater Climate Change Refugia

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Outline

- Climate change in the northeast
- Changes to habitat
- Fish species response
- Climate-adaptive management
  - Identification of coldwater climate change refugia

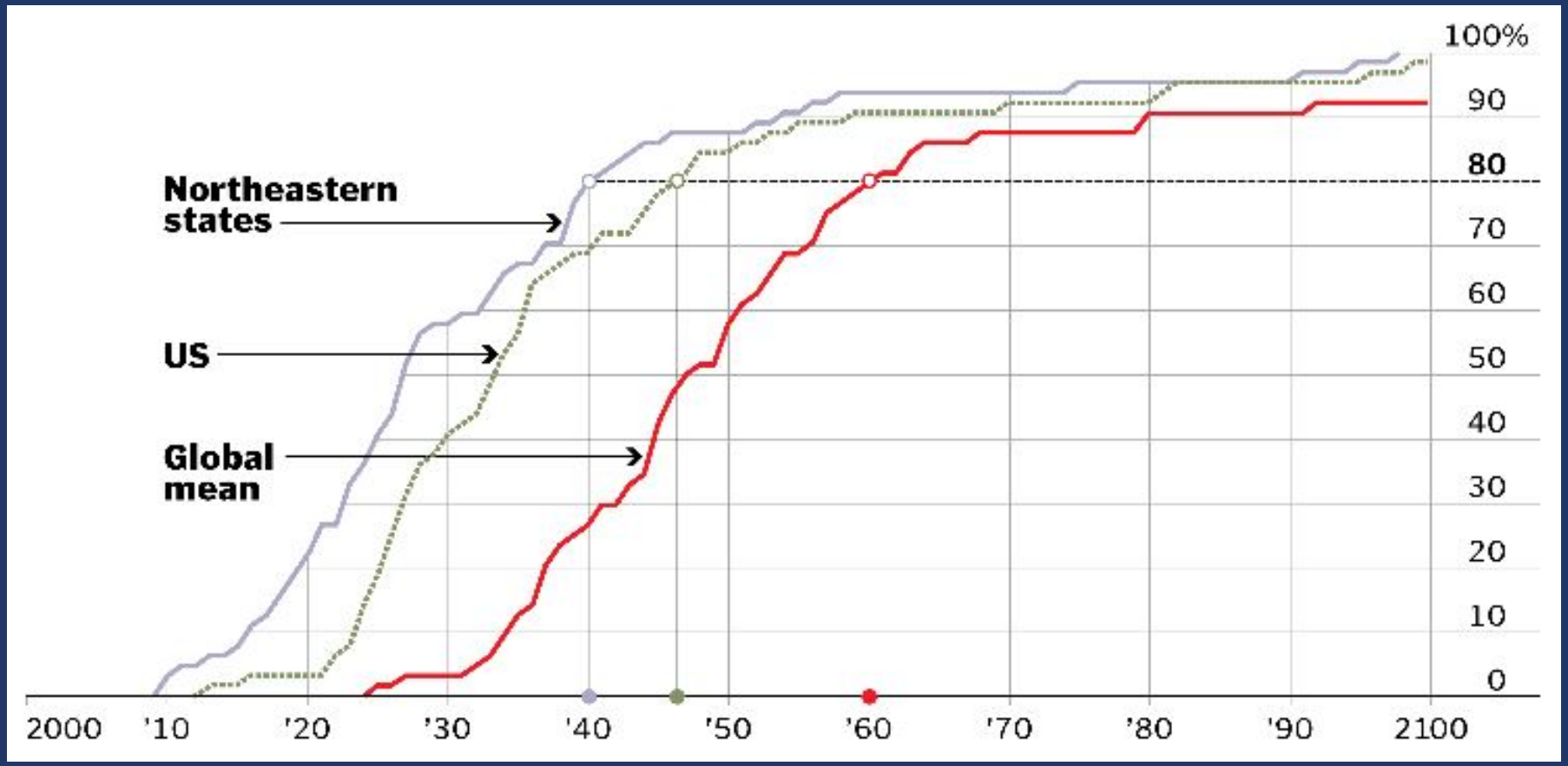
Climate Change Effects to Date

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

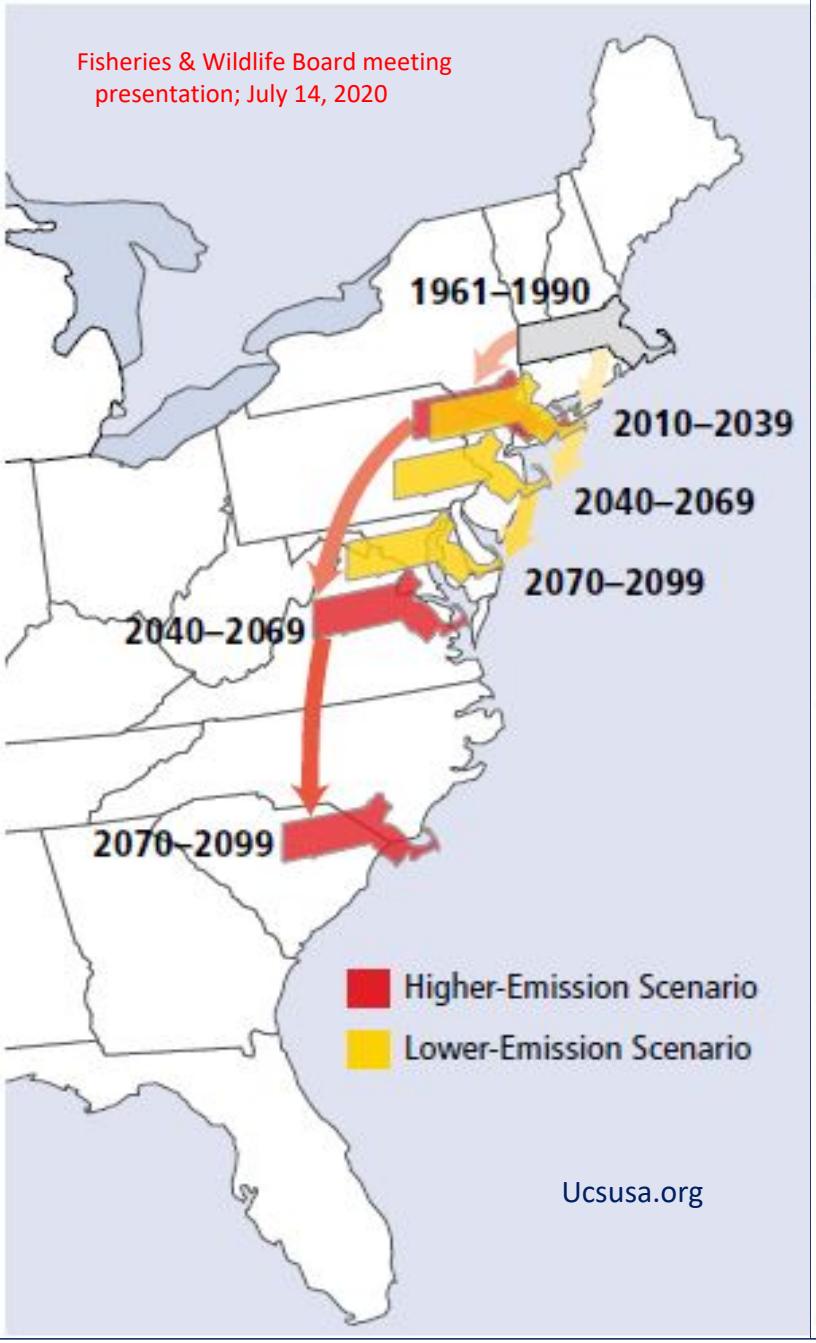
Hayhoe et al 2006 and references therein; Hayhoe et al. 2008; Ucsusa.ogr; Primack et al 2009

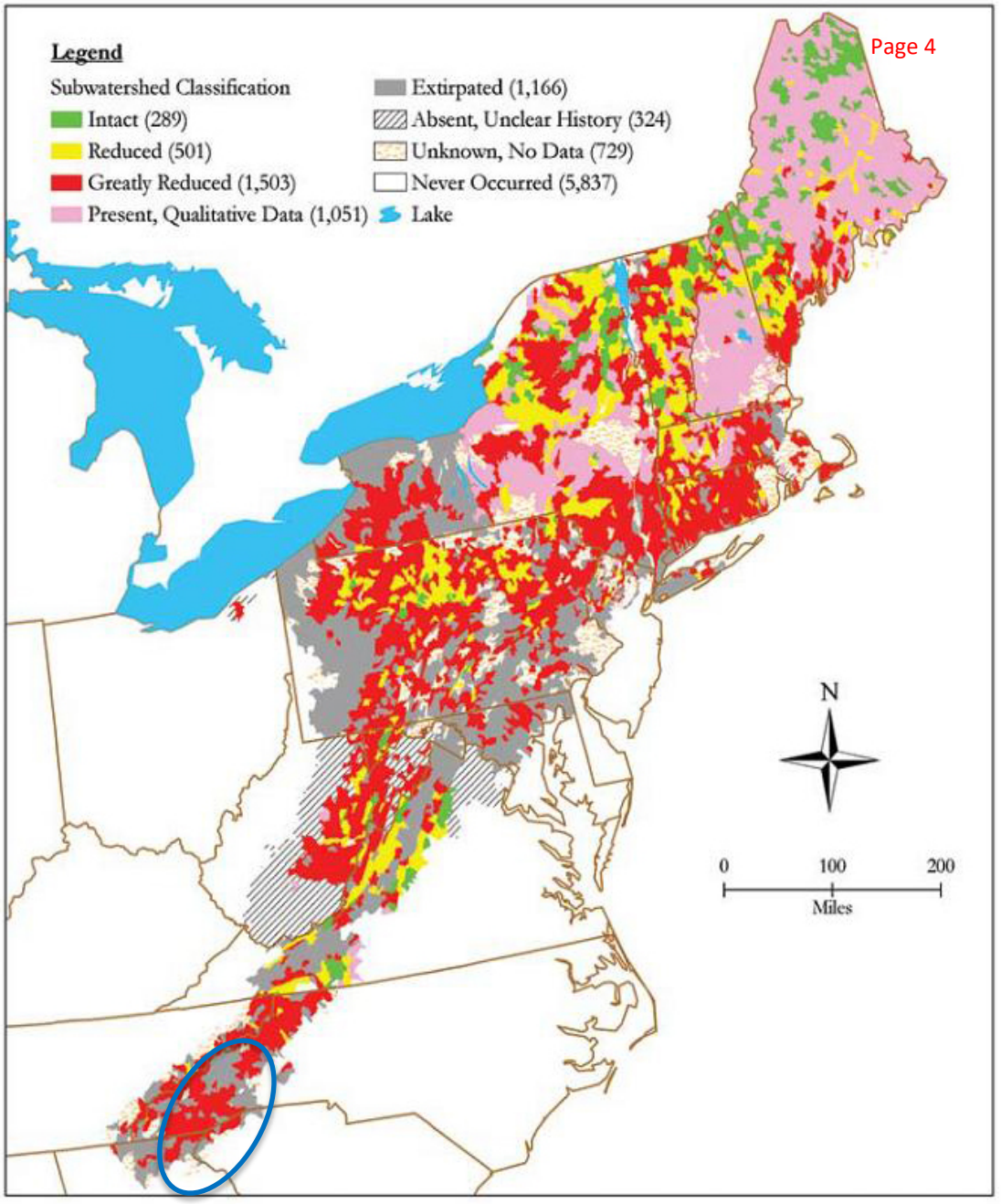
Rate of Change

Northeastern US warming faster than other parts of the world

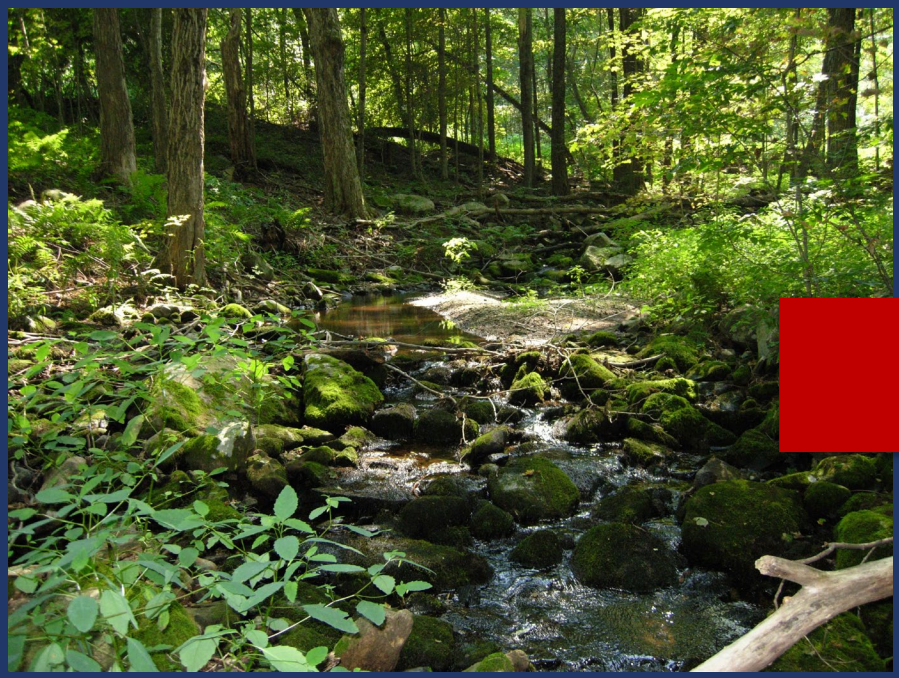


Karmalkar and Bradley 2017


1961–1990
2010–2039
2040–2069
2070–2099
2040–2069
2070–2099
Higher-Emission Scenario
Lower-Emission Scenario
Ucsusa.org


Legend
Subwatershed Classification
Intact (289)
Reduced (501)
Greatly Reduced (1,503)
Present, Qualitative Data (1,051)
Extirpated (1,166)
Absent, Unclear History (324)
Unknown, No Data (729)
Never Occurred (5,837)
Lake
N
0
100
200
Miles

Changes to streams along a gradient



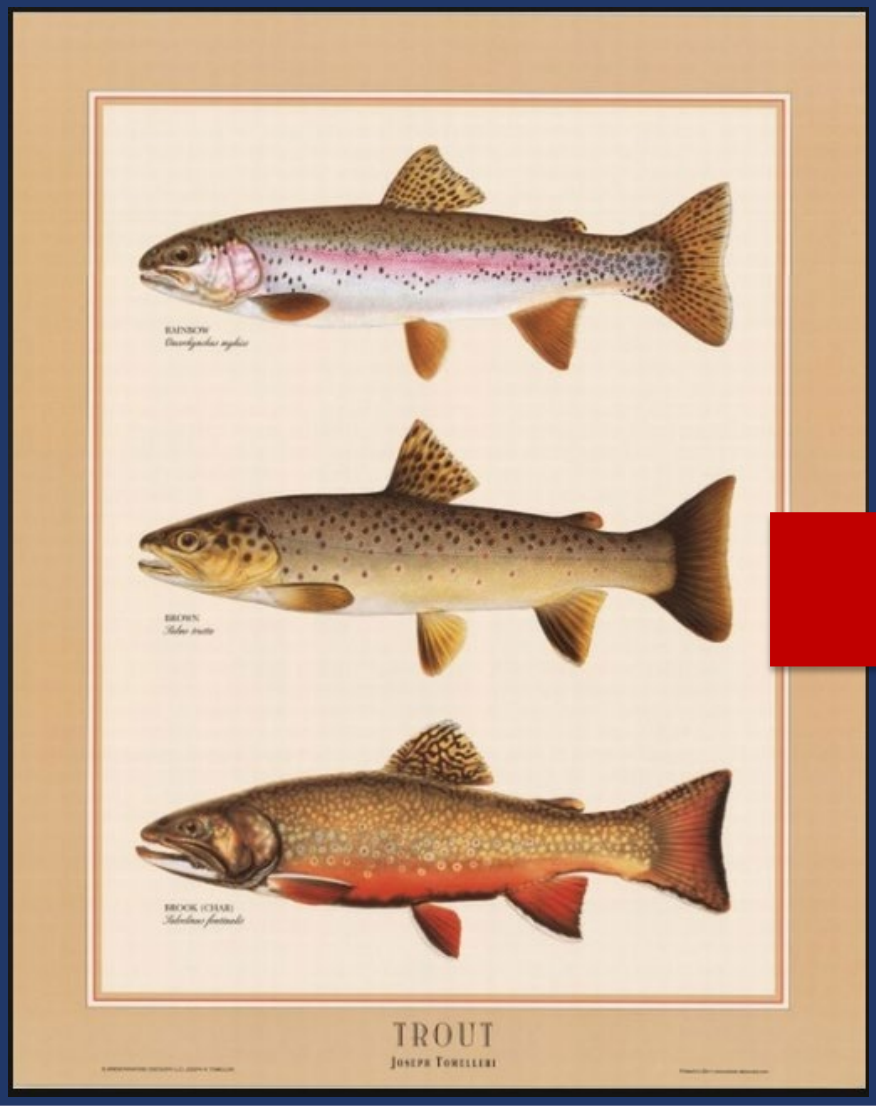
Most altered habitats = novel ecosystems (transformed)

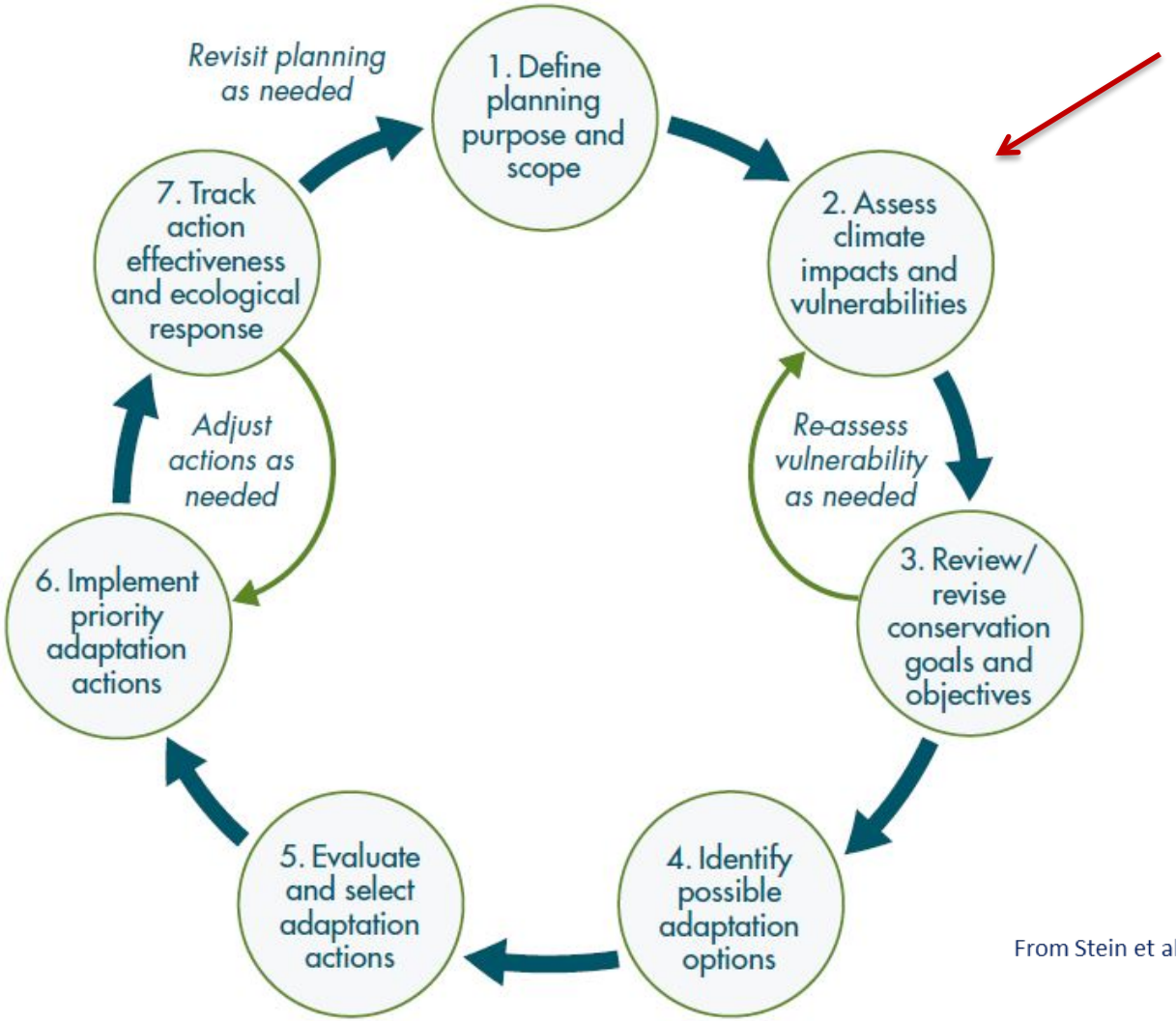
Coldwater fish responses to date

- 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

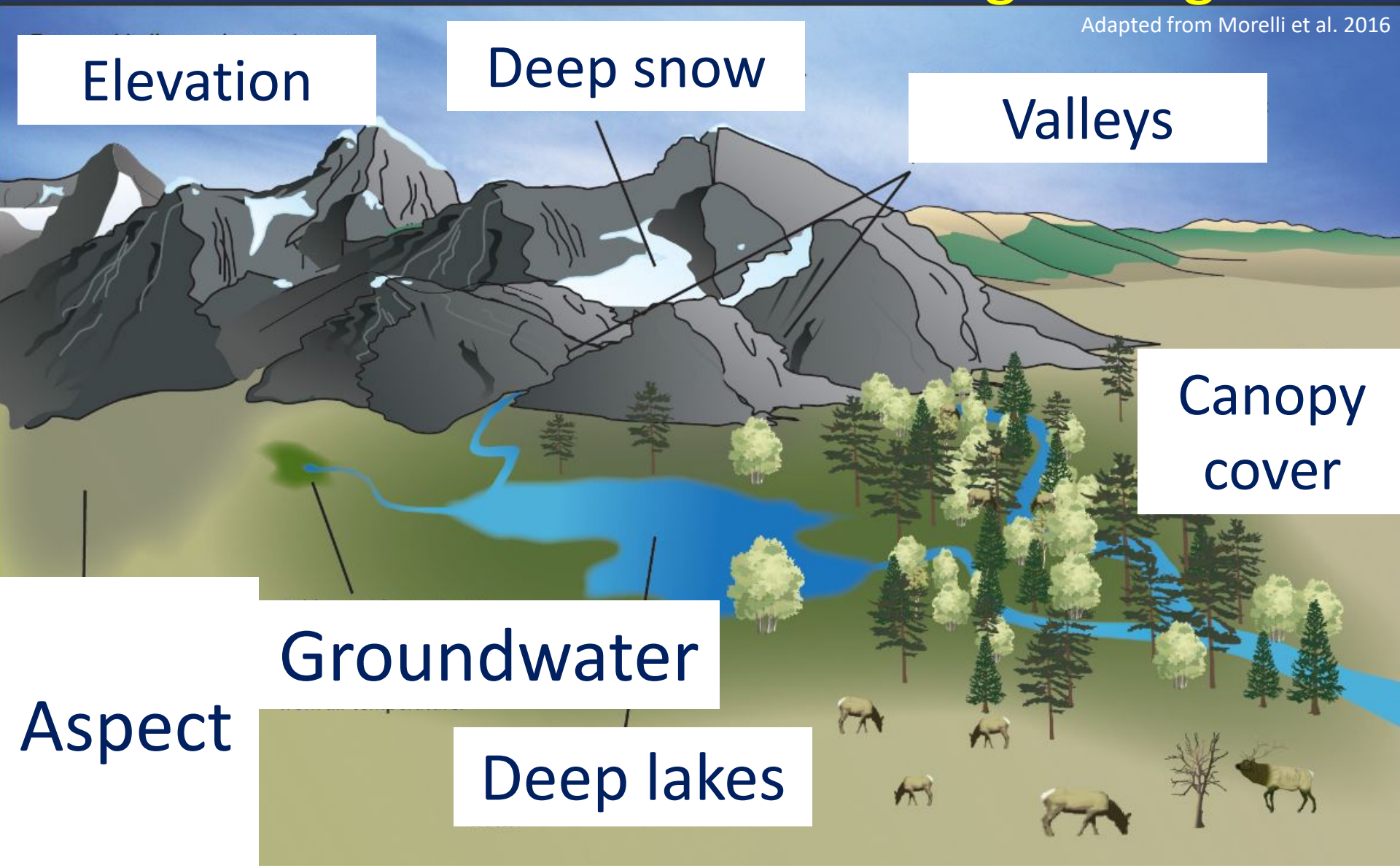




From Stein et al. 2014

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



Brook Trout occupancy models

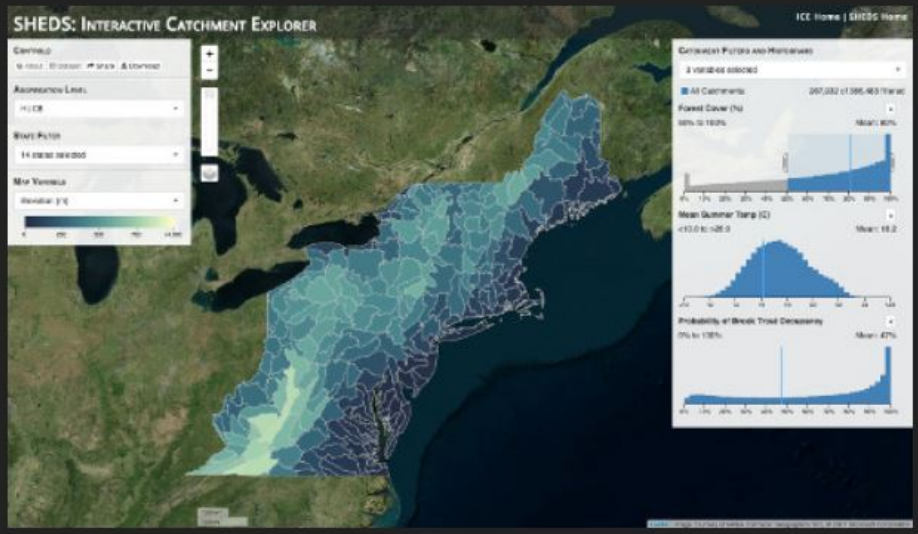
Interactive Catchment Explorer part of the Spatial Hydro-Ecological Decision System

What is ICE?

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

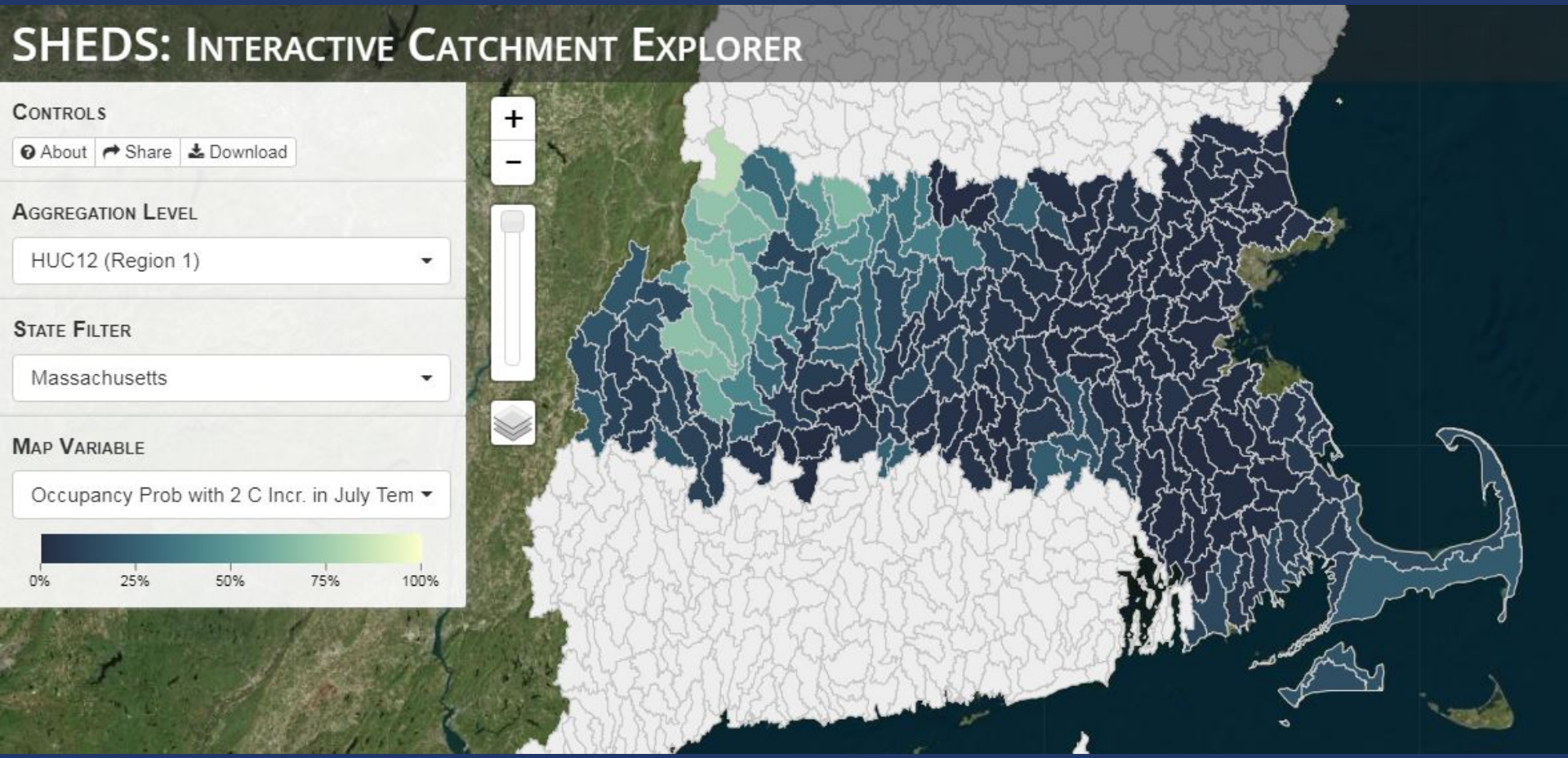
ICE was created for resource managers and researchers to explore complex, multivariate environmental datasets and model results, to identify spatial patterns related to ecological conditions, and to prioritize locations for restoration or further study.

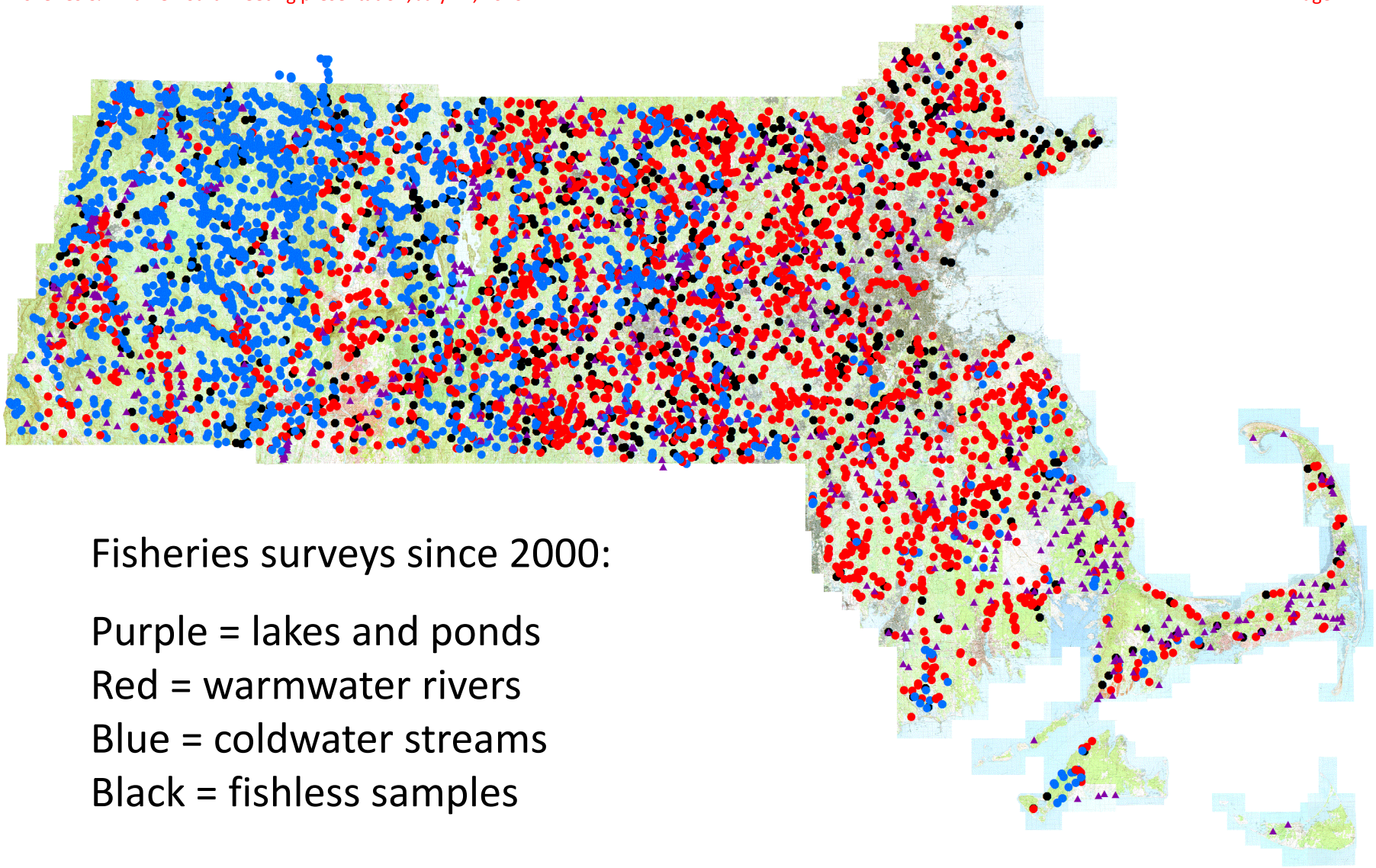
ICE is part of the Spatial Hydro-Ecological Decision System (SHEDS).



Launch ICE ›

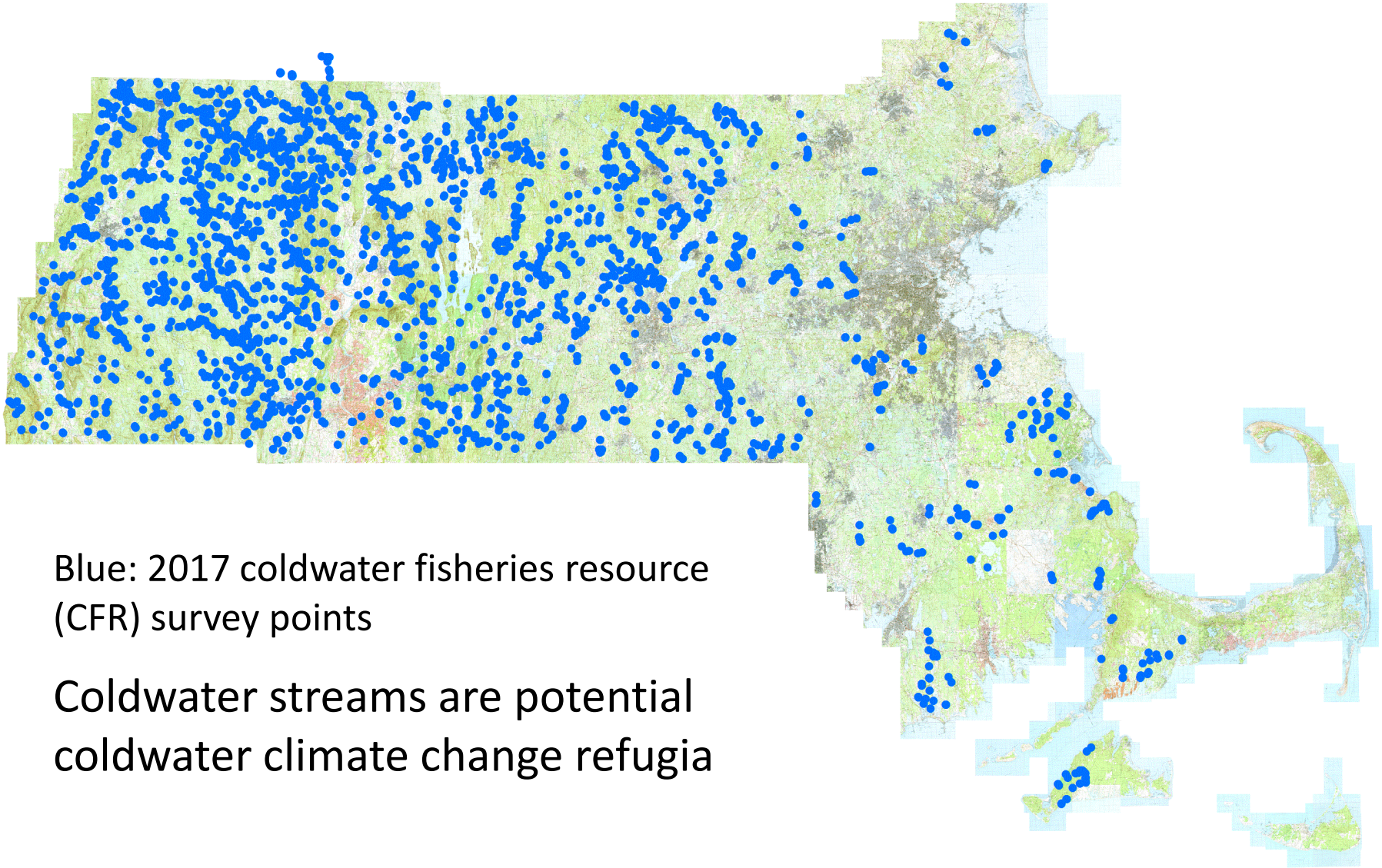
Management scale?





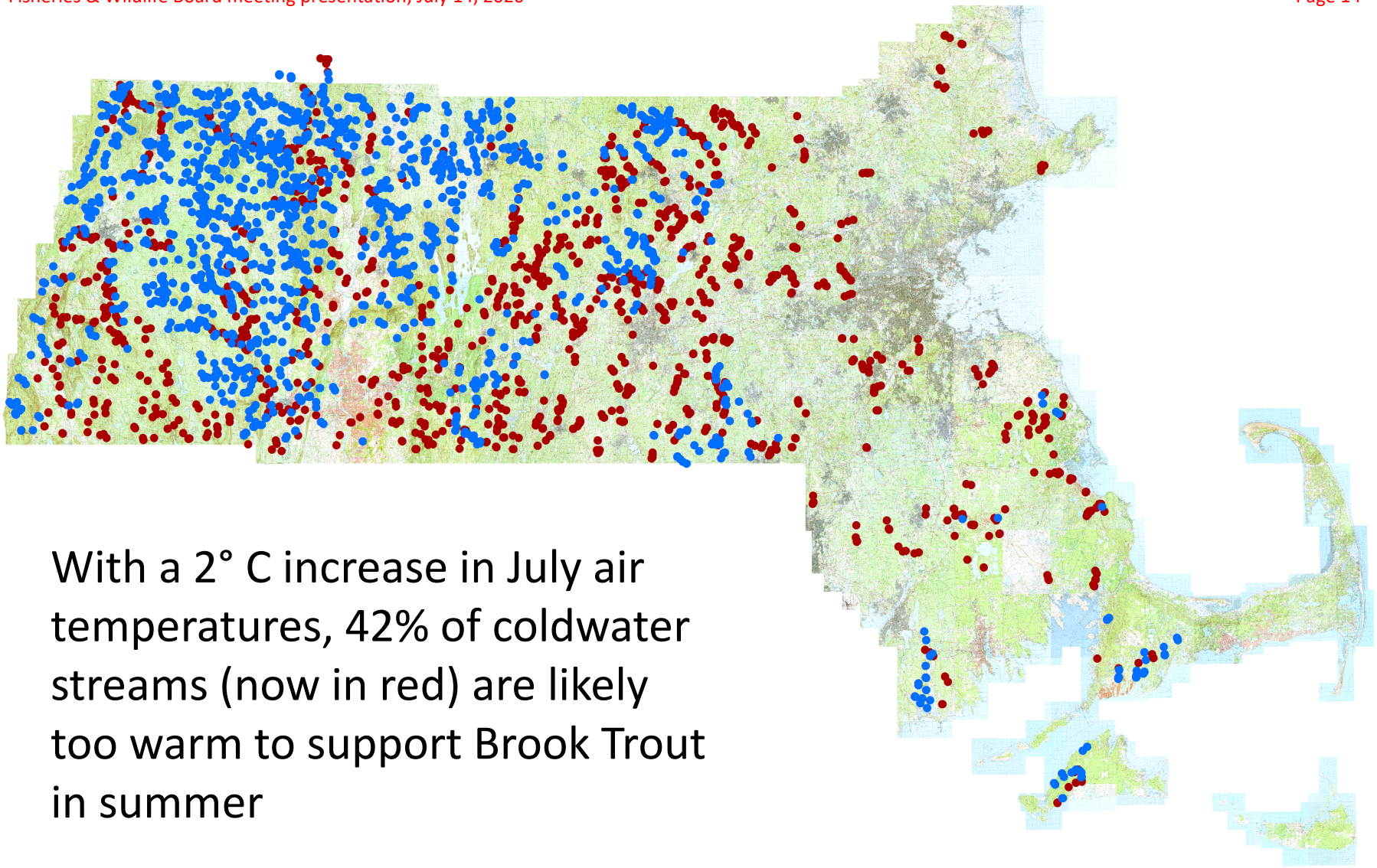
Fisheries surveys since 2000:

Purple = lakes and ponds
Red = warmwater rivers
Blue = coldwater streams
Black = fishless samples

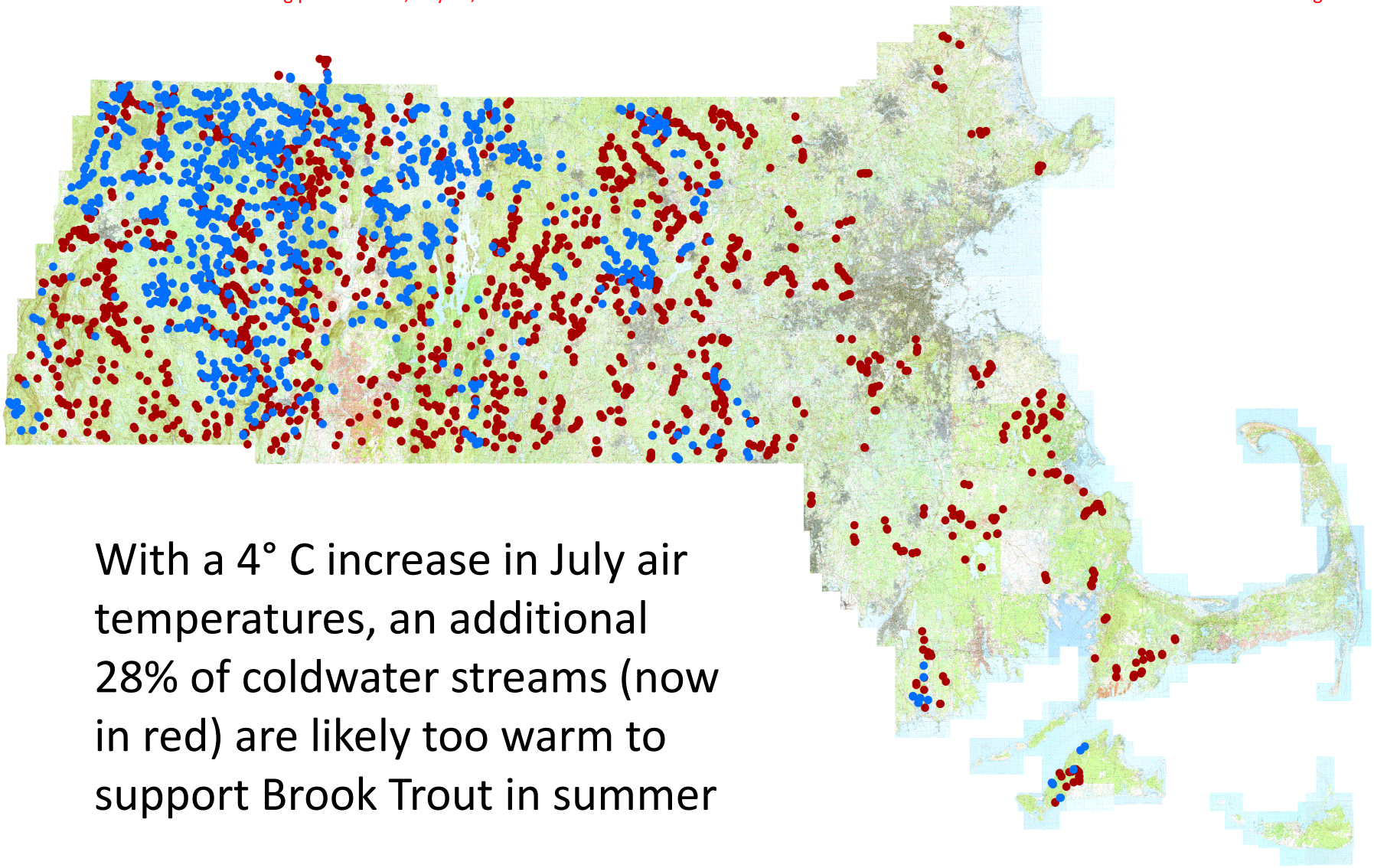


Blue: 2017 coldwater fisheries resource (CFR) survey points

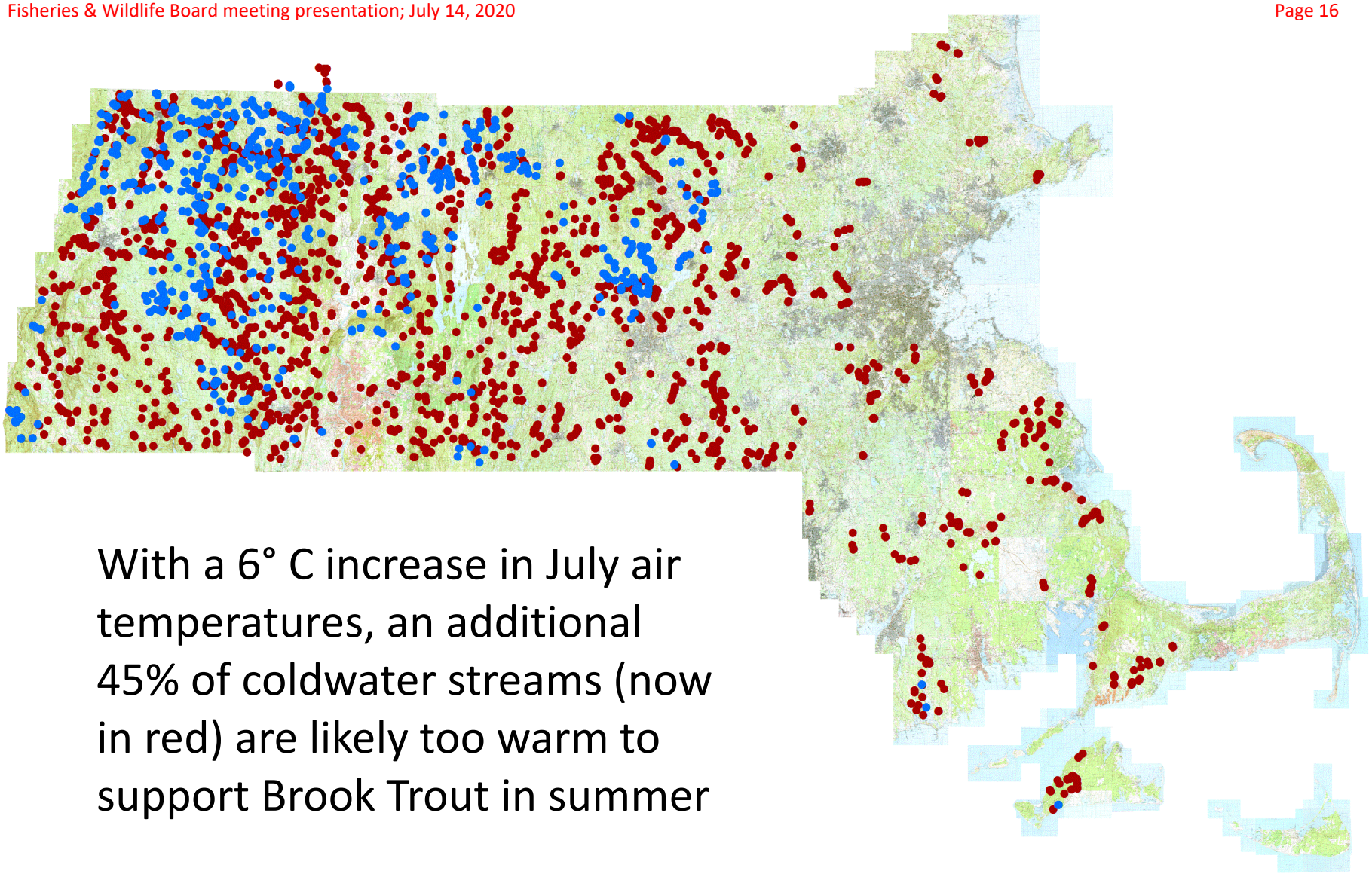
Coldwater streams are potential coldwater climate change refugia



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

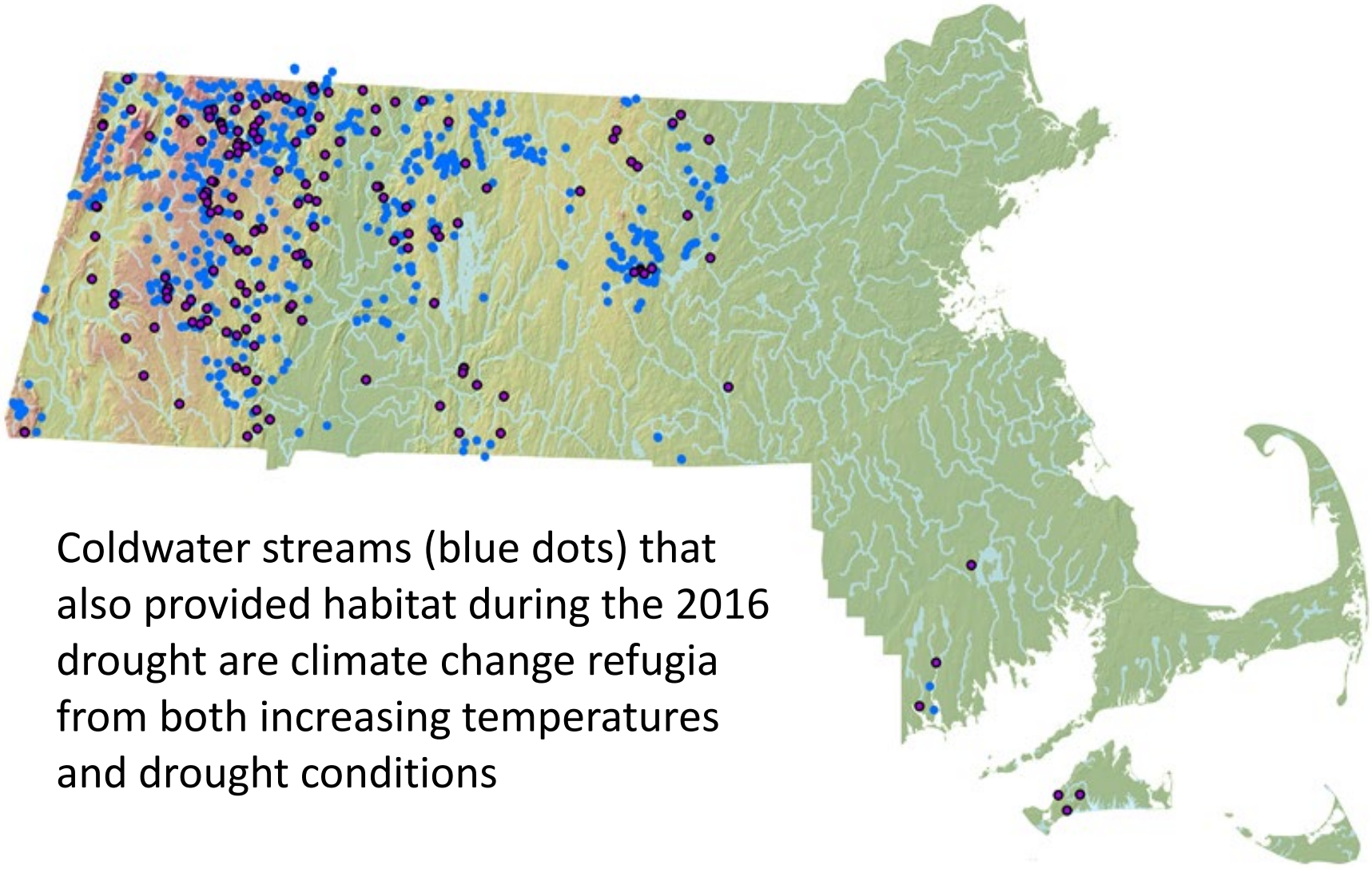


With a 4° C increase in July air temperatures, an additional 28% of coldwater streams (now in red) are likely too warm to support Brook Trout in summer



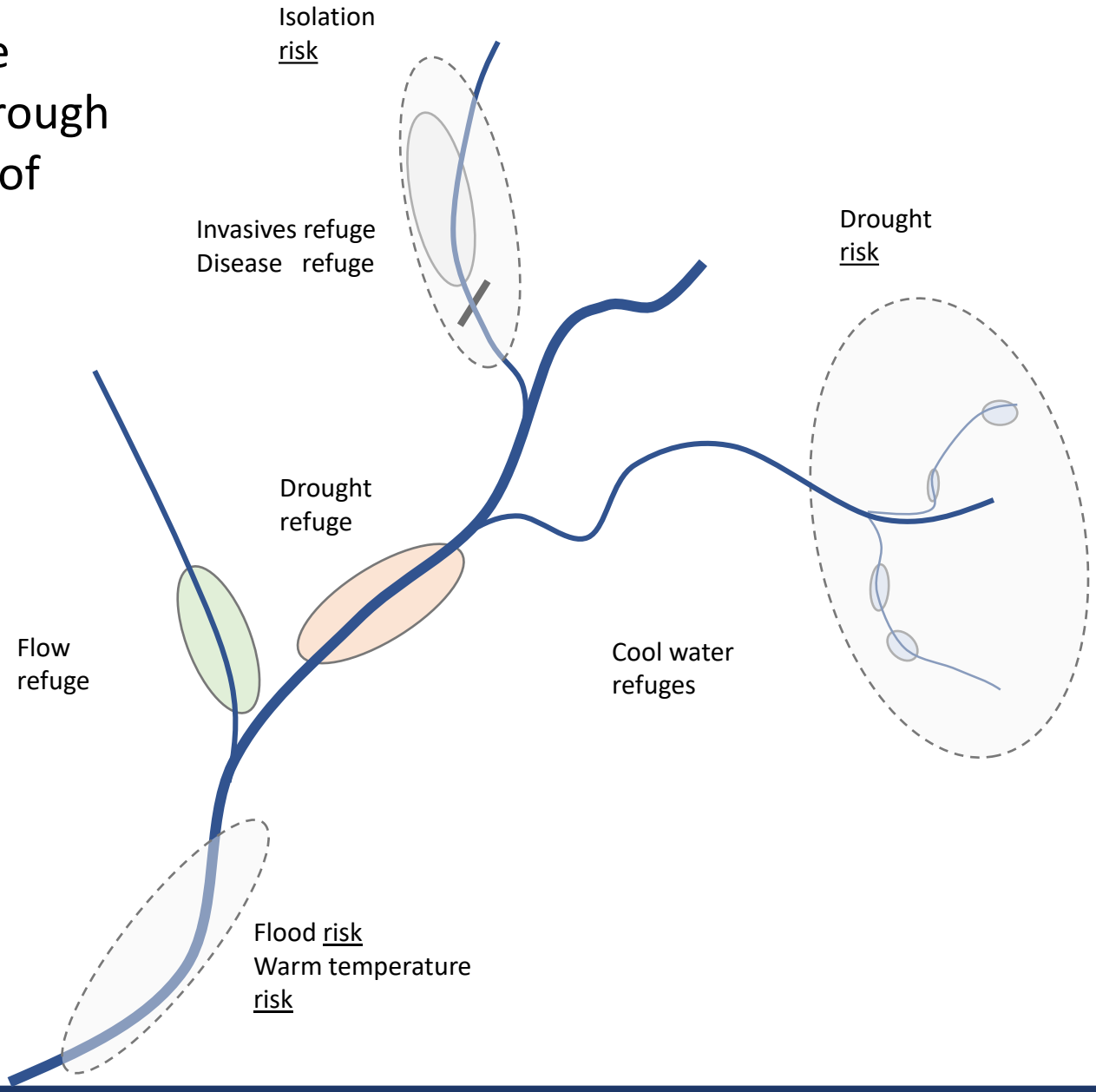
With a 6° C increase in July air temperatures, an additional 45% of coldwater streams (now in red) are likely too warm to support Brook Trout in summer

Temperature + flow



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

American Rivers
RIVERS CONNECT US®

Mass Audubon

New Hampshire
FISH AND GAME
Connecting you to life outdoors

Division of Ecological Restoration
Invested in Nature and Community

The Nature Conservancy

TROUT UNLIMITED

USGS
science for a changing world

UMassAmherst
The Commonwealth's Flagship Campus

NE CASC
Northeast Climate Adaptation Science Center

North Atlantic Aquatic Connectivity Collaborative
NAACC

Thank you