Success stories of on-the-ground climate change refugia conservation

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Climate Change
Adaptation Options

Enable **Response** to Change
• Promote connectivity
• Diversify seed sources & activities
• Translocations

Promote **Resilience** to Change
• Forest thinning
• Restoration of incised banks
• Make snow at ski areas

Create **Resistance** to Change
• Reduce disturbances
• Fire breaks
• Intense removal of migrants

Millar et al. 2007 Eco Apps
Climate Change Refugia

Areas relatively buffered from contemporary climate change that enable persistence of valued physical, ecological, and socio-cultural resources.
“climate refugia” or “climate change refugia”
Hydrological Refugia
Disturbance Refugia
Coldwater Refugia

Ebersole, Quinones, et al. In Review
Frontiers
Vegetative Climate Refugia

Thorne et al. In Review Frontiers
Climate Change Refugia Conservation Cycle

1. Define planning purpose and objectives
   Identify focal resources, study area, & time horizon

2. Assess climate impacts and vulnerabilities

3. Review/revise conservation goals and objectives

4. Identify and map key refugia features
   Consider scale & connectivity

5. Evaluate and prioritize refugial areas for specific management

6. Identify & implement priority actions to manage climate change refugia

7. Monitor the effectiveness of refugia, realign objectives accordingly

Revisit planning as needed

Use additional data to test refugial predictions wherever possible

Morelli et al. 2016
Dedicated to accelerating the science and management of climate change refugia.

NORTHWEST

BORREAL

NORTHEAST

Climaterefugia.org
The goal of the NE RRC is to bring together natural resource managers and scientists from across the region who are interested in using (or just learning more about) climate change refugia management as a tactic for conserving species in the face of climate change.

One of the first steps, which we conducted at our kickoff workshop at the NE CSC’s Regional Science Meeting in May 2017, was to develop a preliminary short list of species and ecosystems to focus northeast refugia management and mapping on. Through a process of real-time voting and discussion we settled on a short list of ecosystems and species to focus on.
Success Stories
Record CA Warming

Mann & Gleick 2015 PNAS
Climate Change Refugia Conservation Cycle

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Morelli et al. 2016
PLOS ONE
Montane Meadows
Climate Change Refugia Conservation Cycle

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   - Re-assess vulnerability as needed

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Revisit planning as needed
Mapping Climate Change Refugia


Maher, Morelli et al. 2017
Ecosphere
Climate Change Refugia Conservation Cycle

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Revisit planning as needed
Belding’s Ground Squirrel
(Urocitellus beldingi)
74 Historical Presences

Original Surveys: 1902-1966
Resurveys: 2003-2011
Detectability (p) > 0.995 for 2+ visits
Persistent Sites = 43
Extirpated Sites = 31

Original Surveys: 1902-1966
Resurveys: 2003-2011
Detectability (p) > 0.995 for 2+ visits
42% Rate of Site Extirpations Across CA

Morelli et al. 2012 *Proc B*
Climate Change Refugia
Predict Persistence

Proportion of Sites where U. beldingi Persisted

*Sig at p <0.05

Morelli et al. 2018
Climate Change Responses
Monitor: meadow wetness via remote sensing and field measurements; indicator species; downstream watershed variables (streamflow, sediment load, etc)

Minimize overgrazing; remove encroaching conifers & invasive species; mitigate road & trail impacts; assist migration of lower elev species; snow fencing to trap snow in desired locations; manage recreation & development; increase connectivity

Medium or large meadows that are highly connected; areas of high biodiversity; meadows where species of management concern exist or might exist in the future; areas of high recreational value (if uses are compatible)

Maintain montane meadow habitats in the Sierra Nevada, w/a 15-20 year planning cycle; consider 50-100 year climate projections

Climate Change Refugia Conservation Cycle

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3. Review/revise conservation goals and objectives

4. Identify and map key refugia features
   Consider scale & connectivity

5. Evaluate and prioritize refugial areas for specific management

6. Identify & implement priority actions to manage climate change refugia
   Adjust actions as needed

7. Monitor the effectiveness of refugia, realign objectives accordingly
   Revisit planning as needed

Use additional data to test refugial predictions wherever possible

Maintain sufficient montane meadow habitats to protect critical ecosystem services in prioritized watersheds

Reduced moisture availability and precipitation; disruption of species synchronicity; vegetation shifts; increased recreation impacts from more visitors and longer seasons
On-the-Ground Refugia Conservation

- Increase Connectivity
- Improved culvert design
- Road crossings
- Reroute trails
- Assisted migration?
On-the-Ground Refugia Conservation

Barrows et al. In Review
Developing a vulnerability index for Sierra meadows and BMP; includes climate refugia maps.

2. Predicted vegetative climate exposure to California Towhee suitable habitat.

3. Vegetation climate refugia in California Towhee suitable habitat.
Identify and protect refugia

- Protect ranches and manage development
- Identify soil attributes that favor sagebrush
- Maintain diversity of structural stages, canopy cover classes
- Restore post-disturbance forests
- Protect healthy trees in larger stands affected by insects, disease, fire
- Conserve refugia that contribute to watershed flows
- Conserve persistent wetlands that remain wet during severe droughts, especially within special management areas
- Conserve refugia and habitat connectivity for pinyon-juniper obligates
- Manage for highest at-risk values (e.g., property, certain trees)
Conserving Conifer Strongholds

Saving Minnesota’s Iconic Conifers
Distribution of cold-water refugia (blue dots) in current conditions (a) and modeled warming scenarios of 2°C (b), 4°C (c), and 6°C (d) increases of average July air temperatures. Red dots indicate existing coldwater refugia that will likely lose cold-water habitat in summer months. (Data from: MA DFQ and ice.ecosheds.org)
## On-the-Ground Refugia Conservation

<table>
<thead>
<tr>
<th>Management Category</th>
<th>Management tools</th>
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<tbody>
<tr>
<td><strong>Land and watershed</strong></td>
<td>Floodplain and riparian restoration and enhancement; Road and barrier removal or enhancement to manage hydrologic and biotic connectivity among stream segments and networks</td>
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<tr>
<td><strong>Water quantity</strong></td>
<td>Water storage, allocation, and release systems; conservation and efficiency measures</td>
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<tr>
<td><strong>Water quality</strong></td>
<td>Nutrient management frameworks</td>
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<tr>
<td><strong>Fish and wildlife</strong></td>
<td>Recreational fishery management (seasons, quotas, special management areas)</td>
</tr>
</tbody>
</table>

Ebersole, Quinones, et al *Frontiers In Review*
The Northeast Climate Science Center provides scientific information, tools, and techniques that managers and other parties interested in land, water, wildlife and cultural resources can use to anticipate, monitor, and adapt to climate change in the Northeast region.

Fellows Retreat

The 2015 NE CSC Fellows Retreat was held September 22-25 in Suring, Wisconsin. Twenty Graduate and Postdoctoral Fellows gathered to share their research, develop collaborations, and learn from stakeholders and scientists who have established strong working relationships.

Read more
Thanks!

Climaterefugia.org

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