Balancing use and sustainability of ecosystem services in dammed rivers: a trade-off assessment in New England

Joseph Dana in front of Veazie Dam removal, 2013 (Credit: Meagan Racey, USFWS)

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Why dams?

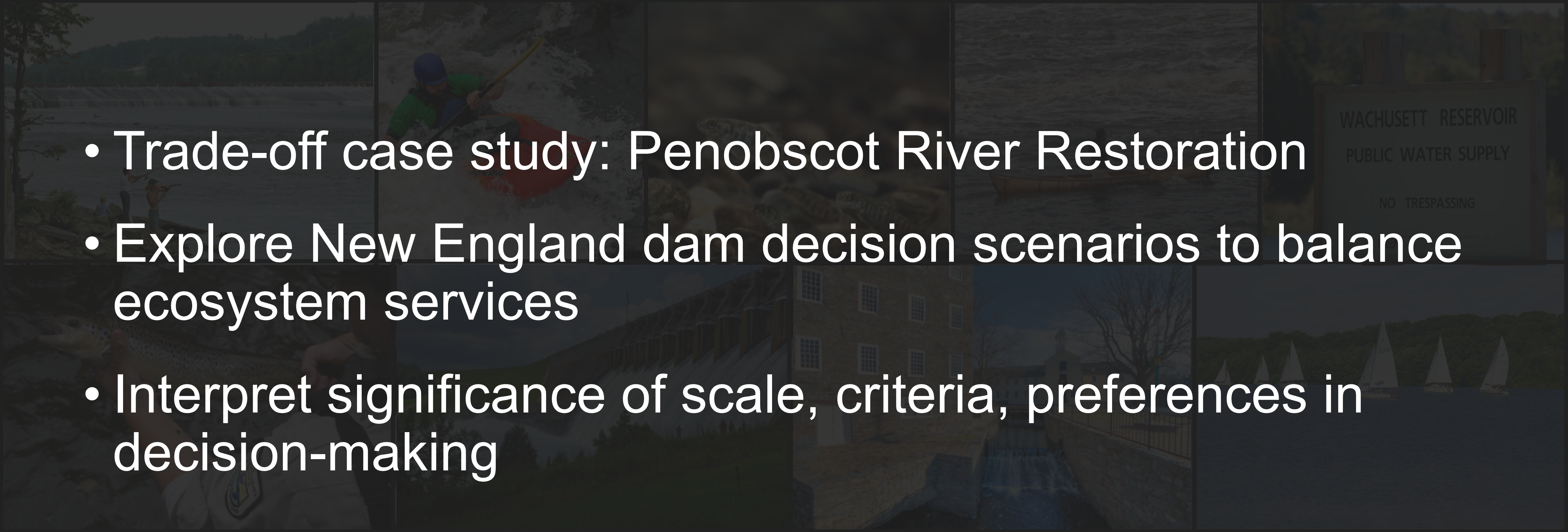







- We receive benefits from rivers and lakes: *ecosystem services*
- Trade-offs: dams produce some ecosystem services at the cost of others
- Can coordinated dam decisions help improve all of these ecosystem services?

Why dams?

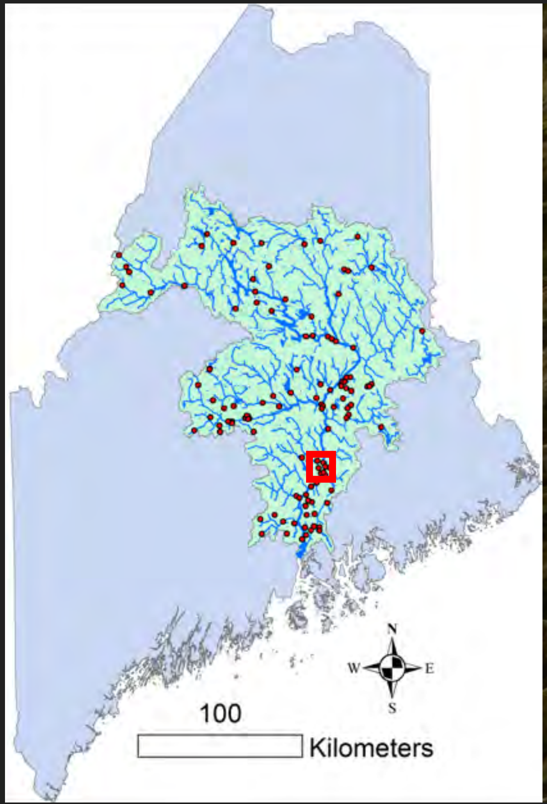


- Trade-off case study: Penobscot River Restoration
- Explore New England dam decision scenarios to balance ecosystem services
- Interpret significance of scale, criteria, preferences in decision-making

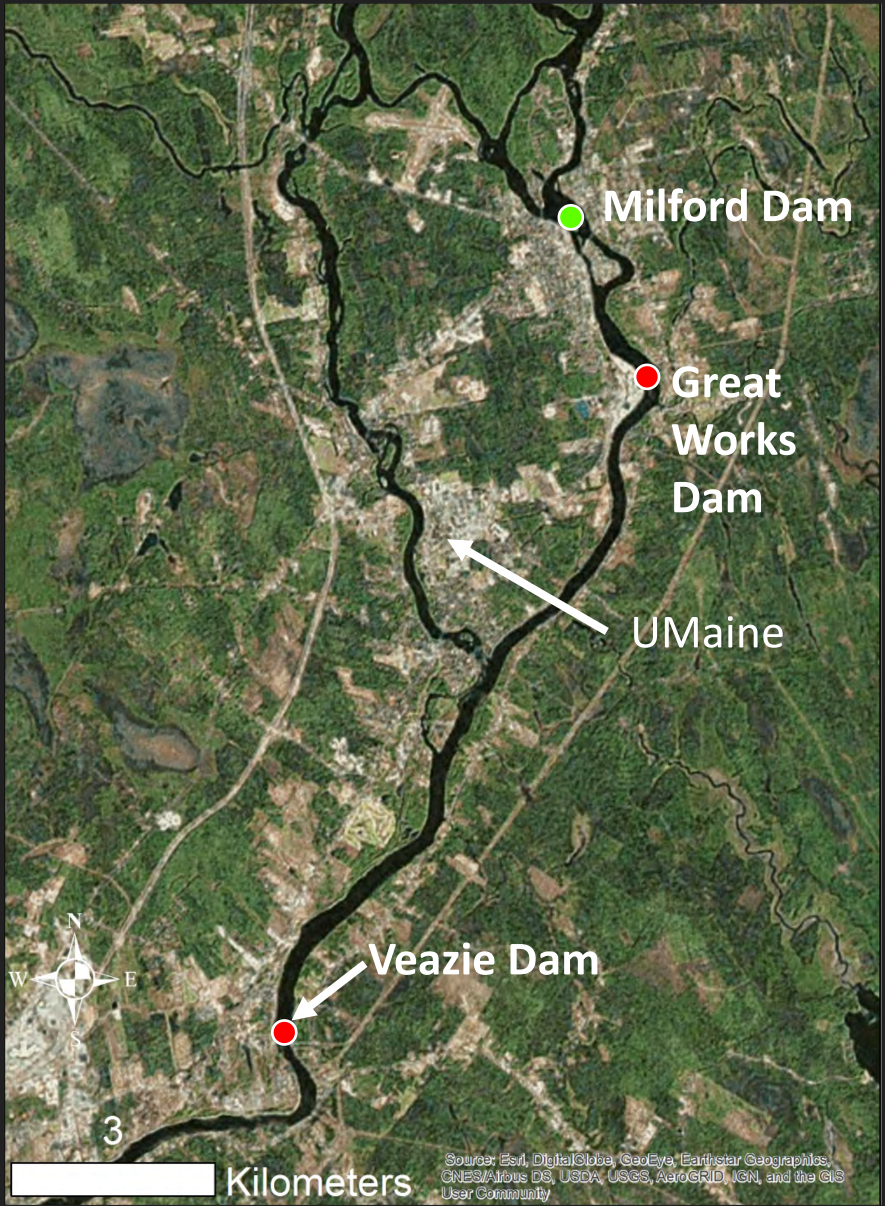
- We receive benefits from rivers and lakes: *ecosystem services*
- Trade-offs: dams produce some ecosystem services at the cost of others
- Can coordinated dam decisions help improve all of these ecosystem services?

Trade-off case study: Penobscot River Restoration

- **<u>Penobscot River Restoration Trust</u>**
- 2 dams removed, several modified (2012-2016)
- 100x increase in river herring population
- ~1% loss in hydroelectric generation



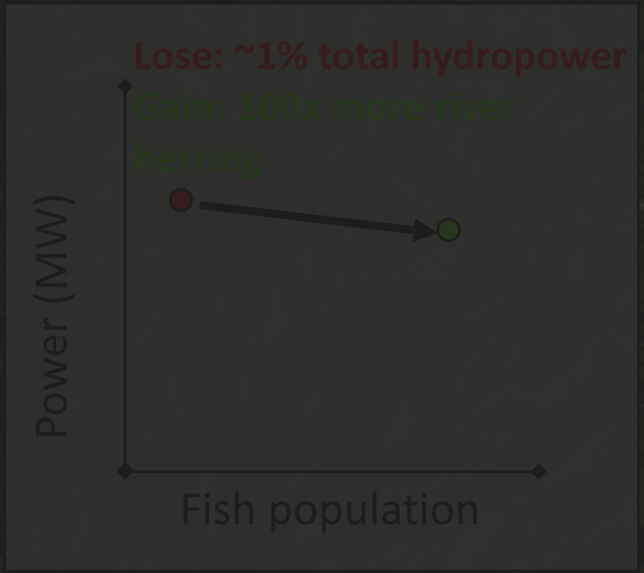
Penobscot River Restoration Trust (http://www.penobscotriver.org/content/4055/fish)

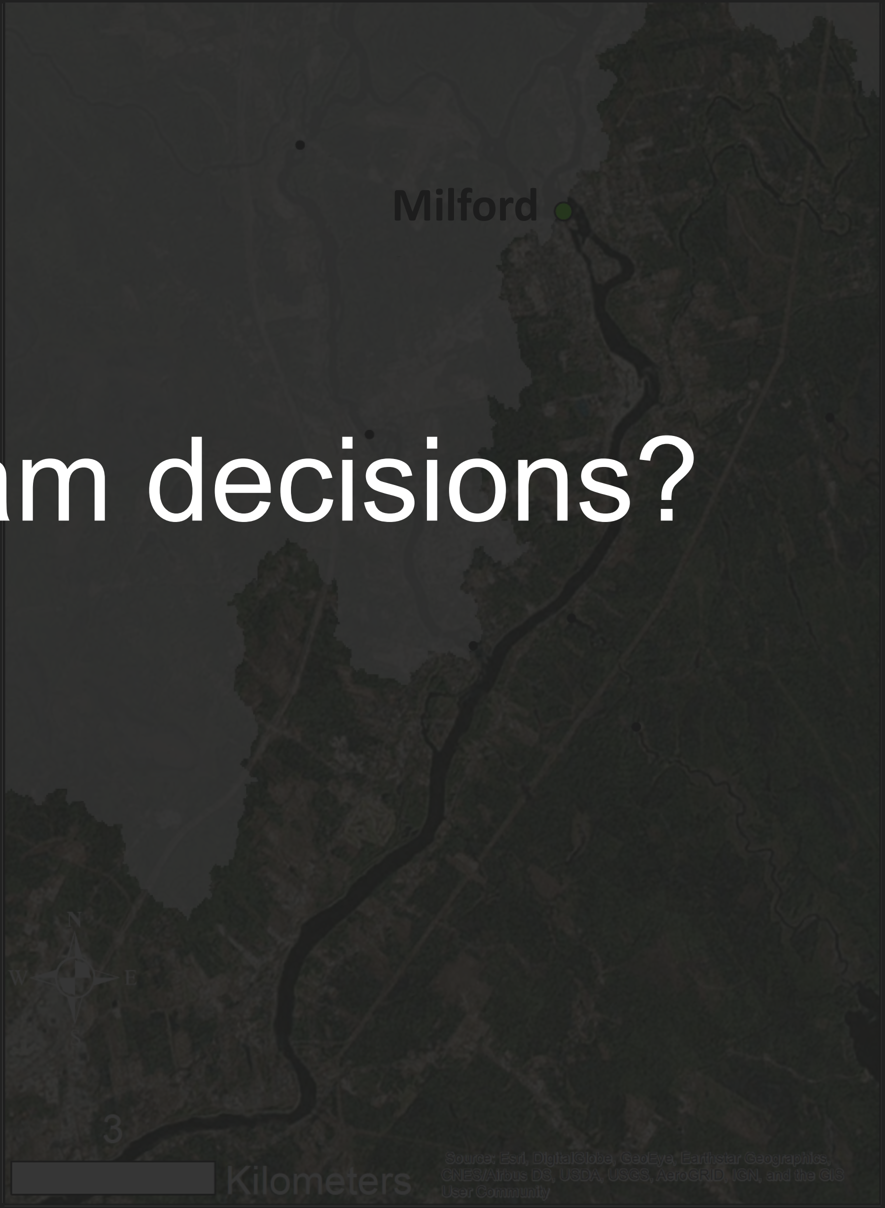


Trade-off case study: Penobscot River Restoration

- **Penobscot River Restoration Trust**
- 2 dams removed, several modified (2012-2016)
- Major historic river herring fishery
- 167.5 MW cumulative capacity

Can we scale up multi-dam decisions?





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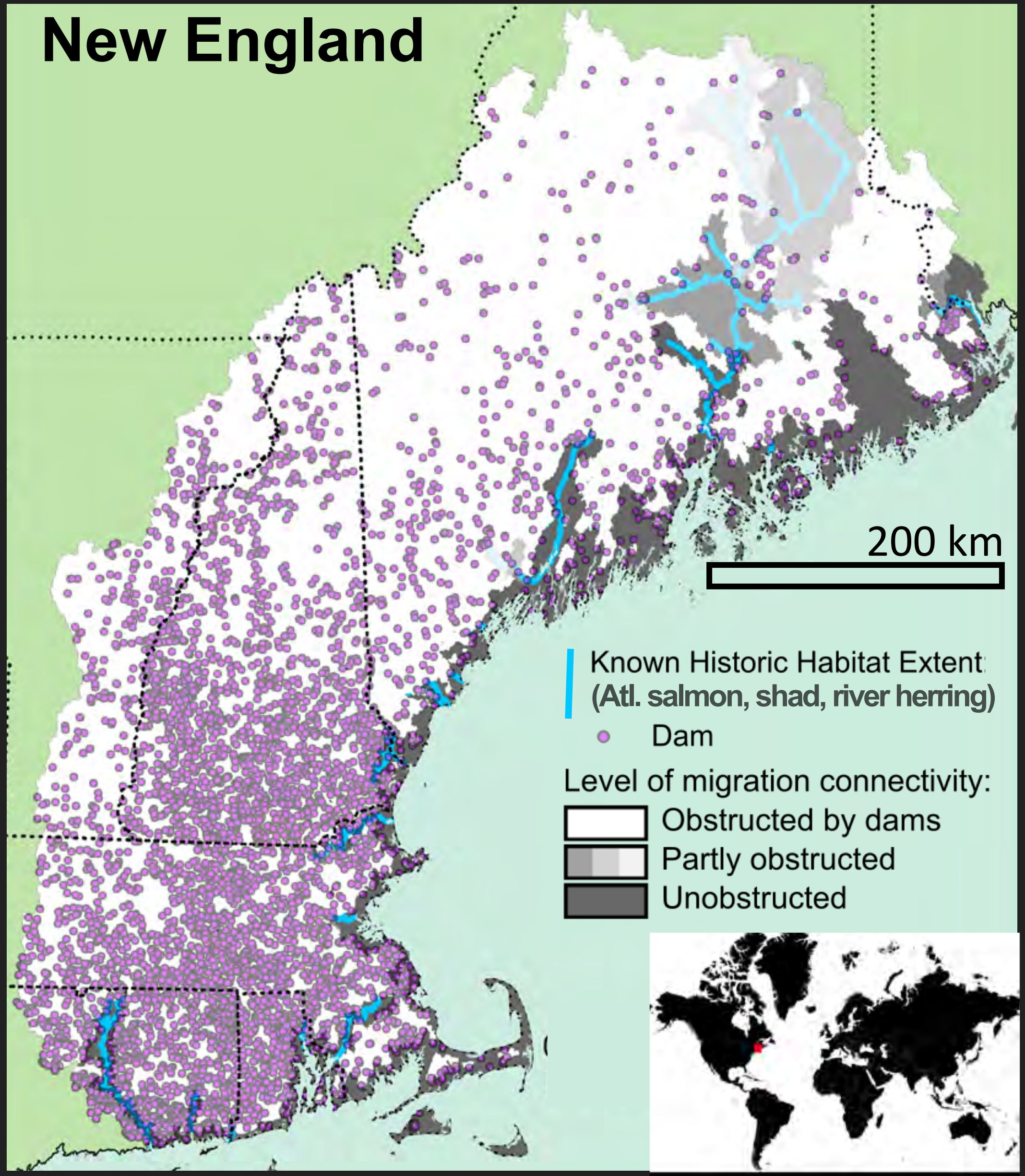
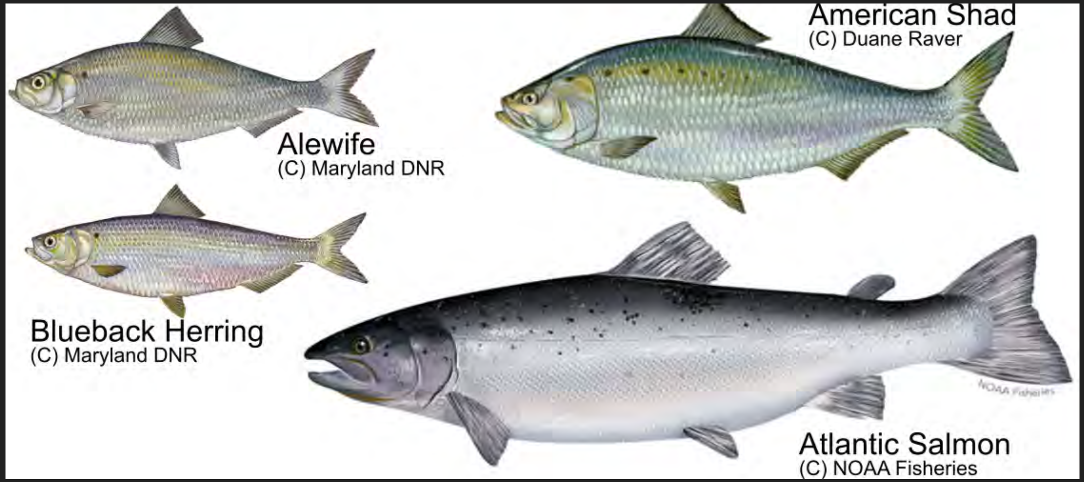
Scaling up: New England

>14,000 dams
>14 million people
11 sea-run fish species
>1.6 GW hydropower capacity
Many old, obsolete dams

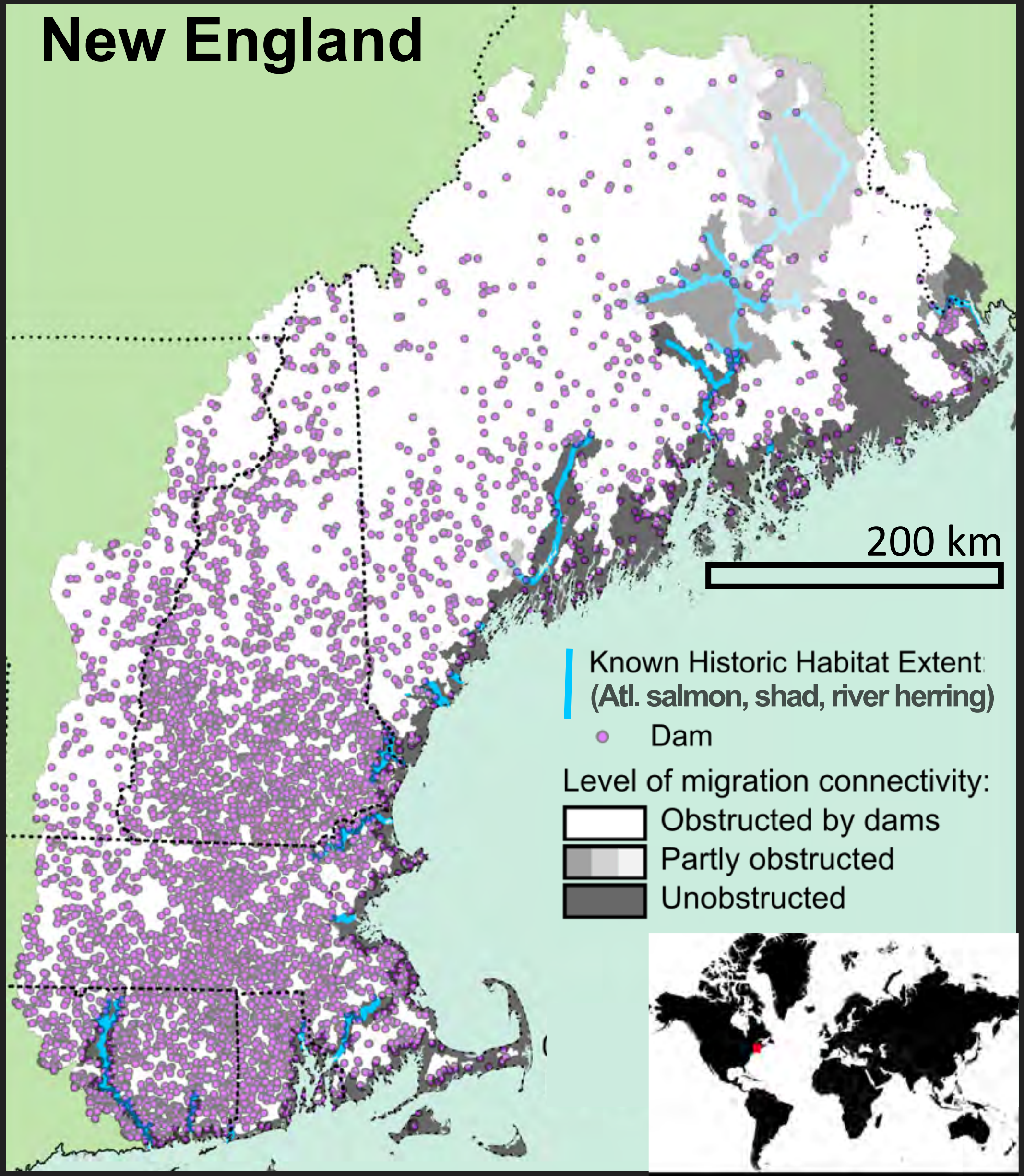


Coordinated dam decisions: 1. Trading off hydropower and sea-run fish

Power produced by flowing water harnessed and channeled through turbines (FERC)



Sea-run fish spend parts of their lives migrating through freshwater rivers/streams (FWS, USGS, TNC)



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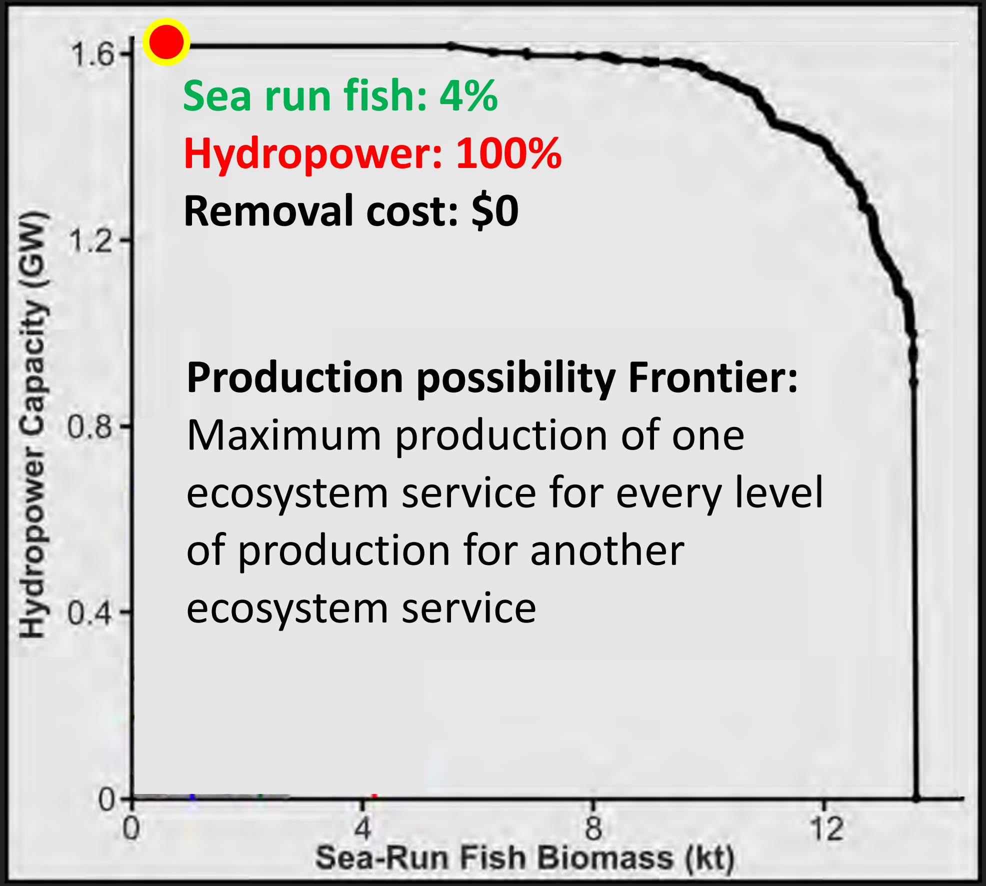

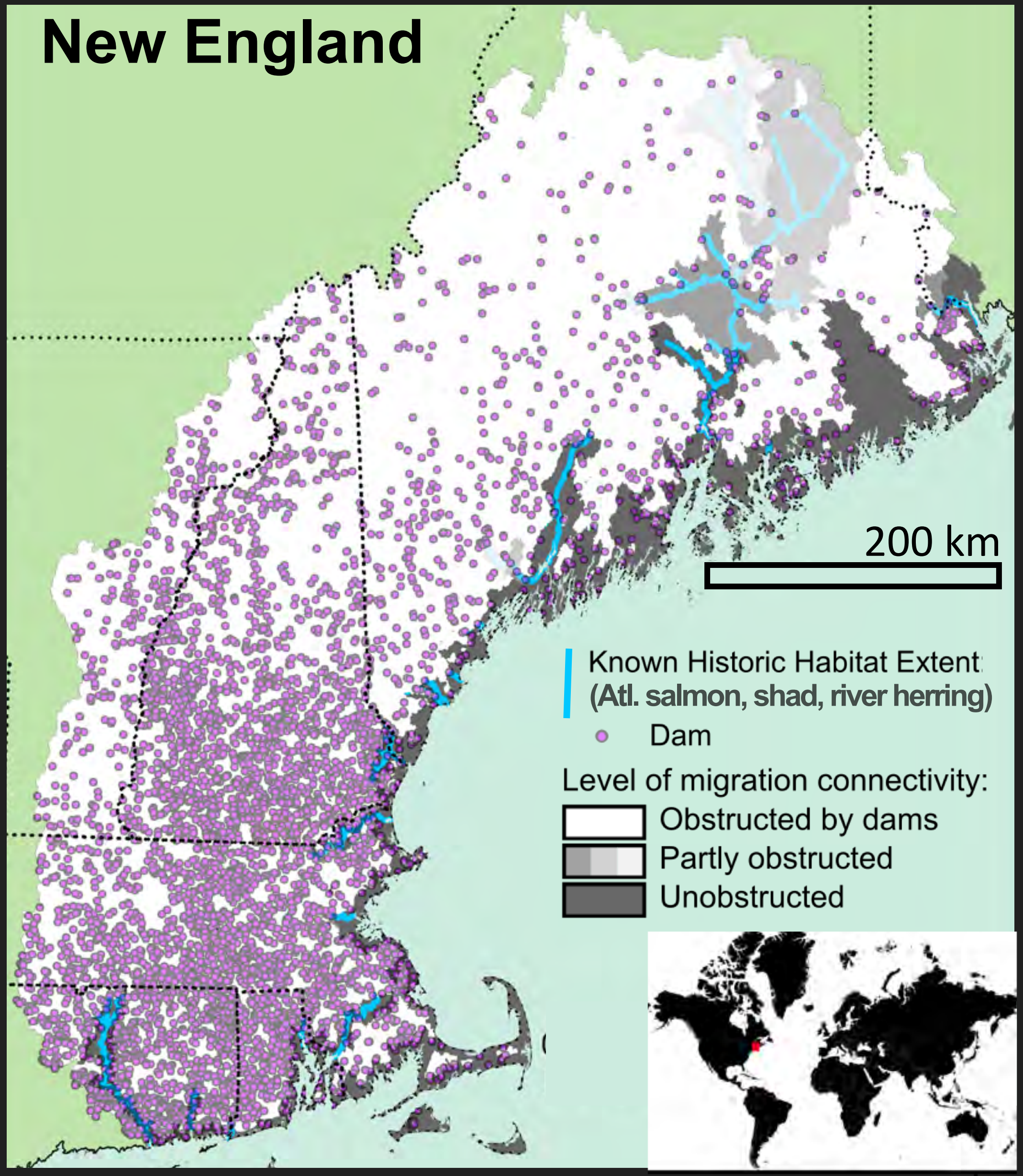

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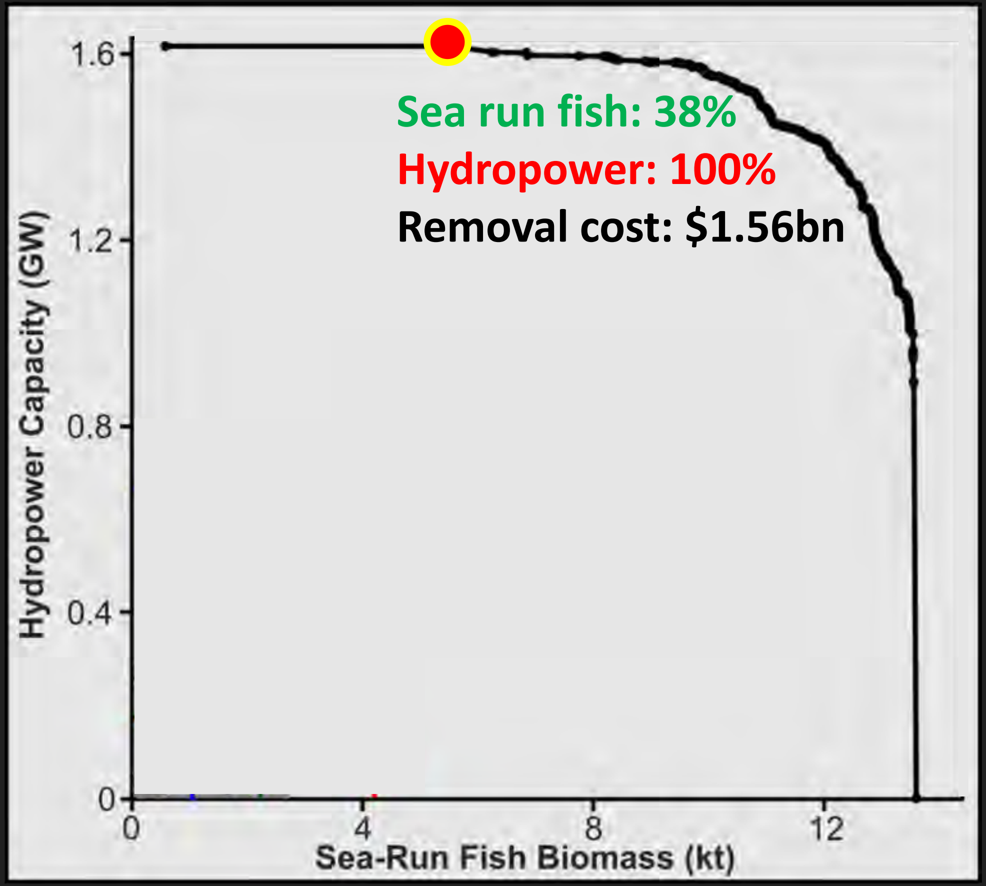

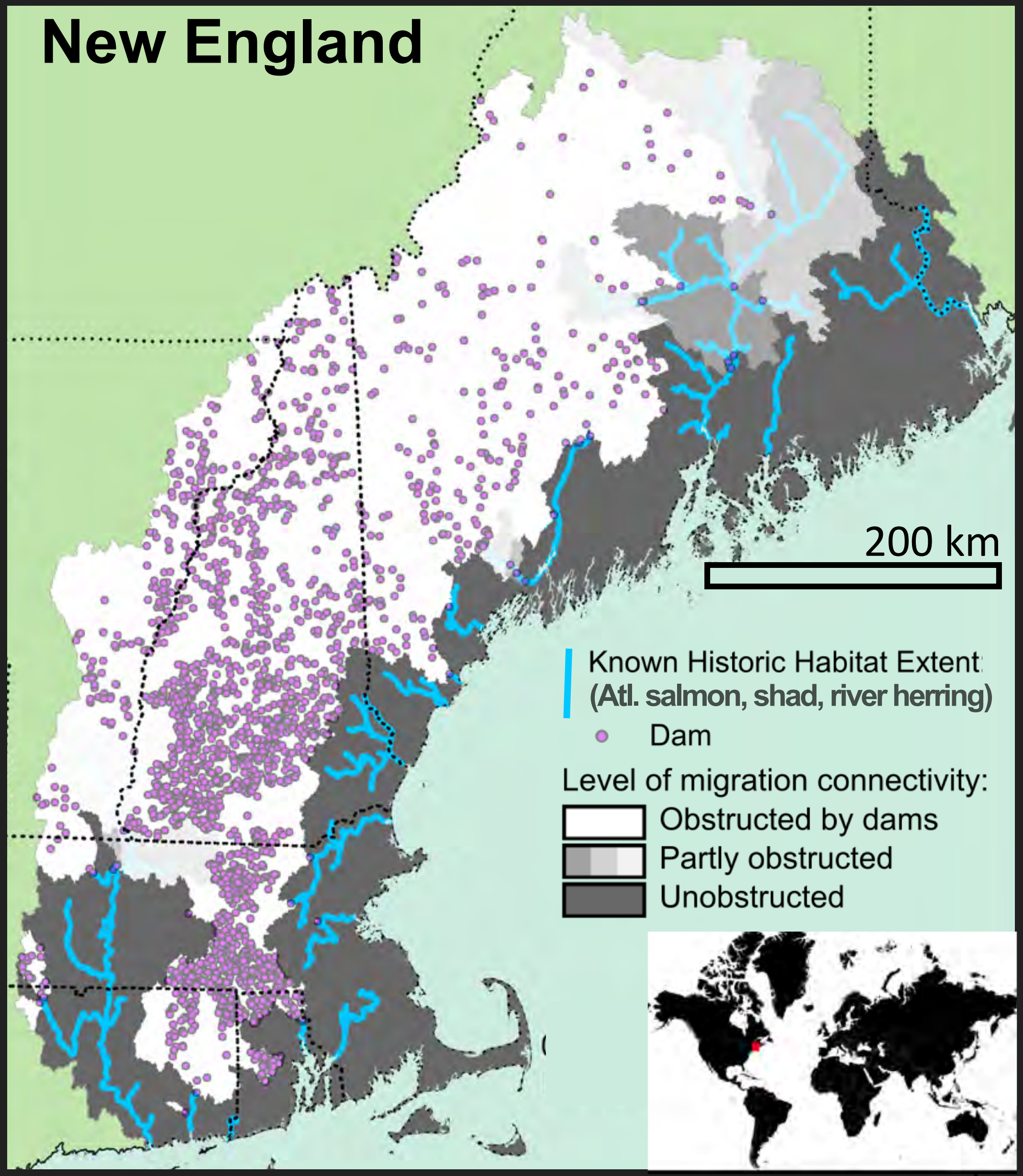

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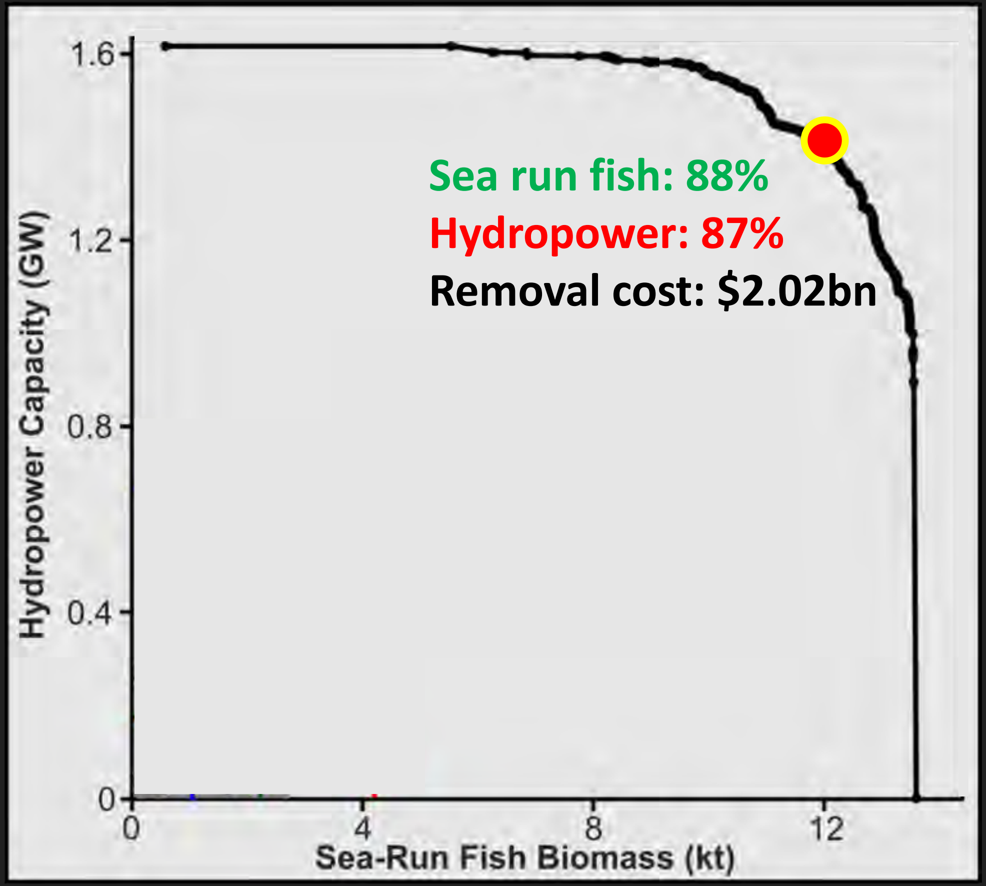

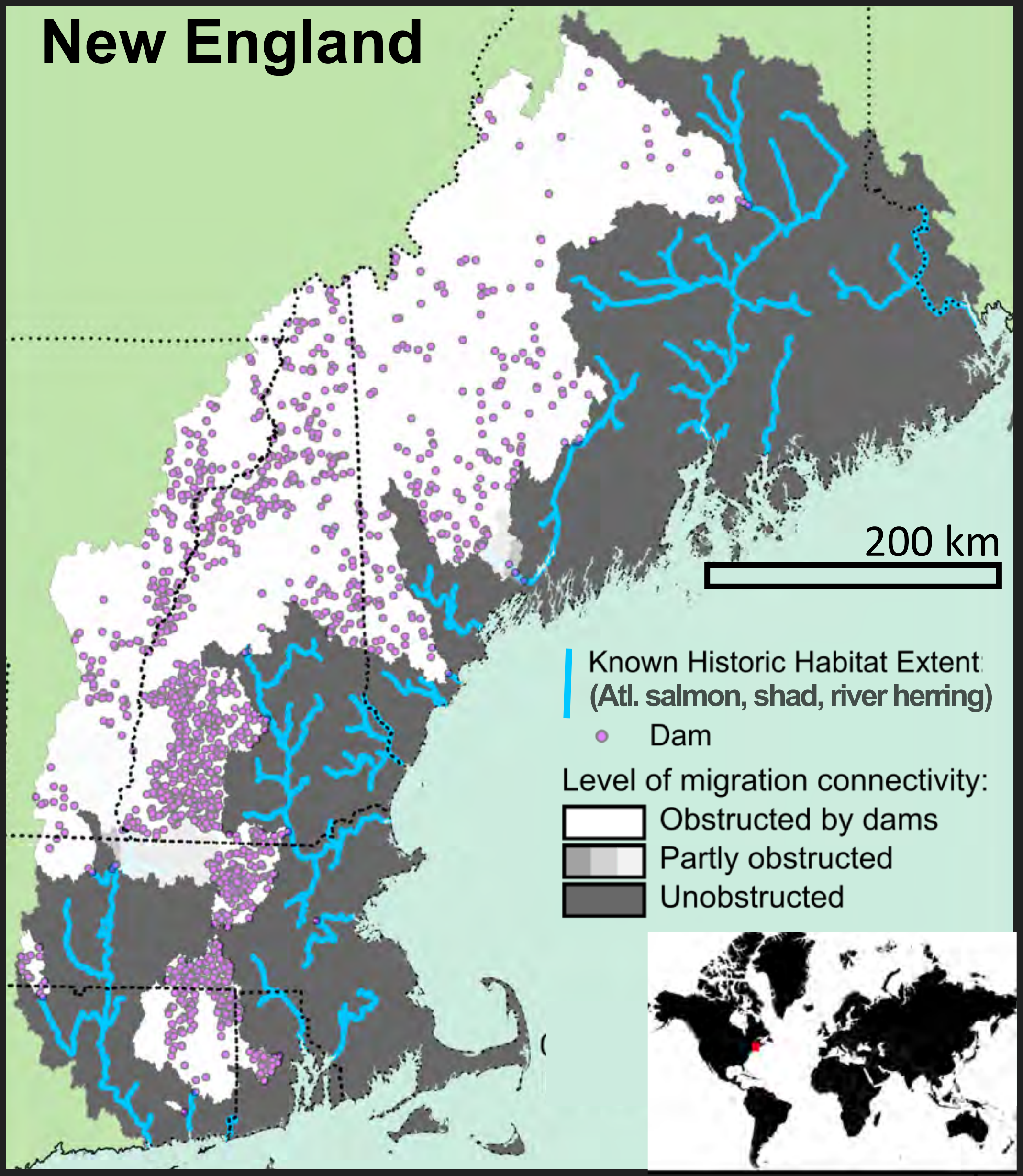

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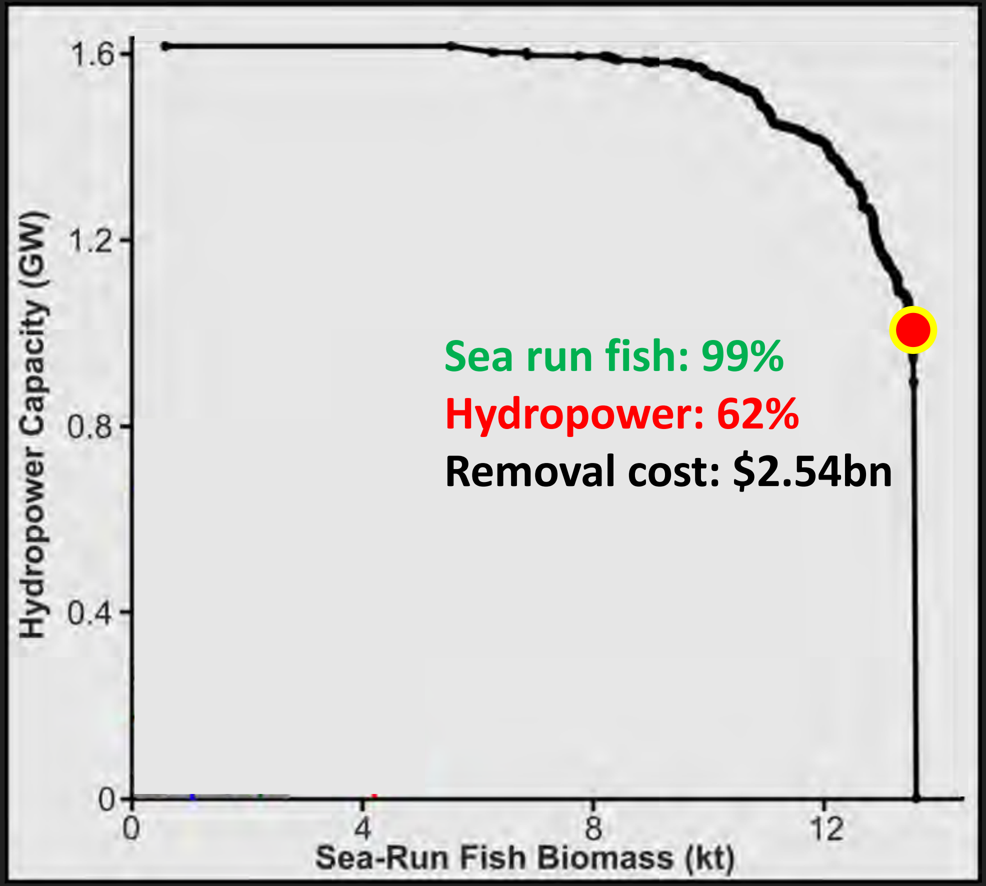
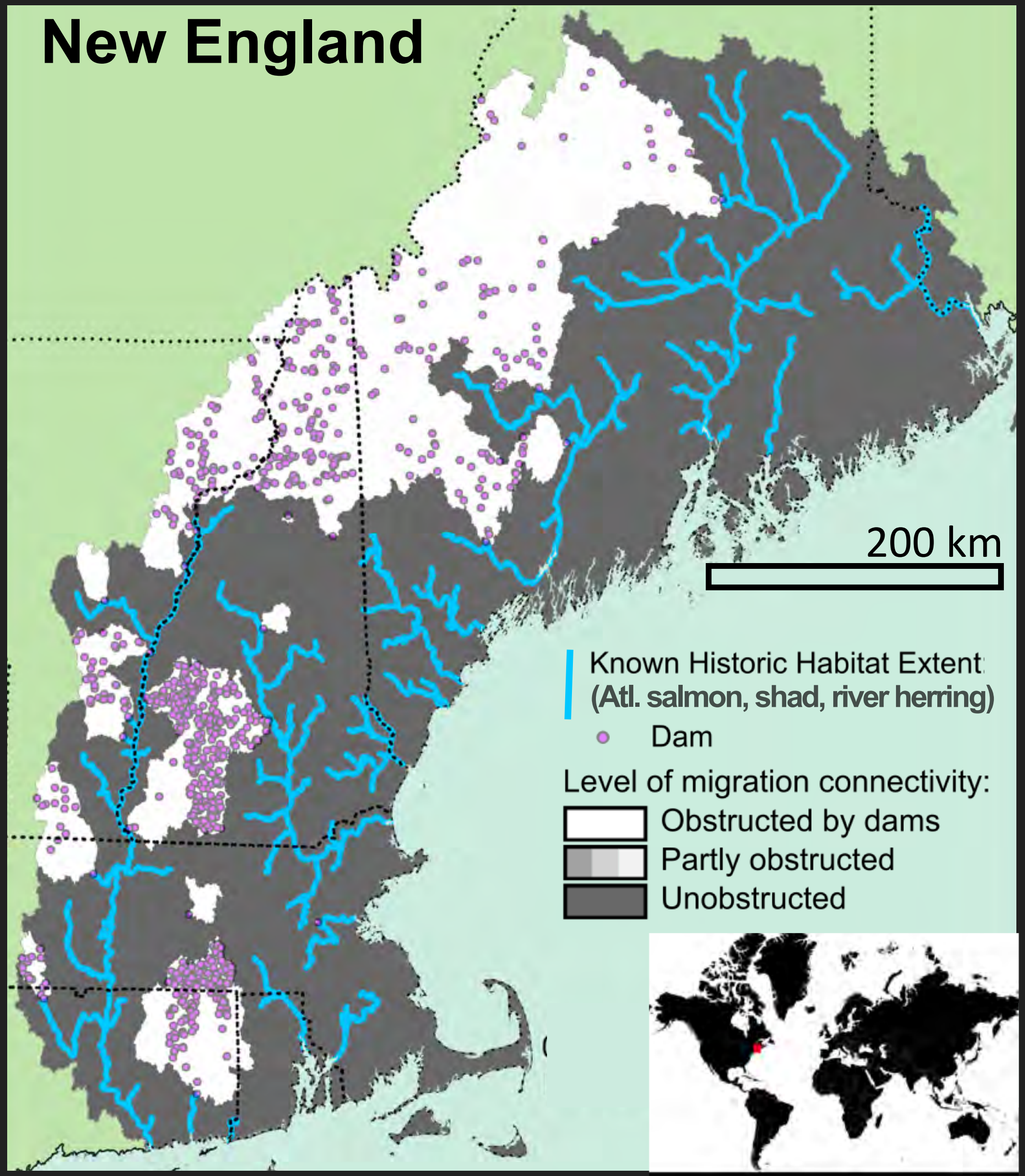
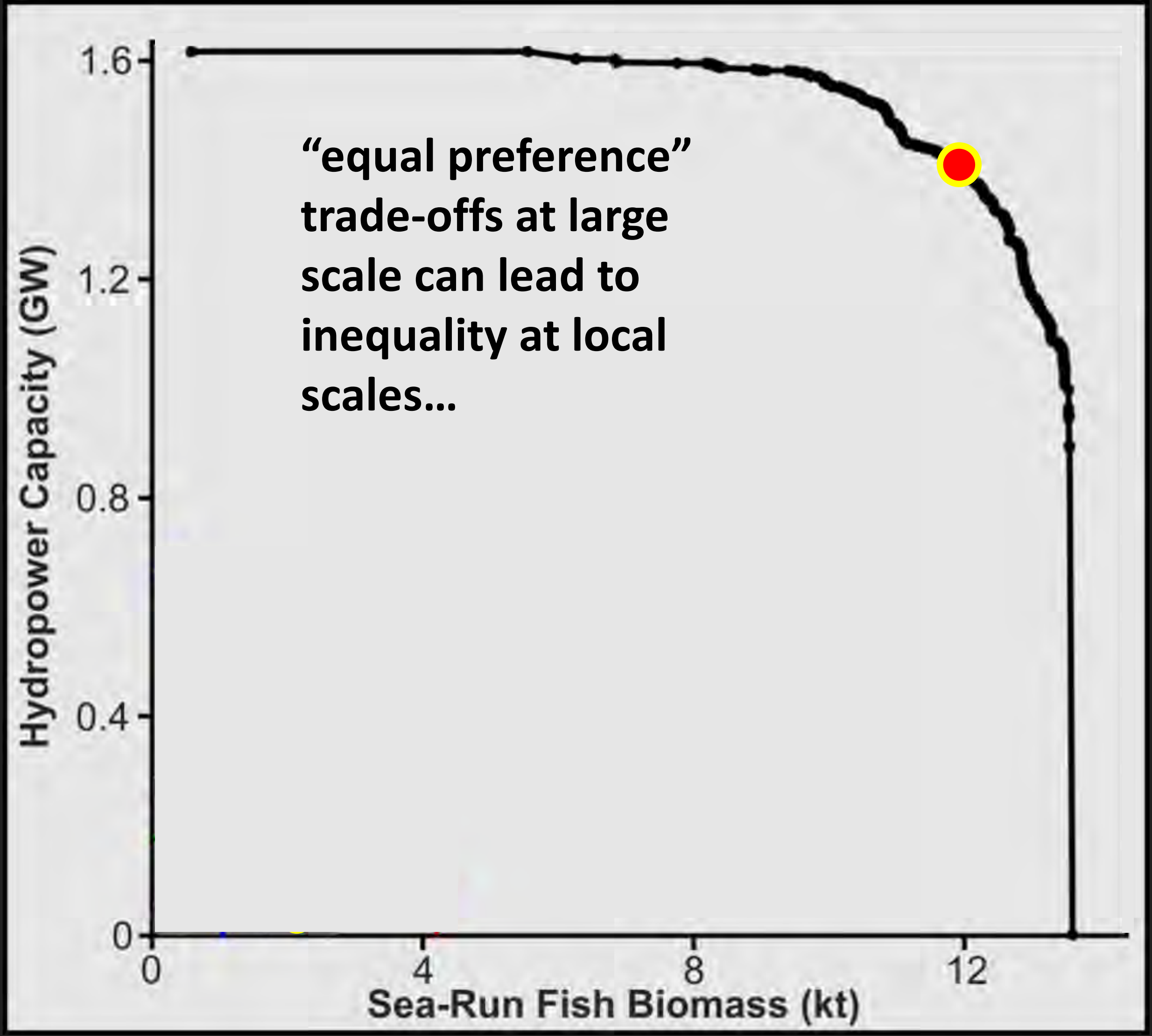
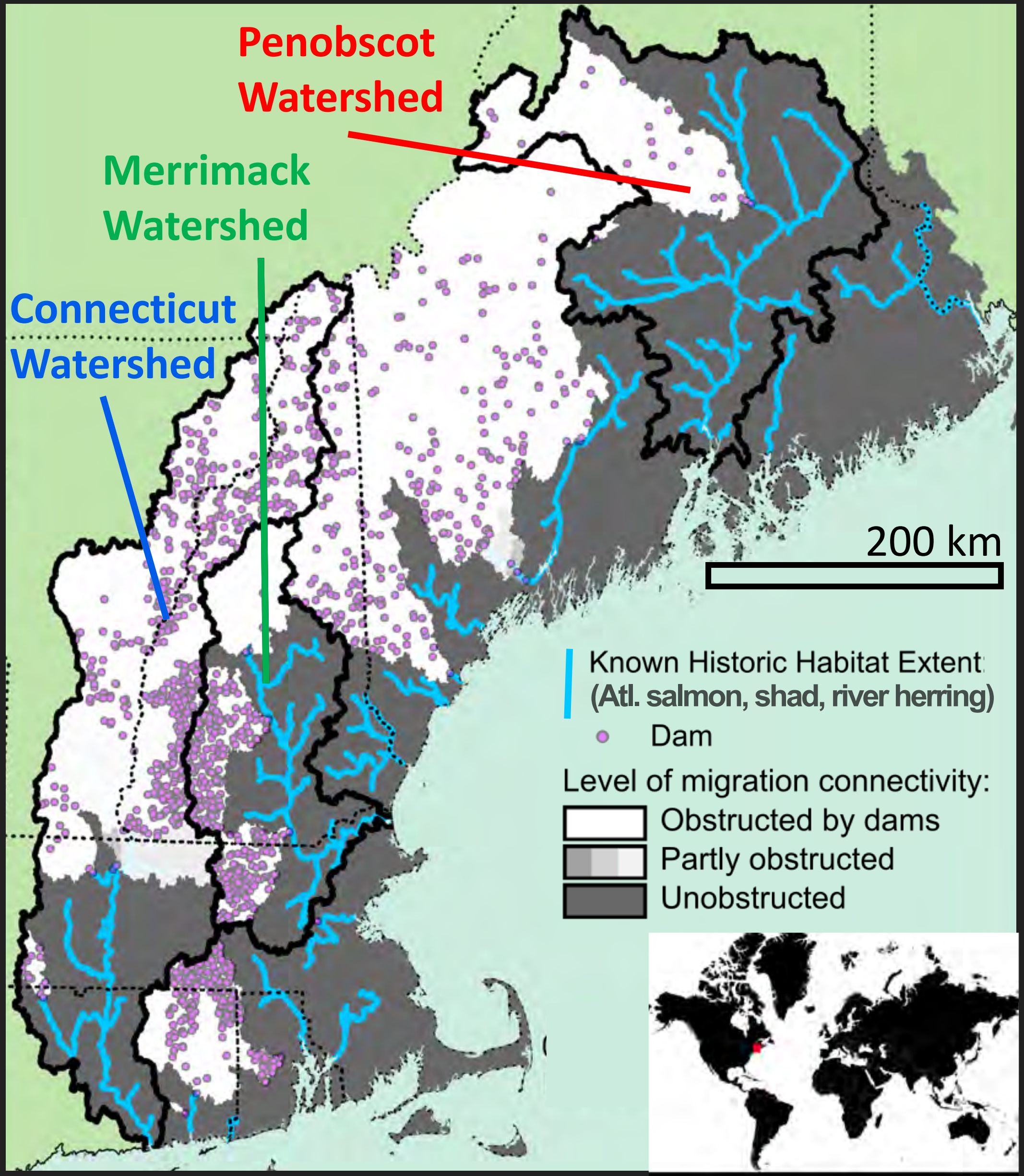




Coordinated dam removal: 2. Significance of scale





Coordinated dam removal:
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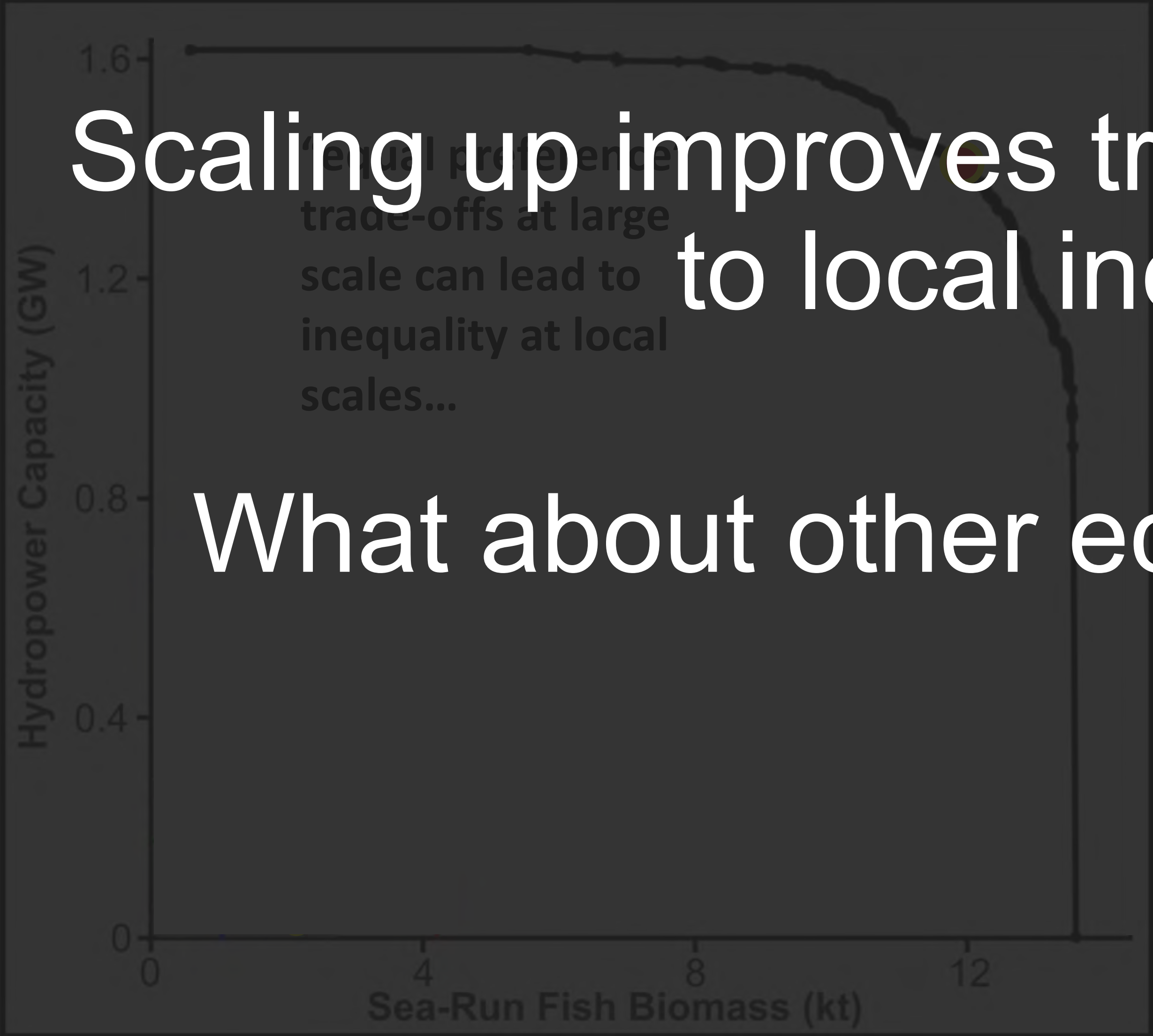
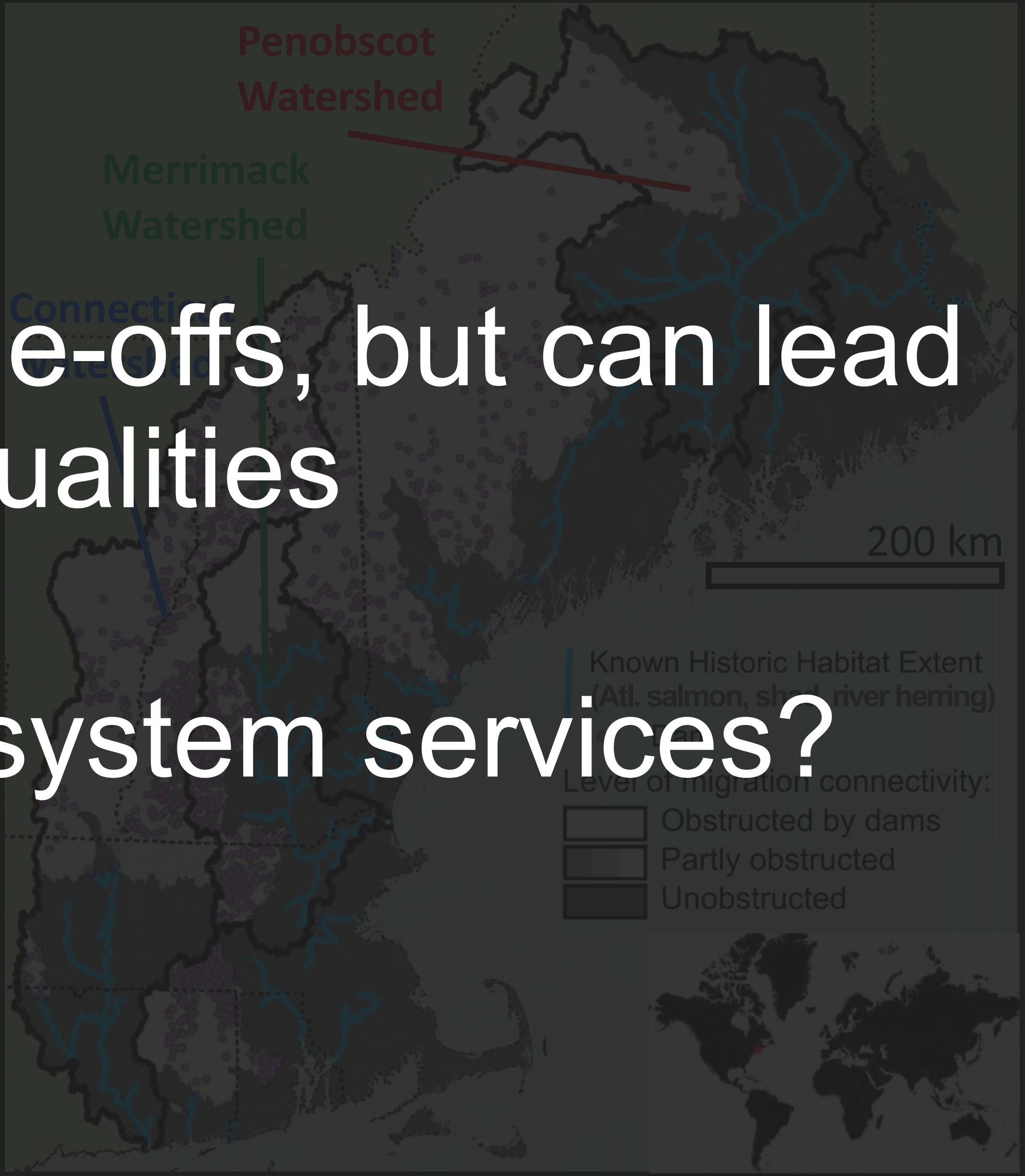


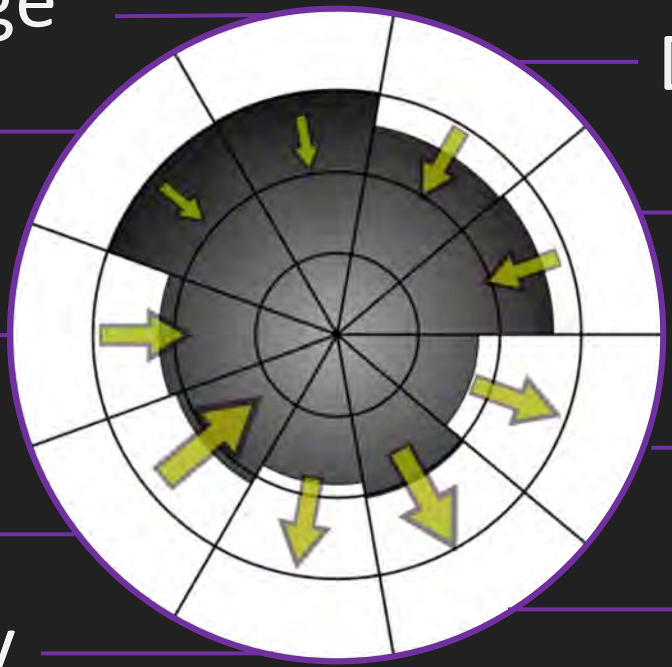


Scaling up improves trade-offs, but can lead to local inequalities

What about other ecosystem services?

Coordinated dam removal: 3. Multiple Criteria

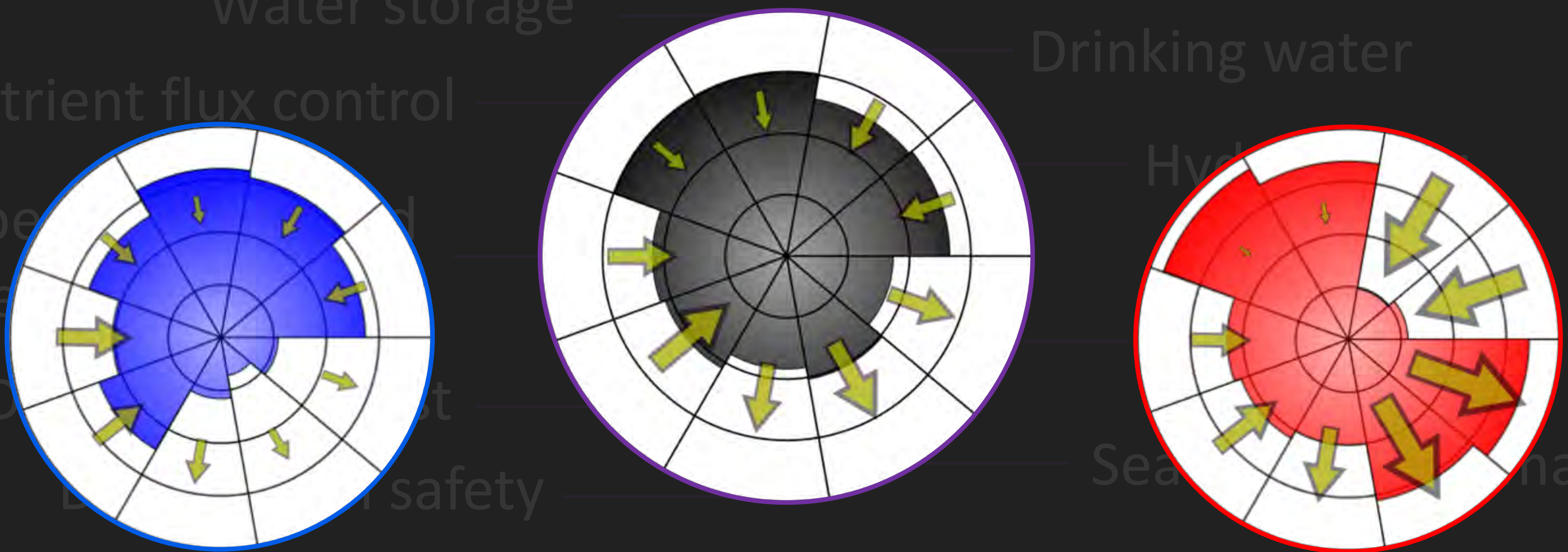
New England: "Equal preference"



Criteria normalized to maximum values, assuming no additional dam construction
Criteria weighed based on hypothetical stakeholder preferences

Coordinated dam removal: 3. Multiple Criteria

New England: “Equal preference”



Connecticut: preserve dam services

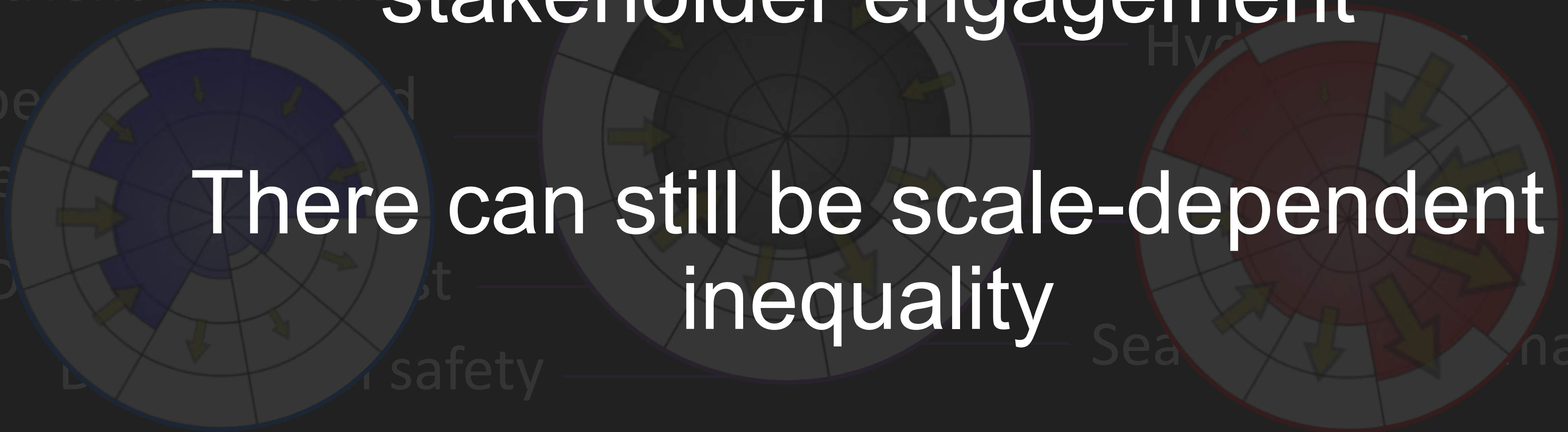
Penobscot: restore fisheries, recreation, preserve lake-related dam services

Coordinated dam removal: 3. Multiple Criteria

More criteria can be useful for diverse stakeholder engagement

There can still be scale-dependent inequality

New England: "Equal preference"



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Dam(n) conclusions

1. New England as a model for informed dam decision-making
2. Decision scale is critical:
    1. Narrow the gap between locally plausible and globally efficient scenarios
    2. Modular decision criteria: iteratively refine based on stakeholder values
3. It takes a village:

Future of Dams: URI Narragansett Campus

Questions?

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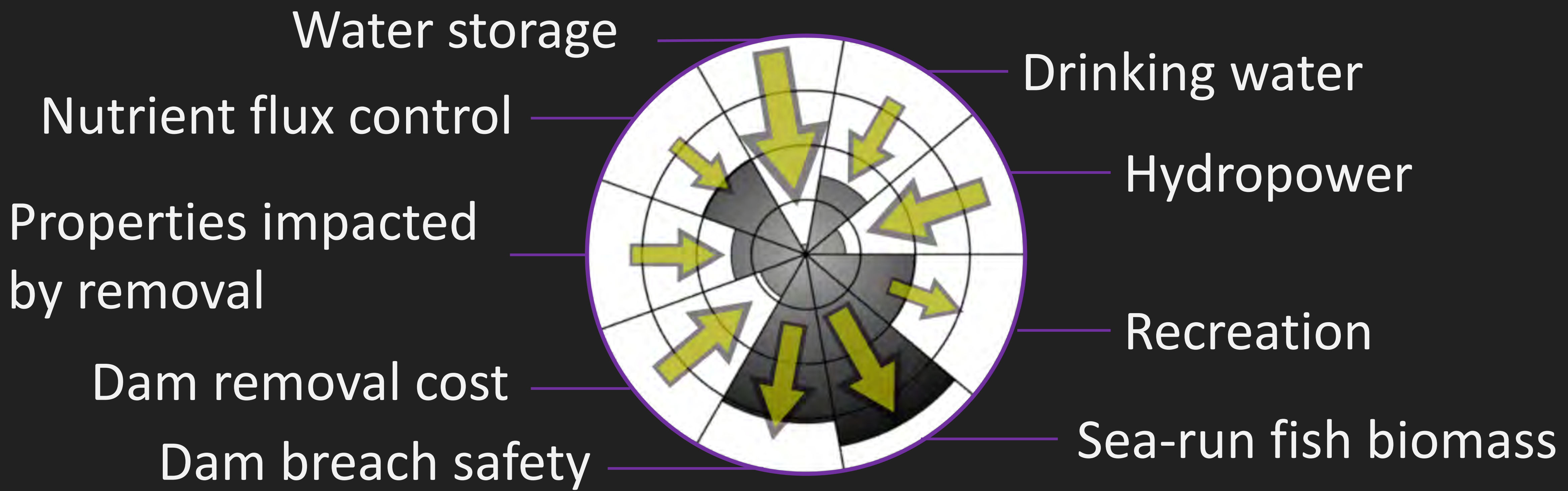
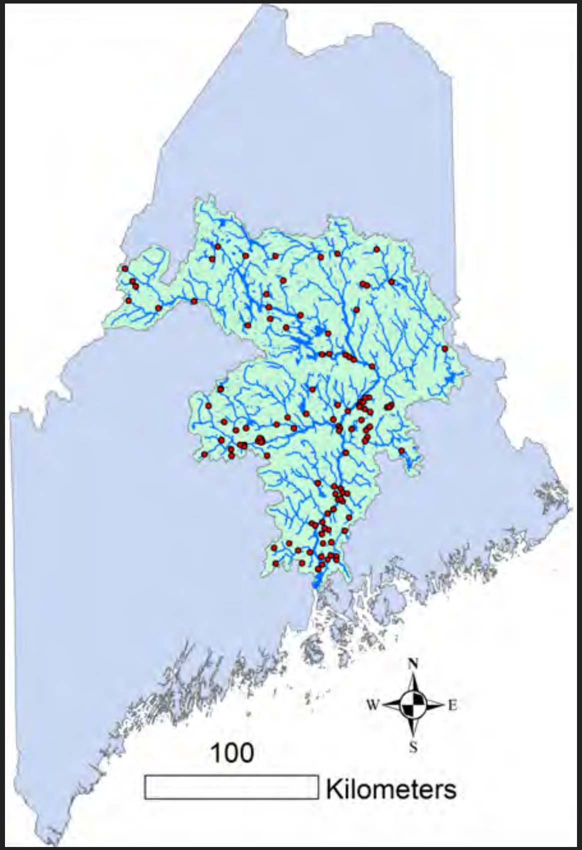
Optimized dam removal: 3. Multiple Criteria

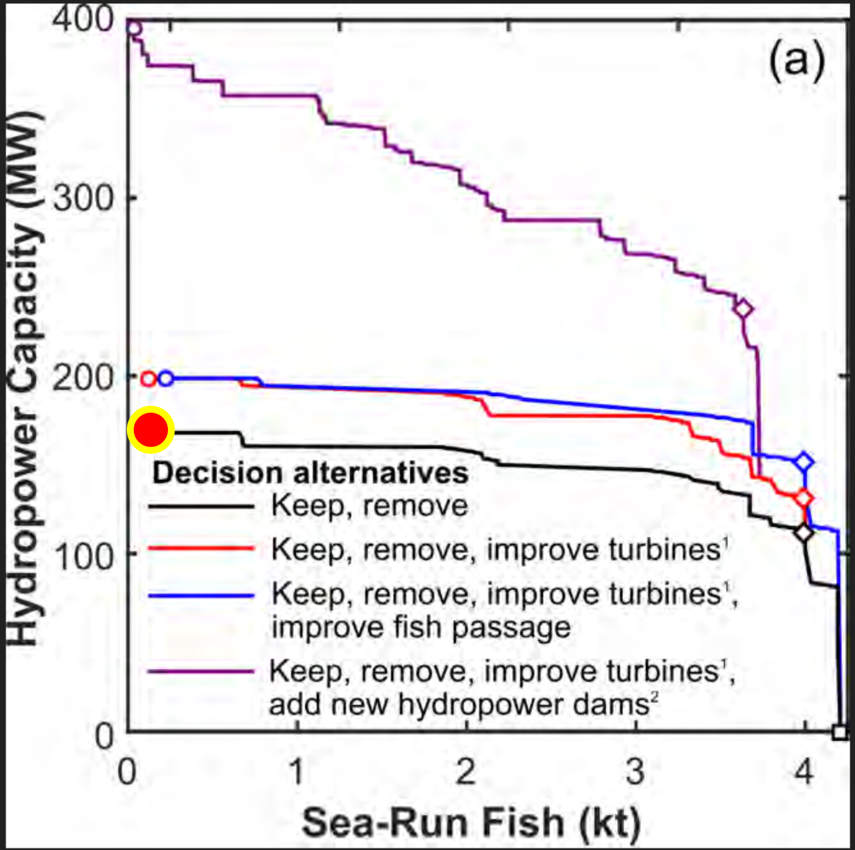
New England: "Eco-restoration"



Criteria normalized to maximum values, assuming no additional dam construction
Criteria weighed based on hypothetical stakeholder preferences

Optimized dam removal: 4. Multiple Alternatives in the Penobscot

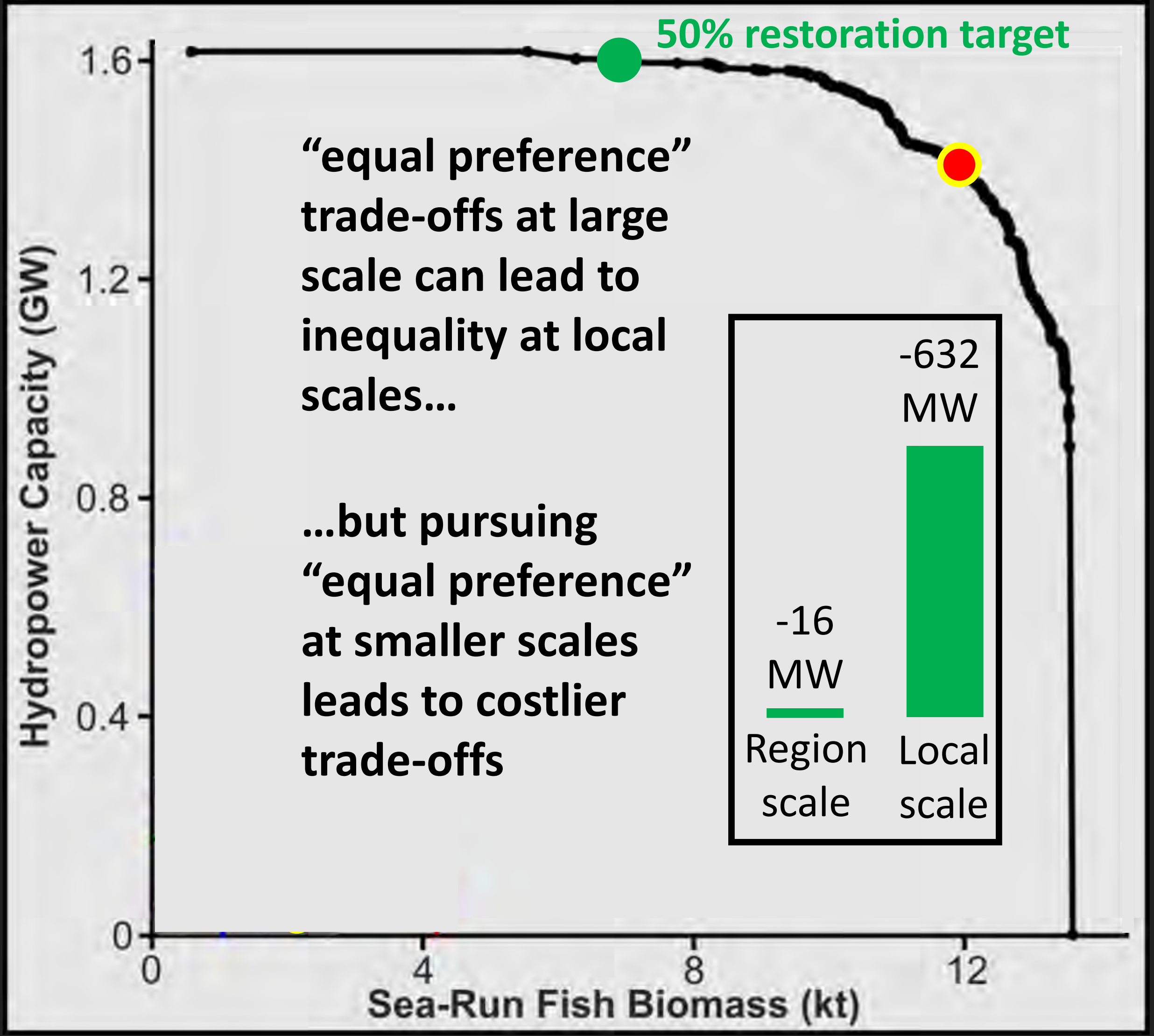


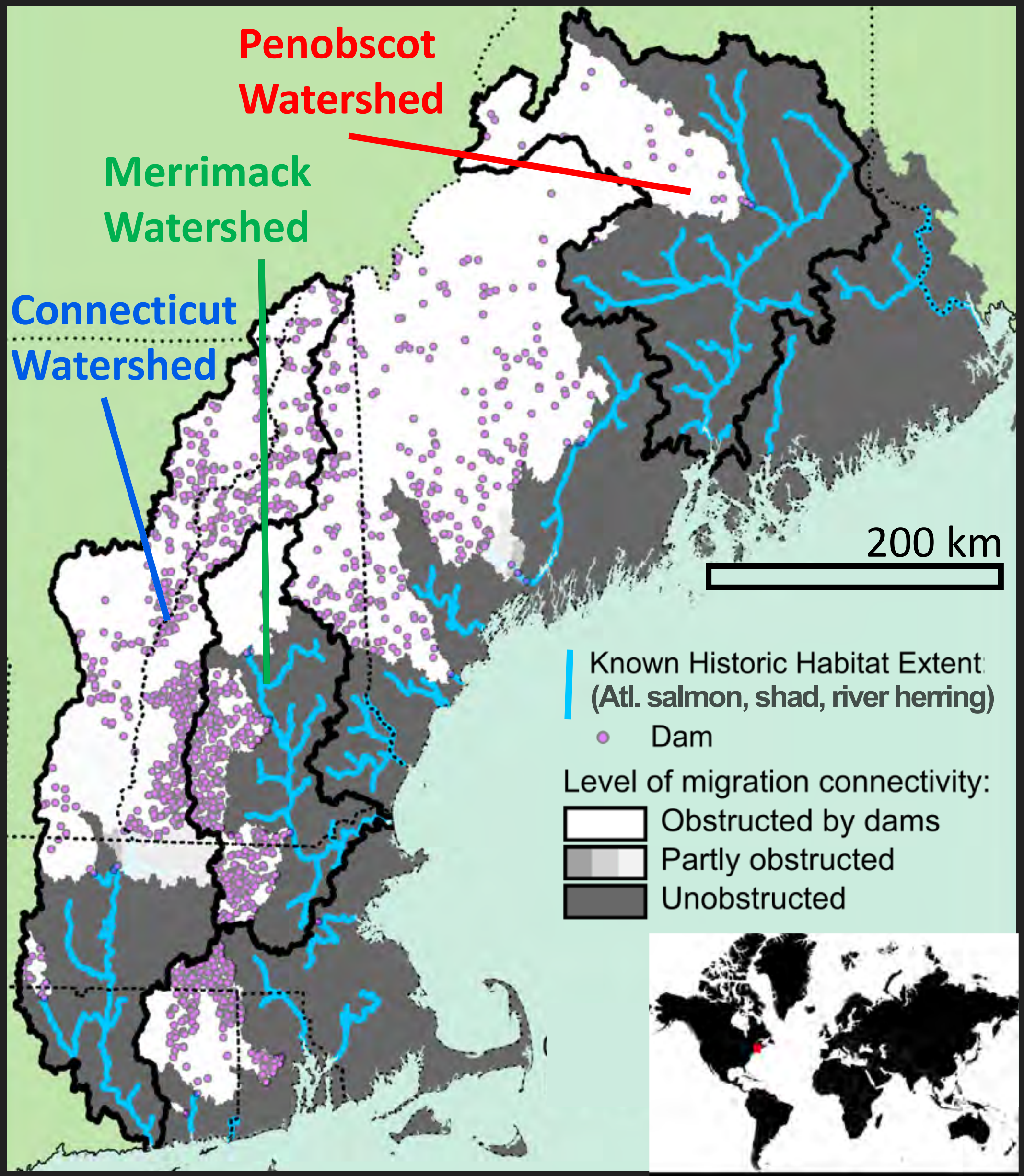


Potential "win-win" scenarios

But, cost of alternatives often far exceed cost of dam removal

Optimized dam removal: 2. Significance of scale





4. Stakeholder perceptions of dam decisions

Different stakeholders

Different perspectives

Different interests

Different objectives

Search for local/regional patterns in stakeholder perceptions to help fine-tune the decision making process

What about potential FERC-related decisions

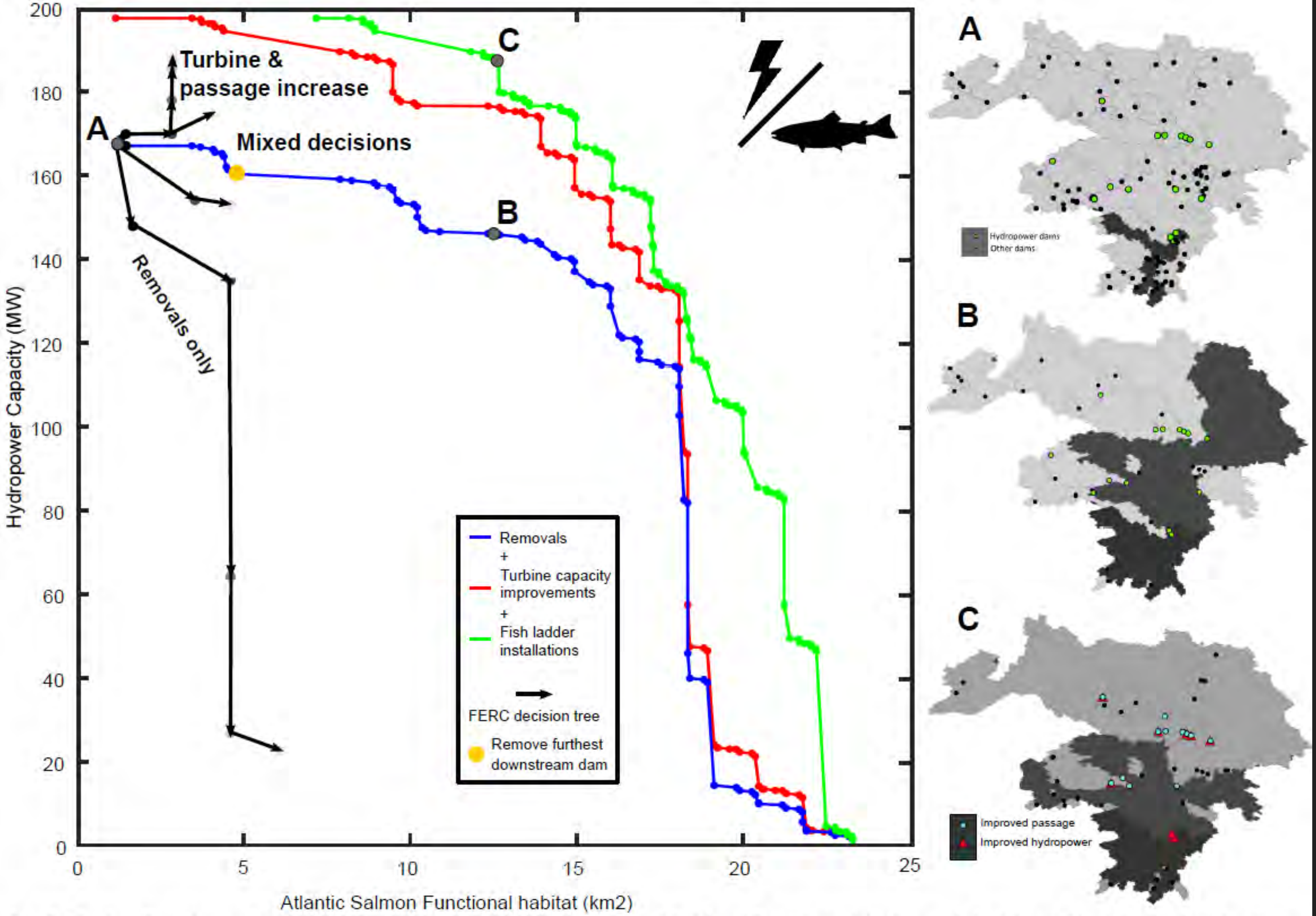
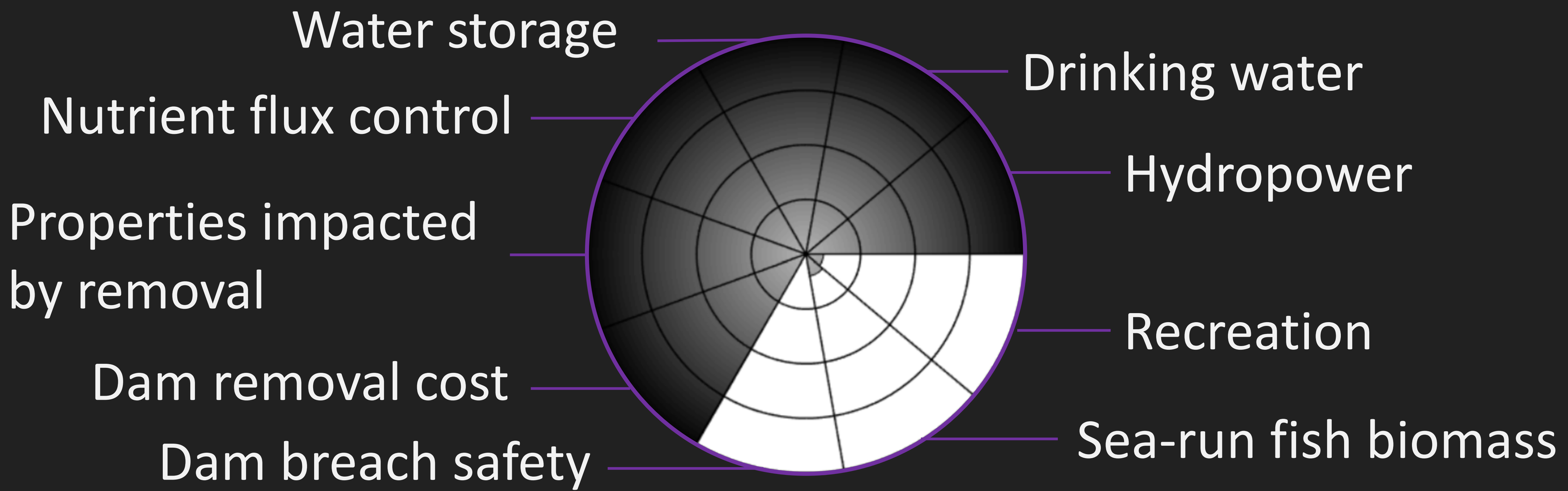


Fig 9: Trade offs between hydropower capacity and Atlantic Salmon habitat for different combinations of decisions. Black lines: decision trees that highlight potential scenarios for renewal in the next 12 years. A: current conditions, B: removals only, C: removals and upgrades.

Optimized dam removal: 3. Multiple Criteria

New England: "Current conditions"



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