Modeling the impacts of stream barrier restoration on watershed-wide aquatic connectivity

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ANEP ▪ November 13, 2025

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Aquatic connectivity in rivers

- The degree in which aquatic habitats are linked, allowing for the movement of organisms upstream and downstream
- Loss of connectivity has contributed significantly to declines in aquatic biodiversity[1,2]
  - Particularly true for migratory fish like diadromous fish

1. Dunn et al., *Proceedings of the Royal Society B: Biological Sciences*, 2019; 2. Silva et al., *Fish and Fisheries*, 2018

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Barriers to connectivity

- Barriers – **dams**, **culverts**, and **bridges** – reduce aquatic connectivity by blocking or limiting passage for aquatic organisms
- Barriers can block fish passage **completely** (e.g., dams), **partially**, or **not at all**

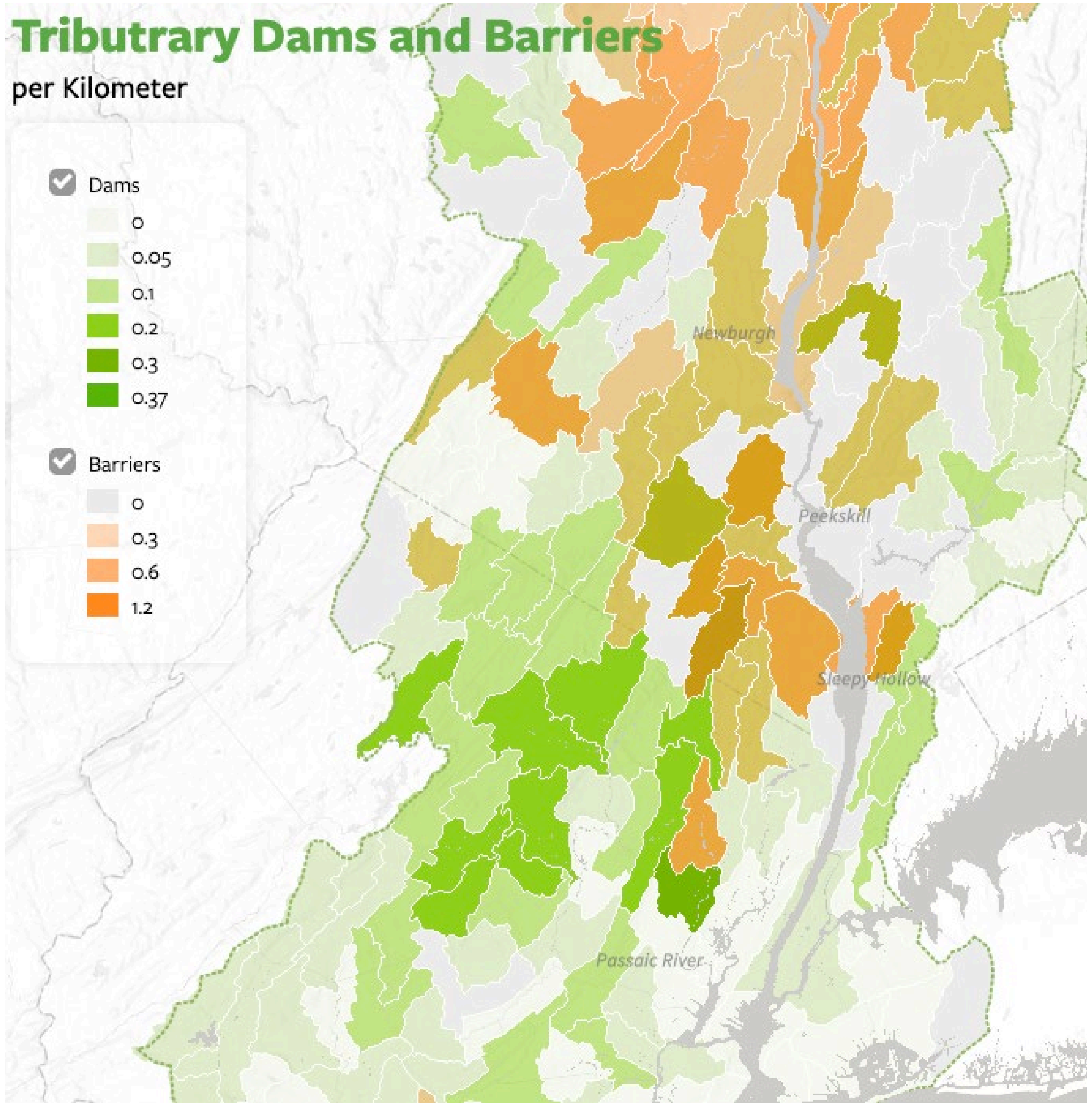
Photo Credit: NY-NJ HEP

Measuring aquatic connectivity at the watershed scale

- Number of dams or barriers per stream km in a watershed
- Stream mileage

These do not consider how partial barriers (e.g., like some culverts) affect connectivity

- **Dendritic connectivity index**



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NY-NJ HEP & NYSDEC HREP, *The State of the Estuary*, 2025

Dendritic connectivity index (DCI)

- **Dendritic connectivity index (DCI)**: Probability of an organism being able to move freely between two random points in the river network[3]
- Considers:
  - **Individual barrier passability and cumulative impact**
  - Barrier location in the stream network
    - Diadromous vs. potamodromous fish
  - Stream mileage

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3. Cote et al., *Landscape Ecology*, 2008

Objectives

- Characterize aquatic connectivity using DCI for coastal New Jersey
- Model improvement to aquatic connectivity with barrier removal to identify most problematic barriers

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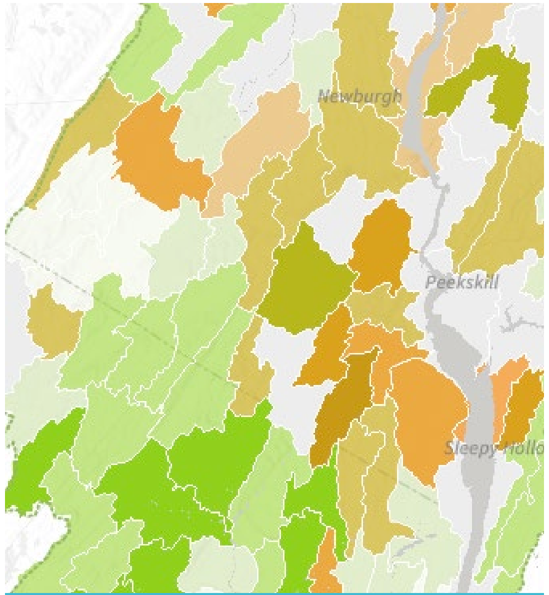

Determine area of interest

- Watershed or sub-watershed
- Region (e.g., coastal New Jersey)

Identify barrier locations

- NAACC* or USGS for culverts and bridges
- Dams from partners or SARP**
- Stream length upstream of barrier

Calculate individual barrier passability

- **Dams**: no passage
- **Culverts** and **bridges**: field assessments (e.g., using NAACC* protocols)

Calculate DCI and model change with barrier removal

- R script to calculate connectivity plot a river network diagram
- Barrier removal impacts to connectivity

* NAACC = North Atlantic Aquatic Connectivity Collaborative (NAACC) **SARP = Southeast Aquatic Restoration Partnership

DCI = 1% → DCI = 13%

>10 times the aquatic connectivity

Severe Barrier

Great Swamp watershed, NJ

- DCI = 1% probability of a diadromous fish being able to move freely between two random points in the network
- Enhancing a **road crossing** (PR1-PR2) increases aquatic connectivity **more than dam removal**

Full Passage

No Passage

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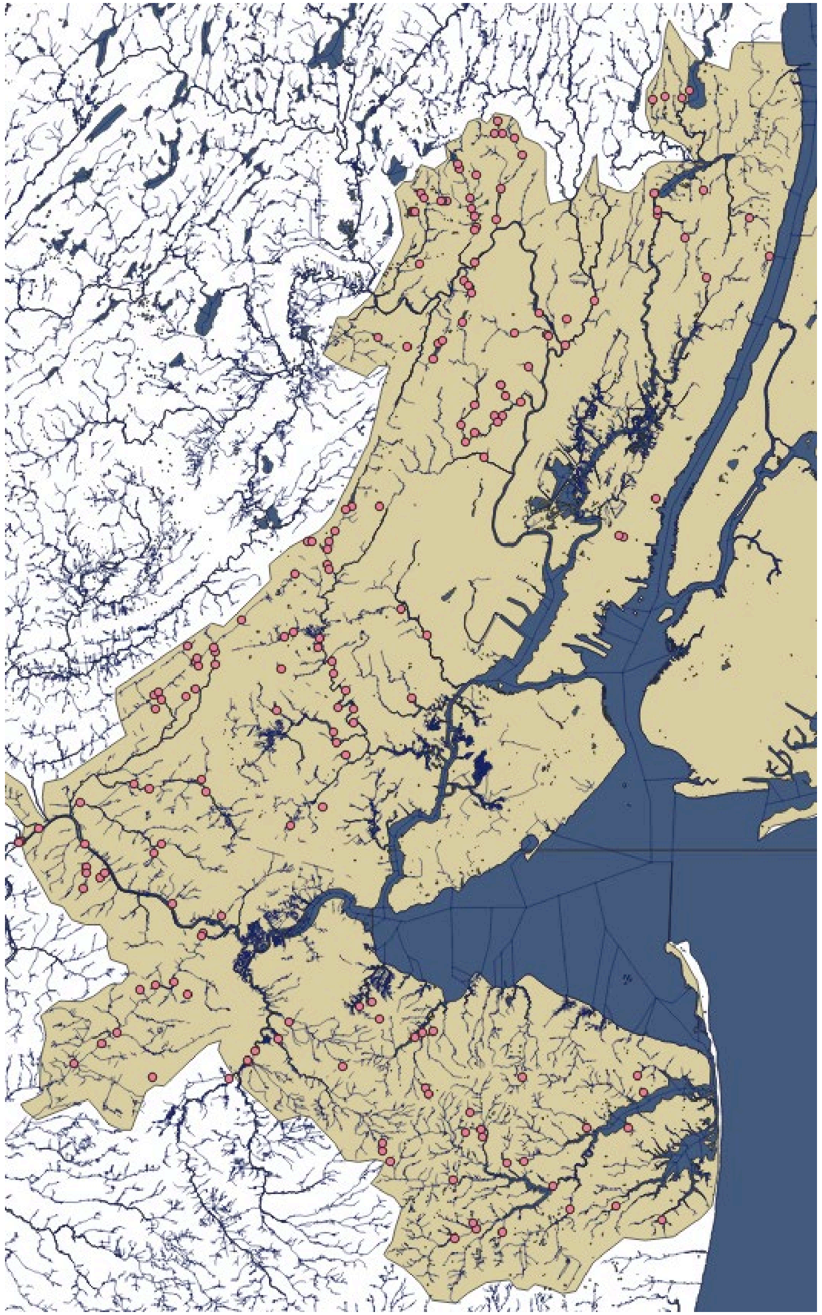
New Jersey dam removal prioritization

- Conducted the DCI analysis for all dams in the coastal/tidal NJ HEP area (183 dams)
- Diadromous fish



Sources: NJDEP (dams), NY-NJ HEP (boundaries), USGS (streamlines)

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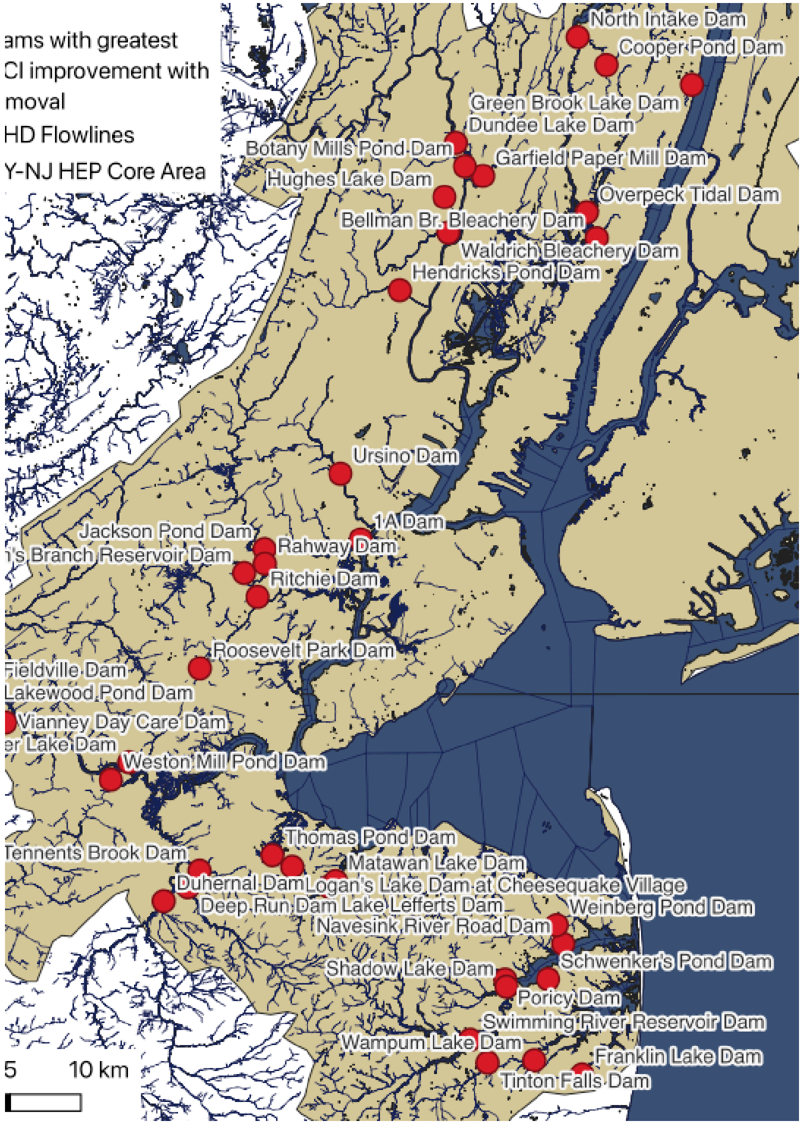
44 dams identified for removal

- Identified 44 dams whose removal would increase the DCI *at all*
  - These were all first barriers to migration
- DCI improvement with dam removal ranged from 4% to less than 0.01%

Analysis did not include other types of barriers



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Identifying barriers for removal

- **Improvements for aquatic passage: DCI**
- Ownership
- Contamination
- Funding availability
- Dam purpose or status
- Public perception

… etc.

Takeaways

- Useful metric for characterizing aquatic connectivity for multiple barrier types *and* prioritizing barrier removal or enhancement for habitat value
- **Dams aren't always the main barrier for aquatic connectivity**
- Caveats:
  - Requires data for every barrier: time and cost-intensive (especially for large areas)
  - Many of the barriers identified may not be possible to remove due to other factors– this is just one metric of many for prioritizing!
- Interested in making this code/tool publicly accessible, if it could add value

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Thank you!

- Isabelle Stinnette (NY-NJ HEP)
- Road crossing evaluators, including:
  - Save Coastal Wildlife
  - Sara Genks
  - Clare Supple
- Matthew Best (Riverkeeper)
- Scott Cuppett (NYSDEC)

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Photo Credit: NY-NJ HEP