Dec 11th, 3:40 PM - 5:20 PM

# Monitoring the Penobscot River Restoration Project: Baseline Data to Inform Ecosystem Response

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# Monitoring the Penobscot River Restoration Project

The Nature Conservancy

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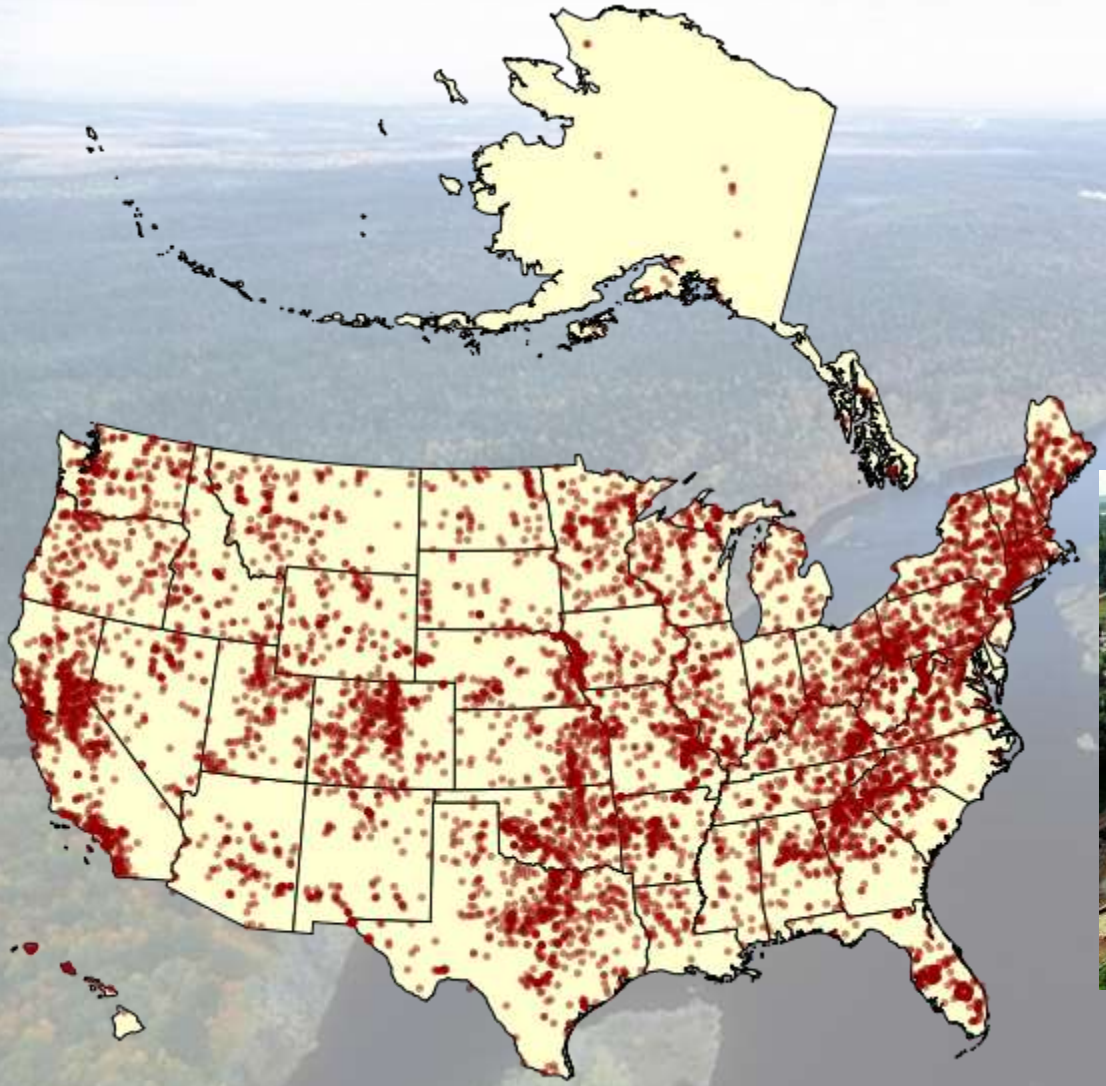
# Acknowledgements

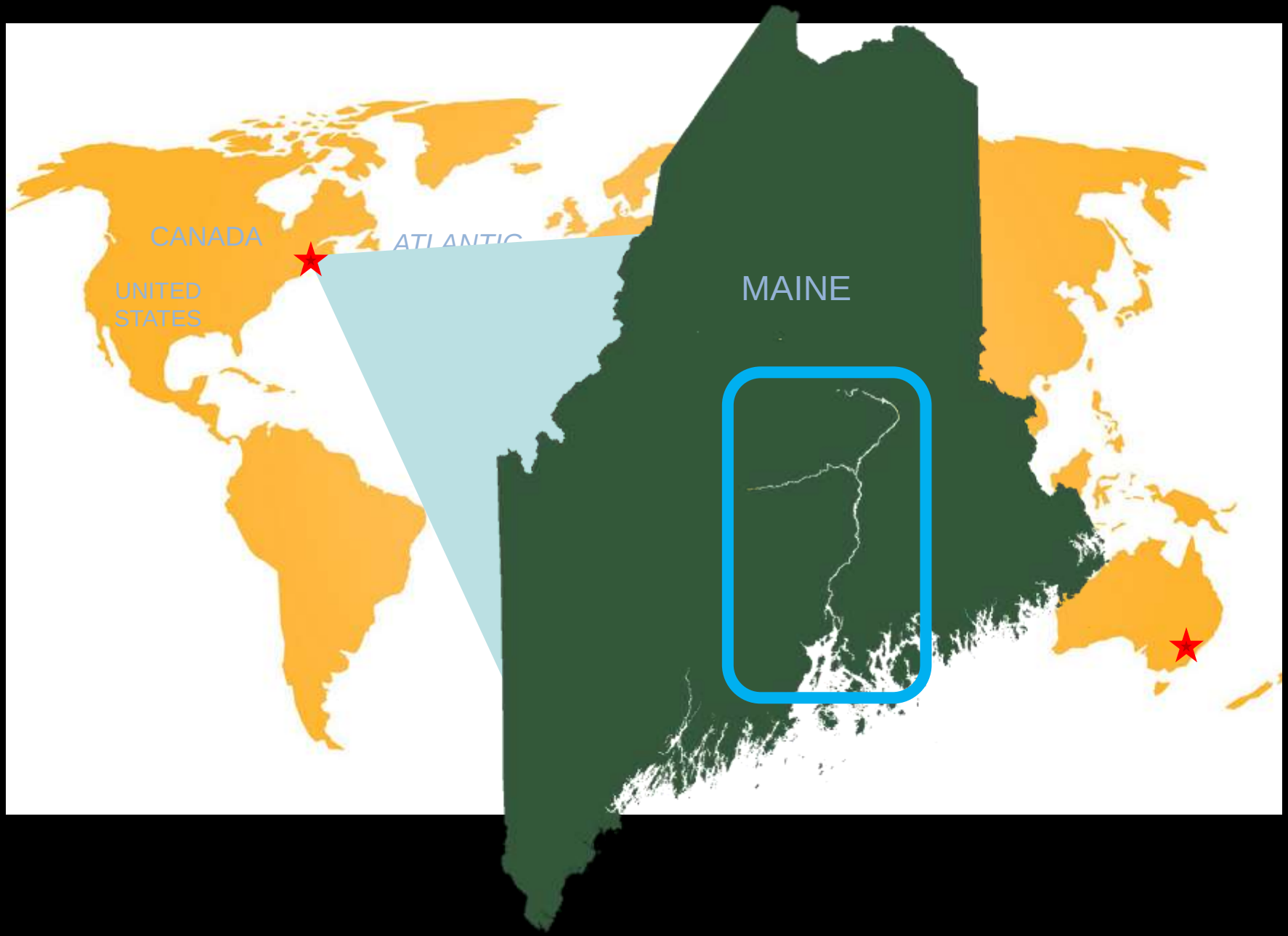
Research Collaborators from:

- University of Maine, Penobscot Nation, University of Southern Maine, Gulf of Maine Research Institute, USGS, NOAA
- Diadromous Species Restoration Research Network (DSRRN), Brookfield Hydro…
- And the countless others who made this work possible…

National Inventory of Dams-
Major US Dams 2006

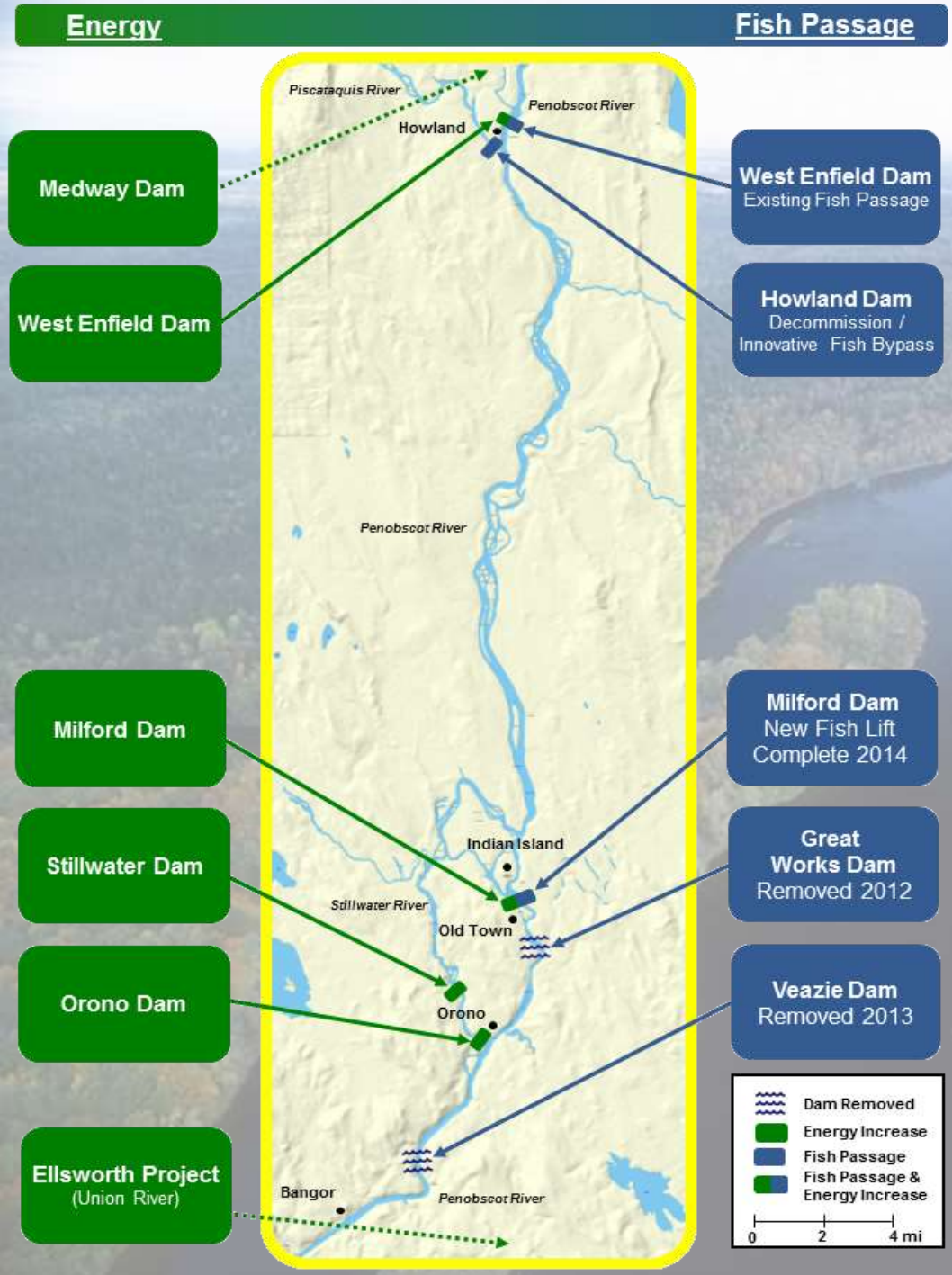
Edwards Dam, Kennebec River
1999




Penobscot River, Maine, a candidate for ecosystem restoration




Comparison of rivers in the Northeast U.S.




# Objectives

**→ Restore:**
12 species of native sea-run fish associated traditions, culture, and economic opportunities

**→ Removed Two Dams**
closest to sea: Veazie & Great Works

**→ Bypass Howland Dam**
for inland habitat access

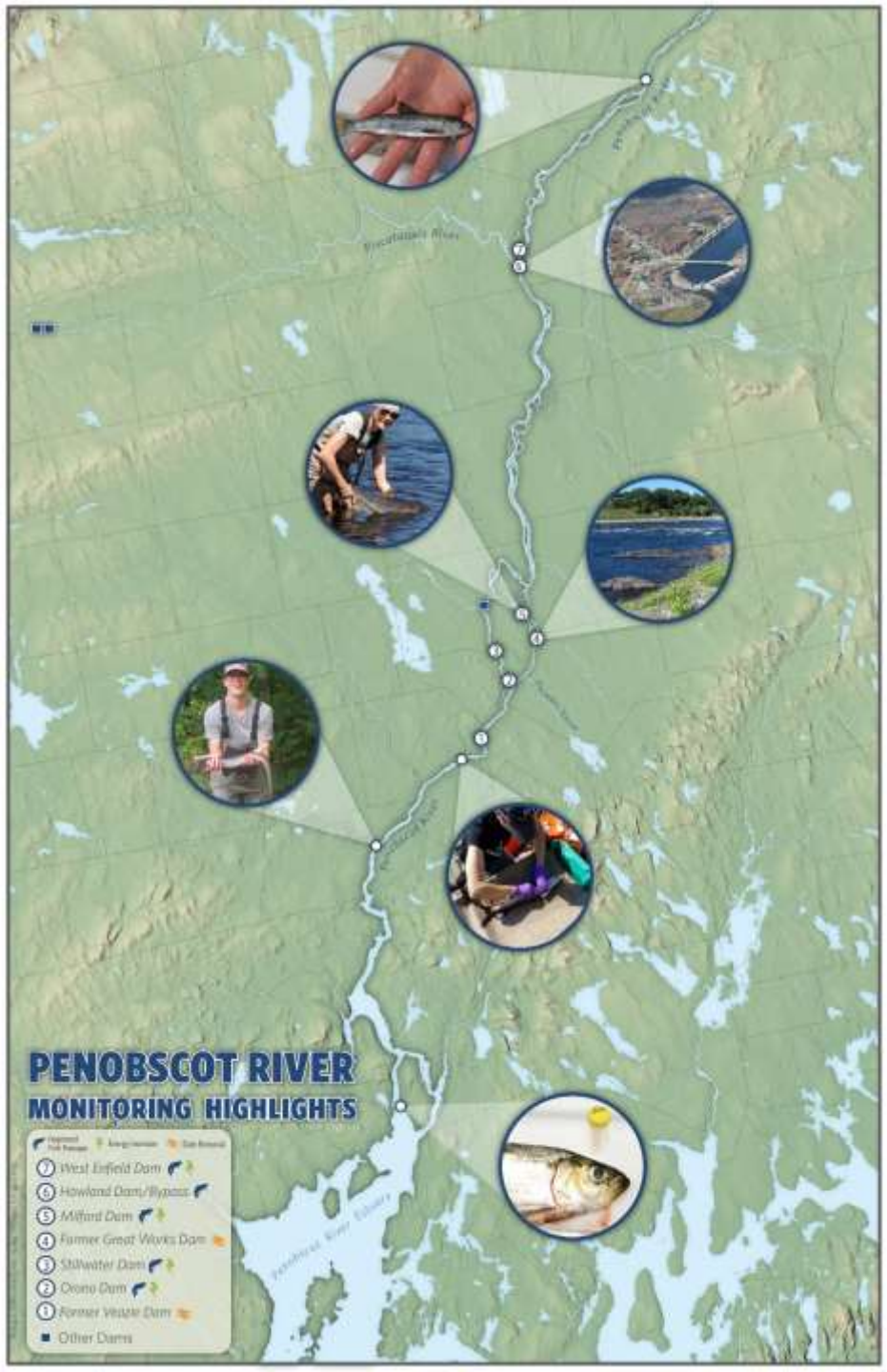
**→ Improved Fish passage**
at four other dams

**→ Increased Energy**
to maintain power generation

**→ Enhanced Habitat Access**
Nearly 3,200 km of historic habitat


CAT

*Photo: CPDaigle/Aerial support provided by LightHawk 06/16/16*




# Ecological Monitoring Framework

- Coordinated effort beginning 4 years prior to dam removal
- Committee formed to help determine priority parameters
- Majority funded with federal awards (NOAA)

# Framework Priorities

Channel Geomorphology

Fish Passage

Water Quality

Fish Behavior

Riparian Zone and Wetlands

Food Web Dynamics

# Additional Research…

Human Dimensions

Passage at Hydroelectric Facilities

Sea Lamprey Ecology

American Eel Phenology

Estuary Dynamics

Riverine Birds

| Project | Objectives | Investigators |
|---|---|---|
| Channel Geometry, Bed Sediments and Photographic Monitoring | channel elevation, sediment characterization, and repeat photographic monitoring at permanent cross sections. | Kelley and Belknap 2012 |
| Water Quality, Water Temperature, and Benthic Marco-invertebrate Monitoring | water quality/chemistry, water temperature, and benthic macro-invertebrates | Kusnierz et al. 2012 |
| Fish Passage: Upstream Passage of Salmon and Other Diadromous Species (PIT tag methods) | PIT tag technology assessments of fish passage and migration timing/movements of Atlantic salmon, American Shad, and alewife. | Sigourney et al. |
| Fish Passage: Seaward Migration of Salmon Smolt (active tag methods) | Movement rates and survival of downstream passage for salmon smolts Passive tracking using an array of acoustic receivers cooperatively maintained by USGS, University of Maine and NOAA. | Stich et al. |
| Fish Passage: Shortnose Sturgeon Habitat Use and Spawning | monitoring of shortnose sturgeon to identify preferred habitat, spawning and population size estimates. | Zydlewski et al. |
| Fish Passage: Diadromous Species Assembling Below Lowest Dam (hydroacoustics) | continuously record the presence and direction of travel of diadromous fish moving through the lower river. | Zydlewski & Erbland 2012 |
| Fish Community Monitoring at the Reach Level (electrofishing and seining methods) | quantify and characterize fish assemblages in the lower ~70 kilometers of river system using electrofishing and other methods. | Kiraly et al. 2012 |
| Wetland and Riparian Habitat Mapping | monitoring of wetland and riparian plants and habitat repeated one year and five years following dam removals. | Boyle Associates 2012; TNC PRRT, et al. |
| Marine-Derived Nutrients and Ecosystem Function (stable isotope methods) | Determine incorporation of marine-derived nutrients and organic matter in to riverine food webs | Wilson and Sherwood 2012 |
| The Penobscot Estuarine Fish Community and Ecosystem Survey | Investigate novel fish capture techniques and hydroaccoustics methods to monitor changes in species composition over time and space in the Penobscot estuary. | NOAA |

# Geomorphology and Hydrology

- Quantify river geomorphology and sediment profile

Little geomorph change (as expected)

# Water Quality

- Benthic macroinvertebrate community composition
- Water chemistry
- Temperature

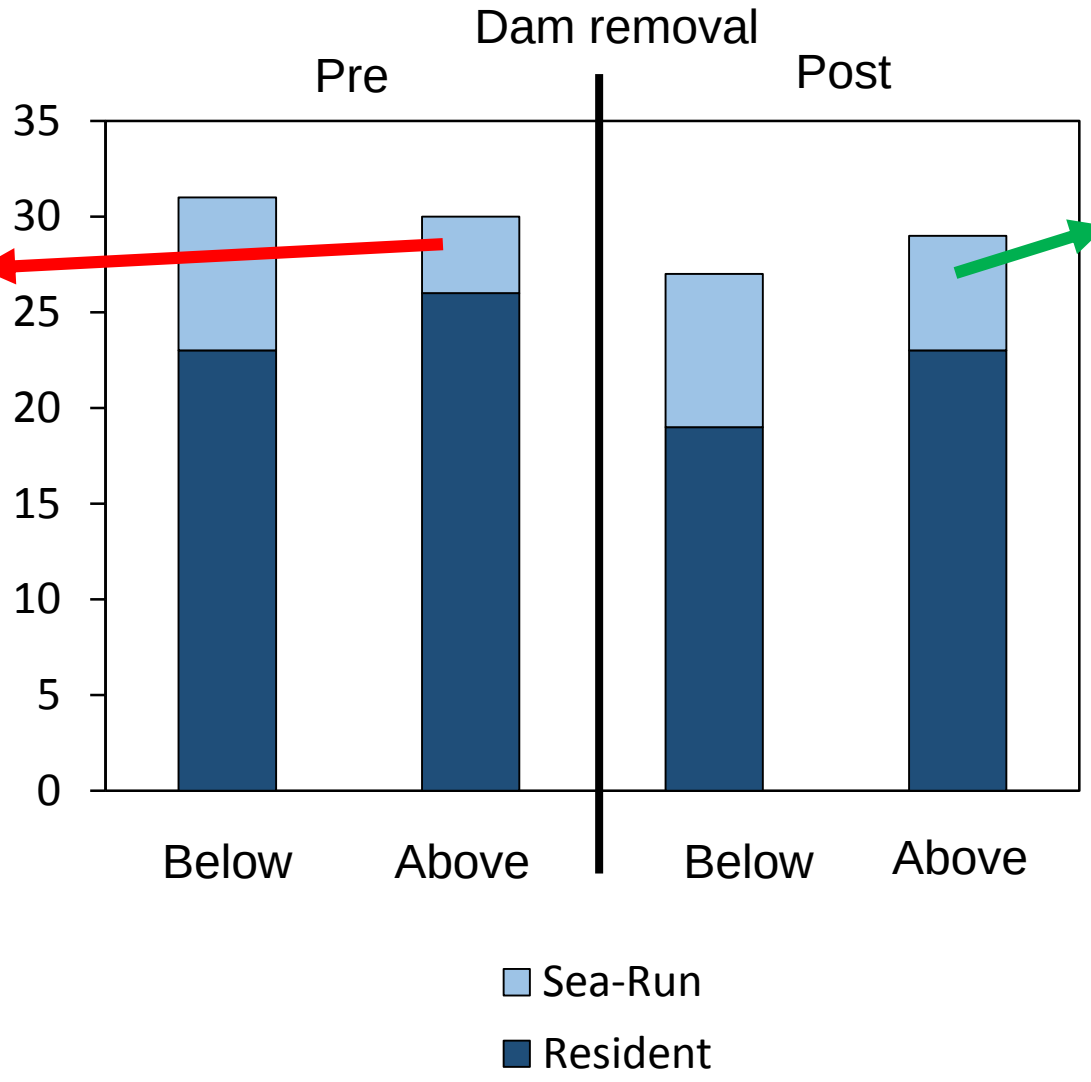
Certain changes linked to dam removal

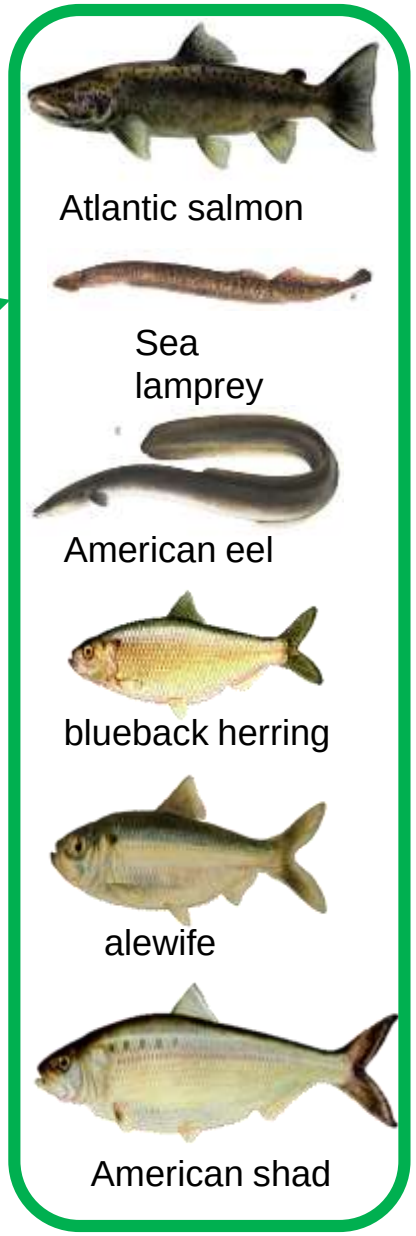
# Fish Community


- Quantify fish community structure
- Hydroacoustics

Significant change to fish community

# Number of Species Documented above and below Veazie dam, Pre vs. Post-Dam Removal


Watson et al. 2018 in review

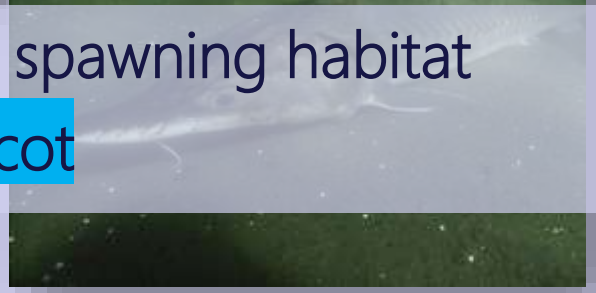
# Fish Passage

- Upstream Passage (Salmon, Shad, Herring)
- Downstream passage (Salmon smolts)

Adult salmon and shad have passed through Howland Bypass

3-8 % smolt mortality at dams; cumulative impacts

# Sturgeon Reproduction and Habitat Use



- Habitat use, movement, assessment of spawning habitat

No evidence (yet) of spawning in Penobscot

Movement in between Maine rivers

# Wetland, Riparian, and Ecosystem Response

- Marine-Freshwater Food Web Linkages (2020)
- Wetland and Riparian Habitat Mapping (2021)
- Estuarine Fish Community Monitoring (ongoing)

# Pre-project Baseline Patterns

1. All 12 native diadromous species of fish are present in the Penobscot River, many of which are successfully reproducing on their own
2. Diadromous species persist despite having access to only a small percentage of their historic habitat
3. Veazie Dam represented a near complete barrier to migration of most species of diadromous fish.
4. Water quality does not appear to be limiting for most diadromous species
5. Large changes to flow, sediment regime, and habitat (except in the immediate vicinity of the former dam sites) are unlikely.

# Baseline Conditions

Importantly, we have a snapshot of pre dam removal conditions and thus an objective basis for evaluation of restoration outcomes post project implementation.


A River Reborn
?
!!!

C. Daigle, PRRT

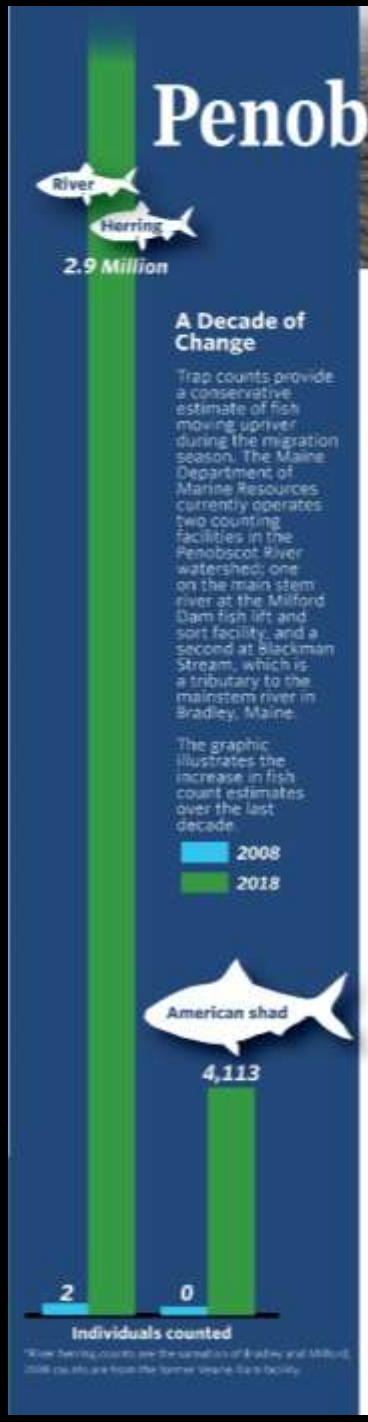
# 2018 Fish Counts

| | |
|---|---|
| **Atlantic salmon** | **772** |
| **River herring*** | **2,174,745** |
| **American shad** | **3,958** |
| **Sea lamprey** | **1,976** |
| **Shortnose Sturgeon** | **2** |

** ME DMR; An additional 540,003 river herring counted at Blackman Stream

2018

# Penobscot River Research Newsletter




The Penobscot River Restoration Project in Maine, USA, an innovative restoration effort aimed at restoring self-sustaining populations of sea-run fish. The project has increased river connectivity via mainstem dam removals and fish passage improvements, while maintaining hydropower output. In 2009, prior to dam removal, researchers began documenting baseline conditions in a multi-disciplinary, coordinated monitoring effort, guided in part by the National Oceanic and Atmospheric Administration's (NOAA) long-term ecological monitoring priorities. This monitoring framework has continued through project implementation, documenting baseline physical and biological conditions of the river. Additionally, state and federal fisheries agencies simultaneously continue ongoing monitoring efforts associated with endangered species and resource management programs. Studies are also underway to address federal permitting requirements specific to hydro-electric dams. On a broader scale, researchers have seized opportunity to address broader questions about restoration impacts to system function.

This year, researchers from academia, the Penobscot Indian Nation and NOAA fisheries, continue projects aimed at evaluating priority ecological parameters of fish passage, water quality, marine connections, and species' life histories on the river. Data collected pre-dam removal continue to illustrate the importance of understanding the complex factors that influence restoration of the Penobscot through fisheries management, operations at remaining hydro facilities, and connectivity between mainstem and tributary habitats. The monitoring framework initiated under the Penobscot River Restoration Project will be incorporated into before-after evaluation of the river, ecosystem, and watershed. This newsletter serves to highlight several on-going research projects conducted on behalf of The Nature Conservancy (TNC), NOAA Fisheries, Penobscot River Restoration Trust, and others. While not an exhaustive list of work, it serves to illustrate the collaborative and comprehensive effort of the monitoring work conducted to date.

*An American Shad is transported from the Milford Fish Lift. ©Catherine Schmitt, Maine Sea Grant*

NOAA FISHERIES

Penobscot River Restoration Trust

The Nature Conservancy

M. Payne Wynne, TNC