Penobscot River Restoration Project, Maine, USA
Early Results and Hydro-balancing Efforts

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The Nature Conservancy’s mission is to conserve the lands and waters on which all life depends.

To solve critical challenges, The Nature Conservancy aims to improve the health of important natural systems that also enhance the lives of people around the world.
The Nature Conservancy is in All 50 US States, 50 Countries

- Land Protection & Management
- Environmental Flows from Dams
- Planning:
  - Reoperate existing hydro for flow & fish
  - Planning new hydro for fish & people
- Dam removal
- Road-stream crossing upgrades
- Climate Change strategies
- Connecting people with nature
Comparison of rivers sizes and numbers of dam in Northeast U.S.
The Penobscot
2.2 M Ha

Maine’s largest watershed

150 dams

85% Forest Lands

Important source of freshwater and historically of fish (16B) for Gulf of Maine

Maine’s 3rd largest City
Bangor

20,117 Km of streams

1830-2013 4% of fish habitat available
Twelve diadromous fish:

- alewife (SC)
- American shad
- blueback herring (SC)
- Atlantic salmon (ES)
- American eel (proposed 4 listing)
- sea lamprey
- striped bass
- searun brook trout (salts)
- rainbow smelt
- tomcod
- Atlantic sturgeon (TS)
- shortnose sturgeon (ES)

future too..hickory shad?
1820 to 2012:
Dams, water pollution & over fishing virtually eliminated sea-run fish from 96% of the Penobscot River Watershed

<table>
<thead>
<tr>
<th>Fish Type</th>
<th>Pre-1820</th>
<th>Pre-Removal</th>
<th>Anticipated Future</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atlantic salmon</td>
<td>75–100,000</td>
<td>1,300 (10 yr. avg.)</td>
<td>10,000-12,000</td>
</tr>
<tr>
<td>River herring</td>
<td>14-20 million</td>
<td>Below 1,000</td>
<td>10-15 million</td>
</tr>
<tr>
<td>American shad</td>
<td>3-5 million</td>
<td>Near 1000</td>
<td>1.5 million</td>
</tr>
</tbody>
</table>
Unprecedented Collaboration
Regulations: FPA, ESA

Fishery on the brink

Motivated Partners

Hydropower Interests
Planning, Licensing, or Reoperation of single dam vs. regional approach

Potential Incremental Improvement in Sustainability

Earliest planning stages
Location(s) selected
Design(s) complete
Project is built

Single project
Regional approach

Existing
Future
Project Objectives

→ Removal of Two Mainstem 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 1,000 miles of historic habitat

→ Help Restore: 11 species of native sea-run fish associated traditions, culture, and economic opportunities
Penobscot River Restoration Project

Before and After Habitat Access

Existing Access for Sea-Run Fish

- Diminished use of upstream spawning habitat by salmon and eels
- Little or no commercial, recreational, or tribal sustenance fisheries

Significantly Improved Access for Sea-Run Fish to

- >2,600 km of habitat
- Saved use of upriver spawning habitat for salmon, shad, alewife, blueback herring, and eels
- Full restoration of historical habitat and access for salmon, shad, alewife, blueback herring, eel, striped bass, sturgeon, smelt, and tomcod
- State of the art passage for salmon, alewife, shad, and blueback herring

Little if any passage of shad, alewife, blueback herring, striped bass, sturgeon, smelt, and tomcod, impaired passage of eels

Little or no commercial, recreational, or tribal sustenance fisheries

Underused state of the art upstream fish passage
Partners in the Penobscot River Restoration Project

Penobscot River Restoration Trust = Penobscot Nation

[Logos of various partners]
Project Milestones
Great Works
Dam Removal
Milford Fish Lift
Howland Fish Bypass
Nature-like Fish Bypass
Town Riverside Park under construction
Project Monitoring: Before - After Approach
Renewable Energy Results

BEFORE

AFTER

Energy exceeds “Before”

All together this is < 3% of the wind generation developed in the last decade in Maine
Baseline Conditions
1) Water chemistry, temperature, and macroinvertebrates
2) River channel morphologic changes
3) River Bank re-vegetation & mussels
4) Salmon & herring passage at dams sites & lift
5) Sturgeon movement into reopened habitat & spawning
6) Silver eel & juv. salmon outmigration timing & mortality
7) Fish community changes (IBI sampling)
8) Fish movement & population change indices (S-Scanning-Sonar)
9) Human well-being (World Bank survey methods)
10) Marine & Freshwater nutrient transfer (Stable Isotope Analysis)
11) Sea lamprey nutrient transfer & ecosystem impacts
Why Monitor?

• To ensure strategies work
• To prove what was there before (future deniers)
• To show project successes or failures – for adaptive management
• To promote dam removal strategy broadly
• To connect people to the wonders of rivers
Shortnose sturgeon (E)

- Unknown ➔ now 800+ confirmed
- Wintering grounds (DIDSON) video
- Travel through marine to spawning river

Scouting habitat upstream in 2015-16

American shad

- Thought gone prior to study
- Study estimate ~1,000
- Baffled by prior fishway over weeks

2016 Counts at Milford: 7,805
(more downstream)
Riparian, Riverine, & Marine Ecosystem

Nutrient (Stable Isotope) analysis: algal slime to predatory fish

River bird use & abundance: surveys & nutritional changes
## Fish Lift Passage Results to date

<table>
<thead>
<tr>
<th>Species</th>
<th>2013 (removal)</th>
<th>2014</th>
<th>2015</th>
<th>2016*</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Shad</td>
<td>near 0</td>
<td>805</td>
<td>1,806</td>
<td>7,867</td>
</tr>
<tr>
<td>River Herring</td>
<td>&lt; 1,000</td>
<td>367,000</td>
<td>909,000</td>
<td>1,803,062</td>
</tr>
<tr>
<td>Atlantic Salmon</td>
<td>~1,000</td>
<td>255</td>
<td>731</td>
<td>509</td>
</tr>
<tr>
<td>Sea Lamprey</td>
<td>?</td>
<td>641</td>
<td>485</td>
<td>4,945</td>
</tr>
</tbody>
</table>

* October 3, 2016 count totals from Milford and Orono Dams and Blackman Stream
34 of 46 tagged Atlantic salmon successfully passed up and downstream through #Penobscot River Restoration's Howland bypass!

Unstocked alewives just found 134 mi. up Penobscot R., 90 mi. past current 1st dam. Amazing fish! Remove barriers, rivers & fish respond!
Aquatic Connectivity Restoration Continues
Other Dam Removal or Fishways in Maine: moderate to great returns

River herring from zero to 2- to 3 Million herring
Largest run in the West Atlantic

Milltown & Grand Falls Dams, St. Croix River
2,000 to to over 3 Million

Three other coastal dam removal/fish passage projects since 2,000
100’s to 10’s of thousands of fish

Economic returns from many Maine towns: harvests >$200,000/year
Applying Lessons of Hydro & Ecological Balance Elsewhere
Projects The Nature Conservancy has been working on solutions the past 20 years
CONTEXT: RAPID GROWTH OF HYDROPOWER

For years the environmental community has tried to stop dams, but construction is ramping up again.
Example of environmental impact to be addressed at basin scale
Breaking of upstream connectivity of river for migratory fish

- Even the best, state-of-the-art fish passage is only partially capable of passing fish.

- Some percentage efficiency is assigned to each passage.

- If multiple dams are located on one tributary the combined efficiency is the product of those efficiencies.

\[ 50\% \times 50\% \times 50\% = 12.5\% \]
If one dam is located on each major tributary in a basin the combined effect is the sum of the tributary effects.

- 50% blockage for Whole Basin -- Only half the fish reach their destination
Example of environmental impact to be addressed at basin scale
Breaking of upstream connectivity of river for migratory fish

- If development of basin were planned to build the three dams on one tributary - and to commit to leave the other two undammed -- the most fish reach their habitat
Summary

- Penobscot River restoration/rebalancing – a win-win
- $$$ but encouraging results (for most species)
- Planning before for hydro, rivers & people → reduces high-cost & mixed results of repairing damaged system
- Technology is improving, but...
- Fish passage at dams: is not for whole Rivers
- Document successes & failures and share!
Gracias, Thank you, Merci, Obrigado,
Dank je, Tack, Tak, Danke, Grazoe,
Kiitos, Mulumesc, Hvala

Questions?

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