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

Penobscot River watershed, Maine, USA

Joshua Royte, Conservation Scientist

The Nature Conservancy
Protecting nature. Preserving life.

European Dam Removal Conference, Leon, Spain
November 14th, 2016

St. John River the North Woods, Maine ©Ami Vitale

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

London, Berlin, Brussels

Balkan Rivers

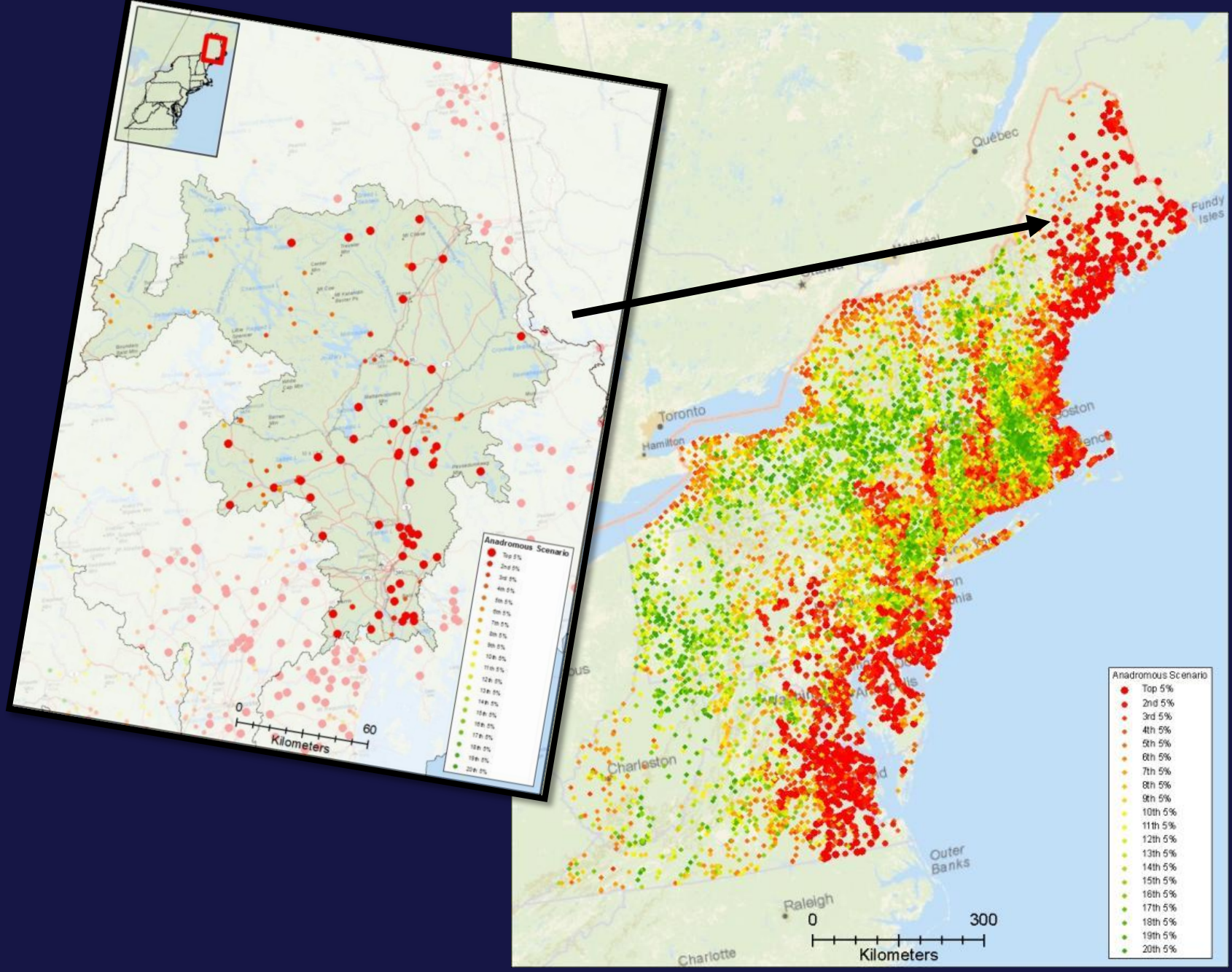
India

Myanmar

Gabon

South Africa

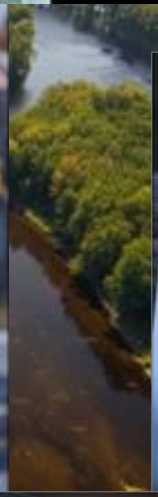
New Zealand?


Québec
Fundy Isles
Toronto
Hamilton
Charleston
Outer Banks
Raleigh
Charlotte
0
300
Kilometers
Anadromous Scenario
Top 5%
2nd 5%
3rd 5%
4th 5%
5th 5%
6th 5%
7th 5%
8th 5%
9th 5%
10th 5%
11th 5%
12th 5%
13th 5%
14th 5%
15th 5%
16th 5%
17th 5%
18th 5%
19th 5%
20th 5%
0
60
Kilometers

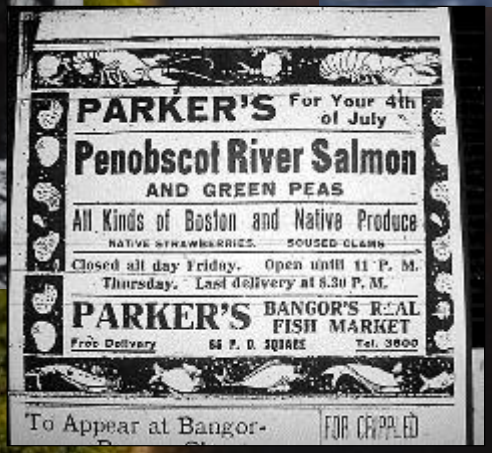
Comparison of rivers sizes and numbers of dam in Northeast U.S.

The Penobscot


HOME OF THE
PENOBSCOTS




CLOSED TO
ALL
FISHING
Penobscot River:
From the Veazie Dam to downstream side of Bangor Water District Pipeline (approx. 3100 feet) marked by 2 red posts on either side of the river in Eddington.


PARKER'S For Your 4th of July
Penobscot River Salmon
AND GREEN PEAS
All Kinds of Boston and Native Produce
Closed all day Friday. Open until 11 P. M. Thursday. Last delivery at 8.30 P. M.
PARKER'S BANGOR'S REAL FISH MARKET
Free Delivery 66 P. O. SQUARE Tel. 3800
To Appear at Bangor-


VEAZIE
SALMON CLUB

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

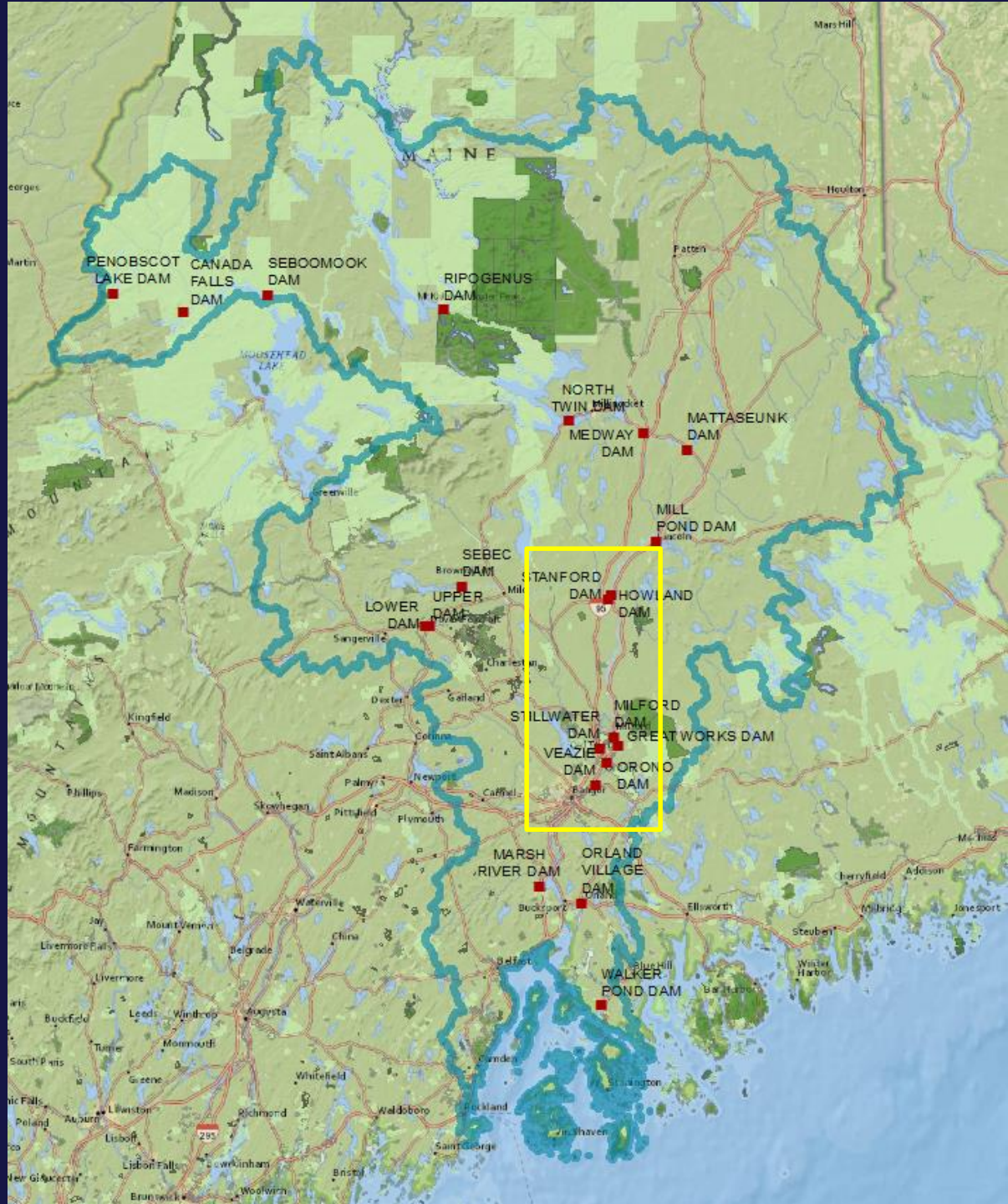



Photo by Linwood Rigg, courtesy of Penobscot River Restoration Trust


(c) Cheryl Dalgle 2013


Photo by Doug Watts, courtesy of
Penobscot River Restoration Trust

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

	Pre-1820	Pre-Removal	Anticipated Future
Atlantic salmon	75–100,000	1,300 (10 yr. avg.)	10,000-12,000
River herring	14-20 million	Below 1,000	10-15 million
American shad	3-5 million	Near 1000	1.5 million


Unprecedented
Collaboration

Regulations:

FPA, ESA

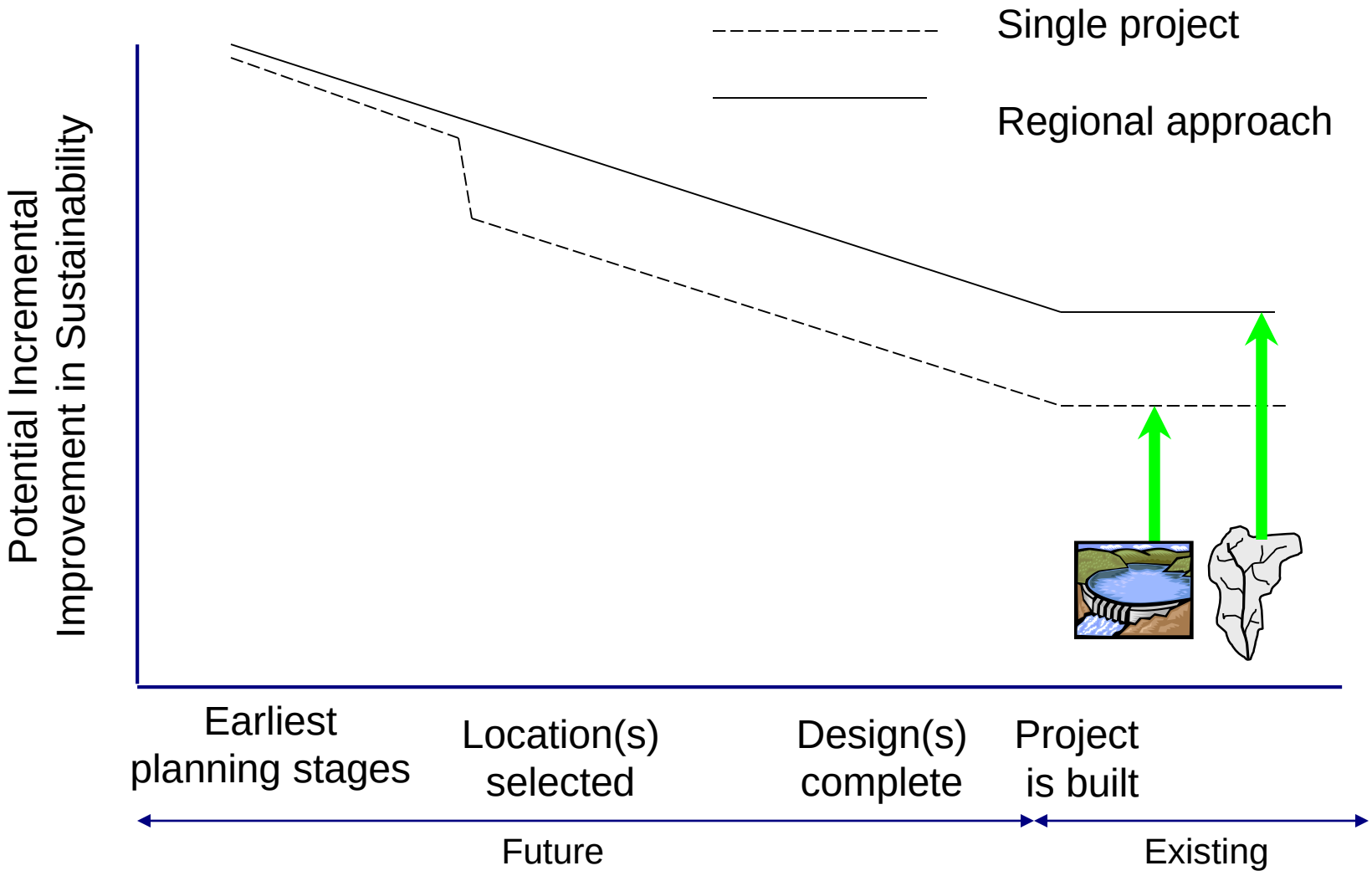
Fishery on the brink

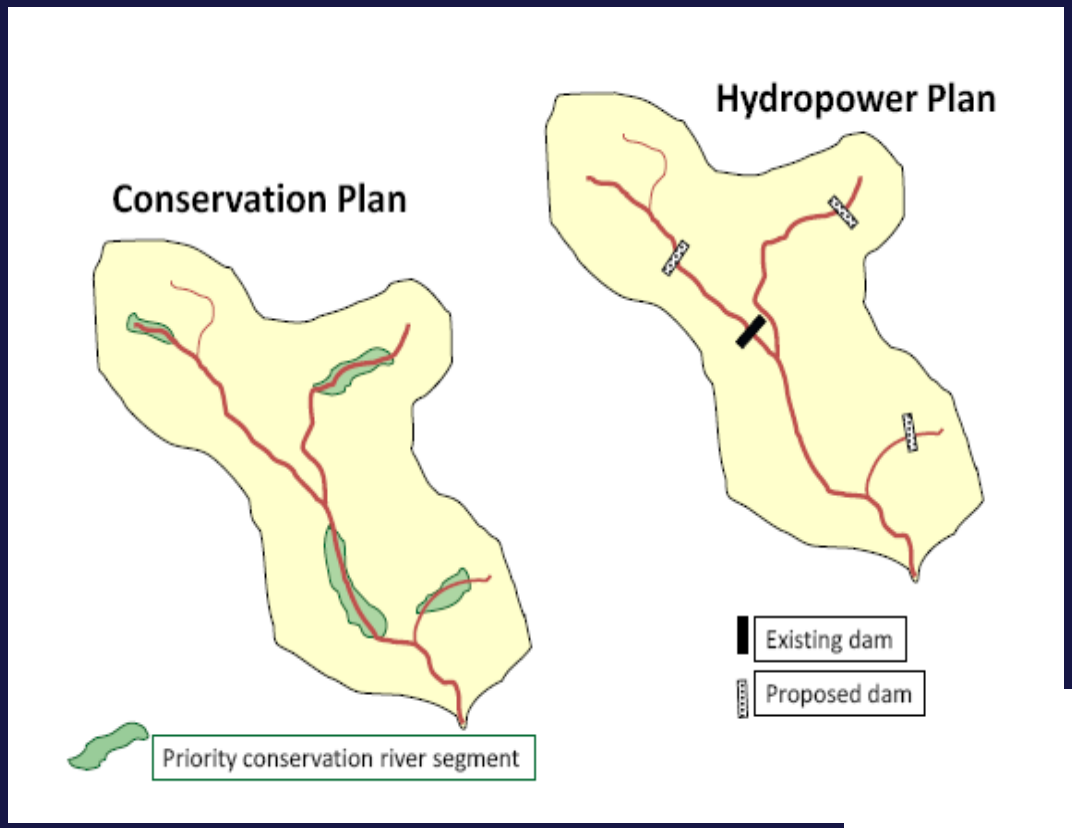
Penobscot Nation

Motivated Partners

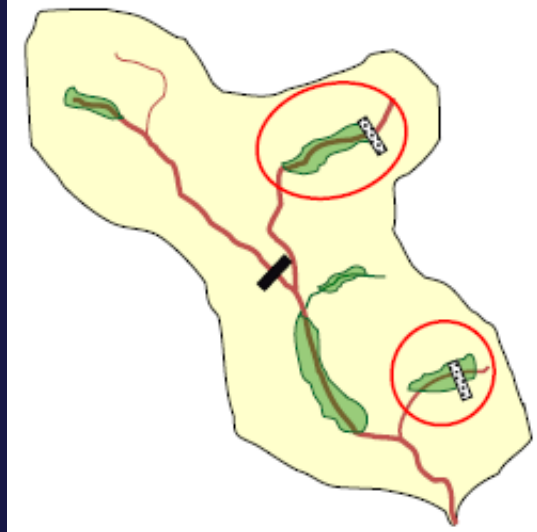
Hydropower Interests

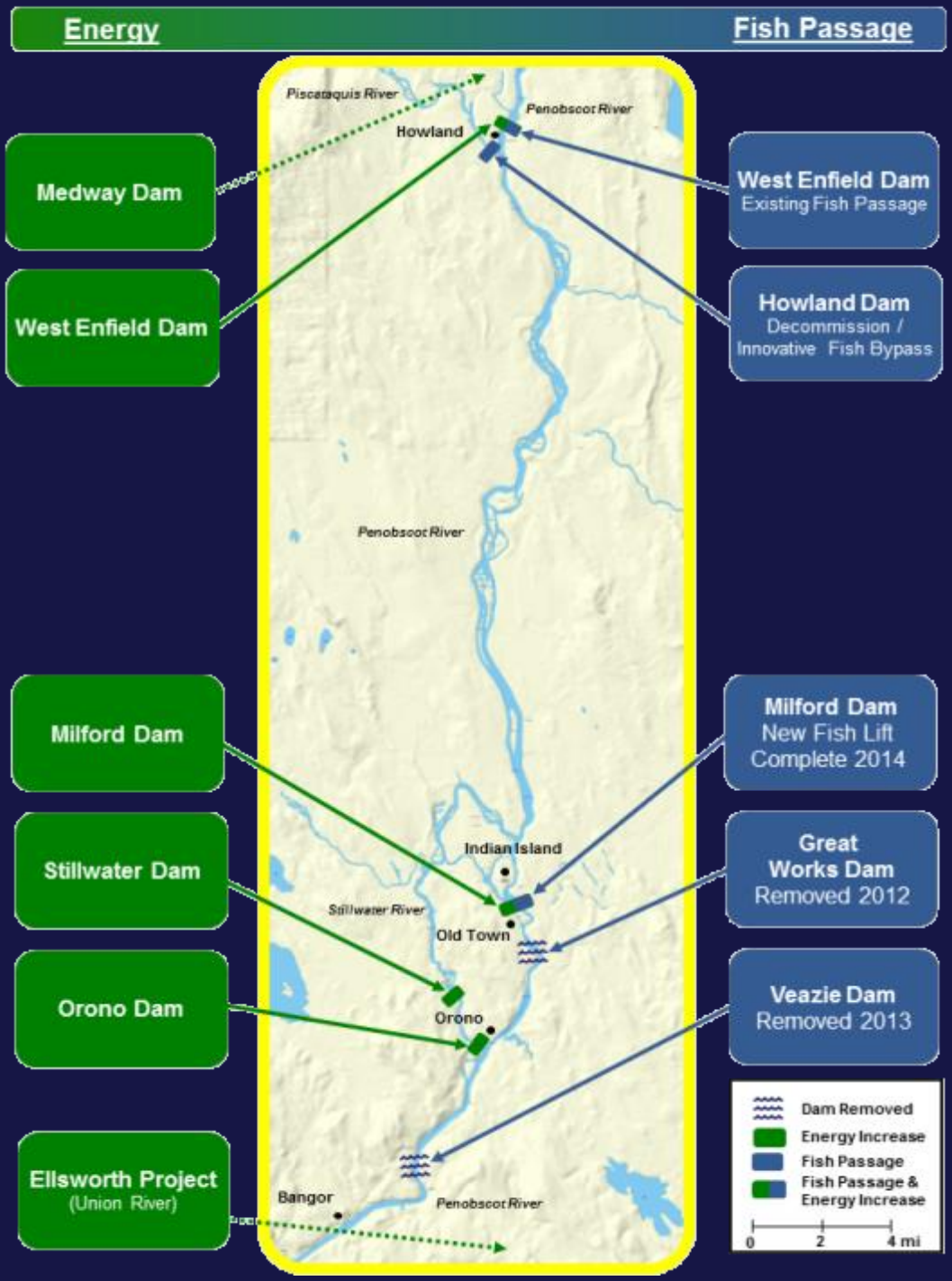
Planning, Licensing, or Reoperation of single dam vs. regional approach





Over-lay Scenarios
Look for Areas of Conflict





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

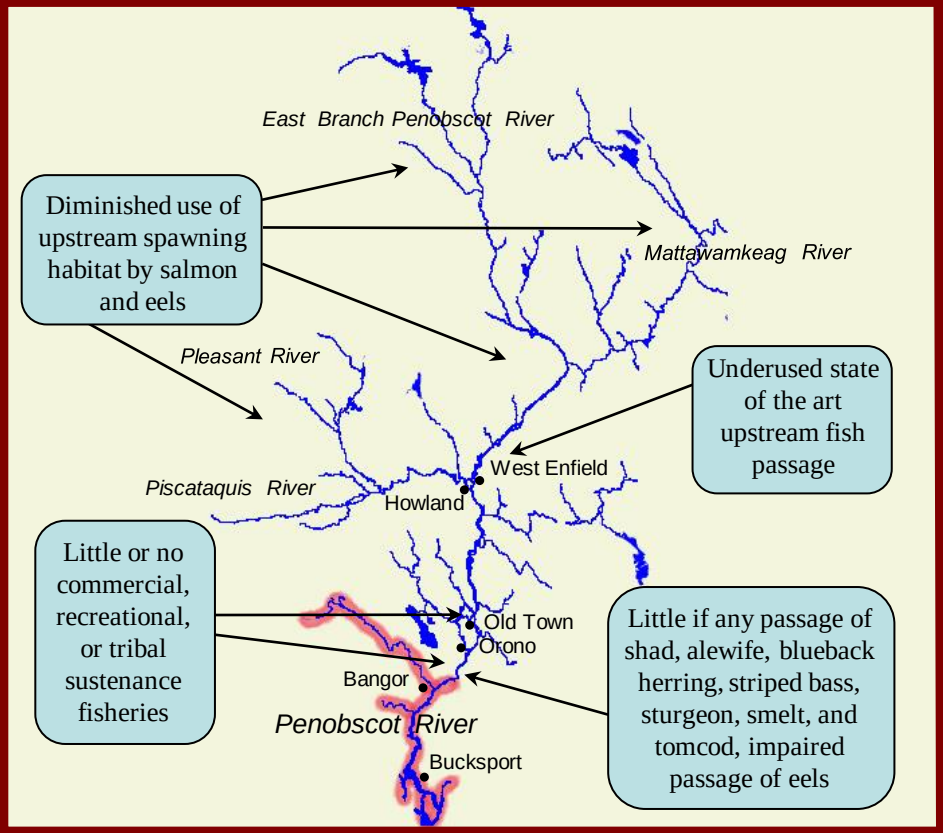
→ **Increased Energy**
to maintain power generation

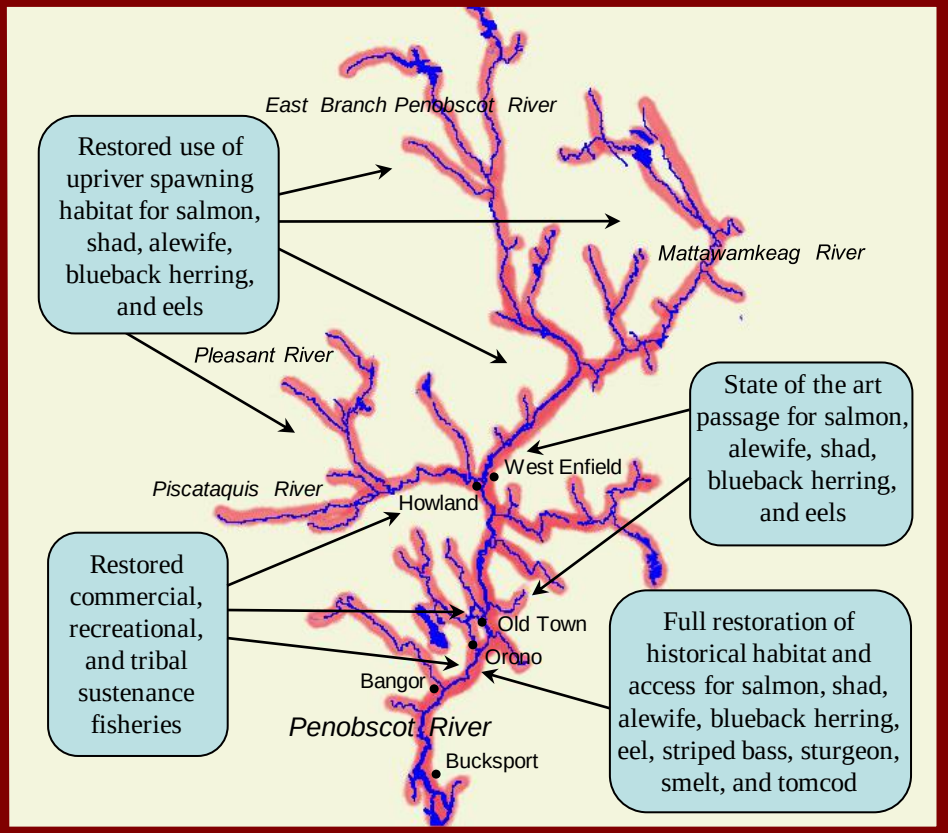
→ **Enhanced Habitat Access**
1,000 miles of historic habitat

→ **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

Significantly Improved Access for Sea-Run Fish to

>2,600 km of habitat

Partners in the Penobscot River Restoration Project

Penobscot River Restoration Trust
=

Penobscot Nation

Atlantic Salmon Federation • Fédération du Saumon Atlantique •

TROUT UNLIMITED

Natural Resources Council of Maine

American Rivers
Thriving By Nature

MAINE AUDUBON

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RECOVERY.GOV

USGS
science for a changing world

U.S. FISH & WILDLIFE SERVICE
DEPARTMENT OF THE INTERIOR

U.S. DEPARTMENT OF THE INTERIOR
March 3, 1849

NATIONAL PARK SERVICE
Department of the Interior

UNITED STATES OF AMERICA
1824
BUREAU OF INDIAN AFFAIRS

NOAA
U.S. NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

MAINE

ppl™

blackBEAR Hydro Partners

DIRIGO
MAINE

National Fish and Wildlife Foundation

EMDC
Eastern Maine Development Corporation

Land for Maine's Future
LMF

WRP
Corporate Wetlands Restoration Partnership

Project Milestones

Great Works
Dam Removal

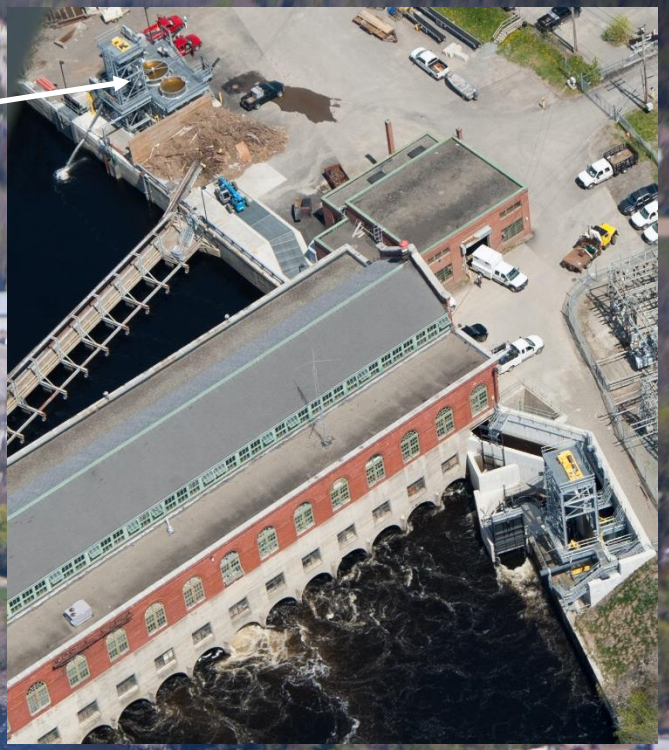
Veazie Dam Removal


CAT
CAT

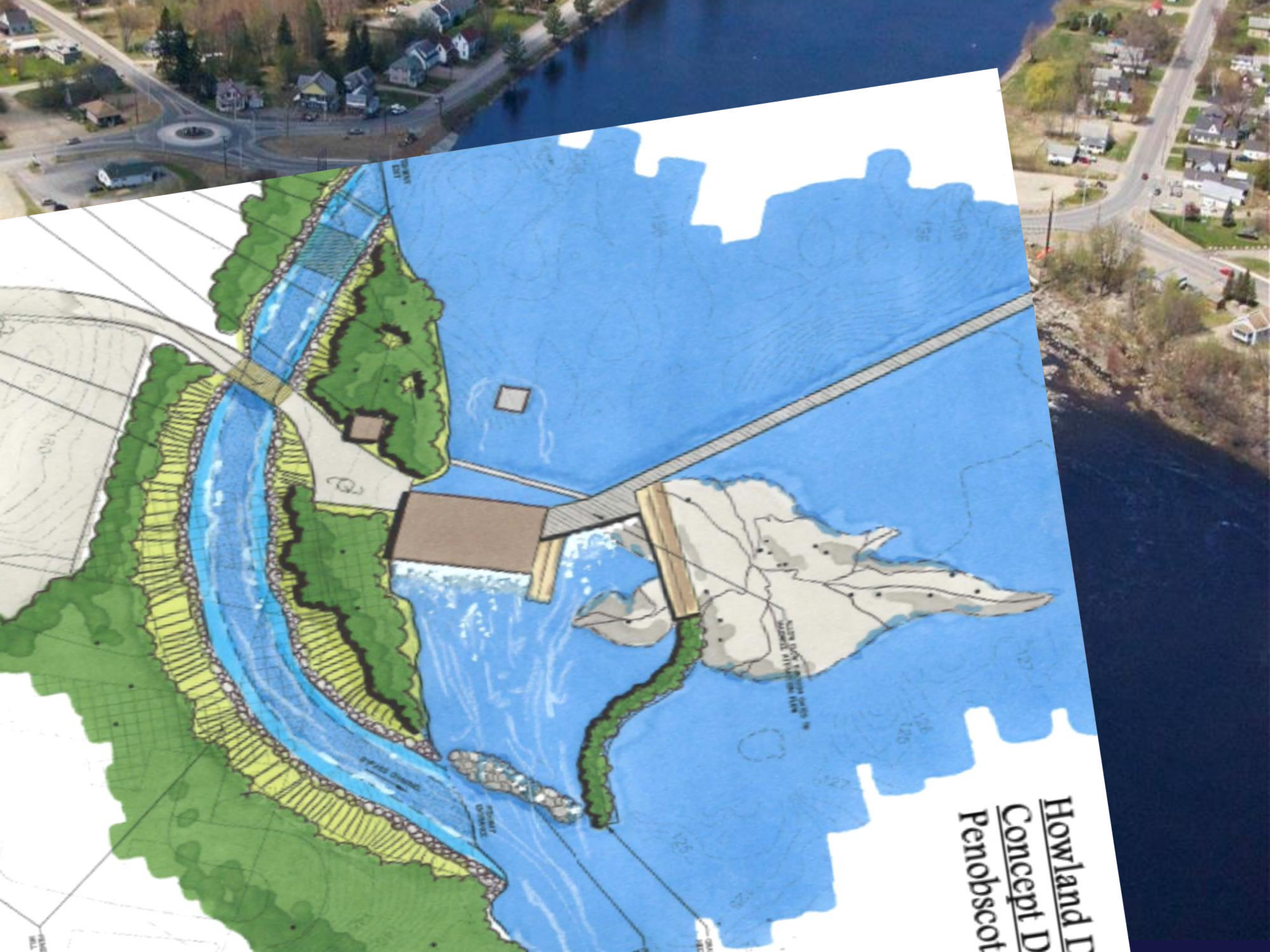

Former Veazie Dam


2
Veazie
Former Veazie Dam
178
Summer St
Main St

Milford Fish Lift



Howland
Fish Bypass



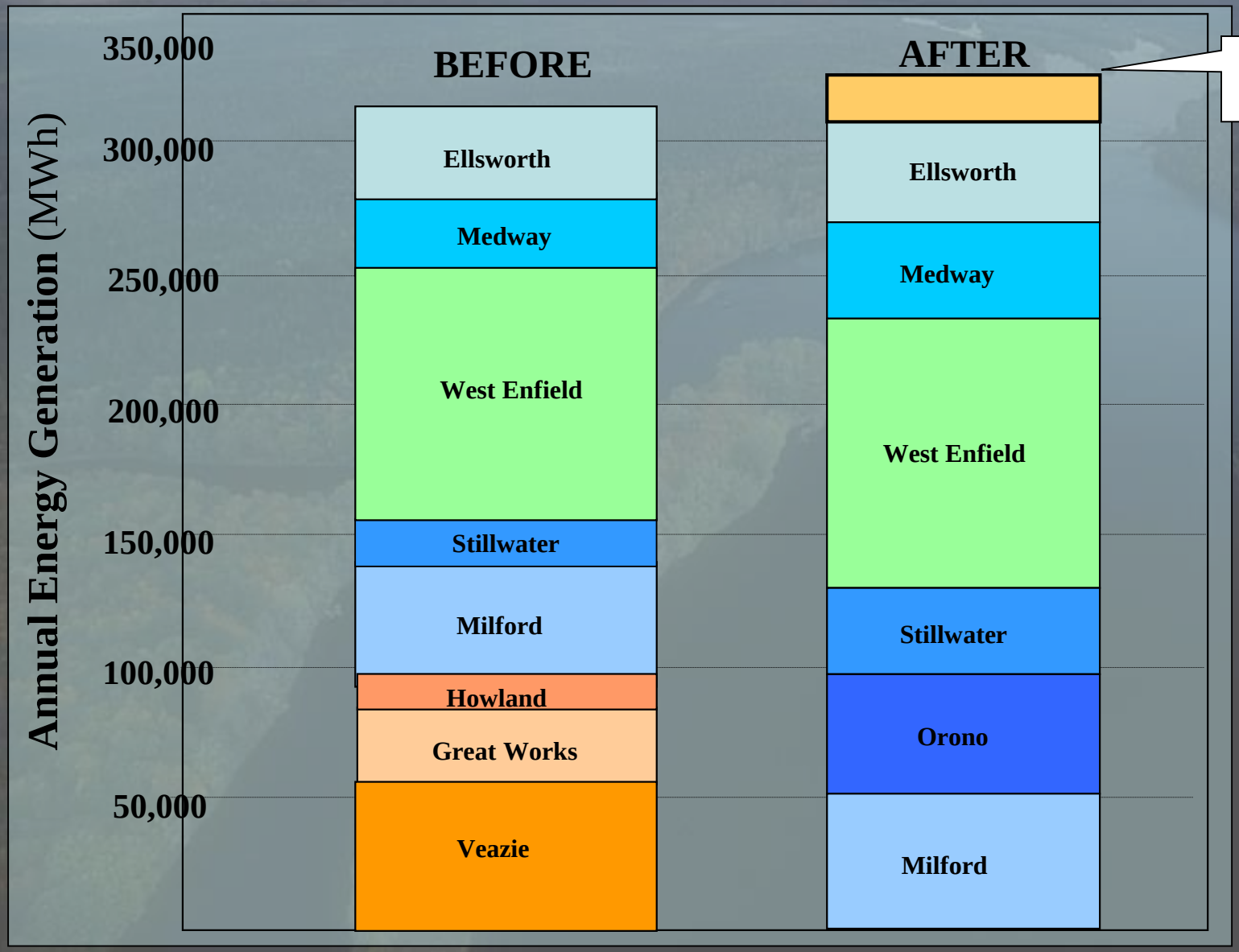
Howland D
Concept D
Penobscot

Nature-like Fish Bypass


Town
Riverside
Park under
construction

Project Monitoring: Before-After Approach

Renewable Energy Results



All together this is < 3% of the wind generation developed in the last decade in Maine

Baseline Conditions

Pre- and Post -removal Monitoring

At least three years pre-removal baseline

1) Water chemistry, temperature, and macroinvertebrates
2) River channel morphologic chances
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

Some Initial Findings & plans for 2014-15

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

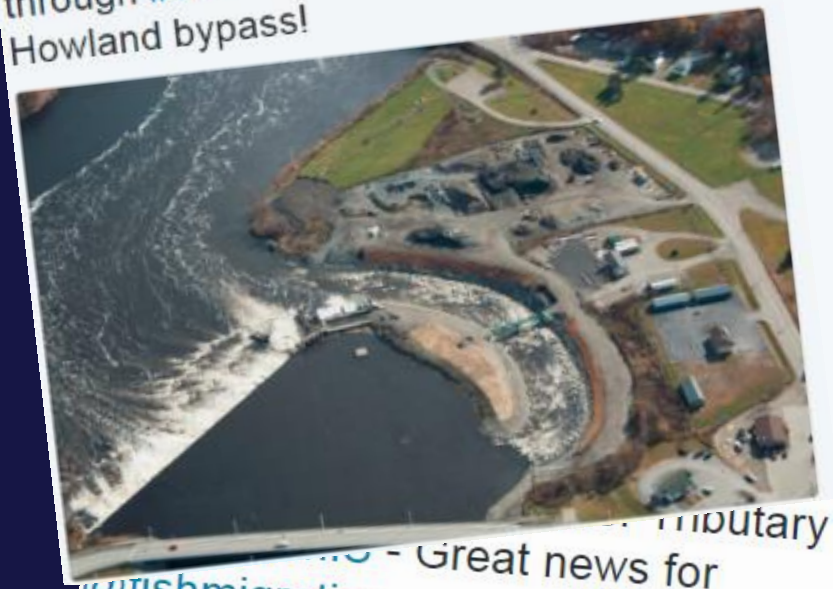
Species	2013 (removal)	2014	2015	2016*
American Shad	near 0	805	1,806	7,867
River Herring	< 1,000	367,000	909,000	1,803,062
Atlantic Salmon	~1,000	255	731	509
Sea Lamprey	?	641	485	4,945

* October 3, 2016 count totals from Milford and Orono Dams and Blackman Stream

Joshua Royte @JRoyte · Sep 30

Unstocked alewives just found 134 mi. up Penobscot R., 90 mi. past current 1st dam. Amazing fish! Remove barriers, rivers & fish respond!

34 of 46 tagged Atlantic salmon successfully passed up and downstream through #Penobscot River Restoration's Howland bypass!



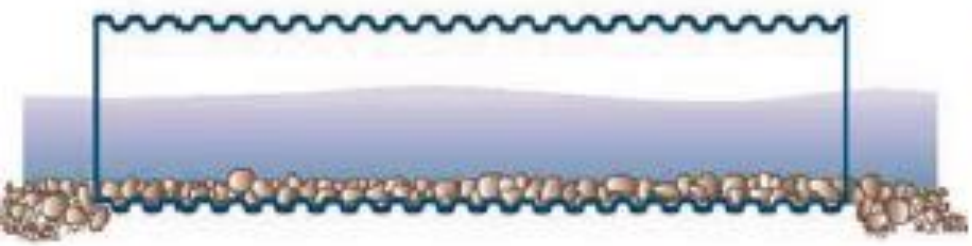
herring

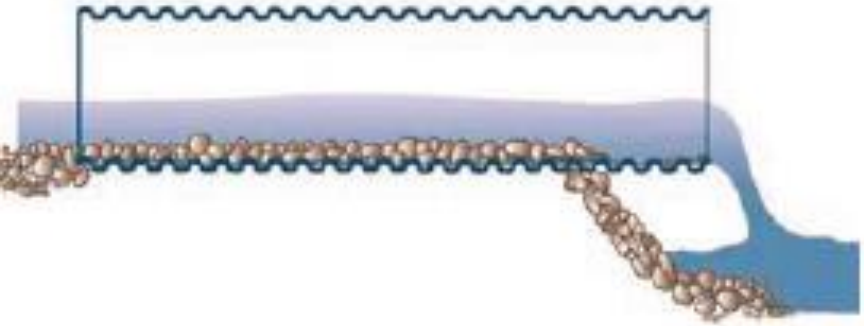
tributary

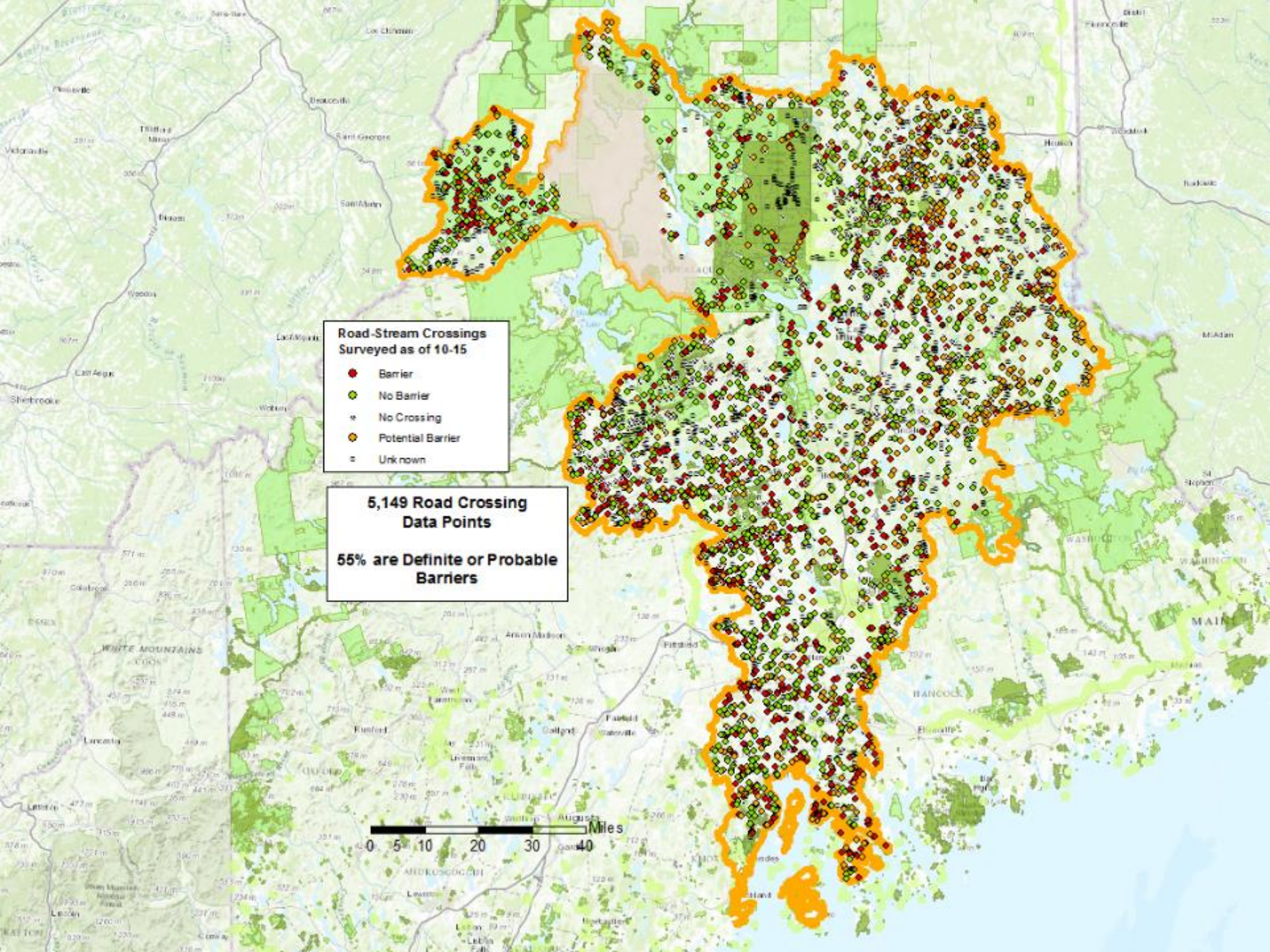
- Great news for

@fishmigration

Aquatic Connectivity Restoration Continues






Road-Stream Crossings
Surveyed as of 10-15
Barrier
No Barrier
No Crossing
Potential Barrier
Unknown
5,149 Road Crossing
Data Points
55% are Definite or Probable
Barriers
0 5 10 20 30 40
Miles


Road Crossings and Dams
No Large Private Landowner Data
Barrier
No Barrier
No Crossing
Potential Barrier
Unknown
Dams
Watershed Boundary
Pushaw Outlet Dam Fishway
Passadumkeag Culvert
Veazie Dam
CORINTH
HUDSON
ORONO

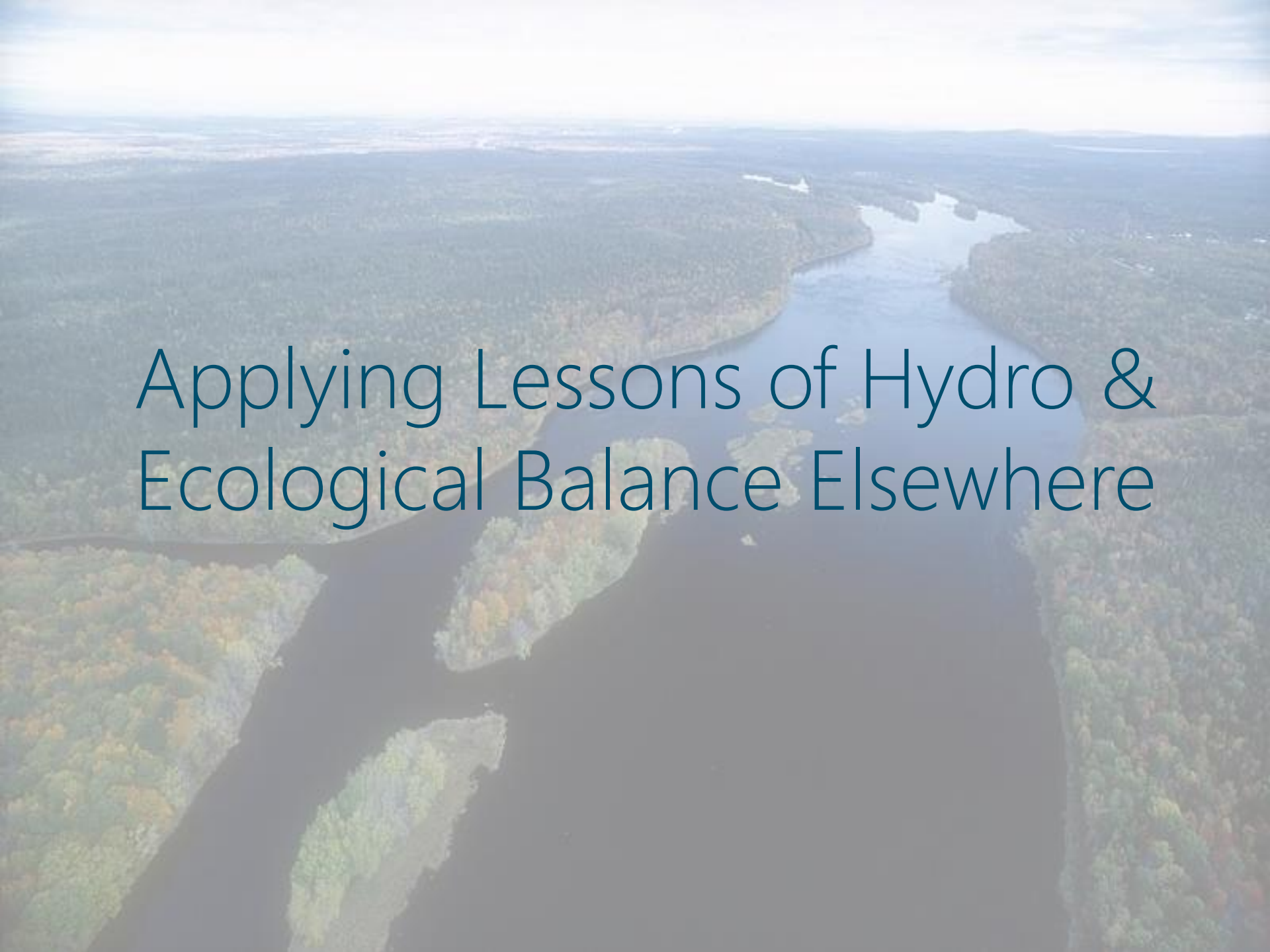
Other Dam Removal or Fishways in Maine: moderate to great returns

Edwards Dam, Kennebec River (1999) & Fort Halifax Dam (2009)
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

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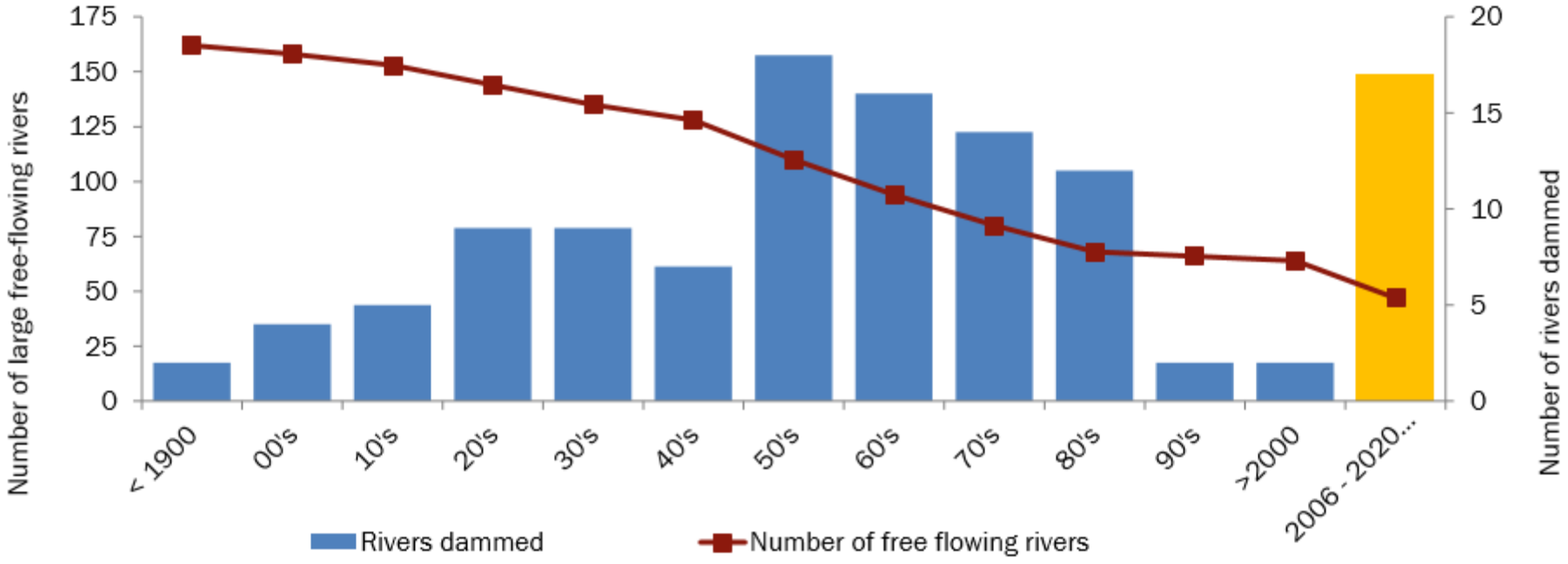
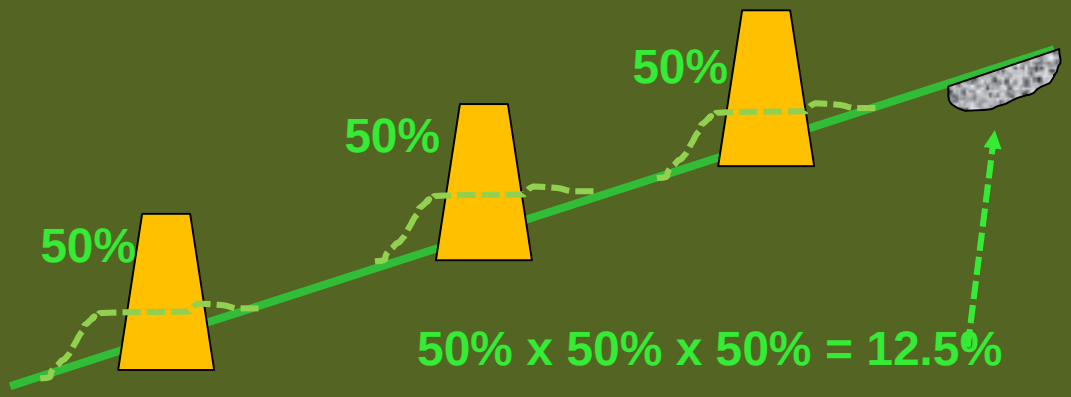
CONTEXT: RAPID GROWTH OF HYDROPOWER

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.



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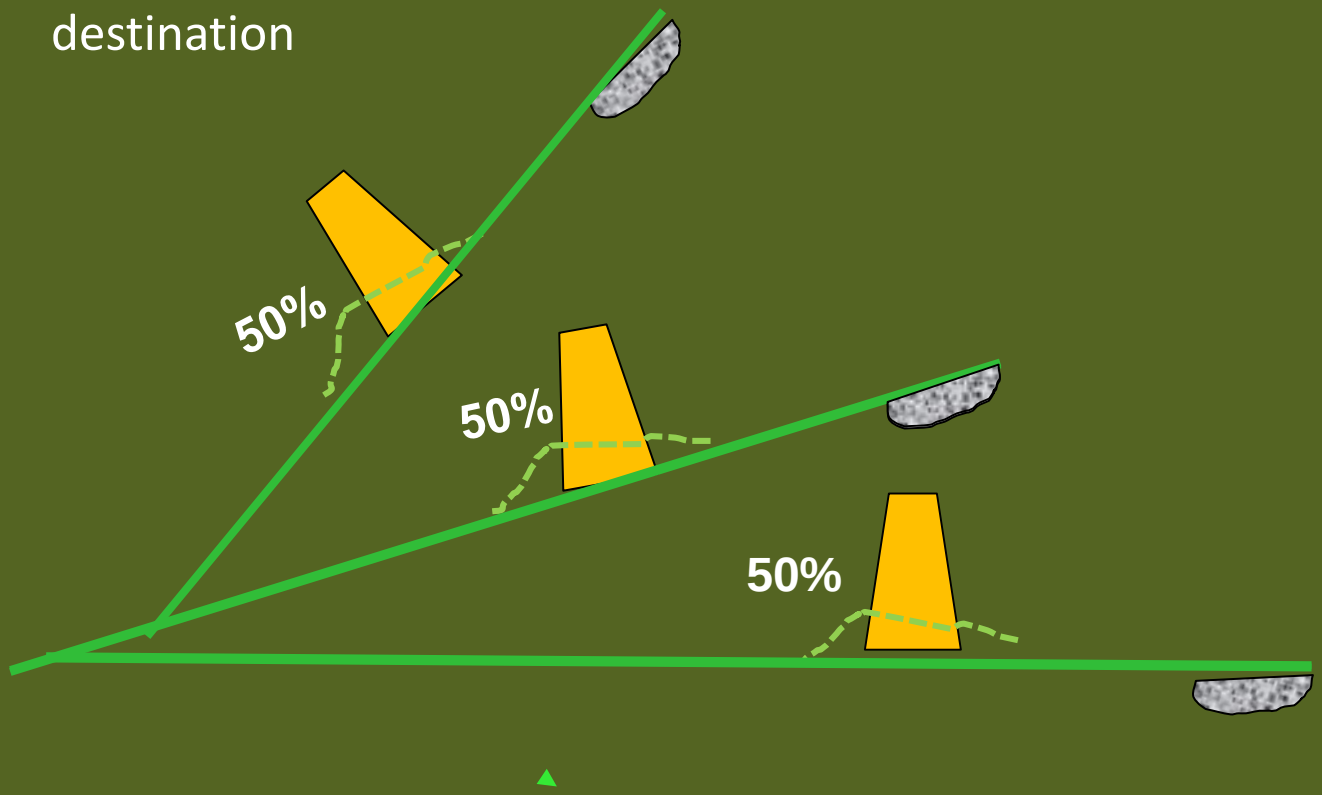
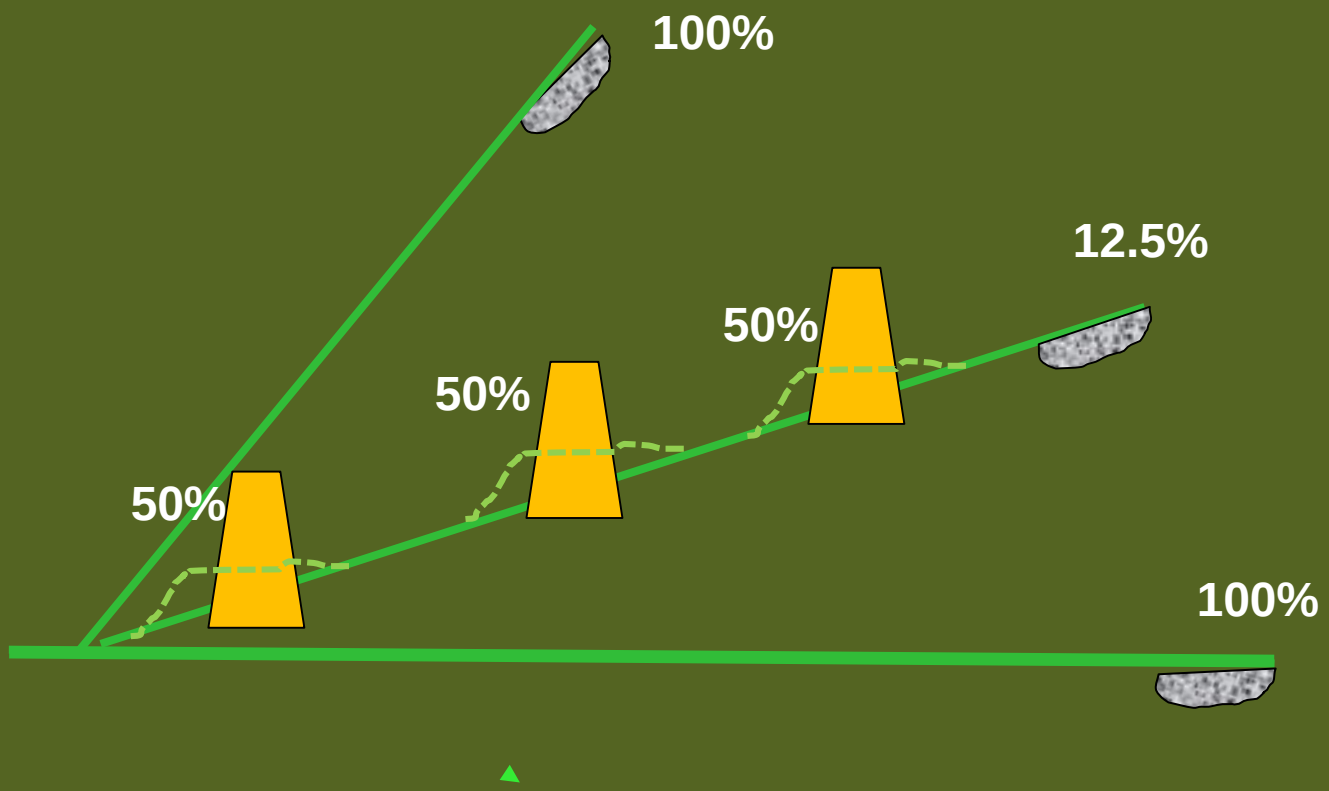
Example of environmental impact to be addressed at basin scale Breaking of upstream connectivity of river for migratory fish

- 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

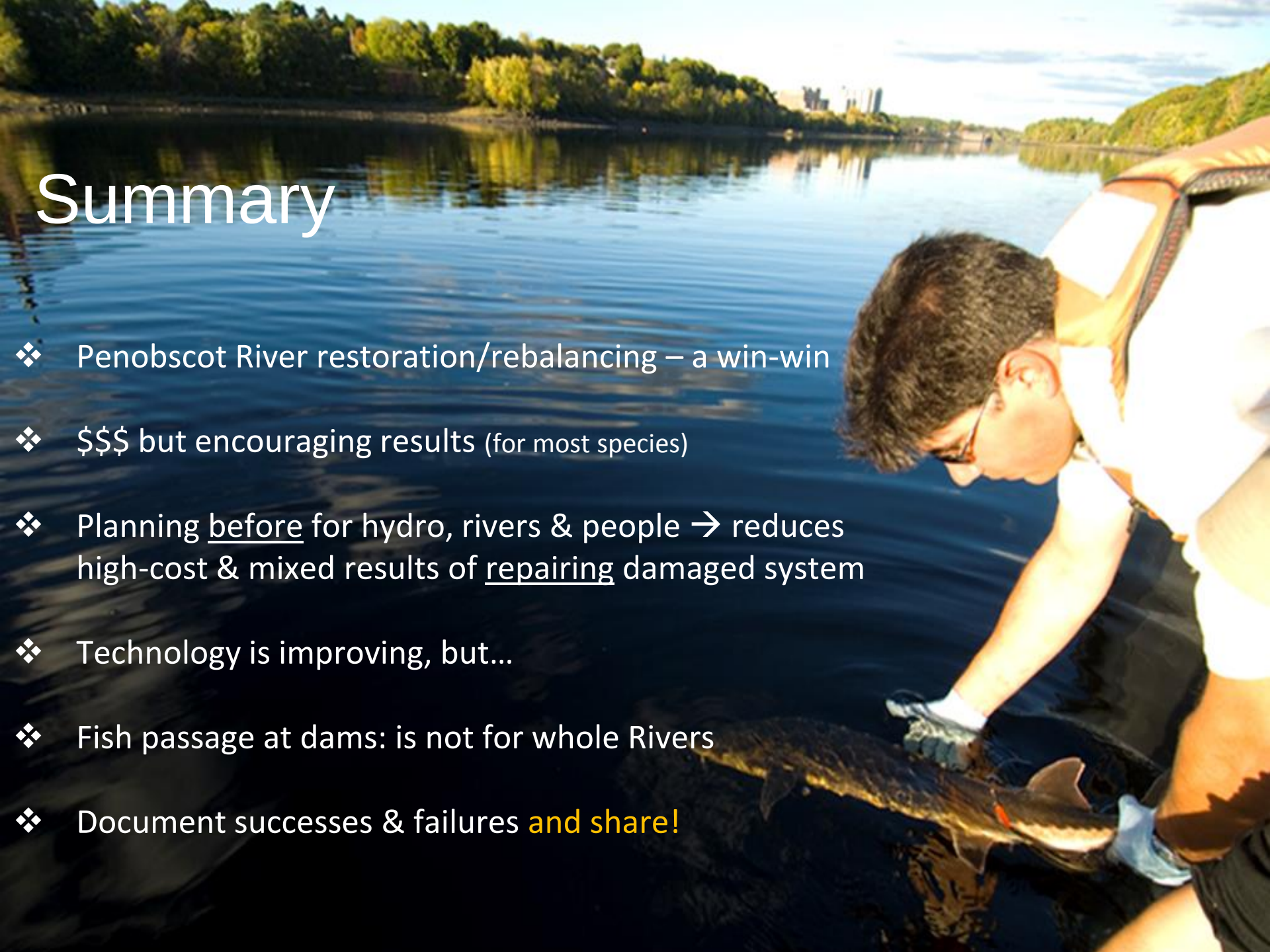


Example of environmental impact to be addressed at basin scale
Breaking of upstream connectivity of river for migratory fish

- 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?
Skype: Josh.Royte & jroyte@tnc.org