Atlantic States Marine Fisheries Commission

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ASMFC Workshop on Fish Passage Issues Impacting Atlantic Coast States

April 3 & 4, 2008
Location: Jacksonville, Florida

Listing of Presentations

Session 1. Background on fish passage, focusing on ASMFC managed species

1. **Presentation on the State of the Art of Fish Passage, *S. Gephard***
    - Brief talk on the common designs for fish passage available today (e.g., dam removal, pool-and-weir, roughened chutes, elevators, nature-like, trap & truck, eel passes) and downstream passage structures.

2. **Presentation on Fish Passage Concerns for Striped Bass, *W. Laney***
    - Overview of the fish passage designs that work for striped bass, and those that do not. Also covering specific challenges in passage of striped bass. Examples will be given of successful and unsuccessful passage projects.

3. **Presentation on Fish Passage Concerns for Shad and River Herring, Atlantic (and Shortnose) Sturgeon, and American Eel, *A. Haro***
    - Overview of the fish passage designs that work for shad and river herring, Atlantic sturgeon, and American eel, and those that do not. Also covering specific passage challenges. Examples will be given of successful and unsuccessful passage projects.

Session 2. Summary and Experiences with the FERC Re-licensing Process

4. **Presentation on the FERC Process, *M. Pawlowski***
    - Overview of how hydroelectric projects are licensed and re-licensed, what the prescriptive powers are of USFWS and NMFS, how state agencies are consulted and interact with the federal agencies, and what are options for involvement. Additionally, common terms will be defined (e.g., “non-jursidictional,” “exempt,” “intervener,” “re-opener clauses,” etc.).

5. **Presentation on Federal FERC Experiences from the Northeast, *M. Grader***
   (S. McDermott and L. Chiarella coauthors)
    - Builds upon the previous descriptive talk to discuss experiences with FERC in the northeast over the years, including what works and what does not. Speaker will also discuss the advantages of watershed management plans prior to FERC licensing, the advantages

of having multiple interveners, how multiple state agencies get involved, how NGOs get involved, where 401 Clean Water Certifications come into play, pre-licensing agreements among parties, evaluation studies, etc.

6. **Presentation on Federal FERC Experiences from the Southeast, *P. Brownell (W. Laney coauthor)***
   - ❖ Builds upon the previous talk to discuss NMFS and USFWS experiences with FERC in the southeast over the years, including what works and what does not.

7. **Presentation on Federal FERC Experiences from the West Coast, *S. Edmondson***
   - ❖ Builds upon the previous talk to discuss NMFS experiences with FERC in the west over the years, including what works and what does not.

8. **FERC Case Studies: Kennebec River, *G. Wippelhauser***

9. **FERC Case Studies: Connecticut River, *M. Grader***

10. **FERC Case Studies: Susquehanna River, *M. Hendricks***

11. **FERC Case Studies: Santee-Cooper River, *P. Brownell***

12. **Presentation on Federal Perspective on Non-Hydropower Dams, *J. Catena***
    - ❖ Overview of program, process, and examples of passage on non-hydropower dams along the East Coast from a federal perspective through voluntary projects.

13. **Presentation on State Perspective on Non-Hydropower Dams, *S. Gephard***
    - ❖ Overview of program, process, and examples of passage on non-hydropower dams along the East Coast from a state perspective—both through the Connecticut regulatory process and through strictly voluntary projects.

14. **Presentation on NGO Perspective on Non-Hydropower Dams, *B. Graber***
    - ❖ Overview of program, process, and examples of passage on non-hydropower dams along the East Coast from a NGO perspective—both through the regulatory process and through strictly voluntary projects.

Session 3. ASMFC/State Involvement in Improving Fish Passage

15. **Presentation of Projects on the Horizon, *A. Hoar***
    - ❖ Map of upcoming FERC relicensings and discussion of projects in progress, including an overview of fish passage work at the Conowingo Dam on the Susquehanna River, Maryland.

Session 4. Technical Issues Surrounding Passage of American Eel

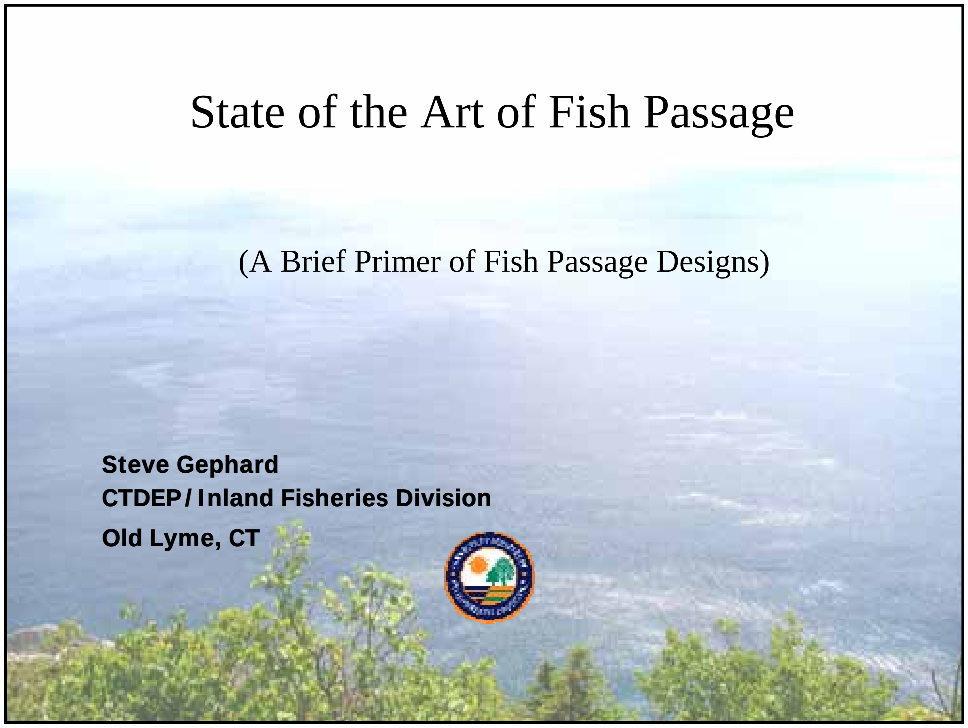
16. **Presentation on Barrier Effects on American Eel Populations, *L. Machut***
    - ❖ An examination of the ability of American eel to pass barriers in tributaries of the Hudson River that lack eel passage structures, as well as the effects of passage efficiency on demographic characteristics of the eel populations along the length of each river.

17. **Follow-up Presentation on American Eel Passage Issues, *A. Haro***

- More in-depth discussion of the passage issues presented for American eel in Session 1 of this workshop.

18. **Case Study: Upper Potomac River, *A. Hoar***

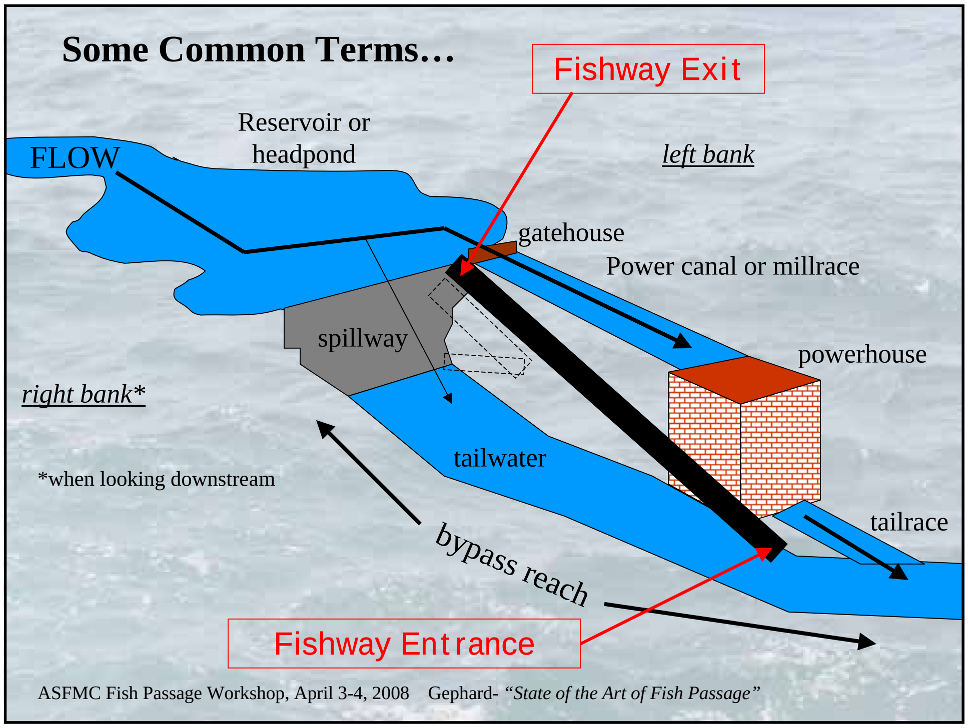
- Success story of cooperation between federal agencies, state agencies, the energy industry, and non-governmental organizations to implement goals of the American Eel Fishery Management Plan and restore population abundance in the Potomac River.



State of the Art of Fish Passage

(A Brief Primer of Fish Passage Designs)

Steve Gephard
CTDEP / Inland Fisheries Division
Old Lyme, CT



Some Common Terms…

Fishway Exit

Reservoir or headpond

FLOW

left bank

gatehouse

Power canal or millrace

spillway

powerhouse

right bank*

tailwater

*when looking downstream

tailrace

bypass reach

Fishway Entrance

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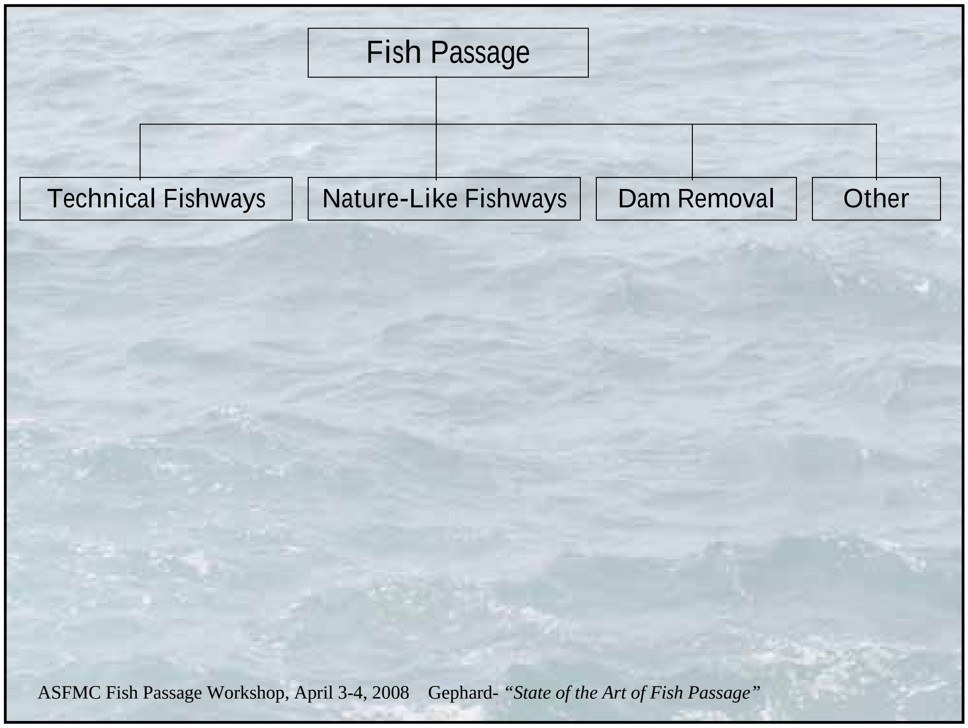
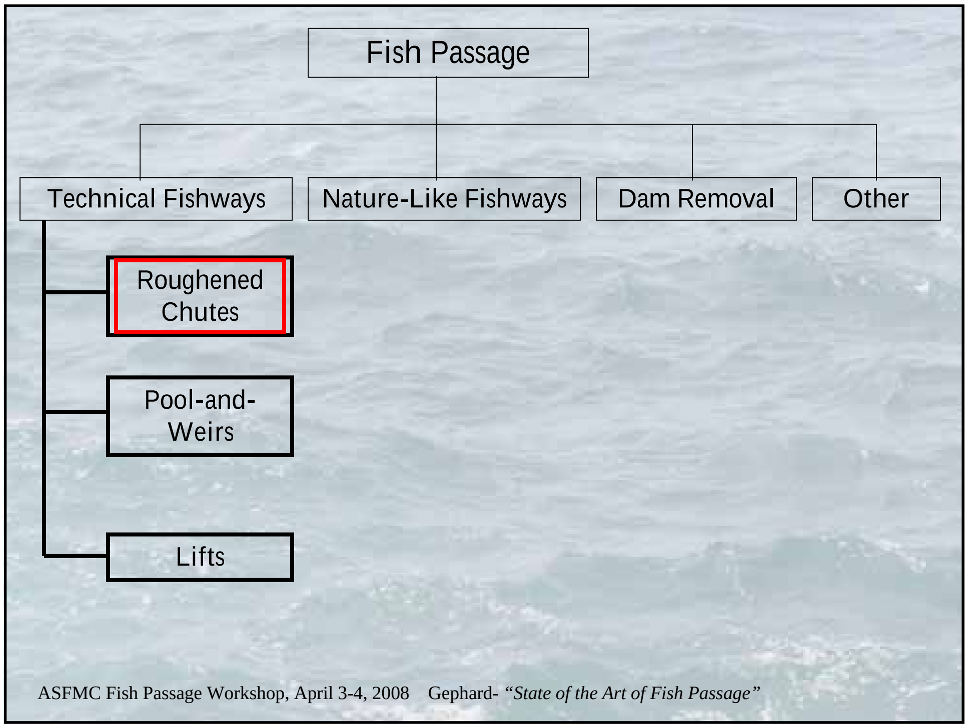


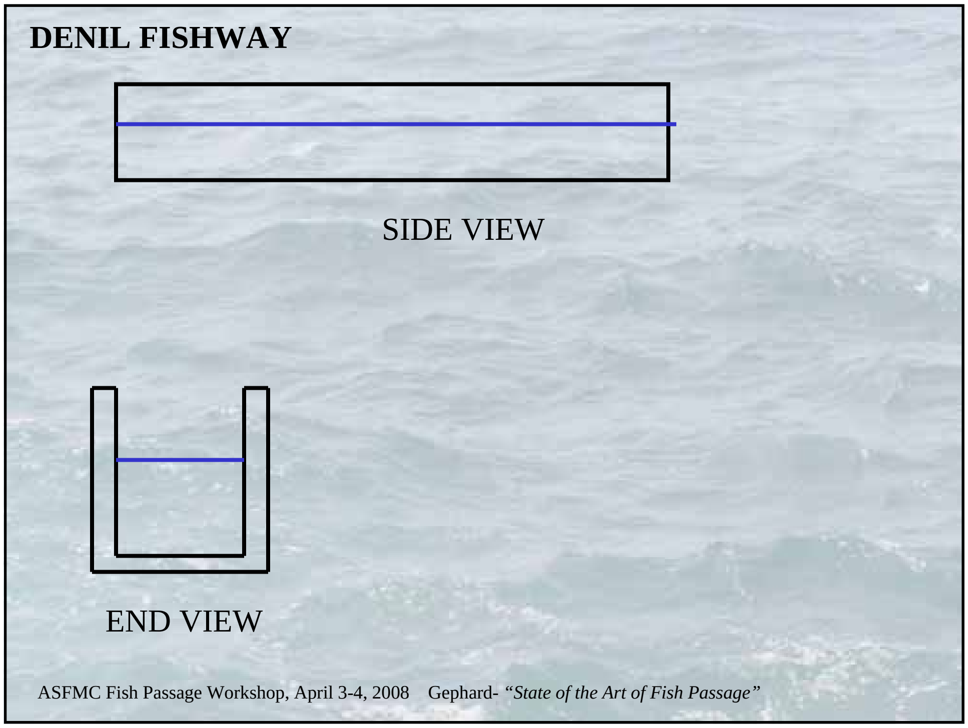
Fish Passage

- Technical Fishways
- Nature-Like Fishways
- Dam Removal
- Other



Fish Passage

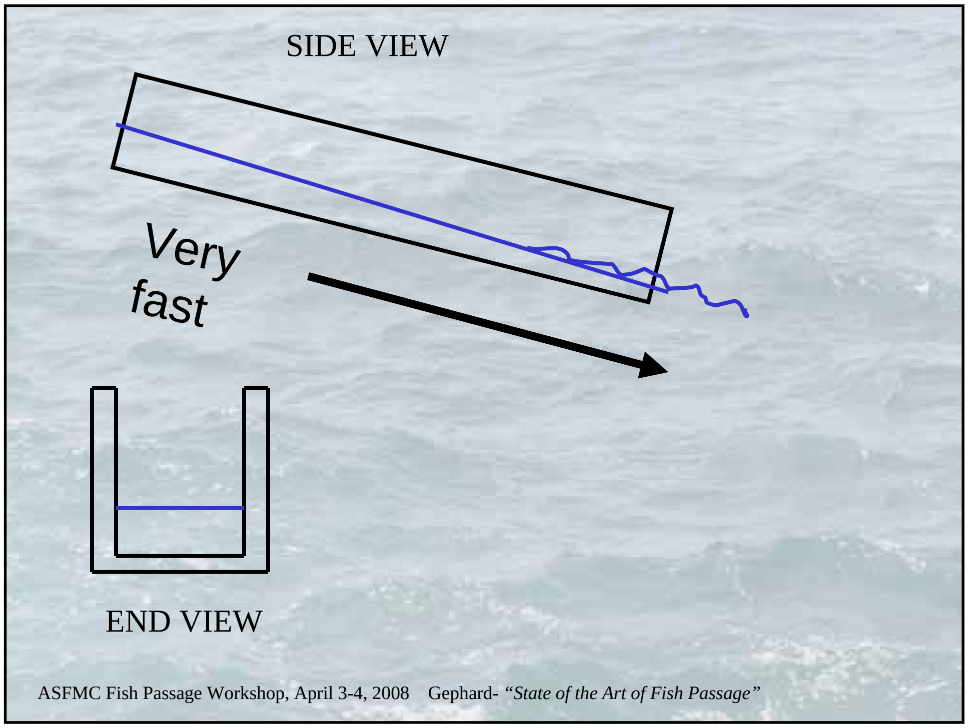
- Technical Fishways
  - Roughened Chutes
  - Pool-and-Weirs
  - Lifts
- Nature-Like Fishways
- Dam Removal
- Other



DENIL FISHWAY

SIDE VIEW

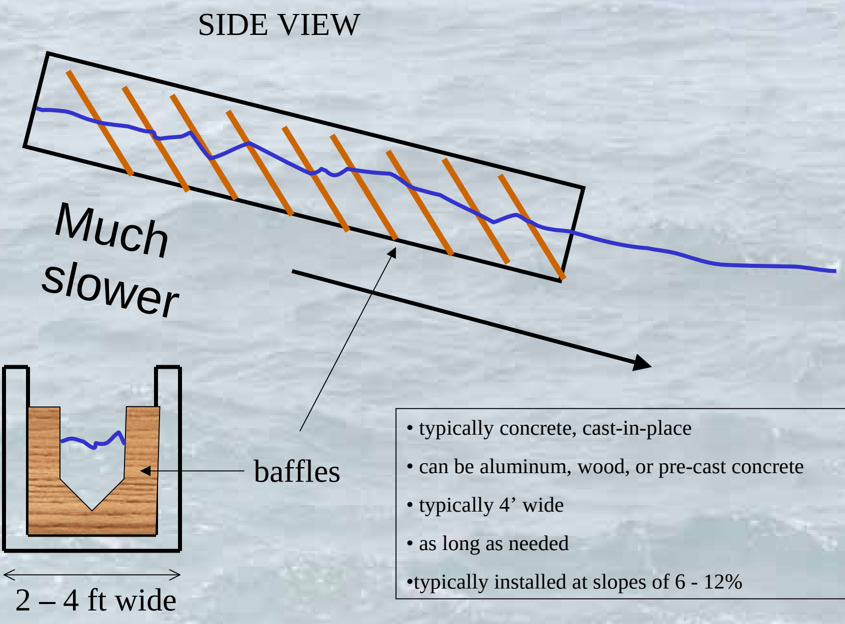
END VIEW



SIDE VIEW

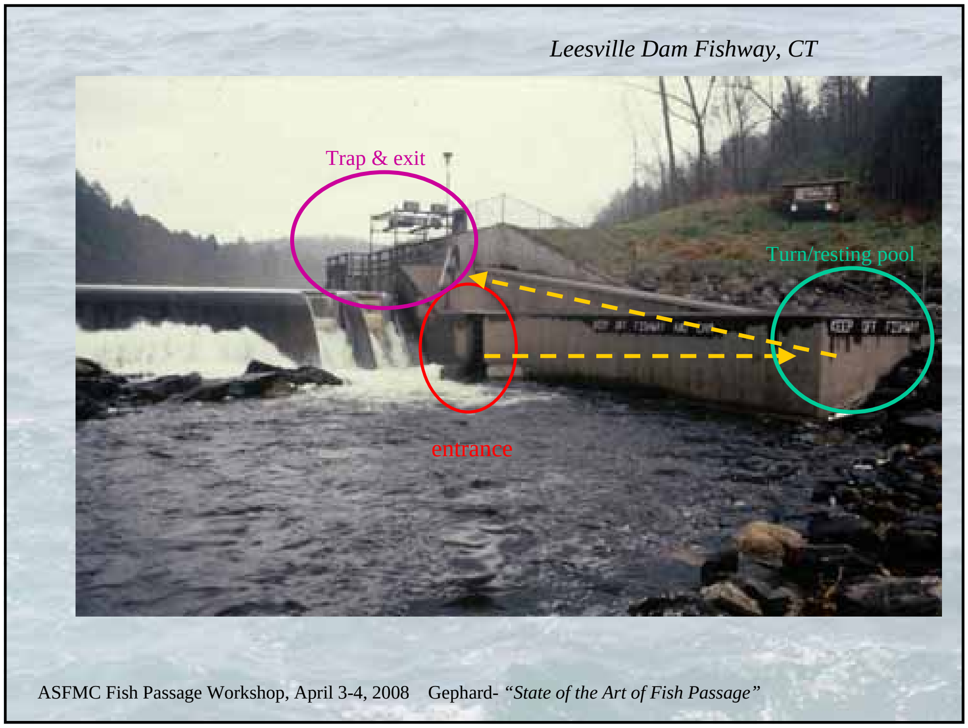
Very fast

END VIEW



- typically concrete, cast-in-place
- can be aluminum, wood, or pre-cast concrete
- typically 4’ wide
- as long as needed
- typically installed at slopes of 6 - 12%

Versailles Pond Fishway, CT



Leesville Dam Fishway, CT

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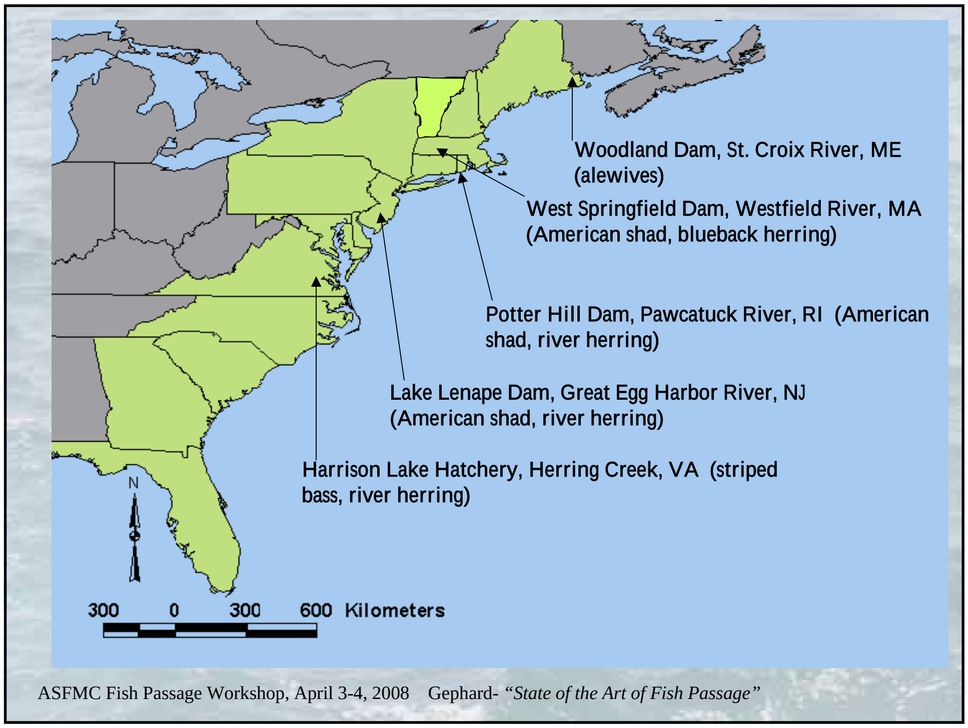

Woodland Dam, St. Croix River, ME (alewives)

West Springfield Dam, Westfield River, MA (American shad, blueback herring)

Potter Hill Dam, Pawcatuck River, RI (American shad, river herring)

Lake Lenape Dam, Great Egg Harbor River, NJ (American shad, river herring)

Harrison Lake Hatchery, Herring Creek, VA (striped bass, river herring)

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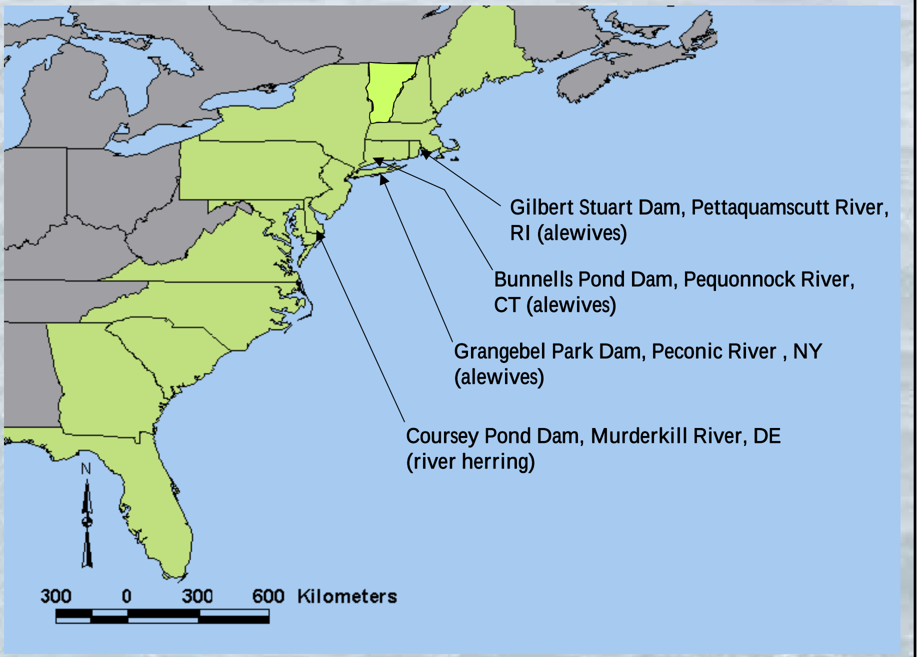
STEEPPASS FISHWAY

- pre-fabricated in standardized units
- heavy-gage aluminum
- 24” wide
- 29” tall
- 10’ long
- multiple units can be bolted together
- typically installed at slopes of 20 – 25%

Bunnells Pond Fishway, CT

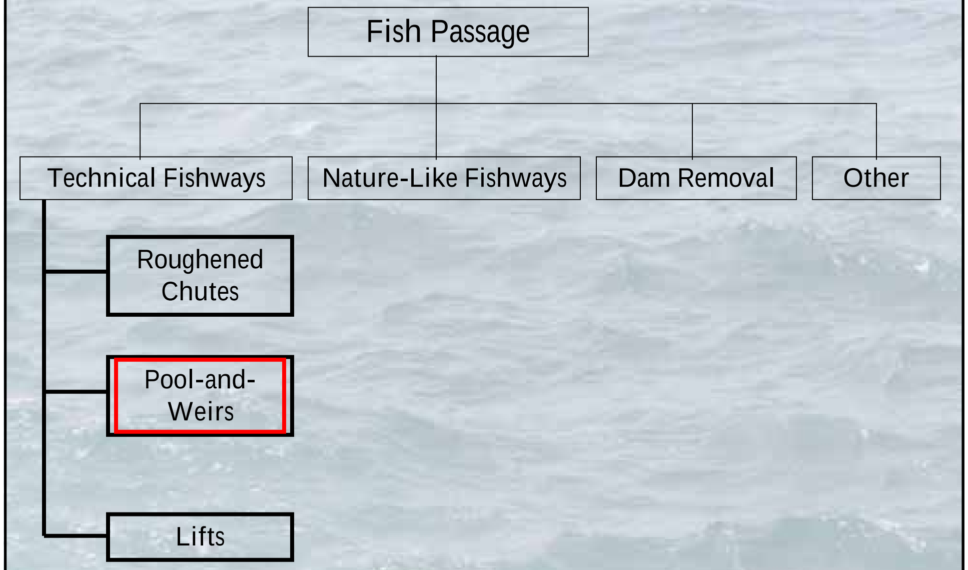


Gilbert Stuart Dam, Pettaquamscutt River, RI (alewives)

Bunnells Pond Dam, Pequonnock River, CT (alewives)

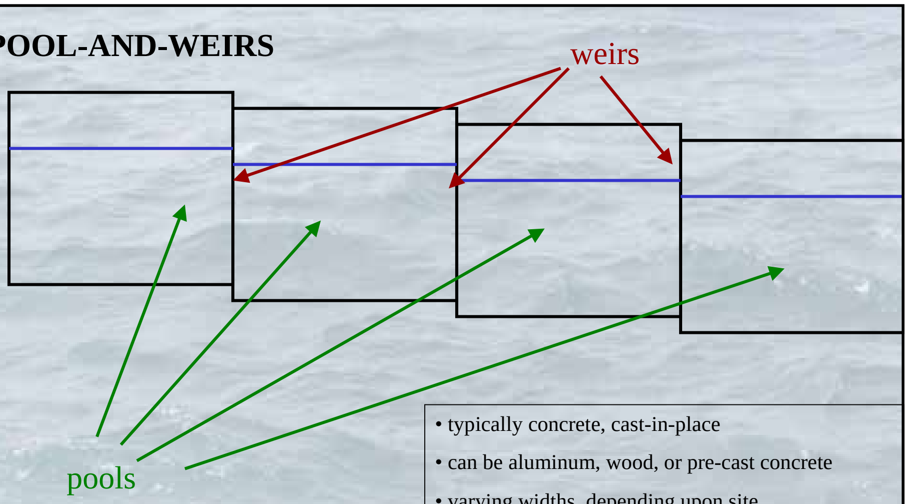
Grangebel Park Dam, Peconic River , NY (alewives)

Coursey Pond Dam, Murderkill River, DE (river herring)



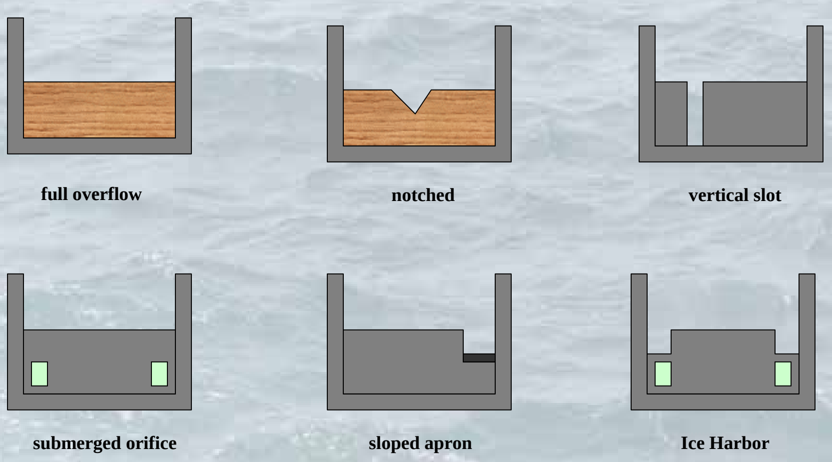
- Fish Passage
  - Technical Fishways
    - Roughened Chutes
    - Pool-and-Weirs
    - Lifts
  - Nature-Like Fishways
  - Dam Removal
  - Other

POOL-AND-WEIRS

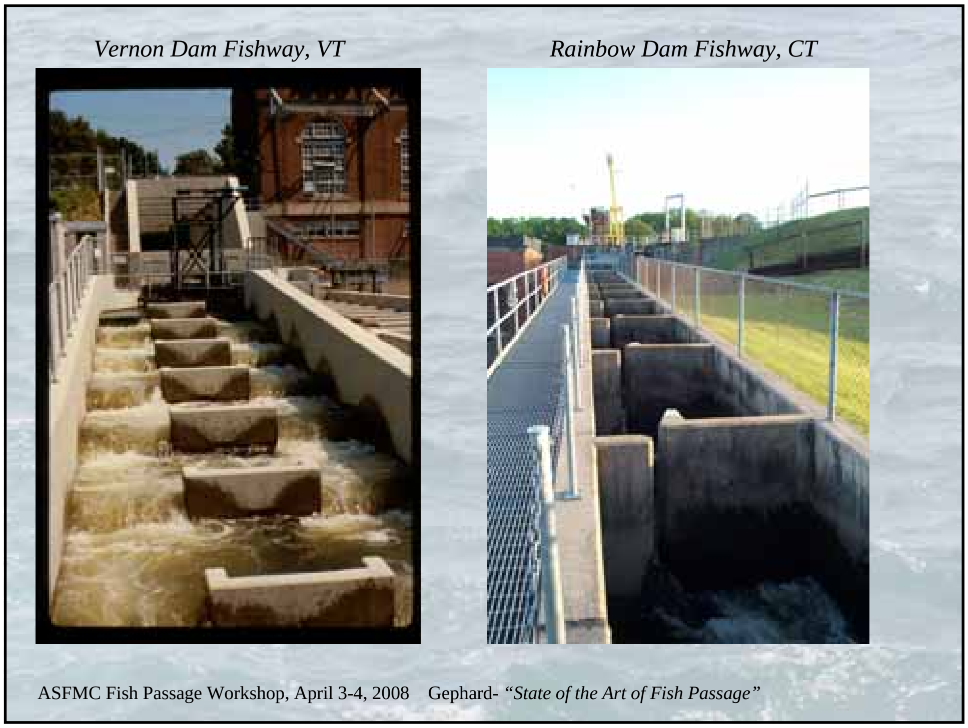


- typically concrete, cast-in-place
- can be aluminum, wood, or pre-cast concrete
- varying widths, depending upon site
- as long as needed
- Varying slopes, depending upon target species--typically 10 - 20%
- typical drops per pool: 6 – 12”

Many weir shapes-

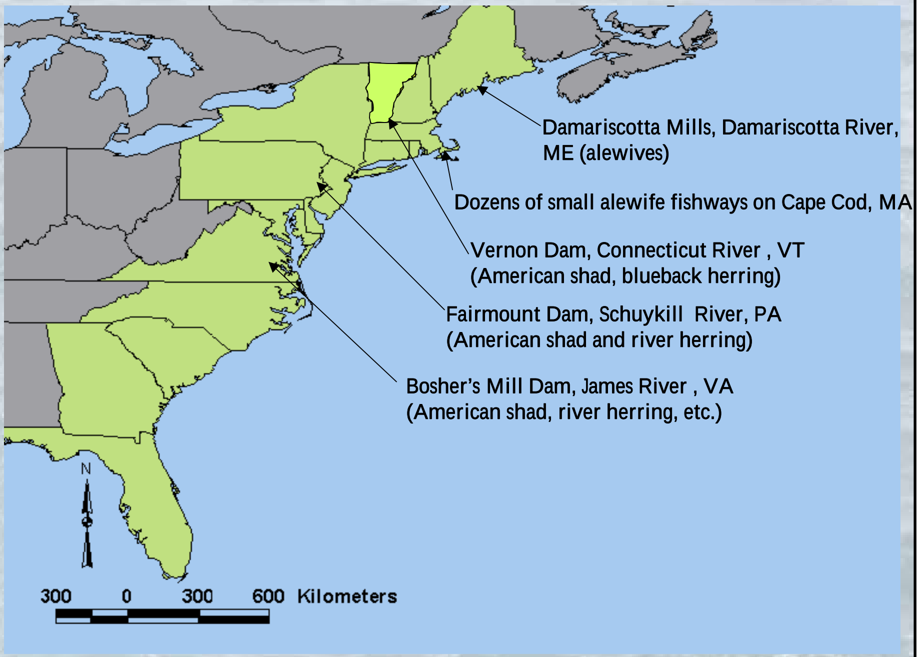


Damariscottia Fishway in Maine perhaps the oldest fishway in the nation.



Vernon Dam Fishway, VT

Rainbow Dam Fishway, CT



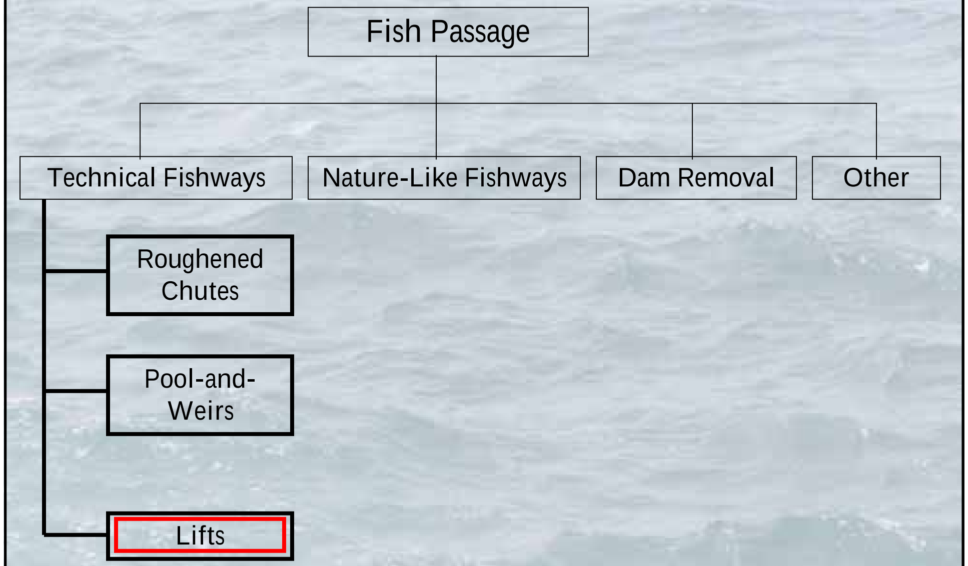
Damariscotta Mills, Damariscotta River, ME (alewives)

Dozens of small alewife fishways on Cape Cod, MA

Vernon Dam, Connecticut River , VT (American shad, blueback herring)

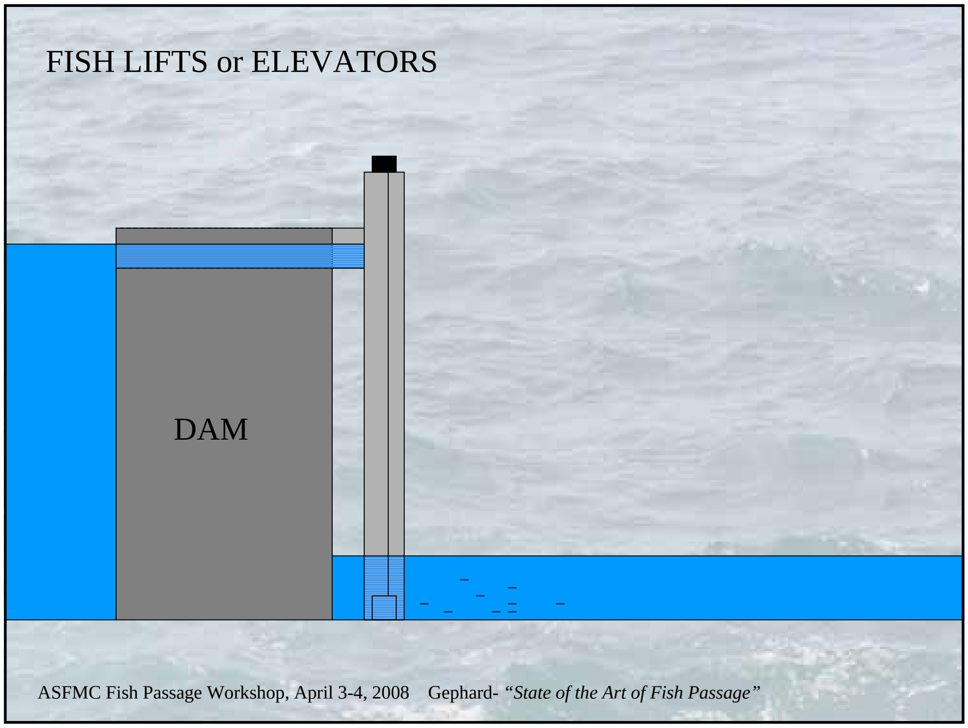
Fairmount Dam, Schuylkill River, PA (American shad and river herring)

Bosher's Mill Dam, James River , VA (American shad, river herring, etc.)



Fish Passage

- Technical Fishways
  - Roughened Chutes
  - Pool-and-Weirs
  - Lifts
- Nature-Like Fishways
- Dam Removal
- Other



FISH LIFTS or ELEVATORS

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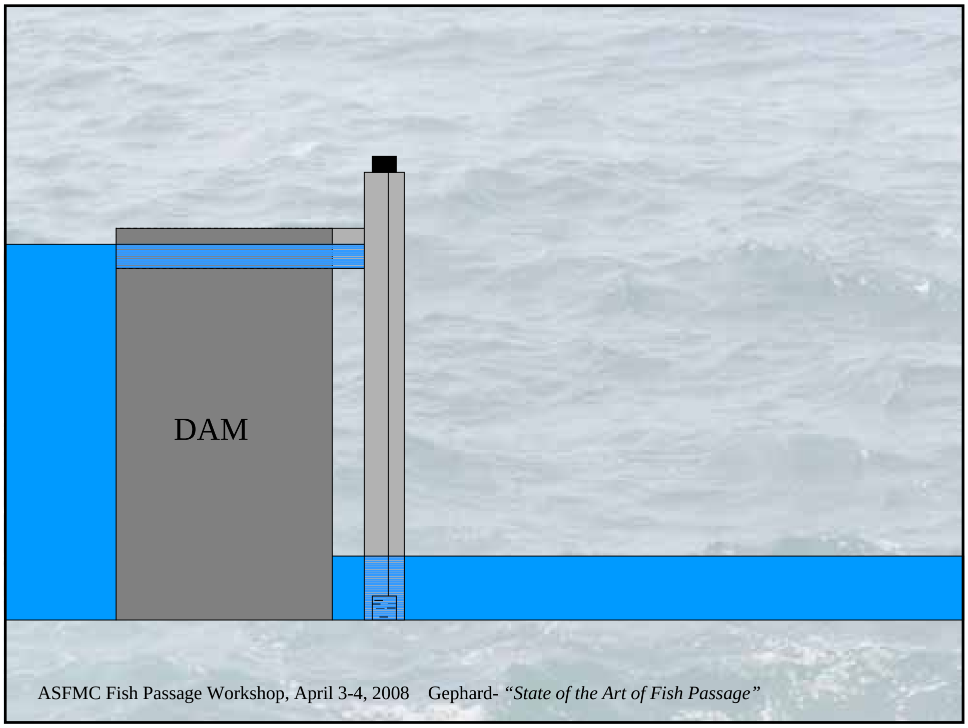

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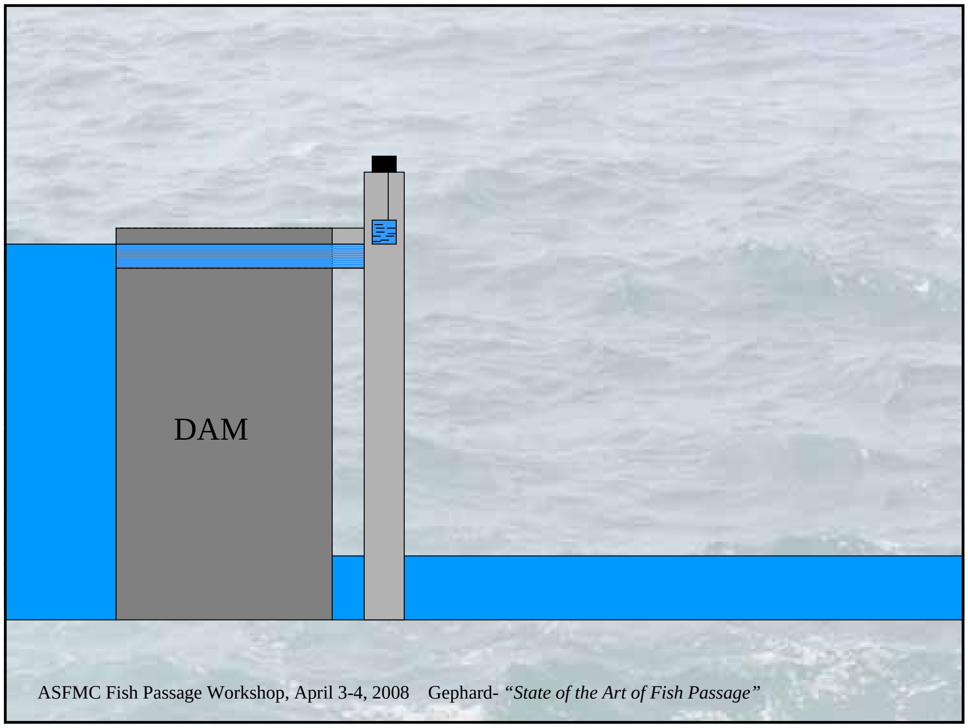

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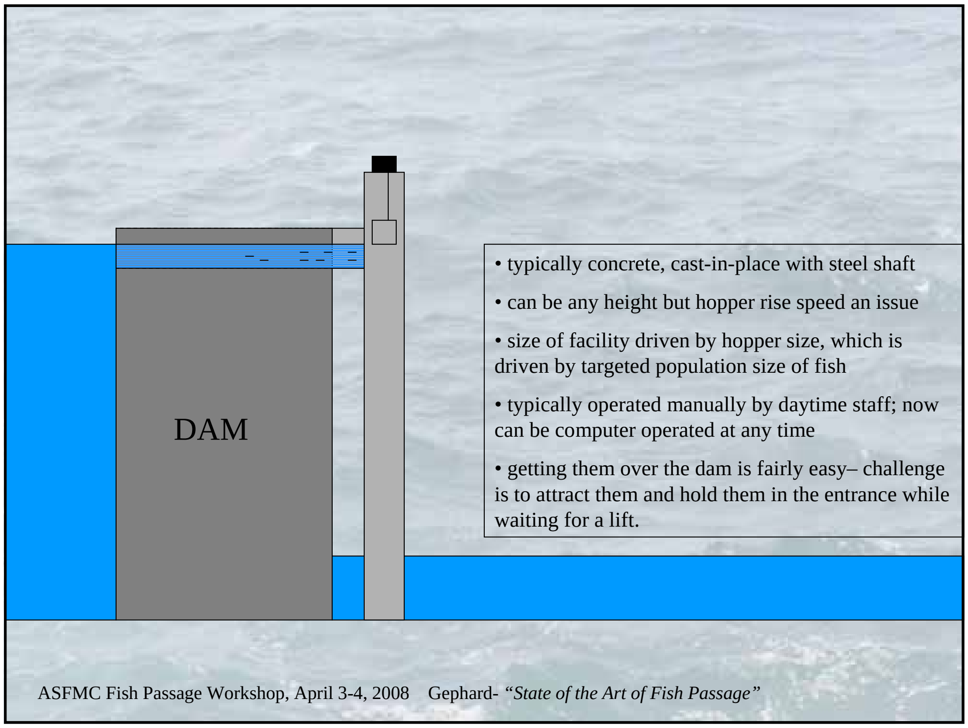

- typically concrete, cast-in-place with steel shaft
- can be any height but hopper rise speed an issue
- size of facility driven by hopper size, which is driven by targeted population size of fish
- typically operated manually by daytime staff; now can be computer operated at any time
- getting them over the dam is fairly easy– challenge is to attract them and hold them in the entrance while waiting for a lift.

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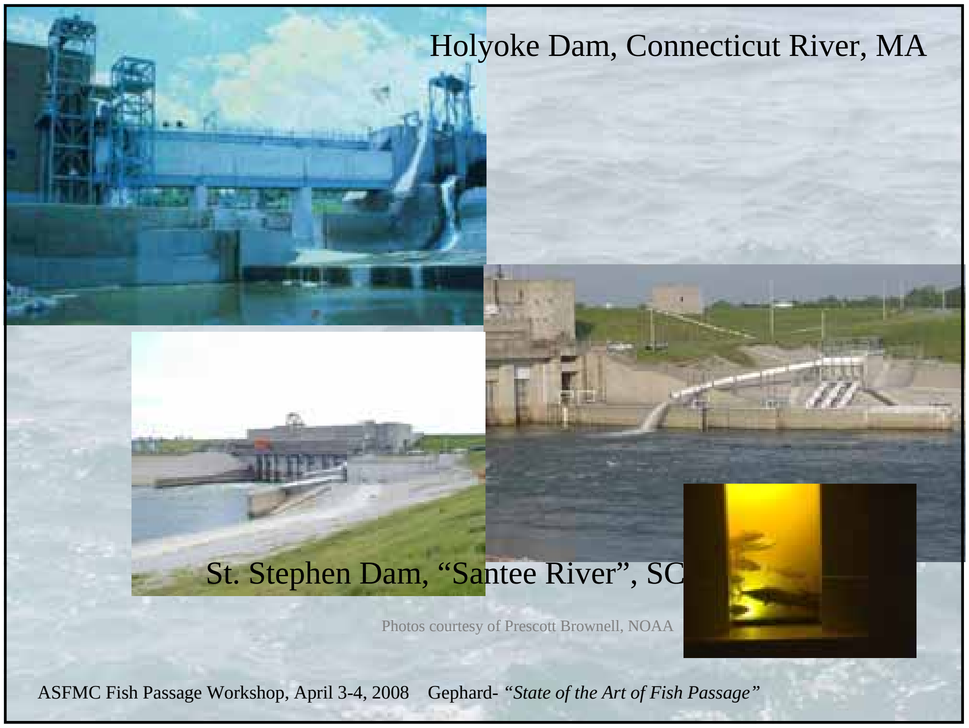

Holyoke Dam, Connecticut River, MA

St. Stephen Dam, “Santee River”, SC

Photos courtesy of Prescott Brownell, NOAA

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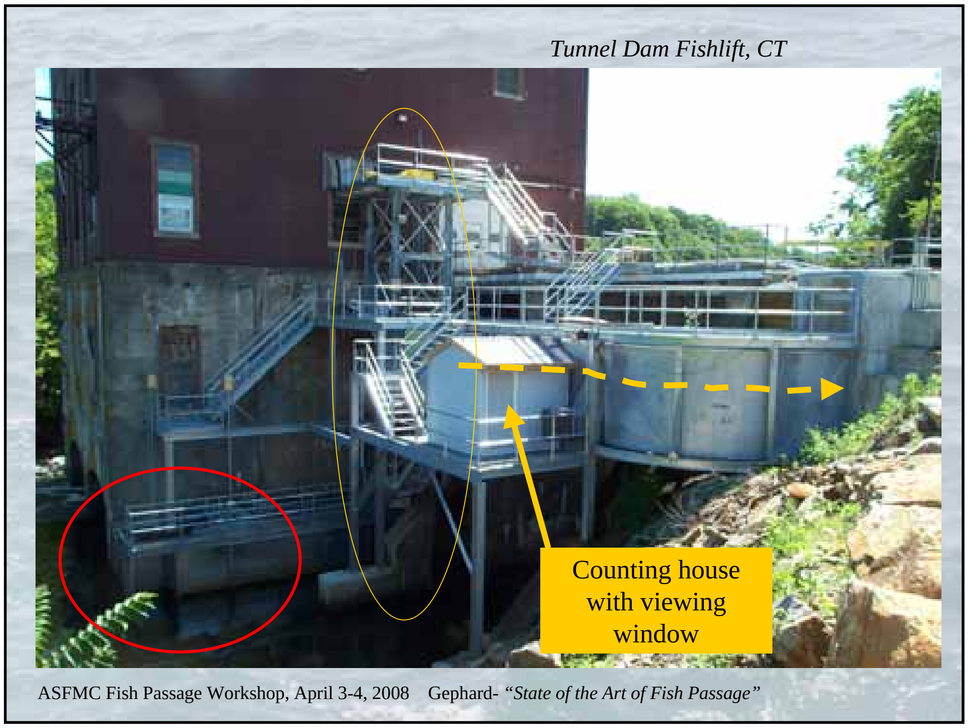

Tunnel Dam Fishlift, CT

Counting house with viewing window

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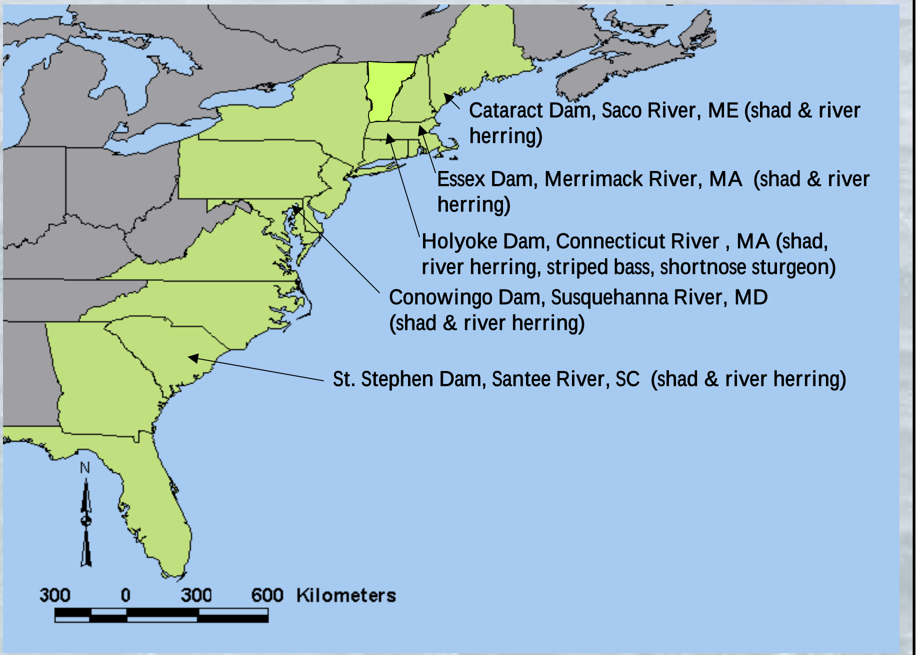


Cataract Dam, Saco River, ME (shad & river herring)

Essex Dam, Merrimack River, MA (shad & river herring)

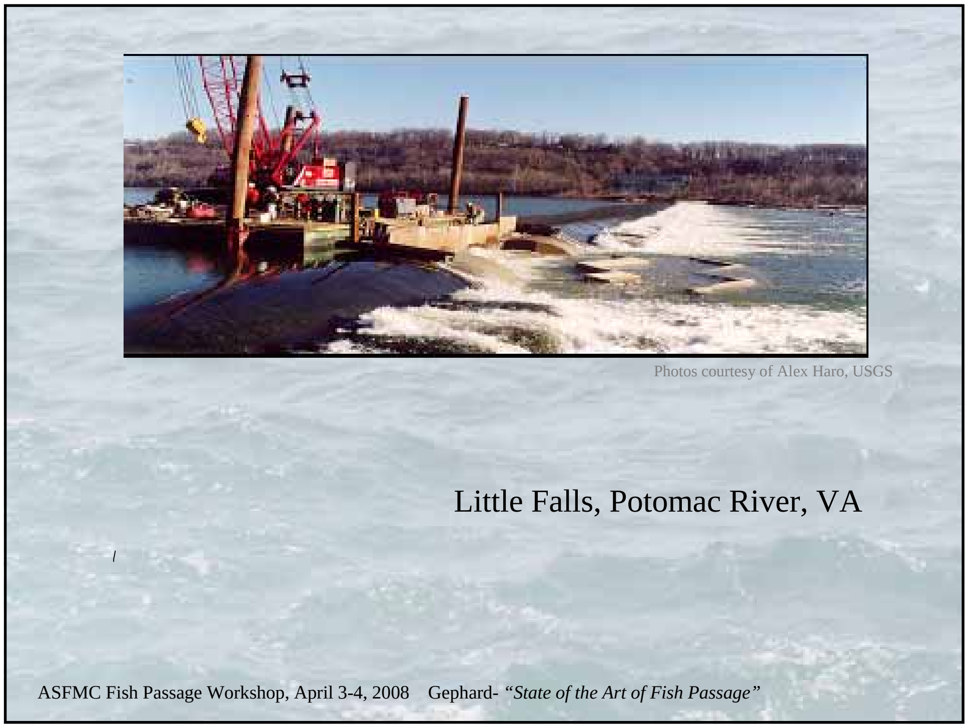
Holyoke Dam, Connecticut River , MA (shad, river herring, striped bass, shortnose sturgeon)

Conowingo Dam, Susquehanna River, MD (shad & river herring)

St. Stephen Dam, Santee River, SC (shad & river herring)

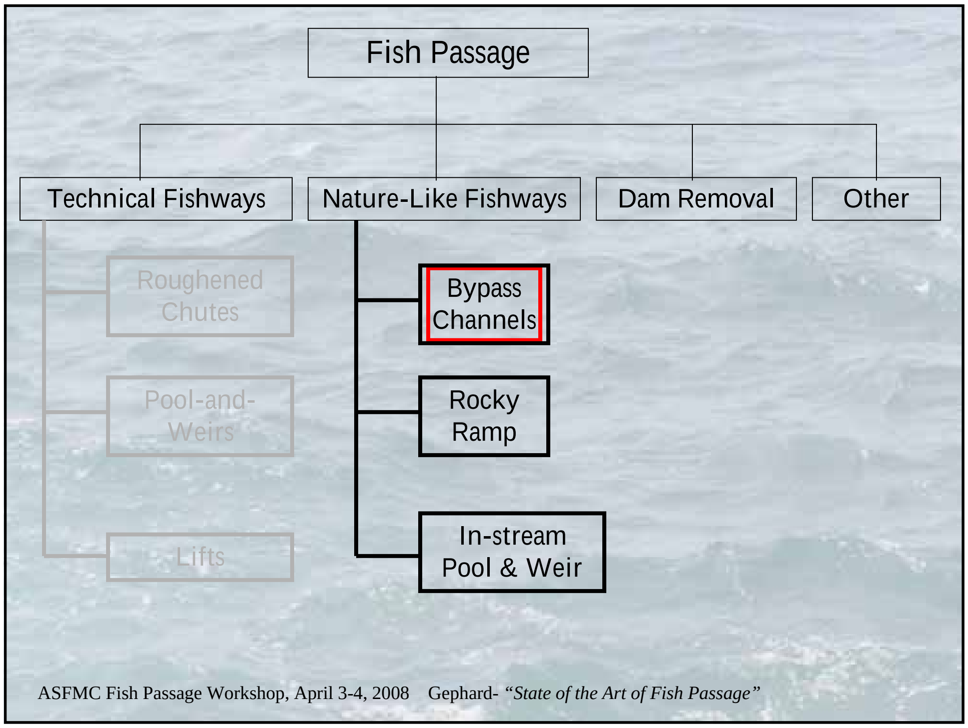
Fish Passage

- Technical Fishways
  - Roughened Chutes
  - Pool-and-Weirs
  - Lifts
  - Miscellaneous
- Nature-Like Fishways
- Dam Removal
- Other



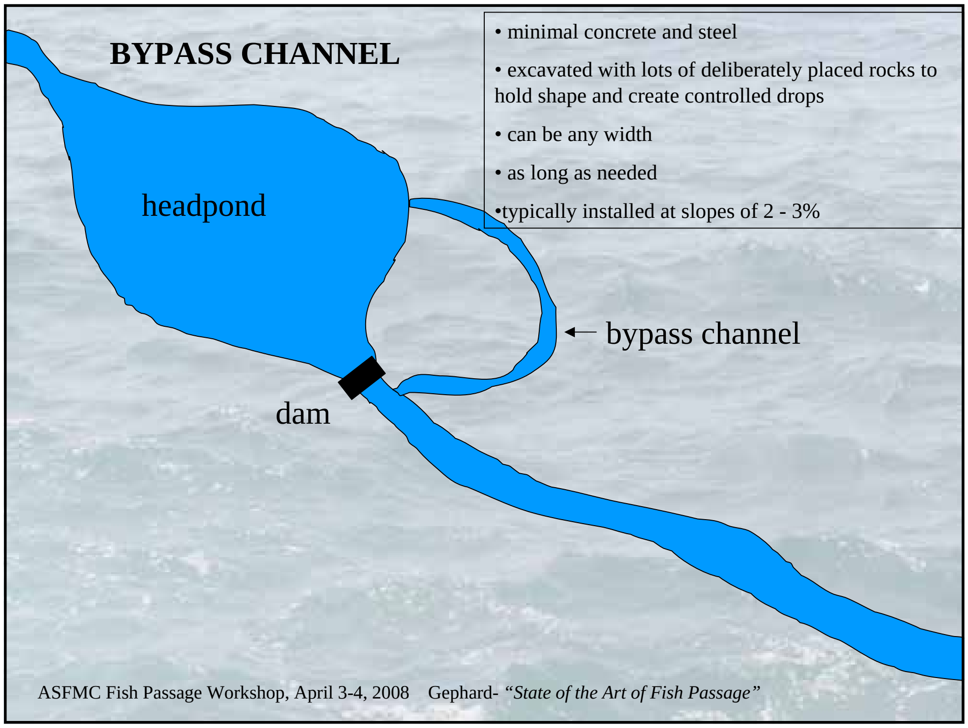
Photos courtesy of Alex Haro, USGS

Little Falls, Potomac River, VA



Fish Passage

- Technical Fishways
  - Roughened Chutes
  - Pool-and-Weirs
  - Lifts
- Nature-Like Fishways
  - Bypass Channels
  - Rocky Ramp
  - In-stream Pool & Weir
- Dam Removal
- Other



BYPASS CHANNEL

- minimal concrete and steel
- excavated with lots of deliberately placed rocks to hold shape and create controlled drops
- can be any width
- as long as needed
- typically installed at slopes of 2 - 3%

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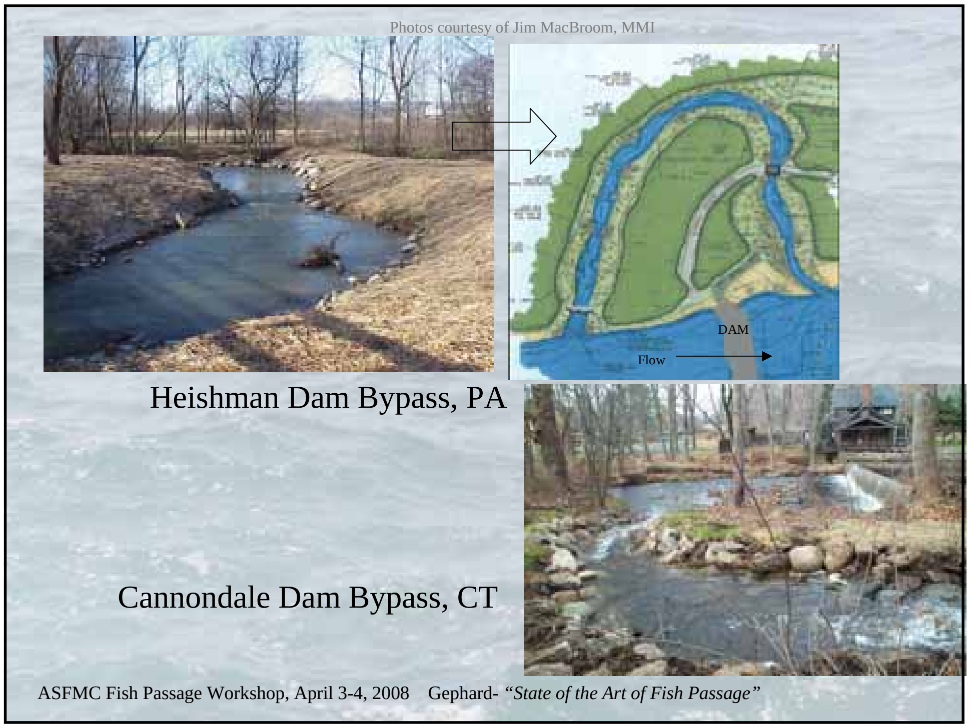

Photos courtesy of Jim MacBroom, MMI

Heishman Dam Bypass, PA

Cannondale Dam Bypass, CT

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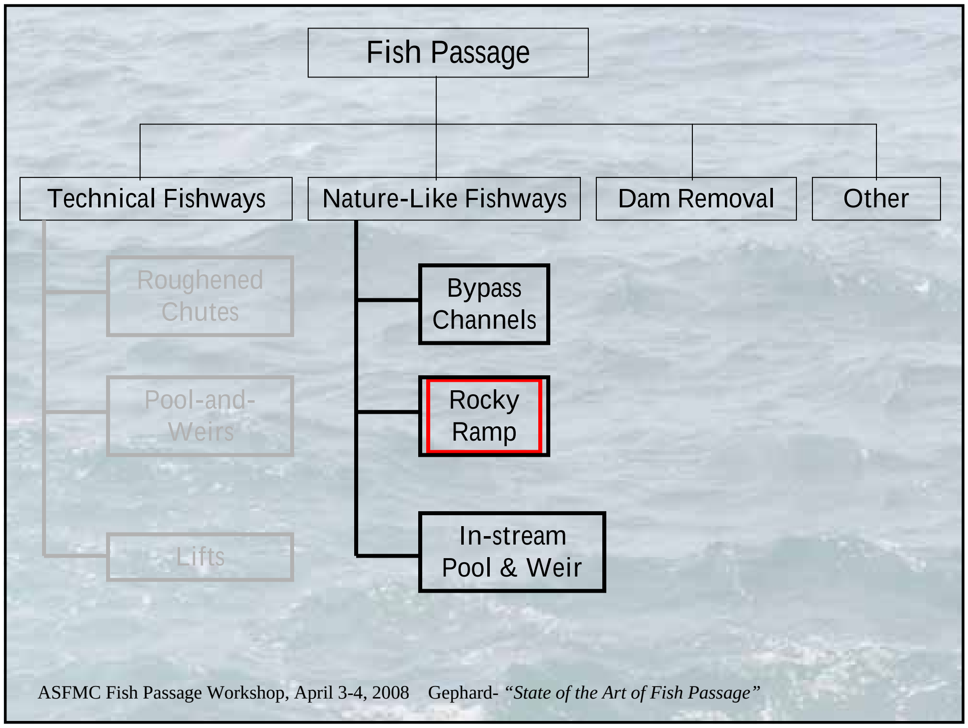

Fish Passage

Technical Fishways

- Roughened Chutes
- Pool-and-Weirs
- Lifts

Nature-Like Fishways

- Bypass Channels
- Rocky Ramp
- In-stream Pool & Weir

Dam Removal

Other

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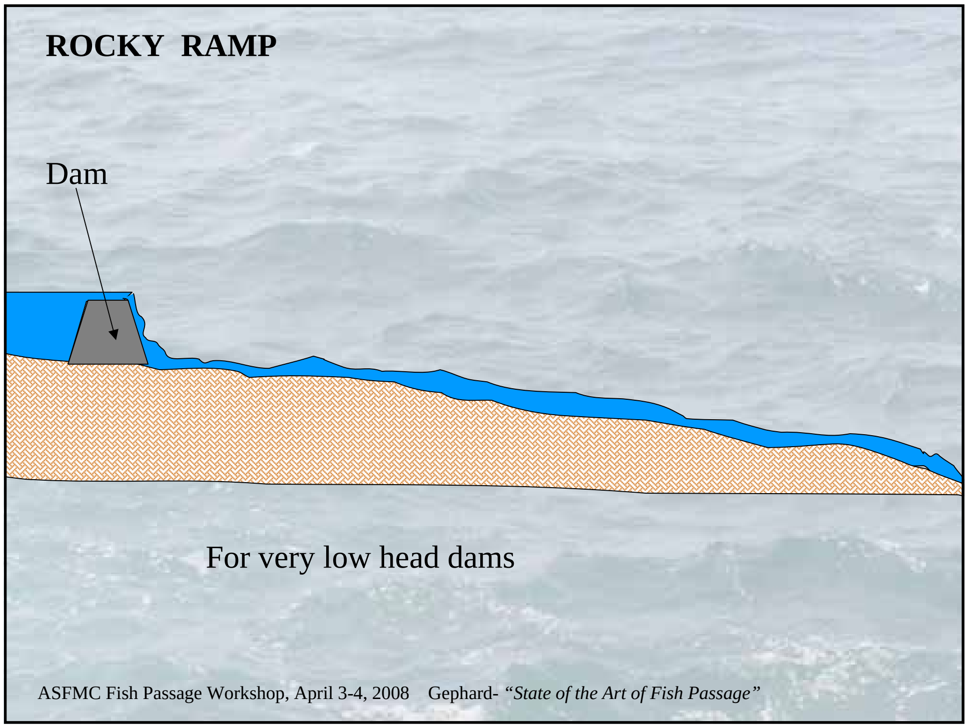

ROCKY RAMP

For very low head dams

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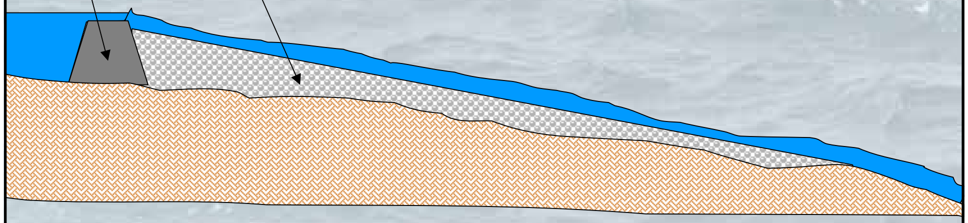
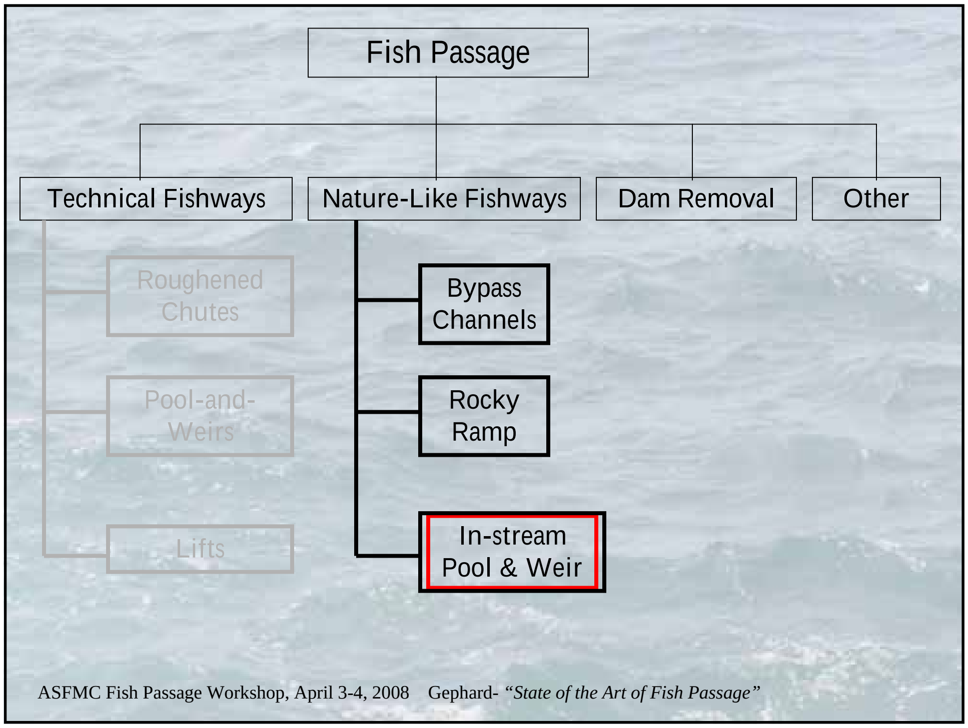


- typically all rock
- ideally ungrouted but some grouting can be done
- typically full-stream width
- as long as needed to achieve proper slope
- typically installed at slopes of 2 - 3%
- if in a large river, requires LOTS of rock placement

The slope of the ramp is typically 1 to 20 or 1 to 30.

Lower Guilford Lake, CT

Sennebec Lake, ME



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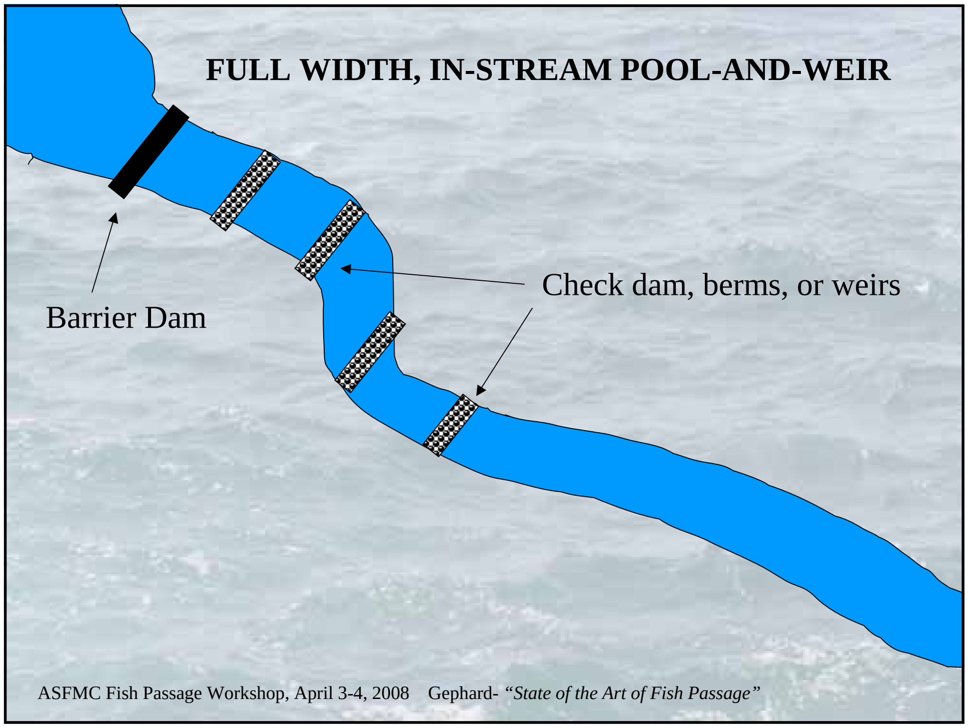

FULL WIDTH, IN-STREAM POOL-AND-WEIR

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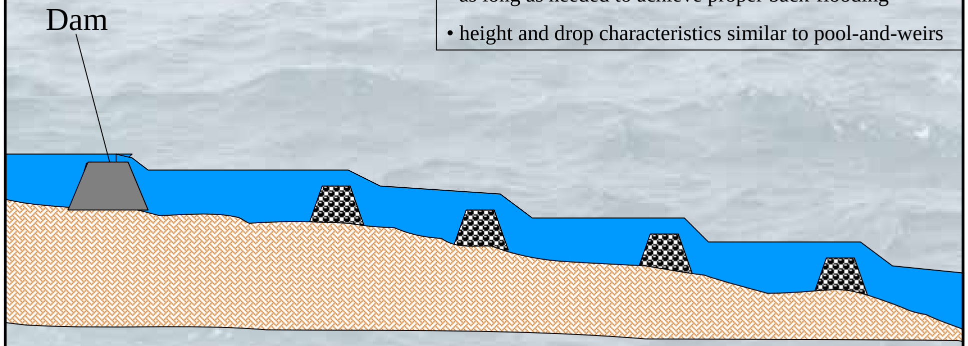
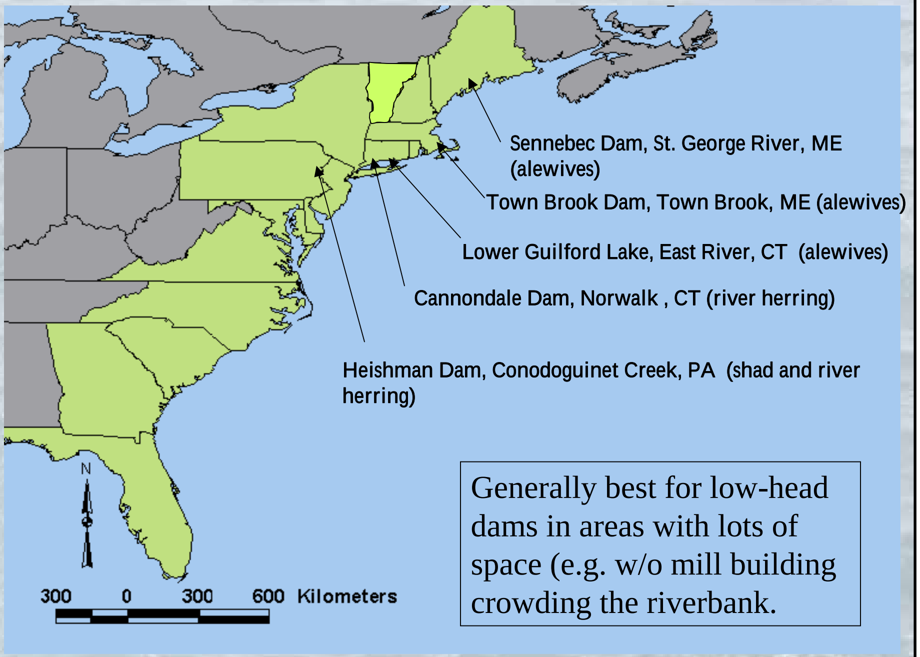
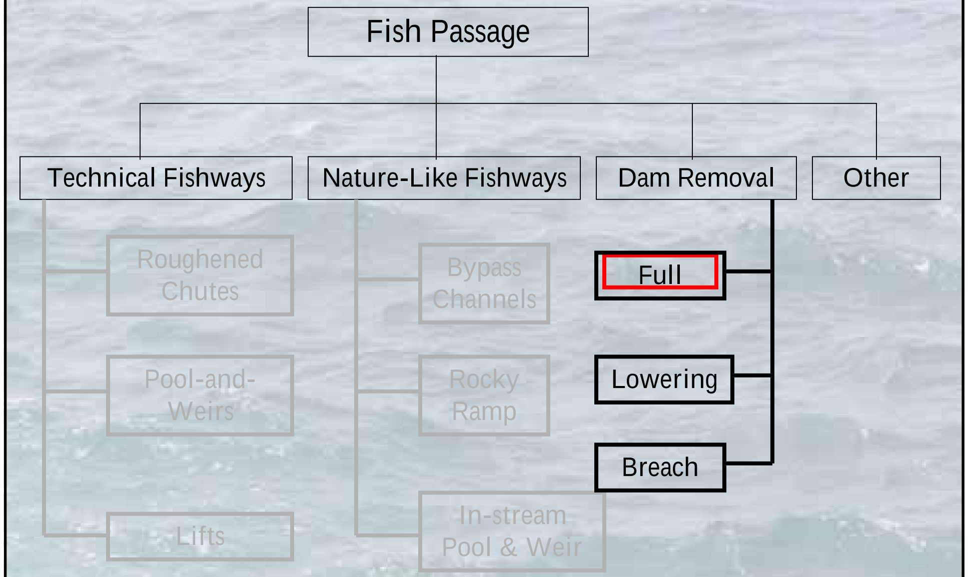
- can be stone, wood, or concrete
- full stream width by definition
- as long as needed to achieve proper back-flooding
- height and drop characteristics similar to pool-and-weirs

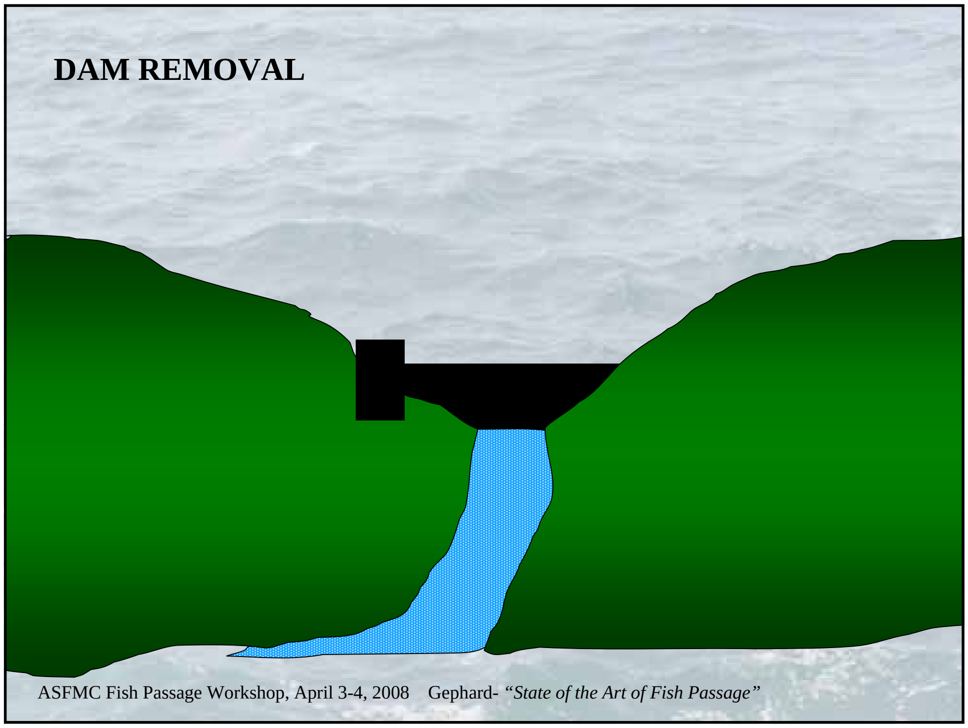


Dorr's Mill, CT

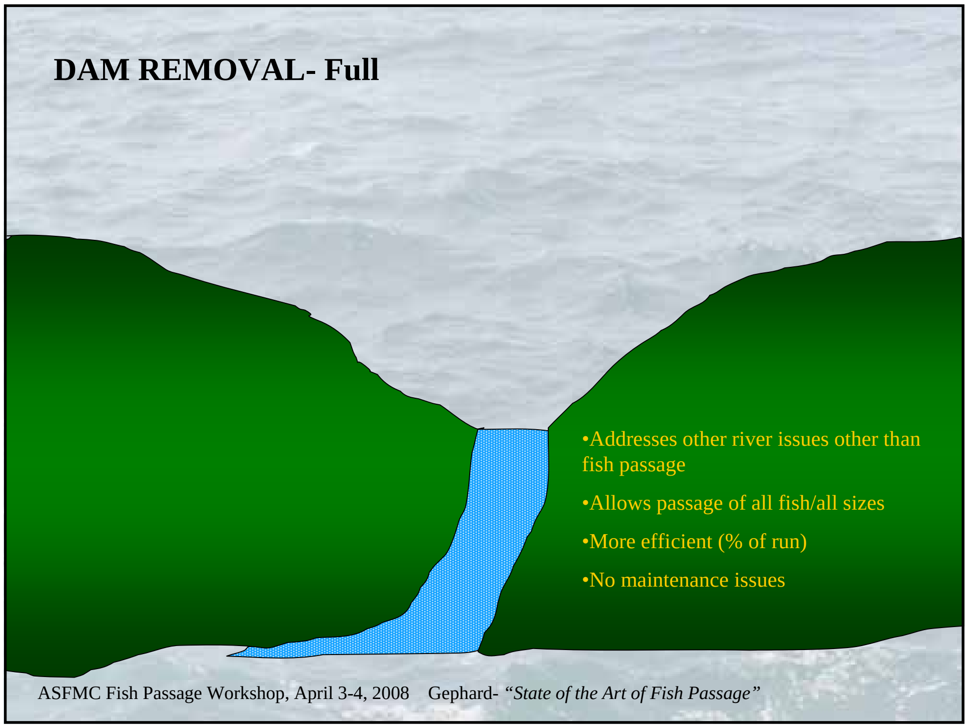


Generally best for low-head dams in areas with lots of space (e.g. w/o mill building crowding the riverbank.



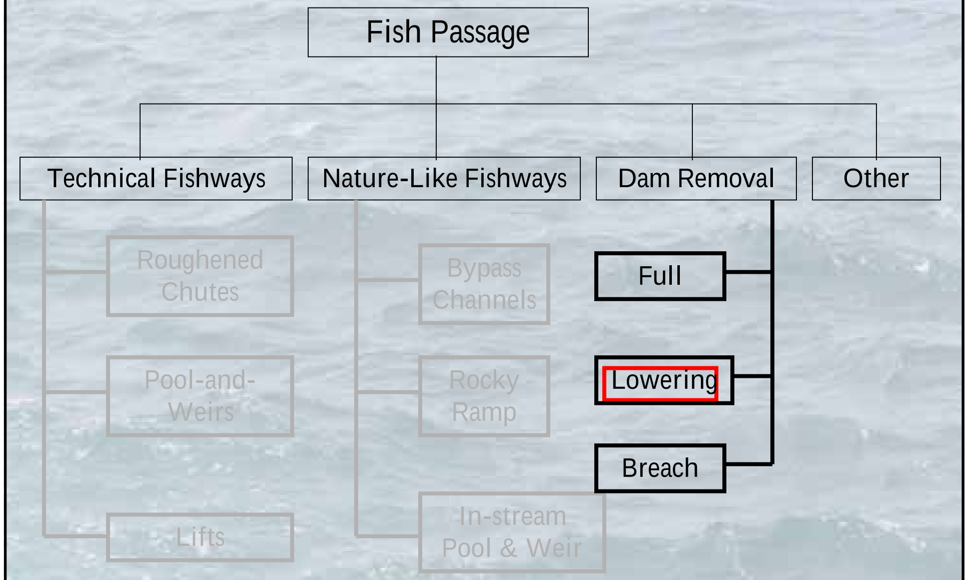


DAM REMOVAL



DAM REMOVAL- Full

- Addresses other river issues other than fish passage
- Allows passage of all fish/all sizes
- More efficient (% of run)
- No maintenance issues



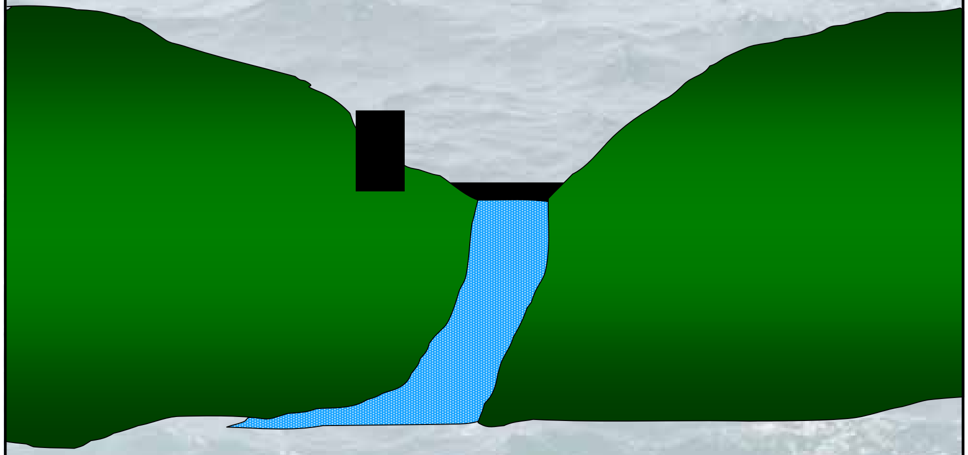
Fish Passage

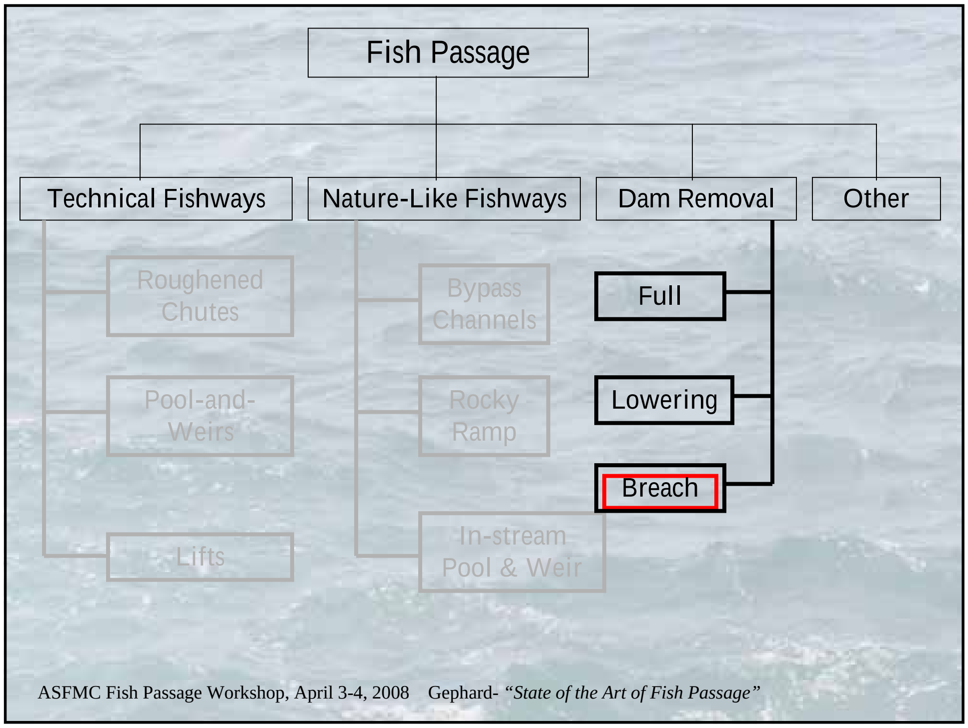
- Technical Fishways
  - Roughened Chutes
  - Pool-and-Weirs
  - Lifts
- Nature-Like Fishways
  - Bypass Channels
  - Rocky Ramp
  - In-stream Pool & Weir
- Dam Removal
  - Full
  - Lowering
  - Breach
- Other

DAM REMOVAL- Lowering

Often still requires fishway.

Often chosen to hold back sediment.





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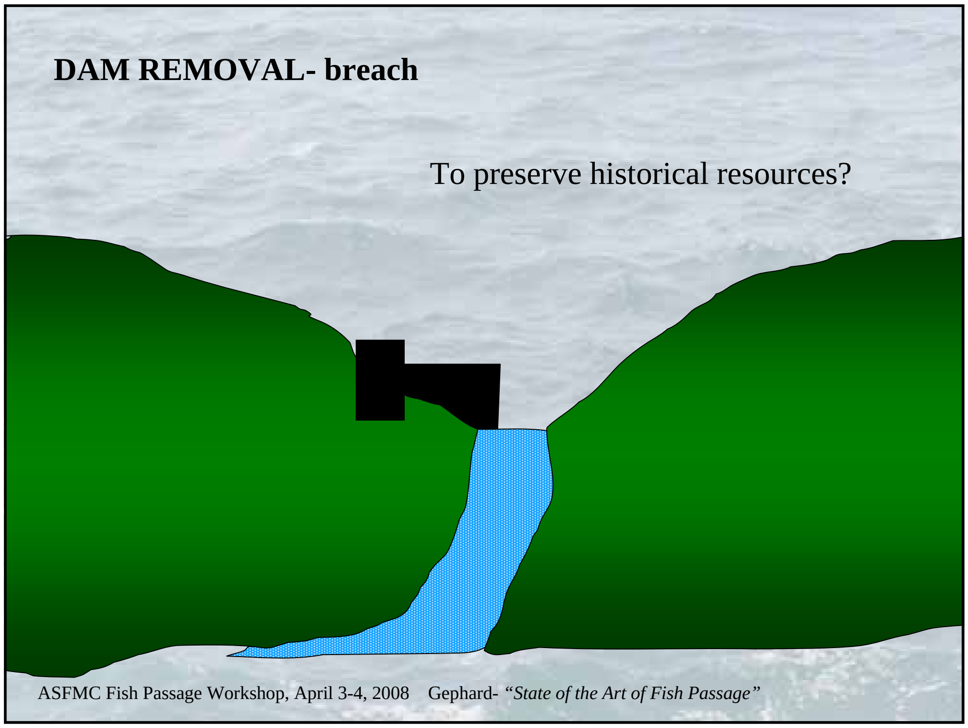
- Breach

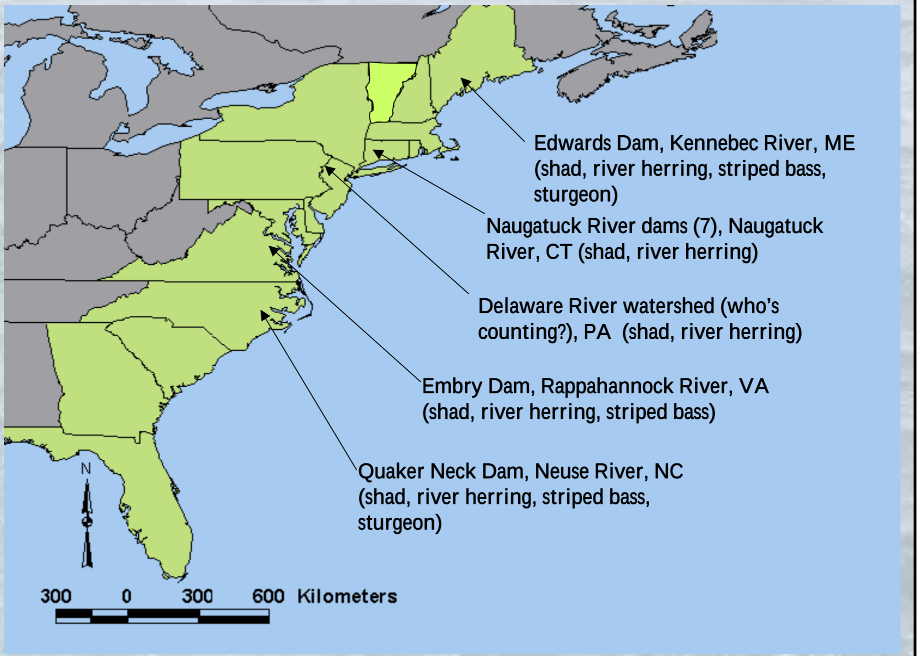
Other



DAM REMOVAL- breach

To preserve historical resources?

Photos courtesy of Laura Wildman, American Rivers



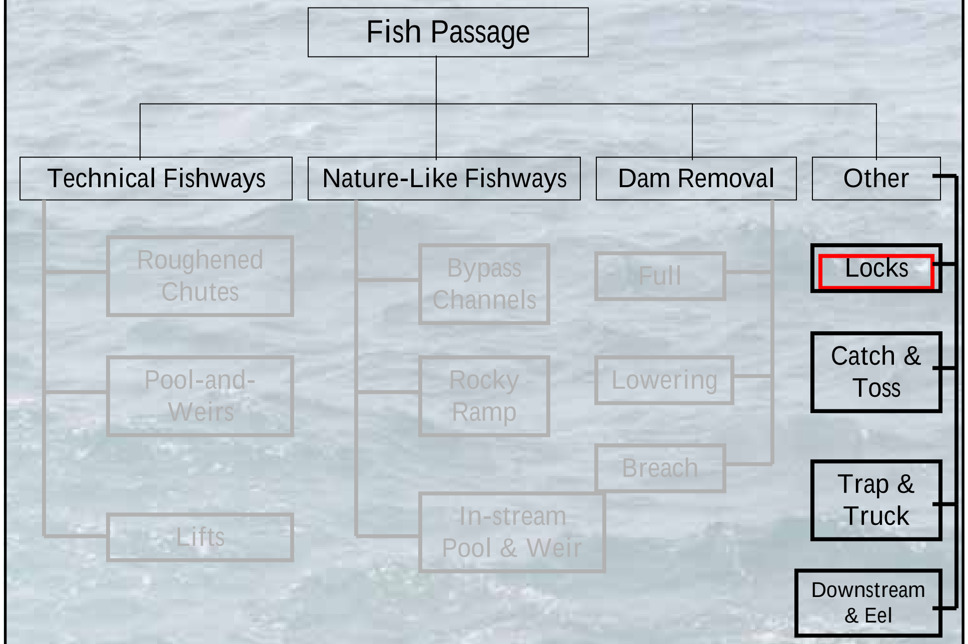
Edwards Dam, Kennebec River, ME (shad, river herring, striped bass, sturgeon)

Naugatuck River dams (7), Naugatuck River, CT (shad, river herring)

Delaware River watershed (who's counting?), PA (shad, river herring)

Embry Dam, Rappahannock River, VA (shad, river herring, striped bass)

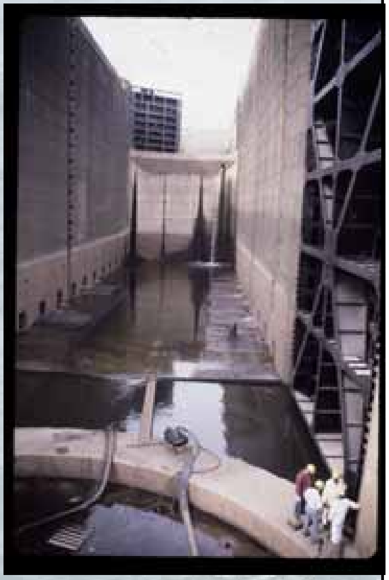
Quaker Neck Dam, Neuse River, NC (shad, river herring, striped bass, sturgeon)



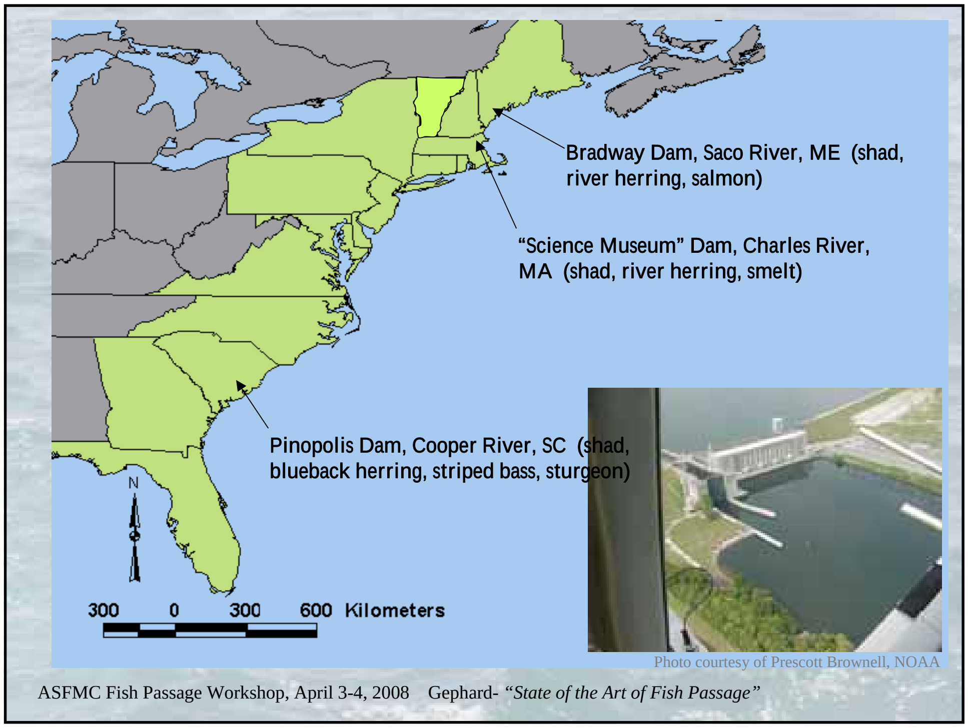
Fish Passage

- Technical Fishways
  - Roughened Chutes
  - Pool-and-Weirs
  - Lifts
- Nature-Like Fishways
  - Bypass Channels
  - Rocky Ramp
  - In-stream Pool & Weir
- Dam Removal
  - Full
  - Lowering
  - Breach
- Other
  - Locks
  - Catch & Toss
  - Trap & Truck
  - Downstream & Eel

NAVIGATIONAL LOCKS



Photos courtesy of Prescott Brownell, NOAA



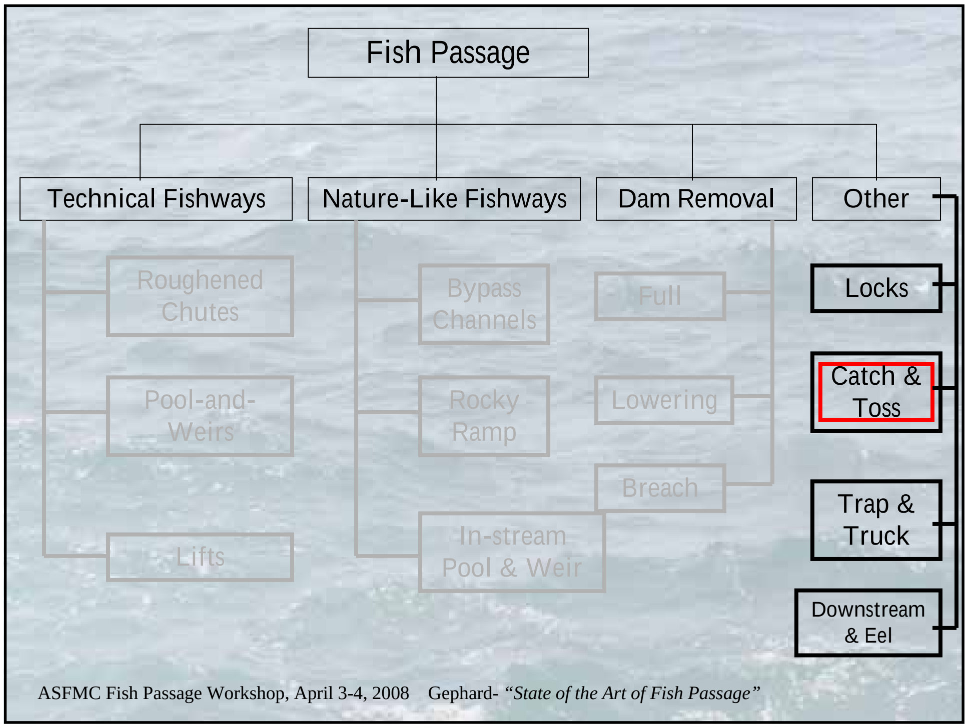
Bradway Dam, Saco River, ME (shad, river herring, salmon)

"Science Museum" Dam, Charles River, MA (shad, river herring, smelt)

Pinopolis Dam, Cooper River, SC (shad, blueback herring, striped bass, sturgeon)

Photo courtesy of Prescott Brownell, NOAA

ASFMC Fish Passage Workshop, April 3-4, 2008 Gephard- *"State of the Art of Fish Passage"*



Fish Passage

- Technical Fishways
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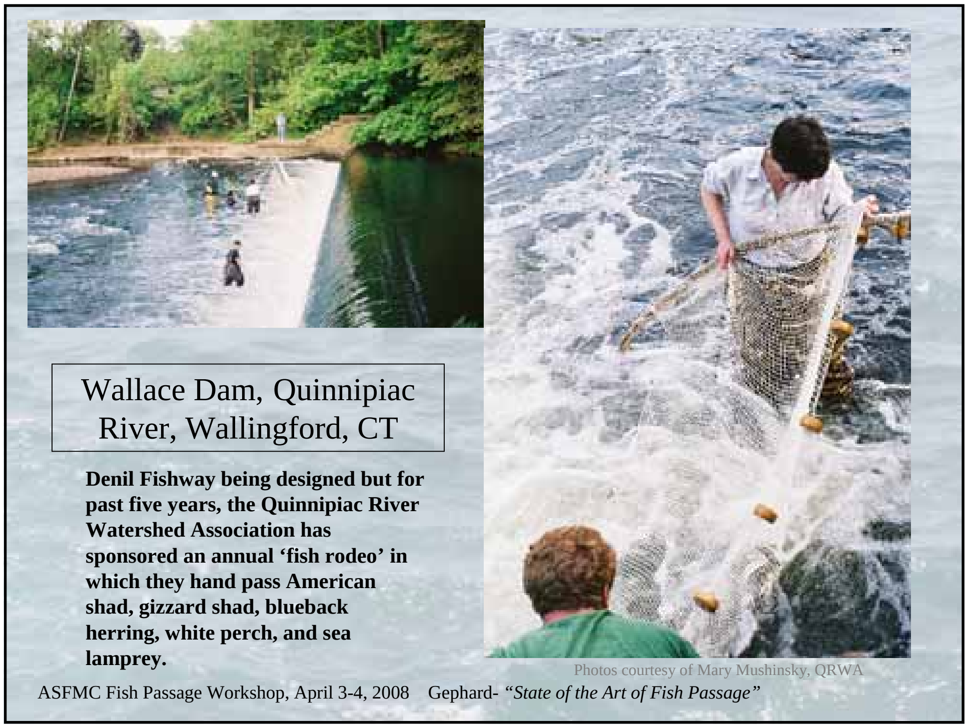
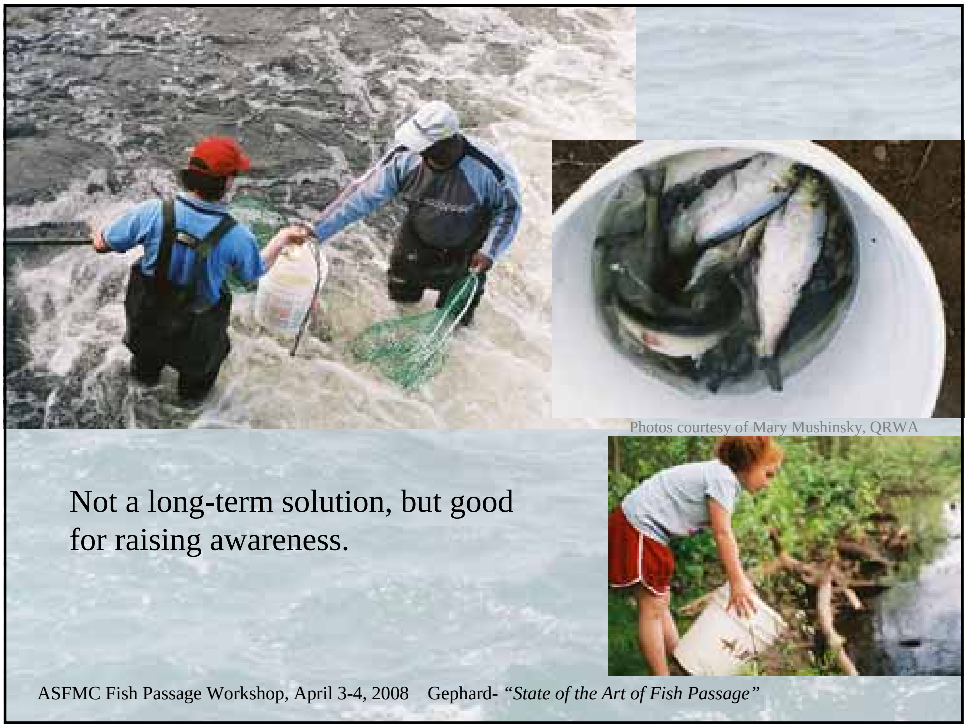


Wallace Dam, Quinnipiac River, Wallingford, CT

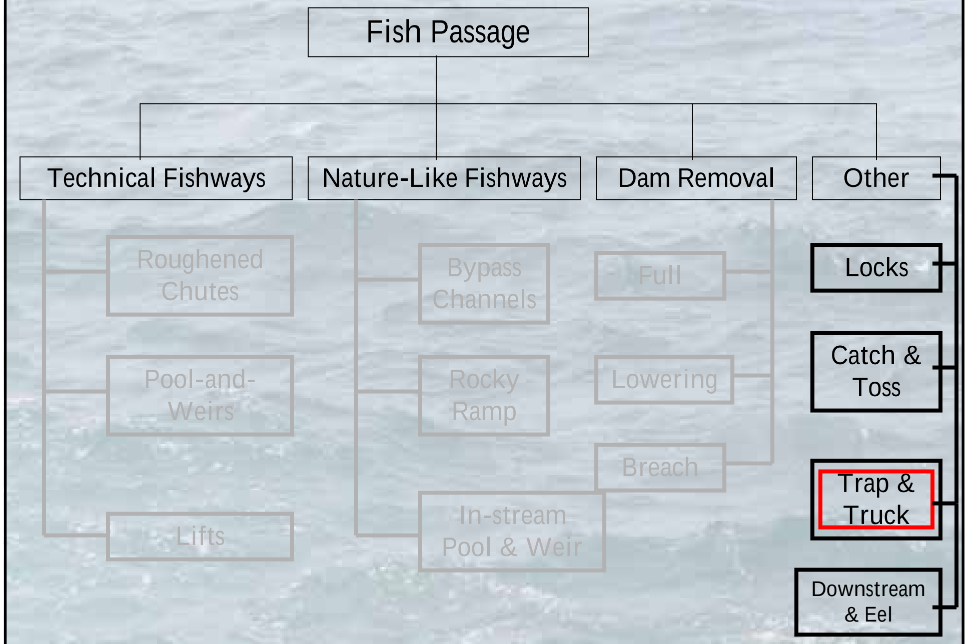
Denil Fishway being designed but for past five years, the Quinnipiac River Watershed Association has sponsored an annual 'fish rodeo' in which they hand pass American shad, gizzard shad, blueback herring, white perch, and sea lamprey.

Photos courtesy of Mary Mushinsky, QRWA



Photos courtesy of Mary Mushinsky, QRWA

Not a long-term solution, but good for raising awareness.



Fish Passage

Technical Fishways
- Roughened Chutes
- Pool-and-Weirs
- Lifts

Nature-Like Fishways
- Bypass Channels
- Rocky Ramp
- In-stream Pool & Weir

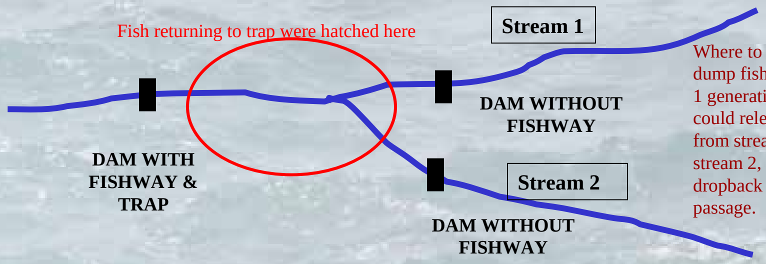
Dam Removal
- Full
- Lowering
- Breach

Other
- Locks
- Catch & Toss
- Trap & Truck
- Downstream & Eel

TRAP & TRUCK

PROBLEMS WITH TRAP & TRUCK

- Interrupted & unnatural migration- additional delays inevitable.
- greater potential for injury and post-handling losses (mortality & drop out of system)
- tends to be species-specific
- relies heavily on human interactions– what happens when trucks break down, etc.?
- typically requires a fishway or trap to collect fish
- may return fish to river from which it did not originate– confuse homing mechanism.



Fish returning to trap were hatched here

Stream 1

DAM WITHOUT FISHWAY

DAM WITH FISHWAY & TRAP

Stream 2

DAM WITHOUT FISHWAY

Where to you dump fish? After 1 generation, you could release fish from stream 1 into stream 2, causing dropback and no passage.

DOWNSTREAM PASSAGE

- Passage is needed for juveniles as well as spent adults
- Some fish will come down fishways designed for upstream passage
- Many will not– particularly if there is competing water use, e.g. hydro
- Going over the spillway may be okay– but if the dam is tall, fish may get injured
- Most East Coast downstream passage devices have been some type of surface collection/spill
- Most effective for salmon, shad, and river herring
- Least effective to sturgeon and eel
- More research is needed

(1) Illuminated opening near turbine intakes (gate opens downward)

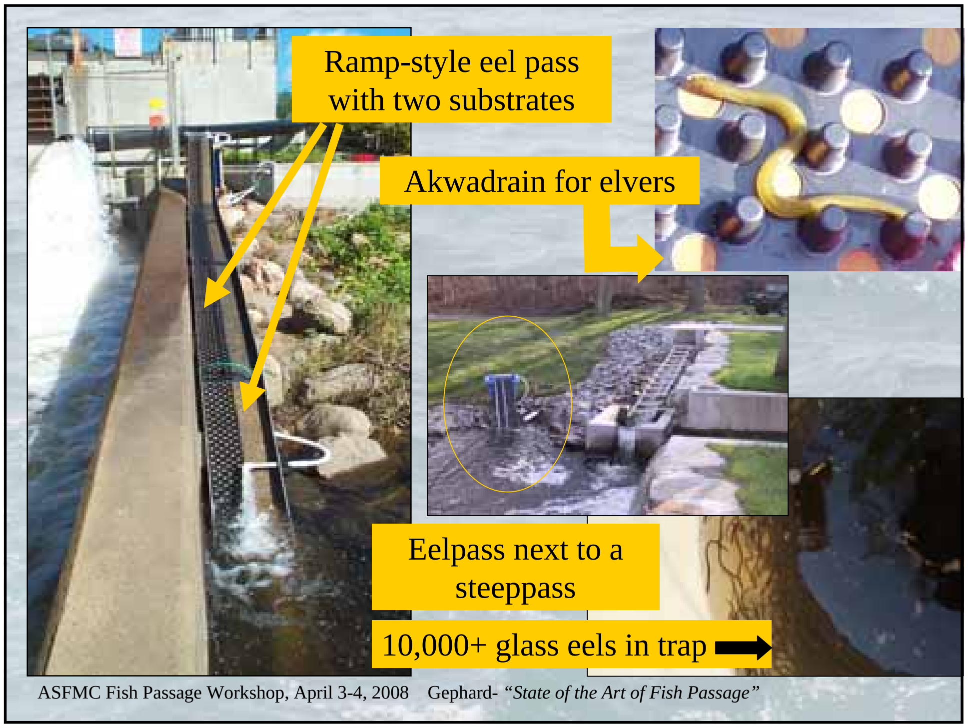
(2) Flows enters sloped pipe that bypasses powerhouse

(3) Pipe discharges into tailwater

EEL PASSAGE (Upstream)

- Some dams are surmounted by many eels; the ability for eels to get over dams varies widely among dams
- Passage is needed for juveniles– the size of the fish depends on the location in the watershed
- Some eels will use other fishways– esp. nature-like and some pool-and-weirs
- Ideal attraction conditions for eels are different than for shad etc. so even if the fishway is passable to eels, many may not find or enter it
- In most cases, a separate, specially-designed eel pass will be beneficial
- Most eel passes can be quite inexpensive
- Eel passes can also trap Y-O-Y and serve as ASMFC monitoring site

Photos courtesy of Lorenz Photography



Ramp-style eel pass with two substrates

Akwadrain for elvers

Eelpass next to a steeppass

10,000+ glass eels in trap

ASFMC Fish Passage Workshop, April 3-4, 2008 Gephard- *“State of the Art of Fish Passage”*

THE END

ASFMC Fish Passage Workshop, April 3-4, 2008 Gephard- *“State of the Art of Fish Passage”*

Passage Concerns for Striped Bass

R.Wilson Laney, Prescott Brownell, Nichola Meserve
With assistance from Alex Haro, Steve Gephard, and Pace Wilber

Atlantic States Marine Fisheries Commission
Fish Passage Workshop
April 3, 2008, Jacksonville, Florida
[Photo by Matt Breece, U.S. Fish and Wildlife Service]

Presentation Outline

- Striped Bass Restoration: How to Define?
- Migratory and “Less” Migratory Stripers
- Atlantic Migratory Striped Bass: ME-NC
- “Less” Migratory Striped Bass: SC-FL
- Available Passage Technologies
- What Works, What Doesn’t
- Existing Projects and Facilities
- Challenges

Striped Bass Restoration Definitions

- How we define **restoration** determines to what extent passage is required.
- If we define it only as attainment of some arbitrary biological reference point (s), or some desired CPUE, (ASMFC approach, to date) passage needs may be minimal or unnecessary. Stock was "restored" absent significant emphasis on passage to historic habitats.
- If on the other hand, we define restoration as reestablishing the full scope of geographic range and ecological function (FWS and NMFS mandate), then passage needs are far more extensive.

Is Migration Size (Limit) Dependent in Southeast States?

- Riverine/Estuarine Size Limit NC North: 18-20 inches (ASMFC standard)
- Offshore Size Limit NC North: 28 inches + (ASMFC standard)
- South Carolina Riverine Limit: can have two fish less than 21 inches in Congaree River; Savannah River, minimum 27 inches
- Georgia Riverine and Ocean Size Limit: 22 inches +; except Savannah, same as SC
- Florida Riverine (St. Marys, St. Johns): 22 inches, or less?; Ocean = no regulation?

Atlantic Migratory Striped Bass as an Identified Passage Priority: ME-DE

- Penobscot River, ME: http://www.penobscotriver.org
- Kennebec River, ME: http://maine.gov/dmr/searunfish/kennebec/
- Androscoggin River, ME: http://maine.gov/dmr/searunfish/programs/androscoggiin.htm
- Presumpscot River, ME: fishway renovation, fish weir installation, striped bass is listed target species.
- Town Brook, MA: striped bass is target species.
- Connecticut River, CT: Present, not a priority for passage.
- Hudson River, NY: Present, passage not needed.
- Schuylkill River, PA: Present, passage a priority
- Delaware River, DE and PA: Present, main stem passage not needed?

Atlantic Migratory Striped Bass as an Identified Passage Priority: Chesapeake I

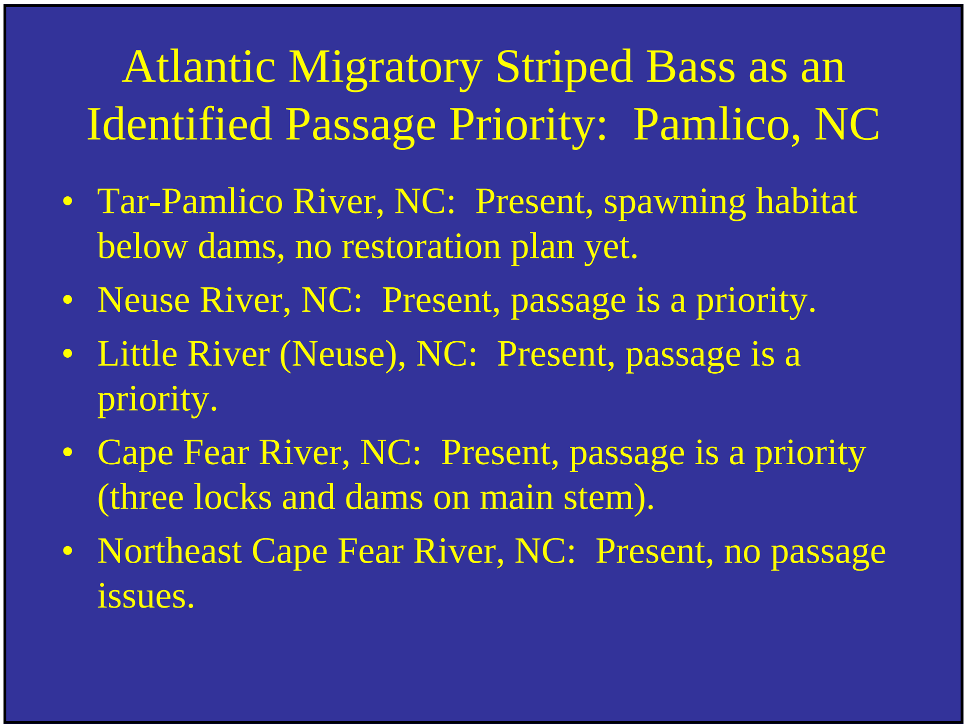
- Pocomoke River, MD:
- Wicomico River, MD:
- Nanticoke River, MD:
- Patapsco River, MD:
- Choptank River, MD:
- Chester River, MD:
- Sassafras River, MD:
- Elk River, MD:
- Susquehanna River, MD/PA:
- Patuxent River, MD:
- [Many passage projects on many of these rivers, but striped bass not a priority species on any of them.]

Atlantic Migratory Striped Bass as an Identified Passage Priority: Chesapeake II

- Potomac River, VA/MD: done, striped bass a target species.
- Rappahannock River, VA: done, striped bass a priority species.
- Mattaponi River (York), VA: present, none needed?
- Pamunkey River (York), VA: present, none needed?
- York River, VA: present, none needed?
- Chickahominy River (James), VA: done, striped bass using it, Walker’s Dam double Denil fishway
- James River, VA: many projects done, striped bass benefitting

Atlantic Migratory Striped Bass as an Identified Passage Priority: Albemarle

- Blackwater River (Chowan), VA: unknown
- Meherrin River (Chowan), VA: lift on Emporia Reservoir, striped bass not a target
- Nottoway River (Chowan), VA: unknown
- Chowan River, NC/VA: Present, passage not needed.
- Roanoke River, NC/VA: Present, passage not a priority.

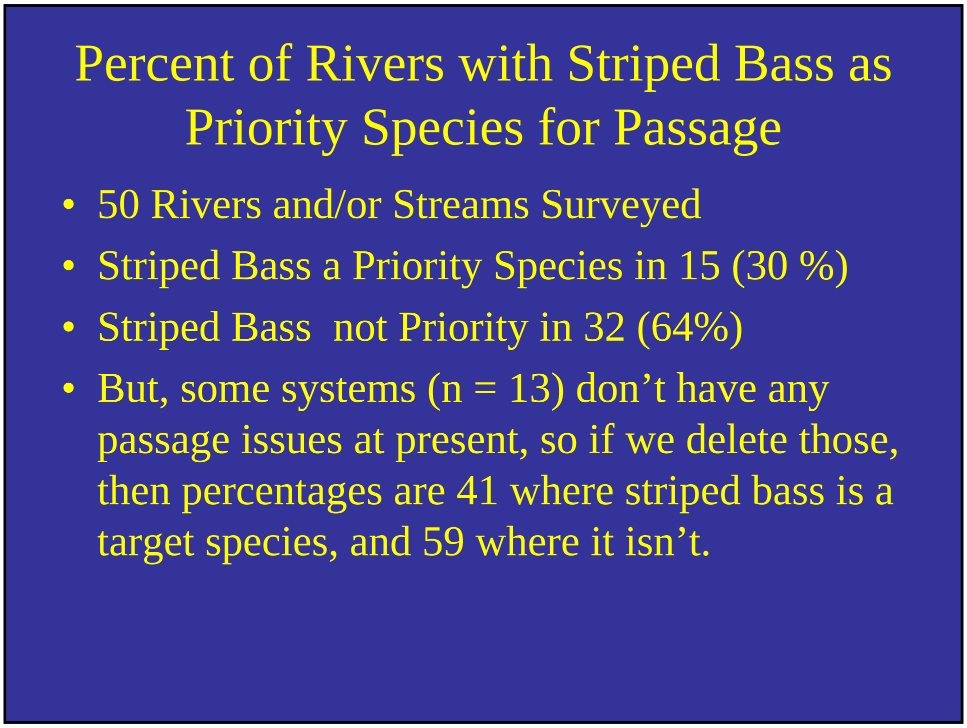


Atlantic Migratory Striped Bass as an Identified Passage Priority: Pamlico, NC

- Tar-Pamlico River, NC: Present, spawning habitat below dams, no restoration plan yet.
- Neuse River, NC: Present, passage is a priority.
- Little River (Neuse), NC: Present, passage is a priority.
- Cape Fear River, NC: Present, passage is a priority (three locks and dams on main stem).
- Northeast Cape Fear River, NC: Present, no passage issues.

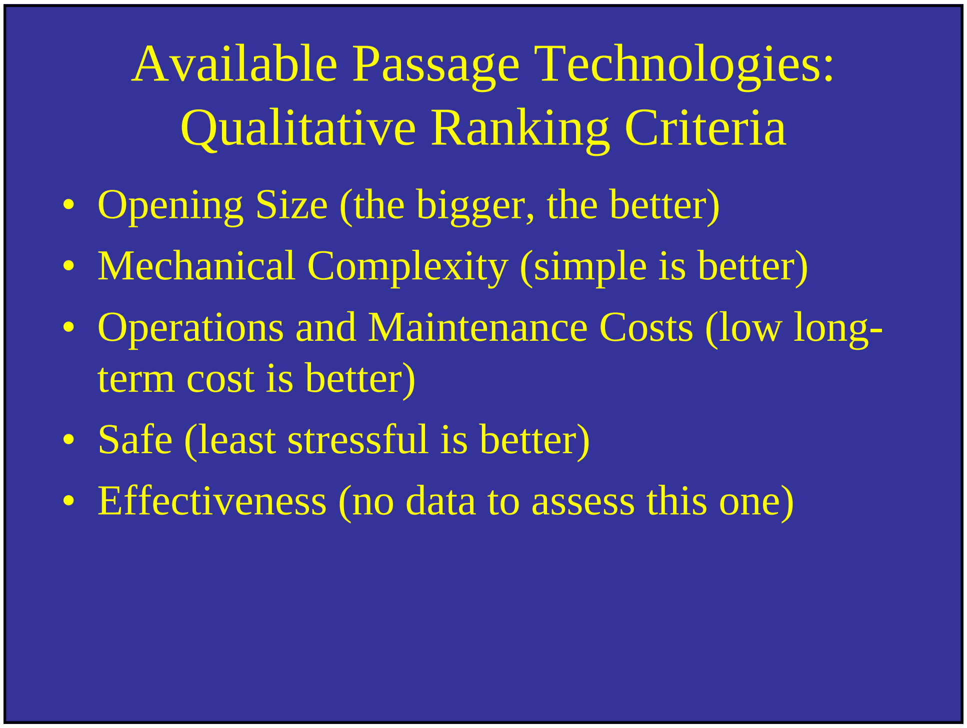
Less Migratory Striped Bass as an Identified Passage Priority: SC-FL

- Yadkin-Pee Dee River, SC/NC: Present, passage not a priority.
- Santee-Cooper River, SC/NC: Present, passage being done.
- Ashley River, SC: Present, passage not an issue.
- ACE Basin Rivers, SC: Present, passage not an issue.
- Coosawhatchie/Broad River, SC: Present, passage not an issue.
- Savannah River, GA/SC: Present, passage is a priority for federal agencies.
- Ogeechee River, GA: not needed, no dams
- Oconee River (Altamaha), GA: reservoirs, striped bass stocked, no passage
- Ocmulgee River (Altamaha), GA: reservoirs, striped bass stocked
- Altamaha River, GA: no dams below confluence, not needed
- Satilla River, GA: no dams, passage not needed
- St. Marys River, GA: no dams, passage not needed
- St. Johns River, FL: Present, passage was a priority.



Percent of Rivers with Striped Bass as Priority Species for Passage

- 50 Rivers and/or Streams Surveyed
- Striped Bass a Priority Species in 15 (30 %)
- Striped Bass not Priority in 32 (64%)
- But, some systems (n = 13) don’t have any passage issues at present, so if we delete those, then percentages are 41 where striped bass is a target species, and 59 where it isn’t.



Available Passage Technologies: Qualitative Ranking Criteria

- Opening Size (the bigger, the better)
- Mechanical Complexity (simple is better)
- Operations and Maintenance Costs (low long-term cost is better)
- Safe (least stressful is better)
- Effectiveness (no data to assess this one)

Available Passage Technologies: Hypothetical Rank

- Obstruction Removal
- Natural Channel Bypass
- Rock Ramp or Weir
- Breach or Notch
- Vertical Slot Fishway
- Alaskan Steep Pass; Denil Fishway
- Locks
- Fish Lift
- Trap and Transport

What Works, What Doesn’t?

- Removing the obstruction generally works one hundred percent of the time.
- Doing nothing, accomplishes nothing.
- We don’t really know how well the other technologies which do pass striped bass work for them, because no one has measured passage efficiency.

Facilities Passing Stripers

- Lockwood Dam Lift, Kennebec River, ME
- Brunswick Dam Fishway, Androscoggin, ME
- Fairmount Dam, Vertical Slot Fishway, Schuylkill River, PA
- Conowingo Dam East Facility, Susquehanna, MD
- Conowingo Dam West Fish Lift, Susquehanna, MD
- Cape Fear River Locks and Dams, NC
- St. Stephens Fish Life, Santee River, SC?
- Pinopolis Lock, Cooper River, SC?

Selected Examples: New England

Edwards Dam Removal

Kennebec River, Maine

Selected Examples: Mid-Atlantic

Little Falls Dam Fishway Construction
Potomac River, Maryland

Selected Examples: Mid-Atlantic

Bosher’s Dam and Fishway
James River, Virginia

Selected Examples: Southeast

Quaker Neck Dam Removal

Neuse River, North Carolina

Challenges

- Managing Our Striped Bass Success (predation issue)
- Perception that Reservoir Striped Bass Fisheries Functionally Replace Anadromous
- Resistance to Reintroduction of Wild Stripers into Reservoirs
- Resistance to Loss of Reservoir Fisheries due to Dam Removal
- If you Pass them Up, You Have to Pass Them Down
- Lack of Supporting Science

Comments/Questions??

John Christian with new New Jersey state record striped bass, Mays Landing, Great Egg Harbor River, April 26, 2002

Passage Technologies for Shad, River Herring, Sturgeon, and Eel

Alex Haro
S.O. Conte Anadromous Fish Research Laboratory
U.S. Geological Survey – Biological Resources Discipline
Turners Falls, Massachusetts

ASMFC Fish Passage Workshop
Jacksonville, Florida April 3-4

WARNING

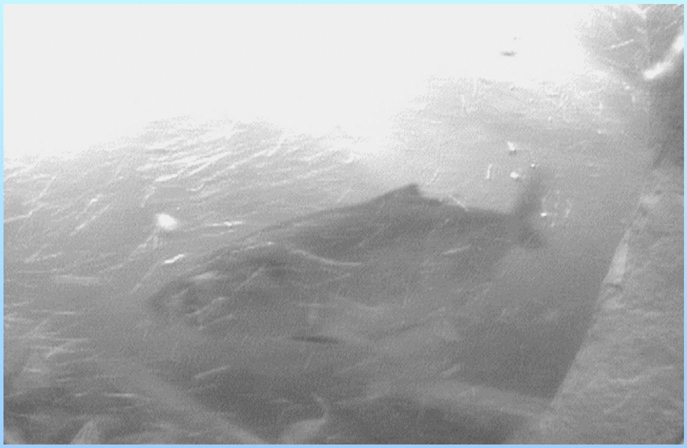
This presentation may contain Yankee geographic bias and ivory tower overgeneralizations

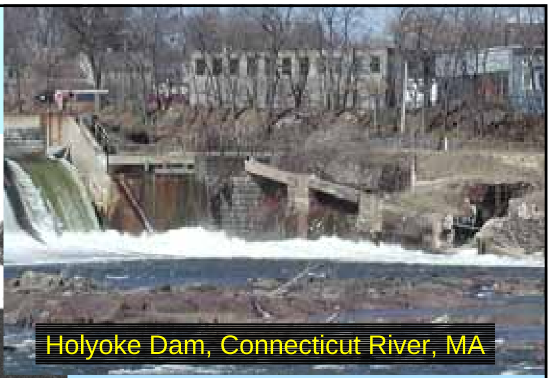
Shad and River Herring Passage

Shad and River Herring Migratory Biology

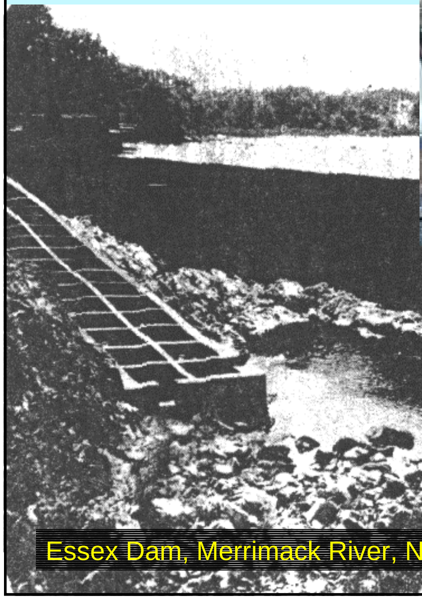
- Pelagic, strong aerobic swimmers; schooling
- Specific spawning habitats
- River-specific populations, possibly within-river subpopulations
- Usually do not jump; behavioral constraints
- Ascend structures primarily during the day

Upstream Passage





Holyoke Dam, Connecticut River, MA



Essex Dam, Merrimack River, NH

Early “shad” fishways

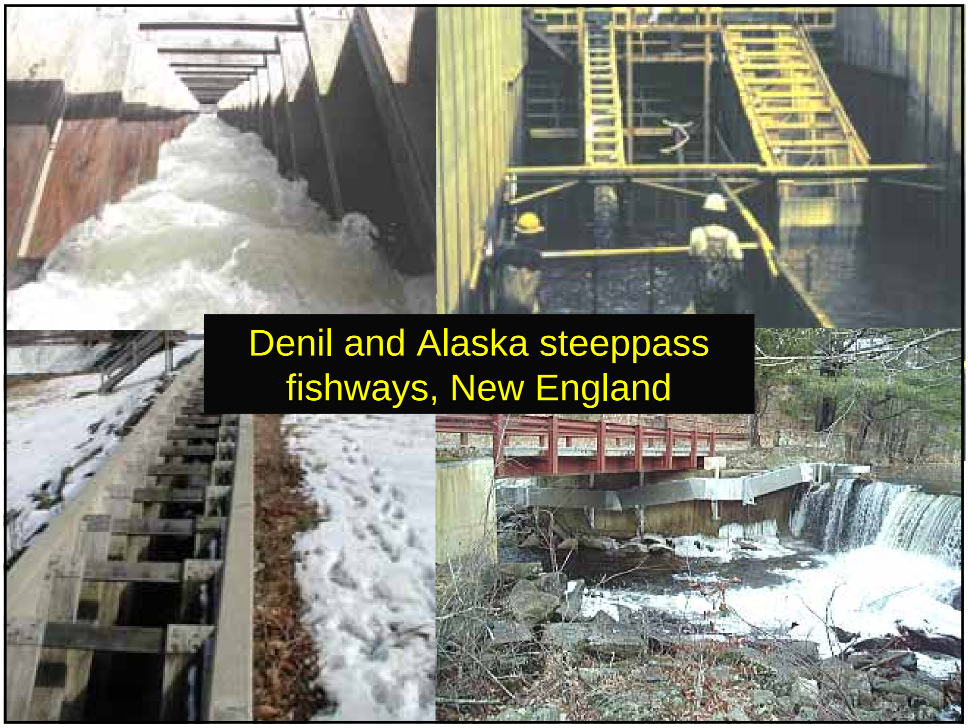
Large technical fishways, Columbia River, WA/OR

East Coast adaptations of Columbia River fishways

Ice Harbor fishway, Turners Falls Dam, Connectict River, VT

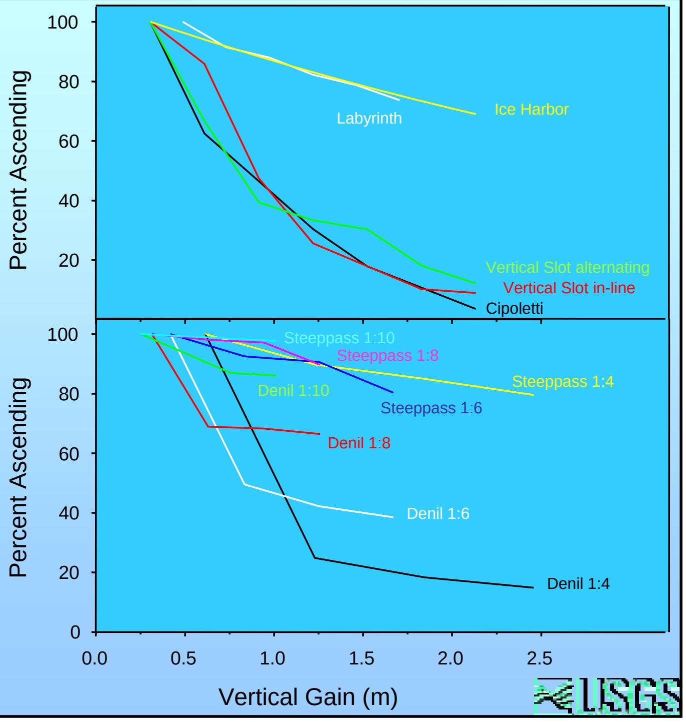
Serpentine regulating section; Vernon Dam, Connecticut River, VT

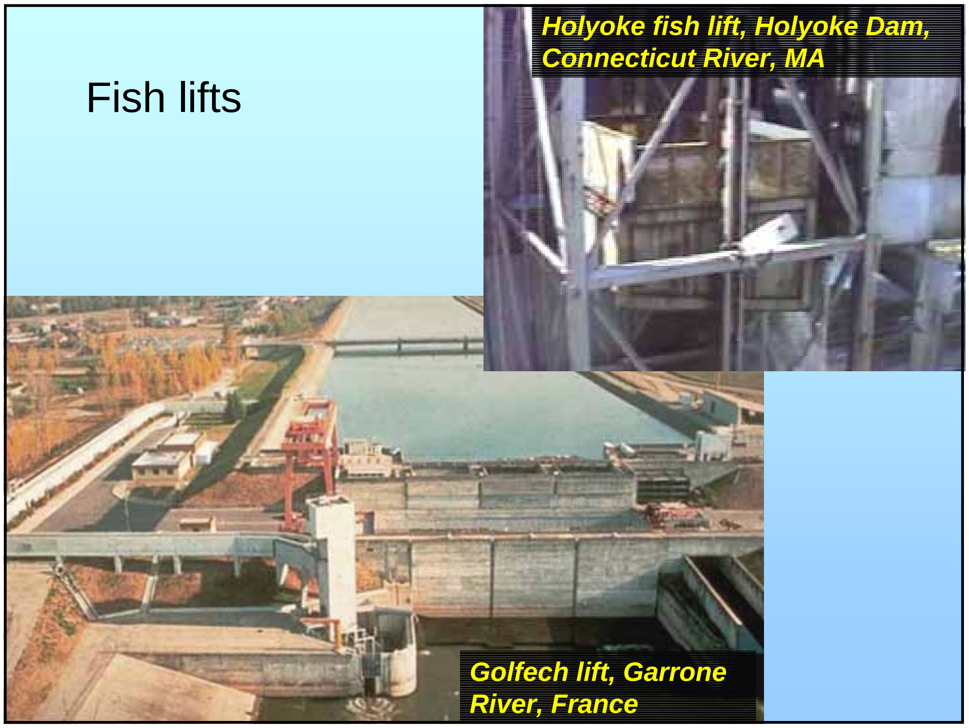
Vertical slot fishway, Veazie Dam, Penobscot River, ME



Denil and Alaska steeppass fishways, New England

Passage performance of various fishways for adult shad; lab & field data

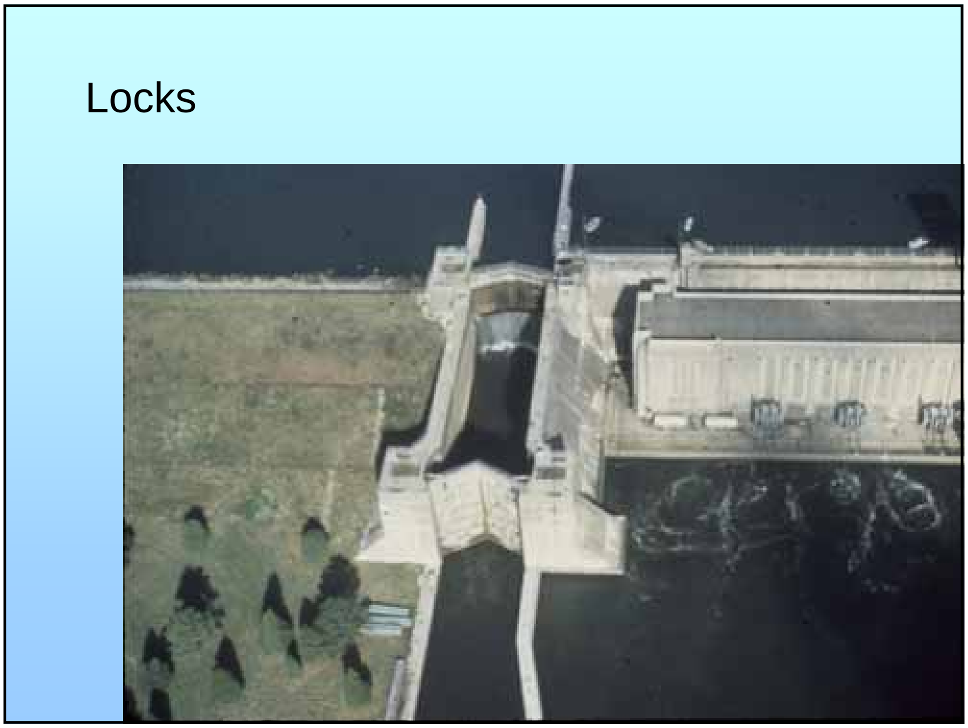




Fish lifts

Holyoke fish lift, Holyoke Dam, Connecticut River, MA

Golfech lift, Garrone River, France



Locks

Nature-like fishways

Criteria & Recommendations – Upstream Passage for Shad & River Herring

Low-head dams (<3 m height):

- Notches, nature-like fishways (large, deep)
- Denil, Alaska steeppass (large and deepened sizes; minimize slope, number of turning & resting pools)

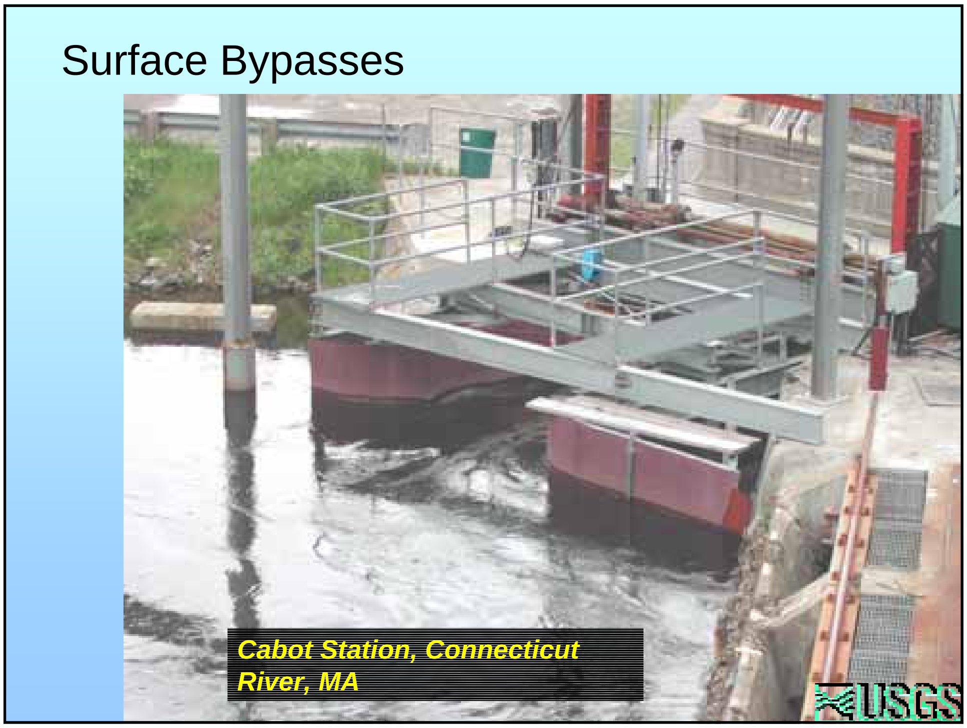
Medium-head dams (3-5 m height):

- Serpentine or vertical slot fishway, ≤0.25 m (9”) drop per pool

High-head dams (>5 m height):

- Fish lift (capacity considerations)
- Very large nature-like fishways?

Downstream Passage



Surface Bypasses

Cabot Station, Connecticut River, MA

Strobe light and acoustic array; York Haven Dam Susquehannah River, Pennsylvania

Criteria & Recommendations – Downstream Passage for Shad & River Herring (adults & juveniles)

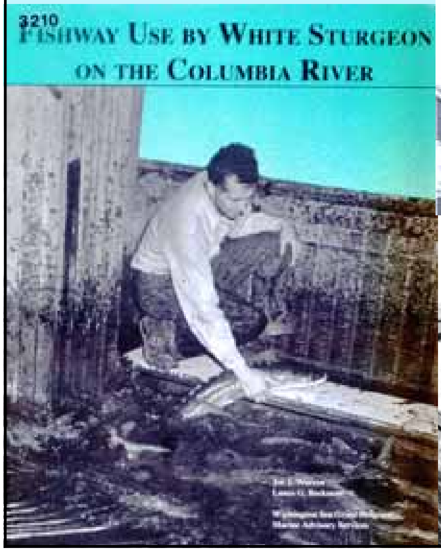
- Reduced bar rack spacing (more problematic for juveniles)
- Reduced approach velocities
- Provision of surface bypass
- Approach flow and flow transition important
- Lighting of bypass entrance at night
- Sound/strobe light deterrence?

Sturgeon Passage

Sturgeon Migratory Biology

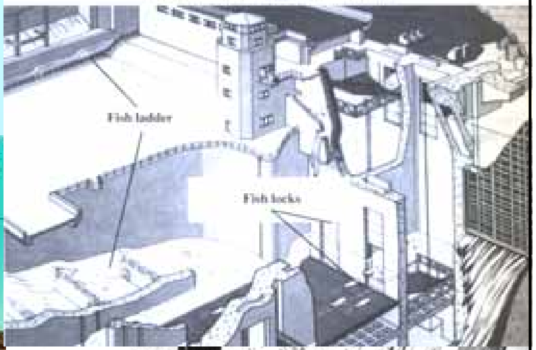
- Demersal, moderate swimming ability (strong sprint swimming); generally nonschooling
- Large size, do not turn easily in small spaces
- Spring migrations of adults to specific spawning habitat
- Seasonal movements of adults & juveniles
- River-specific populations, possibly within-river subpopulations

Early attempts with fish locks (Columbia River)



3210 FISHWAY USE BY WHITE STURGEON ON THE COLUMBIA RIVER

Figure 2. Bonneville Dam fish passage facilities
U.S. Corps of Engineers, Portland District



White & Mefford 2002

~75 cm shovelnose sturgeon in vertical slot & NLF designs

- Vertical slot prototypes 1.7 m (5.5 ft) wide, 2% slope
- 3.7 to 10 cm drop per pool (0.12 to 0.33 ft)
- Slot velocities 0.76 to 1.2 m/sec (2.5 to 3.8 ft/sec)
- Overall passage in vertical slot prototypes poor
- Good passage in NLF

FWS Hell's Gate Vertical Slot

Chevron Dual Vertical Slot

Nature-Like Fishway; 2% slope

White & Mefford 2002 Recommendations

- Fishway attraction velocity 2 to 4 ft/s.
- Flow depths of about 4 ft or more
- Attraction flow should provide a uniform transition between the fishway and the downstream river flow.
- Fishway flow velocities of between 3.0 to 4.0 ft/s
- Substrate, boundary layer may be important

Experimental side baffle (spiral) fishway

- 1:25 slope
- Velocities 3-5 ft/sec

Columbia Hydroproject fishway, Broad River, SC

Criteria & Recommendations – Upstream Passage for Sturgeon

Low-head dams (<3 m height):

- Nature-like fishways (large, deep)
- Side-baffle fishway?

Medium-head dams (3-5 m height):

- Fish lift or lock (capacity considerations)
- Nature-like fishway
- Serpentine or vertical slot fishway? ≤0.25 m (9”) drop per pool; wide (>0.75 m) slots; w/ rock bottom?

High-head dams (>5 m height):

- Fish lift or lock
- Very large nature-like fishways?

Downstream Passage

Impinged shortnose sturgeon on experimental bar rack; 100 mm spacing, 1 m/sec approach velocity

---

Experimental angled bar rack:

- 50 cm bar spacing
- Deep bypass entrance

Criteria & Recommendations – Downstream Passage for Sturgeon

- Low through-rack/-screen velocities
- Louvers?
- Bar spacing/clear opening “as small as possible”
- Provision of bottom-oriented bypass with significant flow

Eel Passage

Eel Migratory Biology

- demersal, moderate swimmers (strong sprint swimming); nonschooling but aggregating
- panmictic, presumably no river-specific populations (no homing)
- able to jump (limited); can climb wet surfaces & passed by some technical fishways
- ascend structures during day or night, but primarily at night
- Upstream migration spring through fall; for several years after entering freshwater
- fall (and spring?) movements of silver phase; primarily during rain events/high flows

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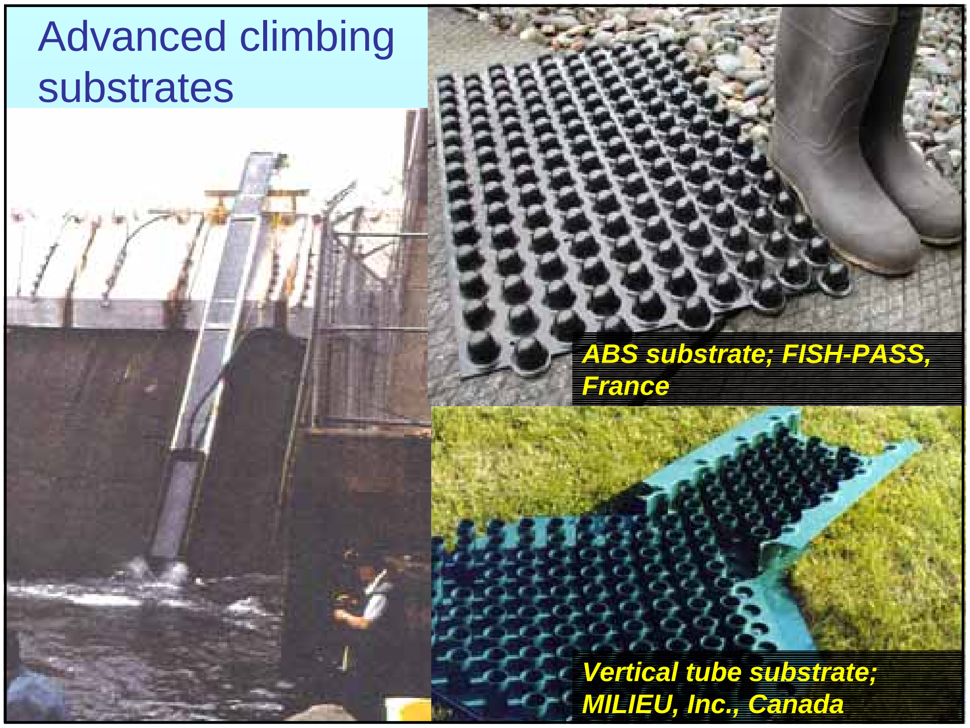
Climbing behavior of elvers

New Zealand elvers ascending wet vertical concrete wall (and stairs!)

"Low tech" or "Delaware" type eel pass at Leesville Dam, Salmon River Connecticut

Installations of brush-type passes at low-head dams in France

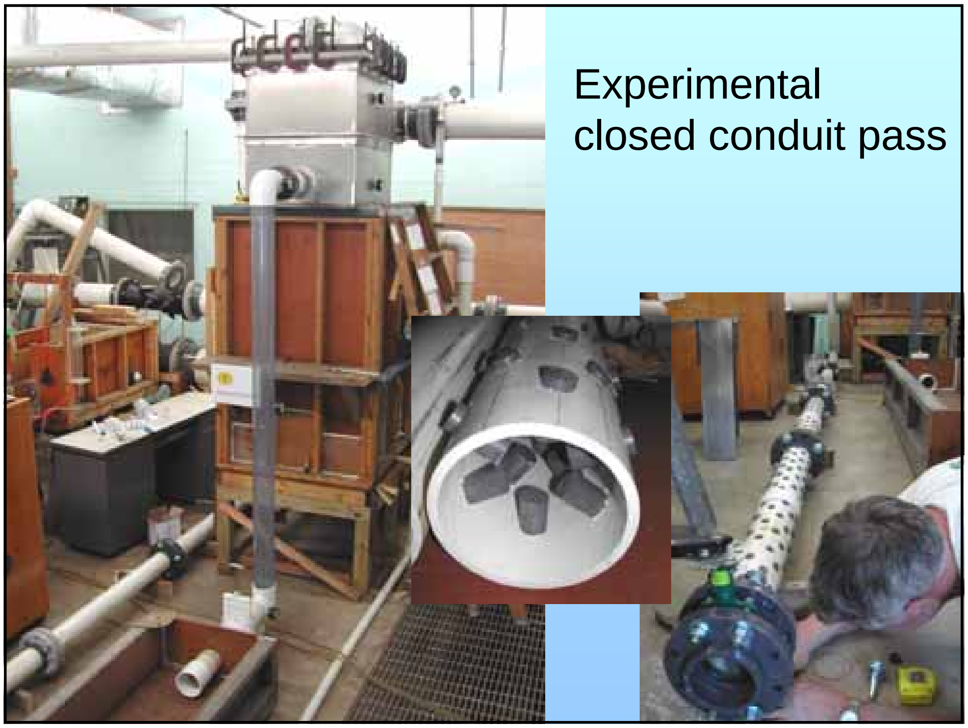
Experimental vertical brush & plastic substrate pass at Greeneville Dam, Norwich, CT



Advanced climbing substrates

ABS substrate; FISH-PASS, France

Vertical tube substrate; MILIEU, Inc., Canada



Experimental closed conduit pass

Criteria & Recommendations – Upstream Passage for Eels

Low-head dams (<3 m height):
- Roughening of existing climbing surfaces
- “Delaware” type pass
- Ramp pass – *appropriate substrate, slope, siting*

Medium-head dams (3-5 m height):
- Ramp pass with or without (full dam height) trap
- Closed conduit pass?

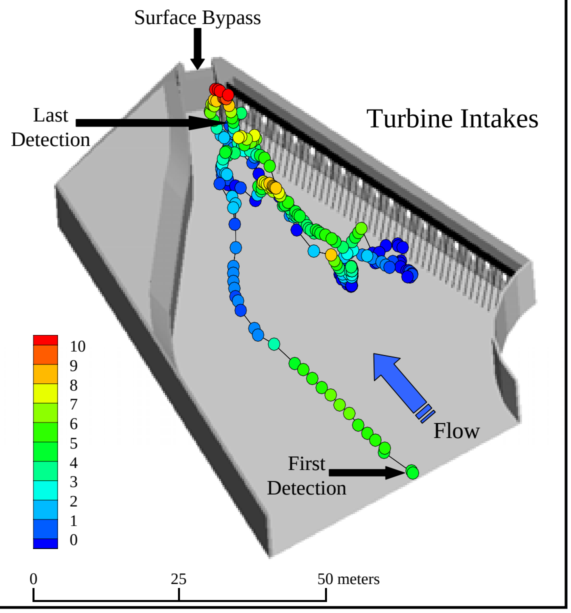
High-head dams (>5 m height):
- Short ramp pass with trap
- Lift (specialized for eels)

USGS

Downstream Passage

Forebay behaviors

Track of depth-telemetered eel in Cabot Station forebay, Connecticut River, MA (Brown 2005)

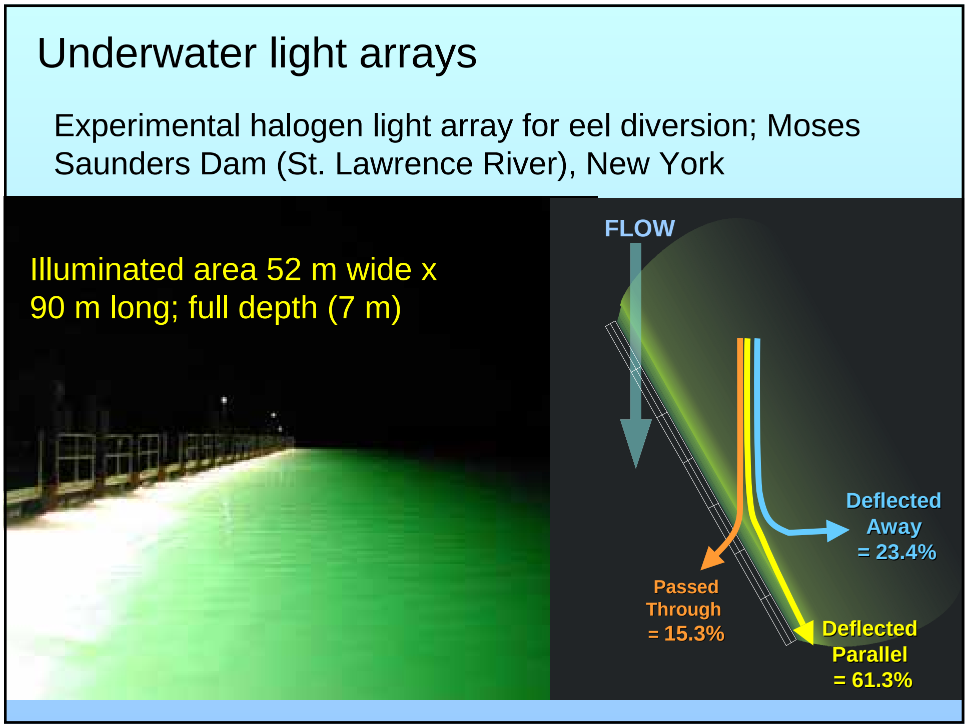


Mechanical and behavioral barriers

Eel impinged on experimental trash racks

Perforated plate rack overlay; Cobbosseecontee Stream, Maine

Experimental "light fence", Netherlands



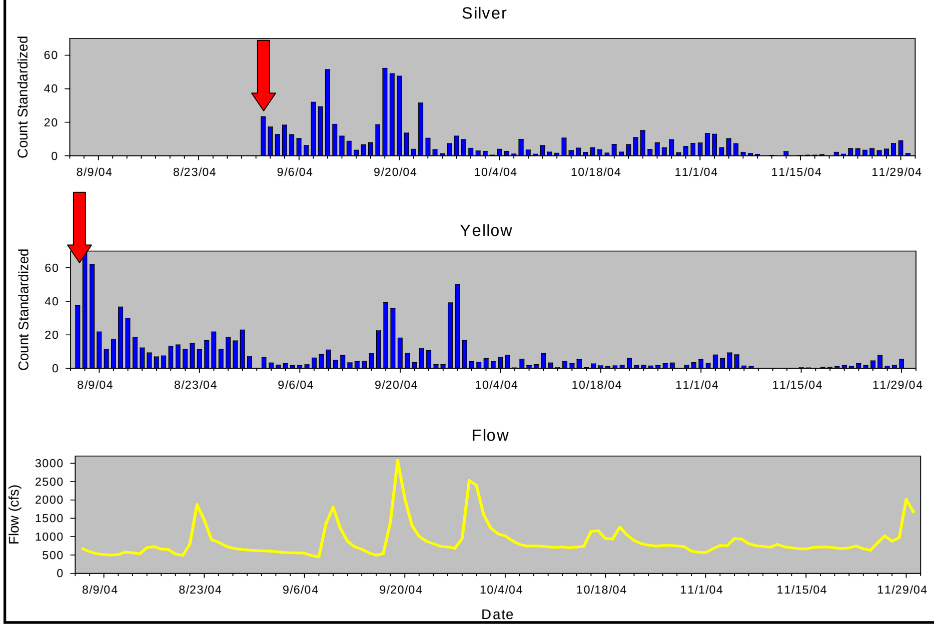
Underwater light arrays

Experimental halogen light array for eel diversion; Moses Saunders Dam (St. Lawrence River), New York

Illuminated area 52 m wide x 90 m long; full depth (7 m)

Migratory activity monitors

Activity monitor data - CT



Criteria & Recommendations – Downstream Passage for Eels

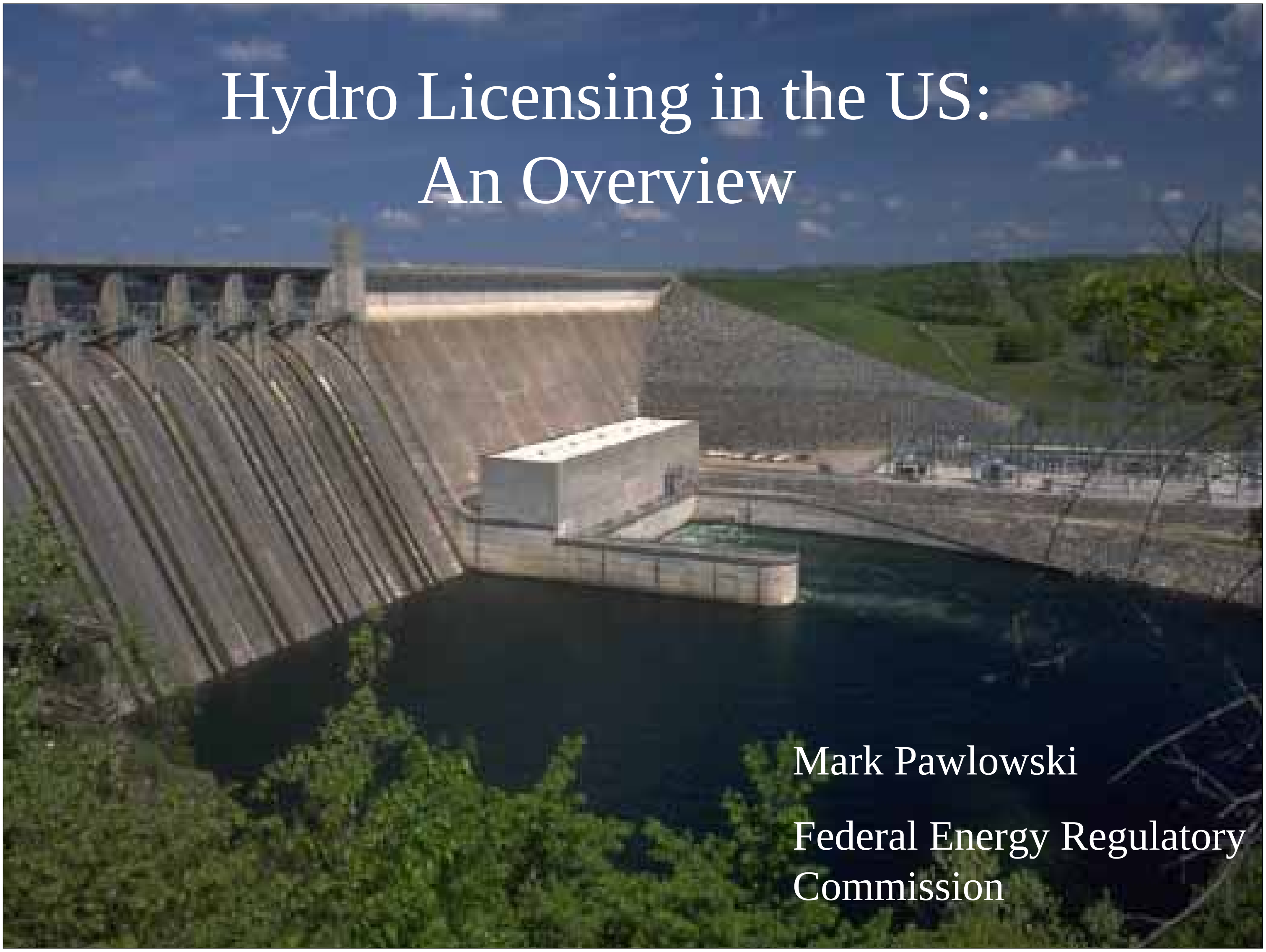
- Low through-rack/-screen velocities
- Bar spacing/clear opening “as small as possible”; overlays
- European “criteria”: approach velocity <0.5 m/sec & spacing <2 cm
- Provision of bottom-oriented bypass with significant flow
- Light arrays (very special cases only!)
- Programmed shutdown/spill

A Beginning…

SPECIES	**Denil Fishway**	**Steeppass Fishway**	**Pool and Weir Fishway**	**Vertical Slot/ Serpentine Fishway**	**Nature-Like Fishway**	**Fish Lift**
Shad	H < 3 m slope ≤ 1:6 L (straight runs) ≤ 12 m W ≥ 1 m D ≥ 1 m	H < 3 m slope ≤ 1:6 L (straight runs) ≤ 12 m W ≥ 0.5 m D ≥ 1 m	H < 5 m drop per pool ≤ 0.25 m pool volume > 30 m^3 EDF < 150 w/m^3	H < 5 m drop per pool ≤ 0.25 m pool volume > 30 m^3 slot width ≥ 0.5 m EDF < 150 w/m^3	max. H = ? ≤ 5% slope max. length = ? W > 3 m D > 0.5 m	H > 5 m capacity limits screen size criteria
River Herring	H < 3 m slope ≤ 1:6 L (straight runs) ≤ 12 m W ≥ 1 m D ≥ 0.5 m	H < 3 m slope ≤ 1:6 L (straight runs) ≤ 12 m W ≥ 1 m D ≥ 0.5 m	H < 5 m drop per pool ≤ 0.25 m pool volume > 10 m^3 EDF < 150 w/m^3	H < 5 m drop per pool ≤ 0.25 m pool volume > 30 m^3 slot width ≥ 0.3 m EDF < 150 w/m^3	max. H = ? < 5% slope max. length = ? W > 3 m D > 0.5 m	H > 5 m capacity limits screen size criteria
Sturgeon	Not Recommended	Not Recommended	Passable, but not recommended	Passable? H < 5 m drop per pool ≤ 0.25 m pool volume > 30 m^3 slot width ≥ 0.5 m	max. H = ? < 2% slope max. length = ? W > 3 m D > 0.5 m	H > 5 m capacity limits screen size criteria entrance transition to bottom
Eel	Passable, but not recommended	Passable, but not recommended	Passable, but not recommended drop per pool < 0.25 m rock substrate	Passable? H < 5 m drop per pool ≤ 0.25 m rock substrate?	max. H = ? < 5% slope max. length = ? W > 3 m D > 0.25 m	Not recommended, except for specialized designs for eels only

A Few Parting Thoughts

- Standards and criteria still not well developed for nonsalmonids
- Need for passage at multiple life stages (especially downstream)
- Design for the appropriate habitat
- Think long-term & beyond today’s “target species”
- If you build it, evaluate it!

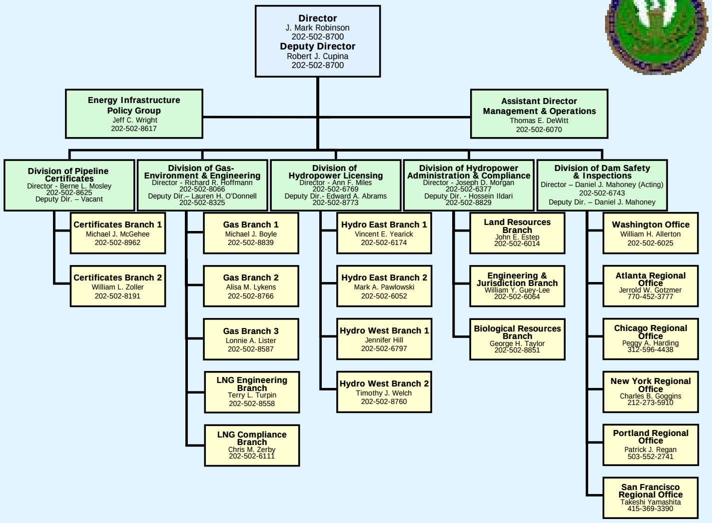


Hydro Licensing in the US:
An Overview

Mark Pawlowski

Federal Energy Regulatory Commission

Commission Oversight - Office of Energy Projects



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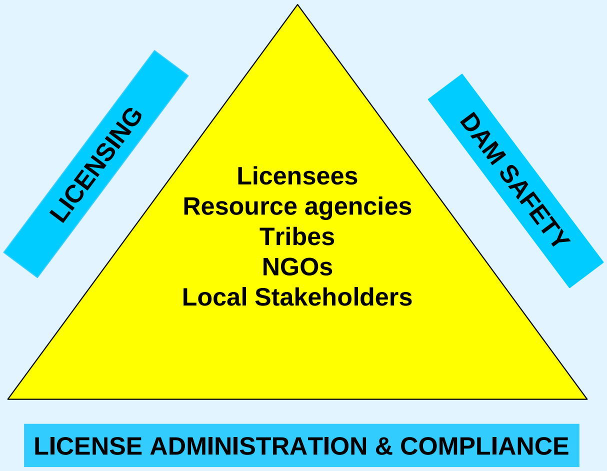
  415-369-3390

Hydropower Program



LICENSING

DAM SAFETY

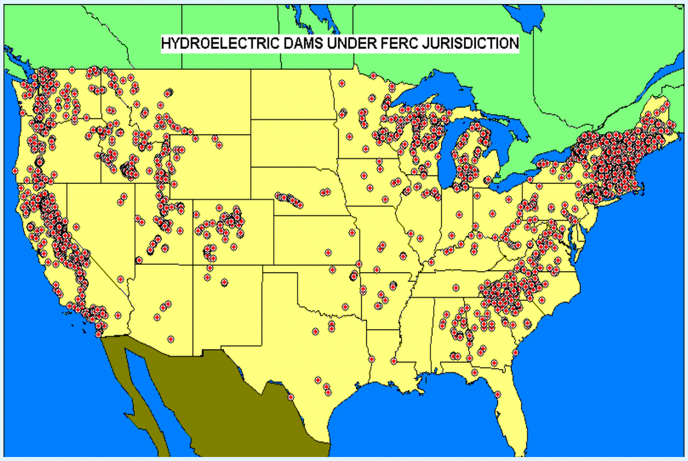
Licensees
Resource agencies
Tribes
NGOs
Local Stakeholders

LICENSE ADMINISTRATION & COMPLIANCE

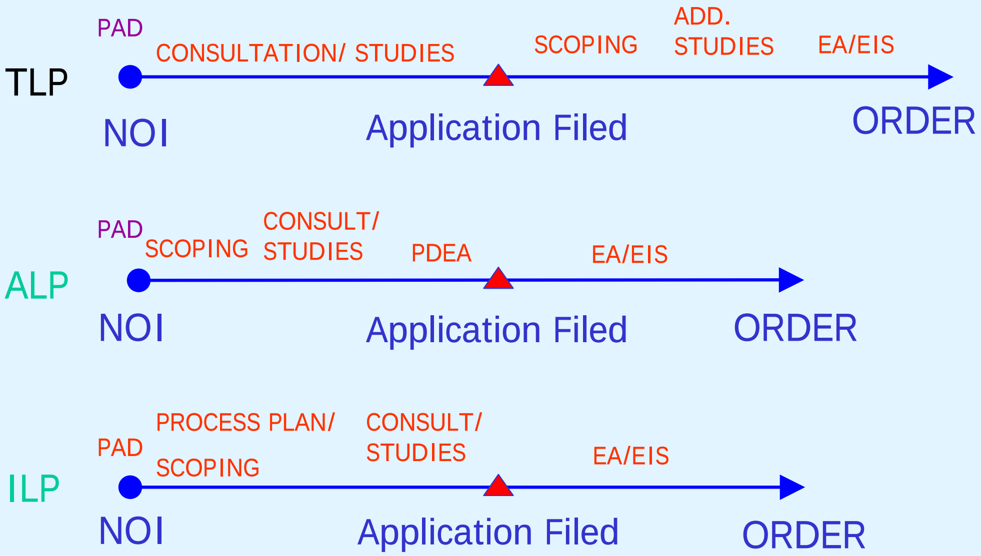
Federal Power Act

FERC Jurisdiction (non federal)

- Located on a navigable waterway
- Occupies lands of the United States
- Affects interstate or foreign commerce
- Utilizes surplus water from a federal dam


HYDROELECTRIC DAMS UNDER FERC JURISDICTION

Licensing Process Comparison



TLP

PAD

CONSULTATION/ STUDIES

SCOPING

ADD. STUDIES

EA/EIS

NOI

Application Filed

ORDER

ALP

PAD

SCOPING

CONSULT/ STUDIES

PDEA

EA/EIS

NOI

Application Filed

ORDER

ILP

PAD

PROCESS PLAN/ SCOPING

CONSULT/ STUDIES

EA/EIS

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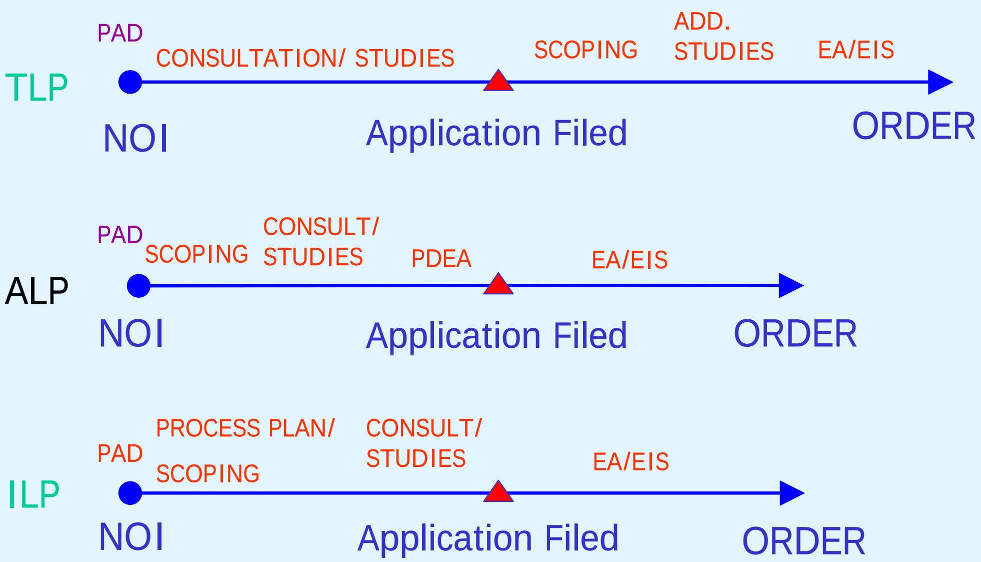
Licensing Process Comparison



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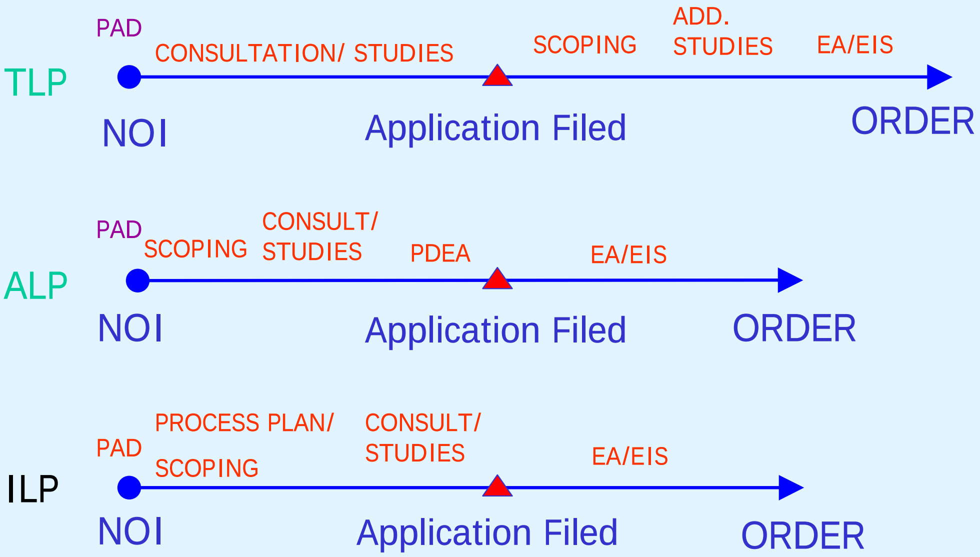

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EA/EIS

NOI

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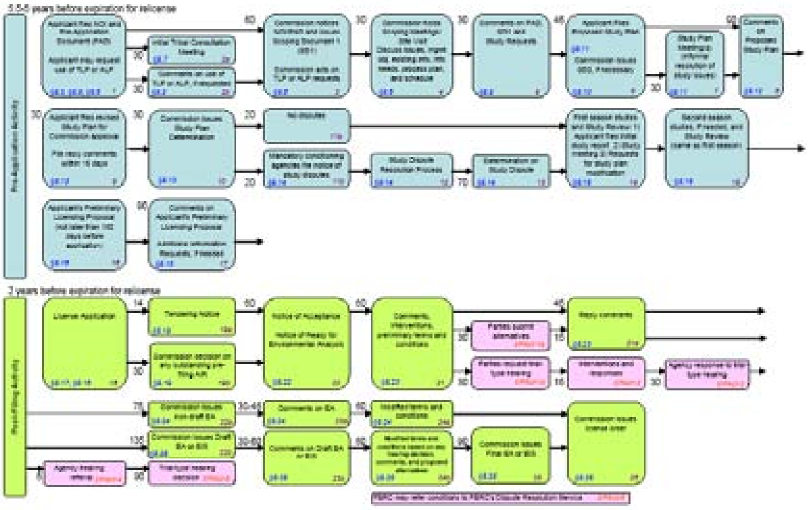
ORDER

Integrated Licensing Process

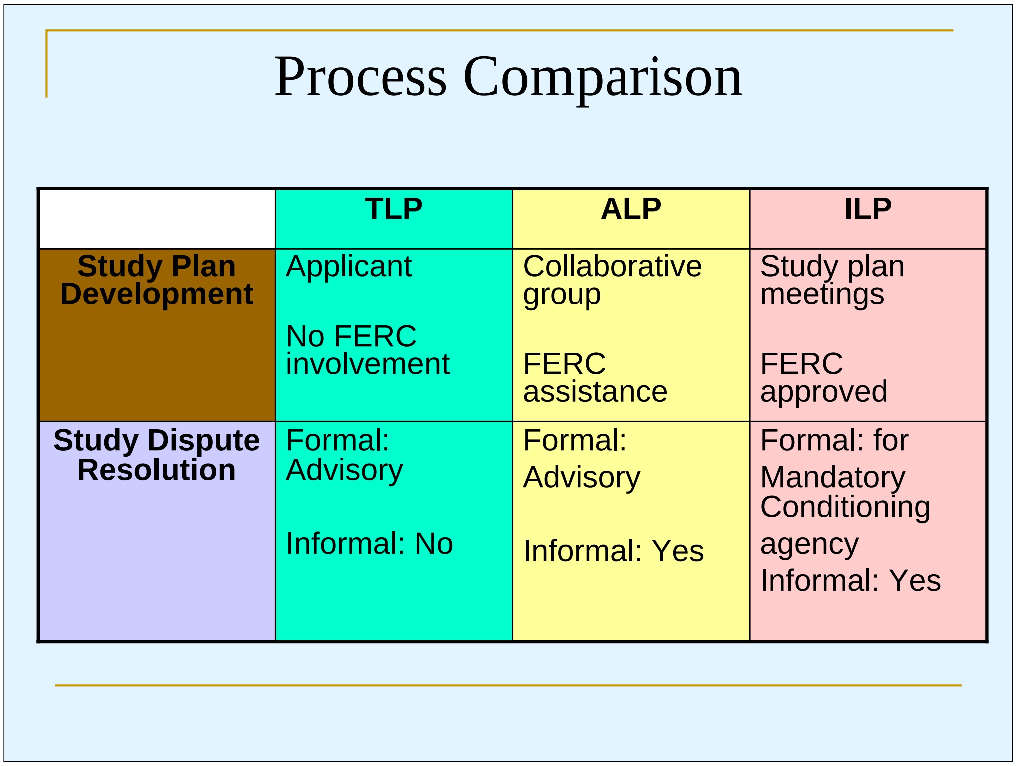
(Section 241 of the Energy Policy Act of 2005)



*Section 241 of the Energy Policy Act of 2005 in pink.

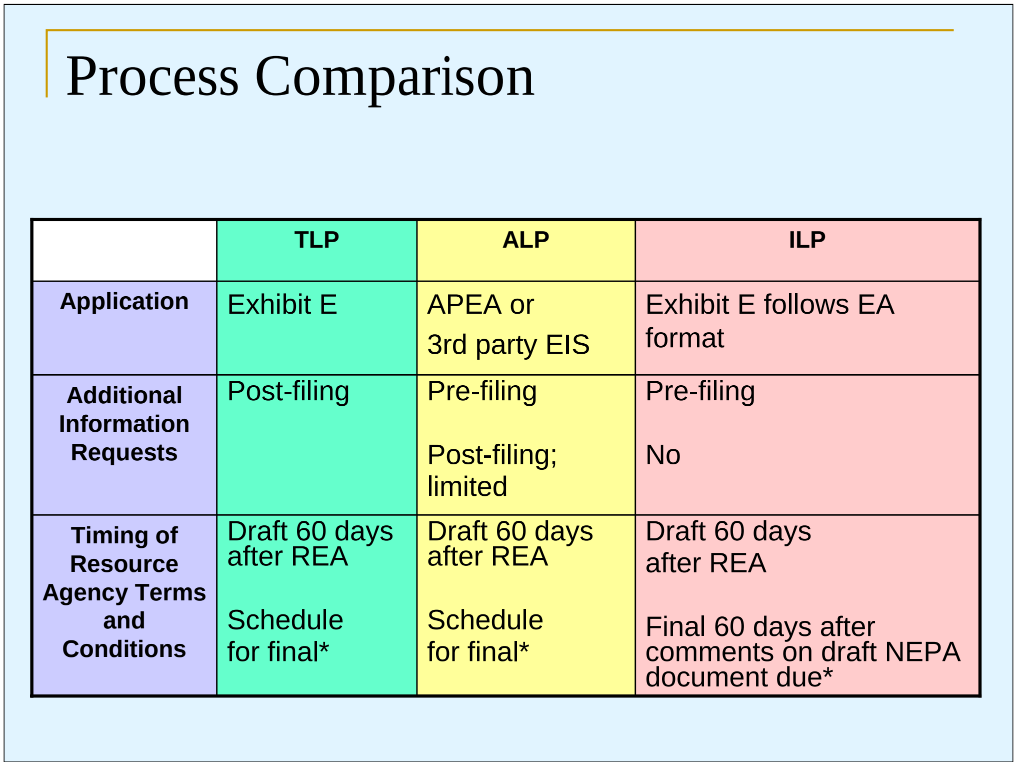
Process Comparison

	TLP	**ALP**	**ILP**
Consultation	Paper	Collaborative	Integrated
FERC Involvement	Post-Filing	Pre-Filing: As Requested	Pre-Filing: Sustained
Deadlines	Some for Participants, not for FERC	Pre-Filing more collaborative; same as TLP post-filing	All participants throughout the process, including FERC



Process Comparison

	TLP	**ALP**	**ILP**
Study Plan Development	Applicant No FERC involvement	Collaborative group FERC assistance	Study plan meetings FERC approved
Study Dispute Resolution	Formal: Advisory Informal: No	Formal: Advisory Informal: Yes	Formal: for Mandatory Conditioning agency Informal: Yes



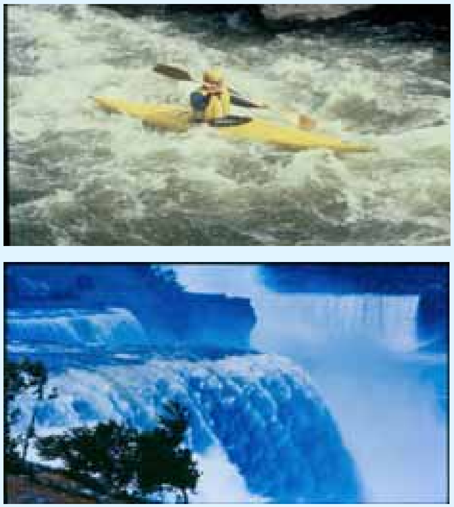
Process Comparison

	TLP	ALP	ILP
Application	Exhibit E	APEA or 3rd party EIS	Exhibit E follows EA format
Additional Information Requests	Post-filing	Pre-filing Post-filing; limited	Pre-filing No
Timing of Resource Agency Terms and Conditions	Draft 60 days after REA Schedule for final*	Draft 60 days after REA Schedule for final*	Draft 60 days after REA Final 60 days after comments on draft NEPA document due*

Project Effects on Non-Developmental Resources

- Water Quality
  - Dissolved Oxygen
  - Temperature
- Fisheries
  - Aquatic Habitat
  - Passage
- Wildlife
  - ROW clearing
  - Transmission line and avian interactions

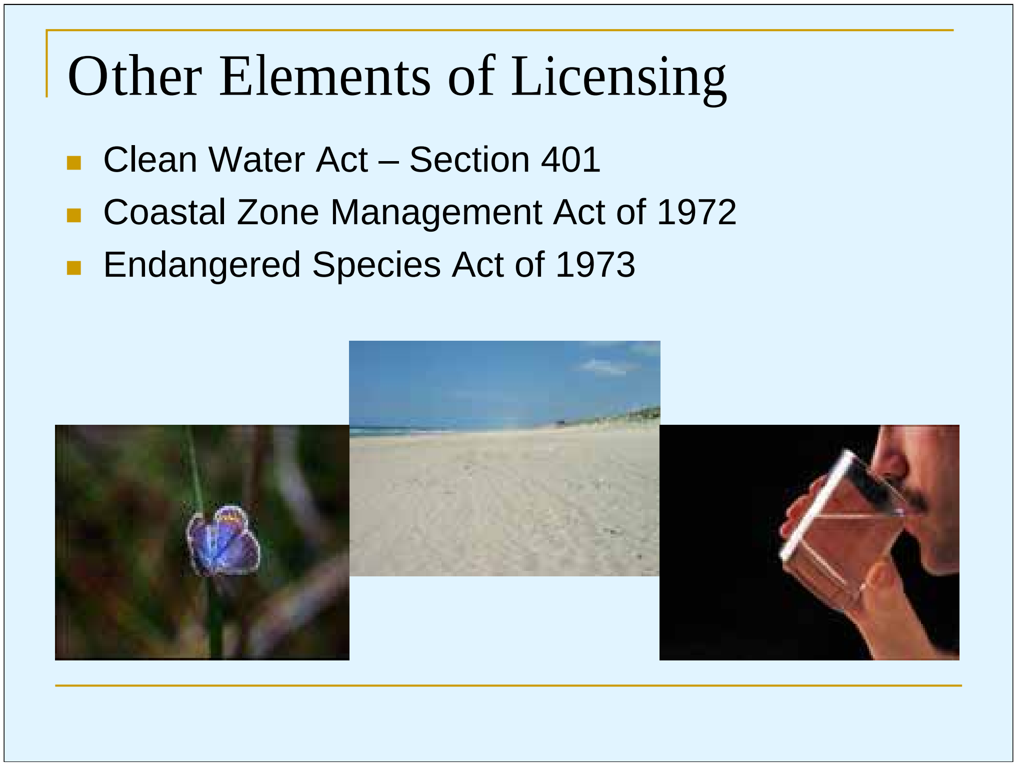
Project Effects on Non-Developmental Resources



- Recreation
  - Boating
  - Swimming
  - Fishing
- Cultural Resources
- Aesthetics
  - Appearance & sound of flow
  - Appearance of structures

Developmental Resources

- Flood Control
- Navigation
- Water Supply
- Energy Production
- Irrigation

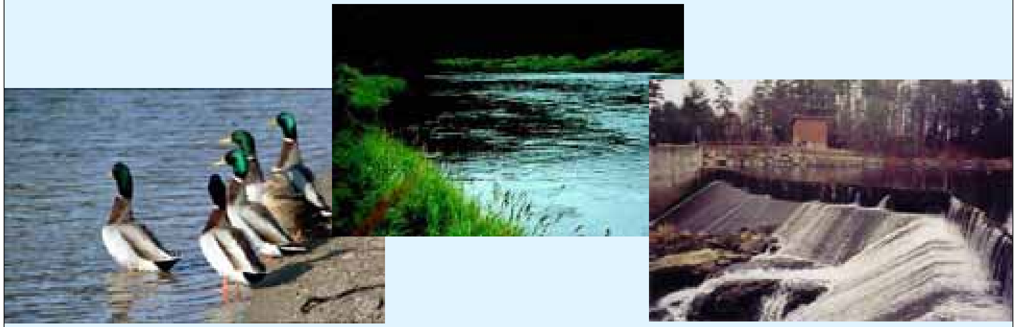


Other Elements of Licensing

- Clean Water Act – Section 401
- Coastal Zone Management Act of 1972
- Endangered Species Act of 1973

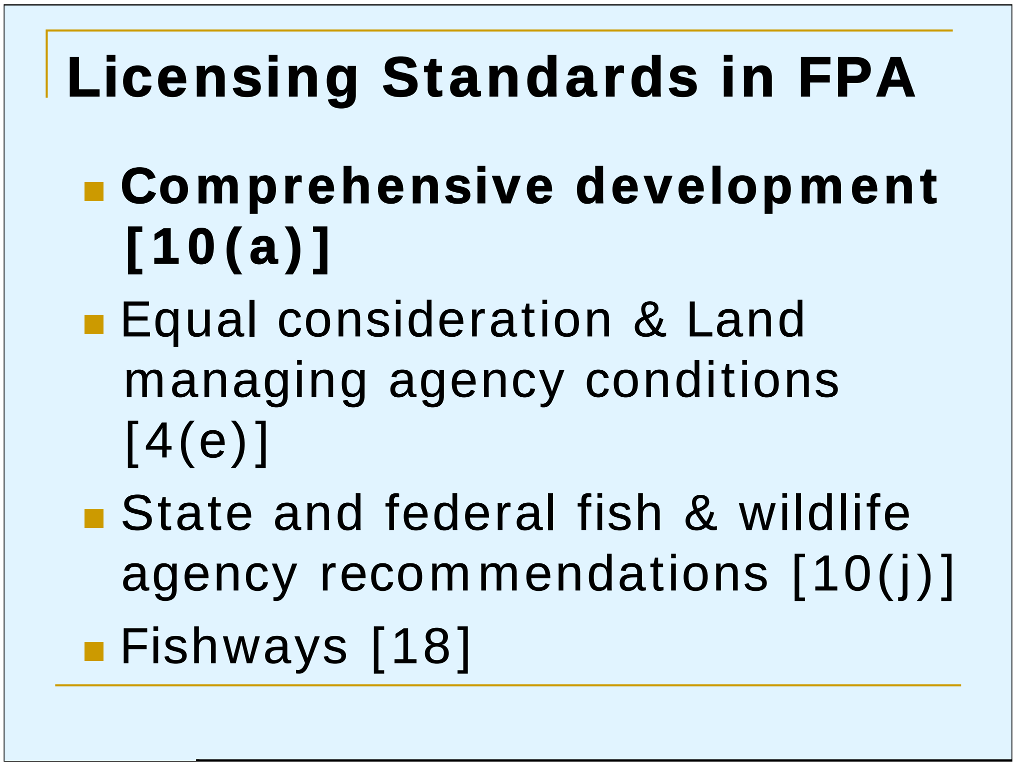
Other Elements of Licensing

- Fish and Wildlife Coordination Act
- Magnuson-Stevens Fishery Conservation and Management Act
- National Historic Preservation Act



Environmental Concerns versus Developmental Concerns

Competing Environmental Concerns



Licensing Standards in FPA

- **Comprehensive development [10(a)]**
- Equal consideration & Land managing agency conditions [4(e)]
- State and federal fish & wildlife agency recommendations [10(j)]
- Fishways [18]

Licensing Standards in FPA

- Comprehensive development [10(a)]
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Licensing Standards in FPA

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Licensing Standards in FPA

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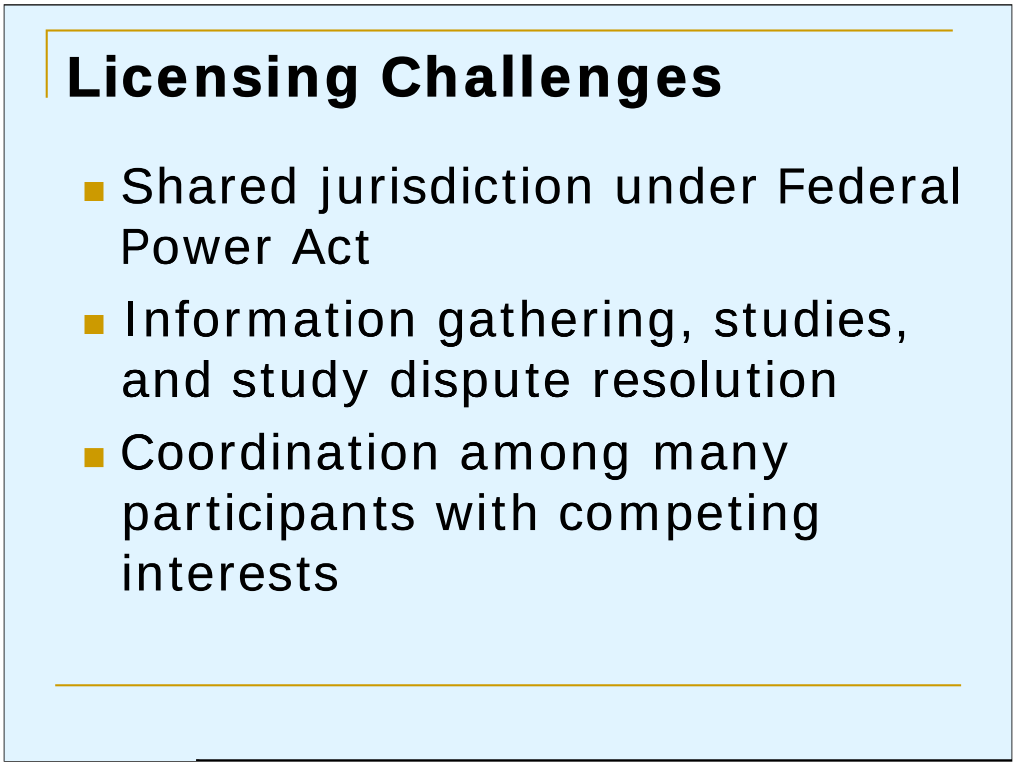
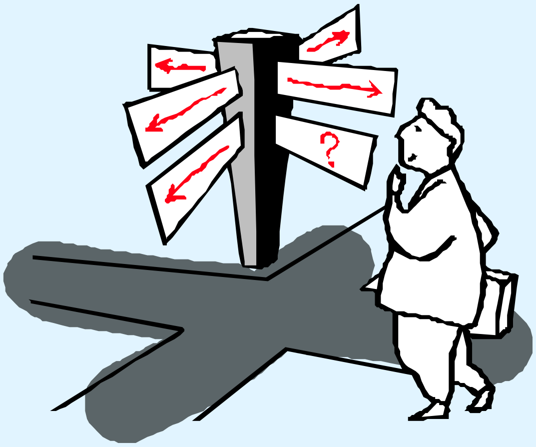


Licensing Challenges

- Shared jurisdiction under Federal Power Act
- Information gathering, studies, and study dispute resolution
- Coordination among many participants with competing interests

Questions

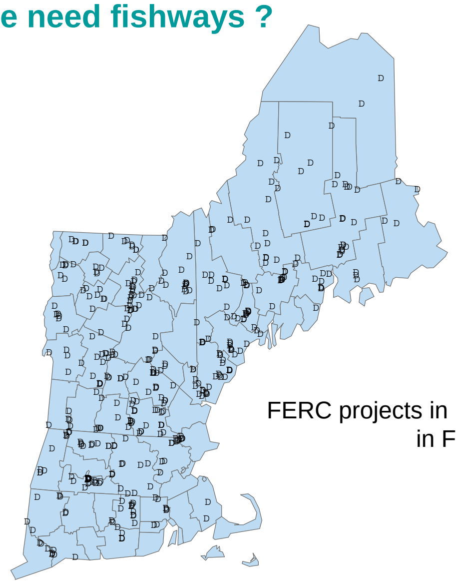


www.ferc.gov

FERC Fish Passage Experiences from the Northeast

Melissa Grader, Fish and Wildlife Service
Sean McDermott, National Marine Fisheries Service
Lou Chiarella, National Marine Fisheries Service

Why do we need fishways ?



FERC projects in New England: 333
in FWS Region 5: 575

	State												
Permit Type	CT	MA	MD	ME	NH	NJ	NY	PA	RI	VA	VT	WV	Grand Total
Exemption	8	29	1	24	42	1	61	8	1	13	18		206
License	14	29	1	71	41	4	106	17	5	22	46	13	369
Grand Total	22	58	2	95	83	5	167	25	6	35	64	13	575

In New England:

- Fish passage at 112 FERC-permitted hydro facilities
- Fishways on 42 rivers in 15 different watersheds
- 108 downstream fishways; 40 upstream fishways

Means of Obtaining Fish Passage at FERC Projects

New Projects ~ Licenses / Existing Projects ~ Re-Licenses
- Section 18 Prescription
- Settlement Agreements
- 10(j) Recommendation
- 401 Water Quality Certification
- Reservation of Authority

Existing Projects ~ Post-License
- Standard license re-opener
- Cooperative approach between agencies and Licensee
- Settlement agreement

New Projects / Existing Projects ~ Exemptions
- Mandatory Terms and Conditions
- Settlement agreement

Means of Obtaining Fish Passage at FERC Projects (Cont'd)

New Projects ~ Licenses / Existing Projects ~ Re-Licenses

1. *Part 1 of the Federal Power Act, Section 18*
   "The Commission shall require the construction, maintenance, and operation by a licensee at its own expense of…such fishways as may be prescribed by the Secretary of Commerce [or the Secretary of the Interior, as appropriate]. "

- ➢ In 80s, typically "recommended" FERC include a reservation of prescriptive authority → outcome less certain and not always satisfactory
- ➢ In 90s, developed our Mandatory Conditions Review Process for prescribing fishways → time consuming, but successful
- ➢ Starting in 2005, EPAct set new requirements on prescribing fishways → This new procedure has, in the northeast, resulted in parties developing settlement agreement and modified prescription before Trial Type Hearing initiated

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Means of Obtaining Fish Passage at FERC Projects (Cont'd)

New Projects ~ Licenses / Existing Projects ~ Re-Licenses

2. *Settlement Agreements*

- ➢ Not used until the late 80s
- ➢ Typically involve multiple projects on same river or multiple dams under one FERC project
- ➢ Often the best option when project complicated with many stakeholders wanting different things
- ➢ Usually will take fish passage provisions of SA and develop Section 18 prescription that comports with SA language
- ➢ Almost always, fish passage via SA will involve compromise over what agencies would have sought through other process (e.g., different "trigger" numbers, dates, etc.)

Means of Obtaining Fish Passage at FERC Projects (Cont'd)

New Projects ~ Licenses / Existing Projects ~ Re-Licenses

3. 10(j) Recommendations

- Pursuant to this section of the FPA, fish and wildlife recommendations must be included in the license unless inconsistent with other Federal Law.
    - Such recommendations must provide for the protection, mitigation, or enhancement of fish and wildlife (including related spawning grounds and habitat).
    - Requires Dispute Resolution with agencies if FERC finds a recommendation inconsistent.
    - If recommendation is not adopted, FERC must make a finding that the conditions it selects meet requirements of Section 10(a).

  "best adapted" to the comprehensive development of the waterway

- Used when Licensee is in agreement with fish passage provisions and/or in cases where State will issue 401 with fish passage conditions
- Obviates need to do Section 18
- Also may be used if cannot fully support a Section 18 prescription due to less clear facts or limited staff resources

Means of Obtaining Fish Passage at FERC Projects (Cont'd)

New Projects ~ Licenses / Existing Projects ~ Re-Licenses

4. 401 Water Quality Certification

- Courts have consistently upheld State's authority to set conditions at FERC projects that MUST BE included in any license issued
- Each State's 401 process is different, and the degree to which States use this authority also varies
- If 401 process allows for appeals, WQC can be held up for years (even decades)

Means of Obtaining Fish Passage at FERC Projects (Cont'd)

New Projects ~ Licenses / Existing Projects ~ Re-Licenses

5. *Reservation of Authority*

- ➢ Used when no active restoration program exists, but river could undergo restoration in the future, or on an upstream dam without a clear timetable for passage ("deferred" category)
- ➢ Used under EPAct, but not subject to Trial-Type Hearing Process
- ➢ Open question as to how difficult it would be for agencies to use reserved authority at a later date (EPAct/TTH rules would apply)

Means of Obtaining Fish Passage at FERC Projects (Cont'd)

Existing Project ~ Post-License

1. *Standard License Re-Opener*

Forms L-15 and L-14, Article 11; Form L-4, Article 15

"The Licensee shall, for the conservation and development of fish and wildlife resources, construct, maintain, and operate, or arrange for the construction, maintenance, and operation of such reasonable facilities, and comply with such reasonable modifications of the project structures and operation, as may be ordered by the Commission upon its own motion or upon the recommendation of the Secretary of the Interior or the fish and wildlife agency or agencies of any State in which the project or a part thereof is located, after notice and opportunity for hearing."

- ➢ Agency would petition FERC to re-open license to require fish passage facilities
  - ❖ FERC process calls for notice, development of NEPA document, public comment, then notices decision with opportunity for rehearing
- ➢ Key word is "reasonable" – FERC decides what is reasonable
- ➢ New England has successfully initiated re-openers at 14 projects
- ➢ Critical to have strong justification (e.g., State or interagency restoration plan, agency commitment to manage restored resource, etc.)

Means of Obtaining Fish Passage at FERC Projects (Cont'd)

Existing Project ~ Post-License

2. Cooperative approach

- Used when parties do not want to risk relying on FERC to determine if fish passage should be required or not (by officially initiating re-opener)
- "informal" – once agreement reached, Licensee would submit an application to amend license to reflect inclusion of fish passage facilities
- Can be long and drawn-out, with many compromises

3. Settlement Agreements

- Similar to Cooperative Approach, but more formal, with development of actual legal document codifying conditions each party must adhere to
- Once signed by parties to the SA, Licensee would submit to FERC with petition to amend license to incorporate provisions of SA as license conditions
- Same drawbacks (and benefits) as Cooperative Approach, but may be more costly because lawyers would be involved

Means of Obtaining Fish Passage at FERC Projects (Cont'd)

Existing / New Projects ~ Exemptions

1. Mandatory Terms and Conditions (T&Cs)

18 CFR §4.106(b) Article 2

"The construction, operation, and maintenance of the exempt project must comply with any terms and conditions that the United States Fish and Wildlife Service, the National Marine Fisheries Service, and any state fish and wildlife agencies have determined are appropriate to prevent loss of, or damage to, fish or wildlife resources or otherwise to carry out the purposes of the Fish and Wildlife Coordination Act…"

- Can either require immediate passage or set condition for future fish passage
- Still should provide justification so decision does not appear arbitrary or capricious
- Not subject to EPAct/Trial-Type Hearing Process
- Not subject to FERC's review or discretion
- Applicant MUST accept T&Cs or FERC will not grant permit
- If triggering an existing fish passage T&C, Exemptee must either (1) abide by condition, (2) surrender exemption, or (3) have permit revoked by FERC

Means of Obtaining Fish Passage at FERC Projects (Cont'd)

Existing / New Projects ~ Exemptions

2. Settlement Agreements

- May be in addition to an existing T&C (e.g., Swans Falls, Saco R), or used in cases where no T&C related to fish passage exists

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Pros and Cons of Different Methods of Achieving Fish Passage at FERC Projects

Method	Pros	Cons
Section 18	If prescription survives TTH, can get what is needed without significant compromise	Consumes significant staff time/resources; may end up having to adopt an alternative prescription or compromise via SA
State 401	Assures that provision will become part of any license issued	If 401 can be appealed, could cause significant delays in licensing
Section 10(j)	Less onerous than Section 18 process	No guarantee FERC will adopt fish passage recommendation
Settlement Agreement	Minimizes/eliminates risk of appeal of either Section 18 or 401	Invariably involves compromise; Consumes a lot of staff time; Necessitates involvement of legal
Mandatory T&C (Exemptions)	Get what we want when we want it	If applicant feels they cannot accept T&Cs, may opt to get a license
Post-License Re-opener	In some cases, only means of obtaining passage; track record of success using this process	Ultimate decision at FERC's discretion

Project	Timing	Method Used
Occum, Shetucket River	Original License	401 WQC; FWS Section 10(j) recommendations
Holyoke, CT River	Relicense	Section 18 and 401 WQC; after 401 appealed, reached settlement agreement and submitted modified Section 18 and 401
Housatonic, Housatonic River	Relicense	Section 18 and 401 WQC – relicense was prior to EPAct & CT has no appeals process for 401
Merrimack, Merrimack River	Relicense	Section 18 appealed under EPAct; parties reached settlement agreement and FWS issued modified prescription
Indian River, Westfield River	New Exemption	FWS and MA DFW submitted nearly identical T&Cs
Kinneytown, Naugatuck River	Existing Exemption	Triggered passage under “reserved authority” T&C
Saco River projects	5 Licenses and 1 Relicense	SA involving 6 projects, including Bar Mills -project that was under appeal/TTH; after SA filed, NMFS and FWS submitted modified Section 18s

Key Components to Obtaining Fish Passage

- Strong relationship between State and Federal resource agencies
  - State fisheries and 401 programs
- Support from NGO community (e.g., TU, watershed association, etc.)
- State or interagency fisheries restoration/management plan with clear goals and objectives
  - These plans should be filed with FERC so they become part of the administrative record
- Can never have too much justification (pile it on!)
  - e.g., surveys, stocking records, mgmt plans, historical information
  - agencies rely on data to support their decisions
- Perseverance – these things take time regardless of approach

Key Problems that may be Encountered

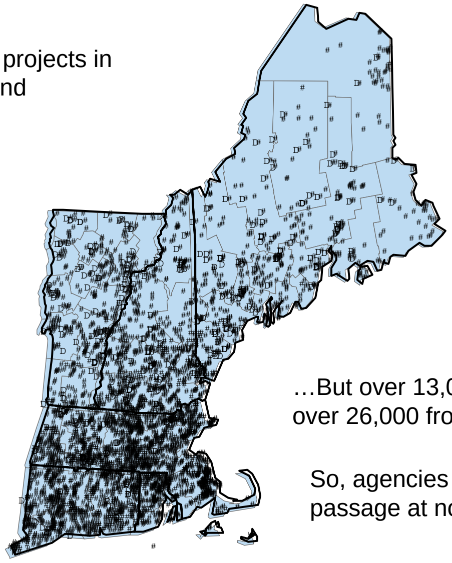
- Stakeholders’ lack of familiarity with FERC process
- Variability among States’ 401 processes and implementation of WQC
- No current restoration/mgmt plan for subject waterbody
- Lack of data to support determination/need
- May be conflict within a State’s fisheries agencies (e.g., between inland, diadromous and/or marine programs) regarding management decisions, priorities, etc.
- No history of relationship between state and federal agencies
- Poor track record (i.e., lack of achieving stated restoration goals at existing FERC projects with passage facilities)
- Presently STRONG pressure to develop renewable energy projects that has led to sharp spike in number of proposed hydro projects in New England

Lessons Learned

- As soon as a project is proposed, fisheries agencies should meet to discuss need for fish passage and strive to get on same page (to represent unified voice to FERC and other stakeholders)
- If fish passage will (or may in the future) be an issue at a proposed hydro project, it is NEVER too early to make the applicant and FERC aware of it
- Determine data needs as early in the process as possible
- Should coordinate among agencies to determine best method of achieving fish passage (e.g., via Section 18, 401, SA, etc.)
  - Method will in large part be based on specifics of THAT particular project (e.g., location, configuration, stakeholders involved, etc.)
- Get the fishways designed correctly the FIRST time
  - compromising to develop least-cost yet still effective fishway typically results in need to “tweak” facilities to make them work correctly
- ALWAYS include provision for multi-year evaluation/effectiveness studies

Parting Thoughts

333 FERC projects in
New England



…But over 13,000 dams in NE &
over 26,000 from ME to PA

So, agencies need to deal with
passage at non-hydro dams also

Fish Passage in the Southeast …Building Success

Prescott Brownell, National Marine Fisheries Service
Habitat Conservation Division

Wilson Laney, U.S. Fish and Wildlife Service
South Atlantic Fisheries Coordination Office

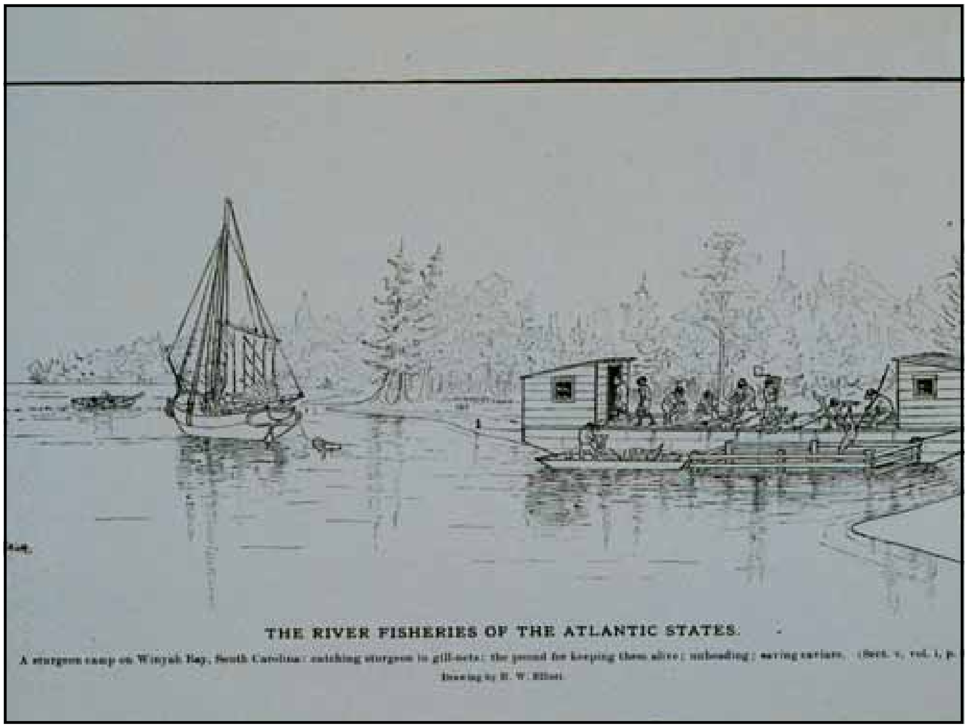
ASMFC Workshop on Fish Passage Issues
Impacting Atlantic Coast States
April 3 & 4, 2008
Jacksonville, Florida

Topics for Discussion

- 1790-1960 historical perspective: gradual demise of the great river anadromous fisheries.
- 1940-1980 inland anadromous fish management priority wanes in the south.
- 1980-2000 new hydropower licensing era, rebirth of diadromous fish passage as a management objective.
- Building fish passage success: what works & what does not.
- Suggested role for ASMFC.

THE RIVER FISHERIES OF THE ATLANTIC STATES.

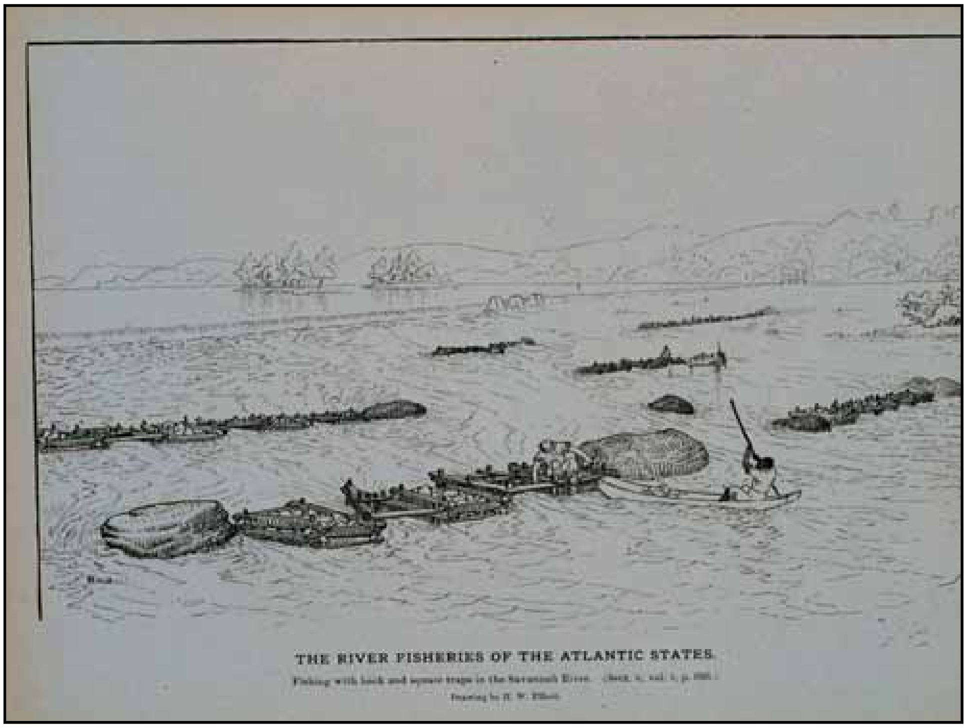
From a photograph.



THE RIVER FISHERIES OF THE ATLANTIC STATES.

A sturgeon camp on Winyah Bay, South Carolina: catching sturgeon in gill-nets; the pound for keeping them alive; unloading; saving caviare. (Sect. v, vol. i, p.

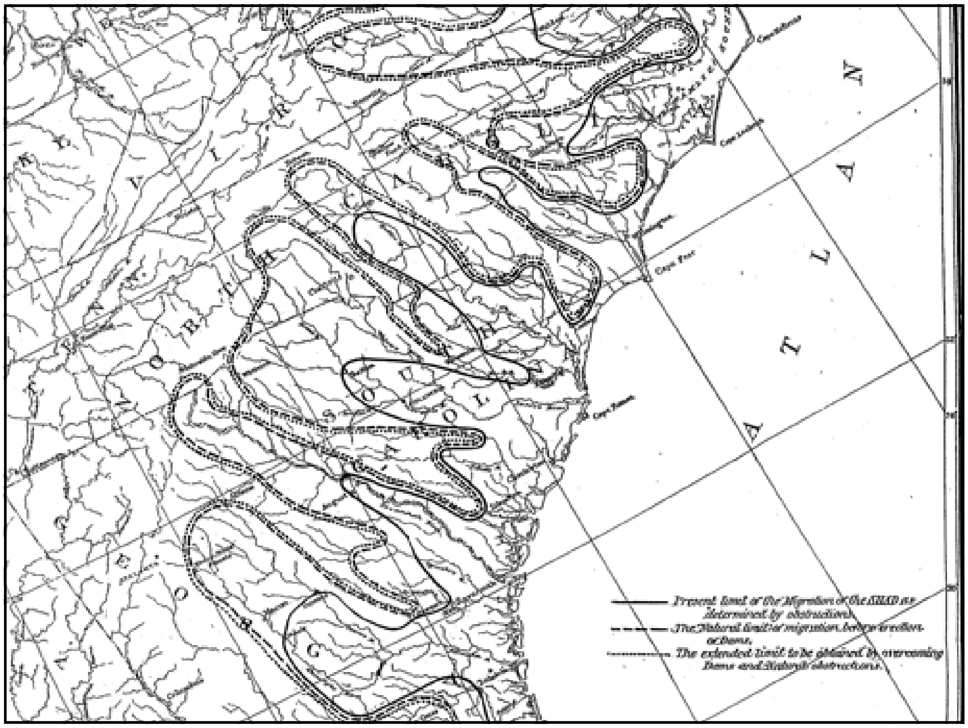
Drawing by H. W. Elliott.



THE RIVER FISHERIES OF THE ATLANTIC STATES.

Fishing with rock and square traps in the Savannah River. (Sect. v, vol. i, p. 665.)

Drawing by H. W. Elliott.



DAM CONSTRUCTION IN THE U.S.

Source: Aadland, 2004

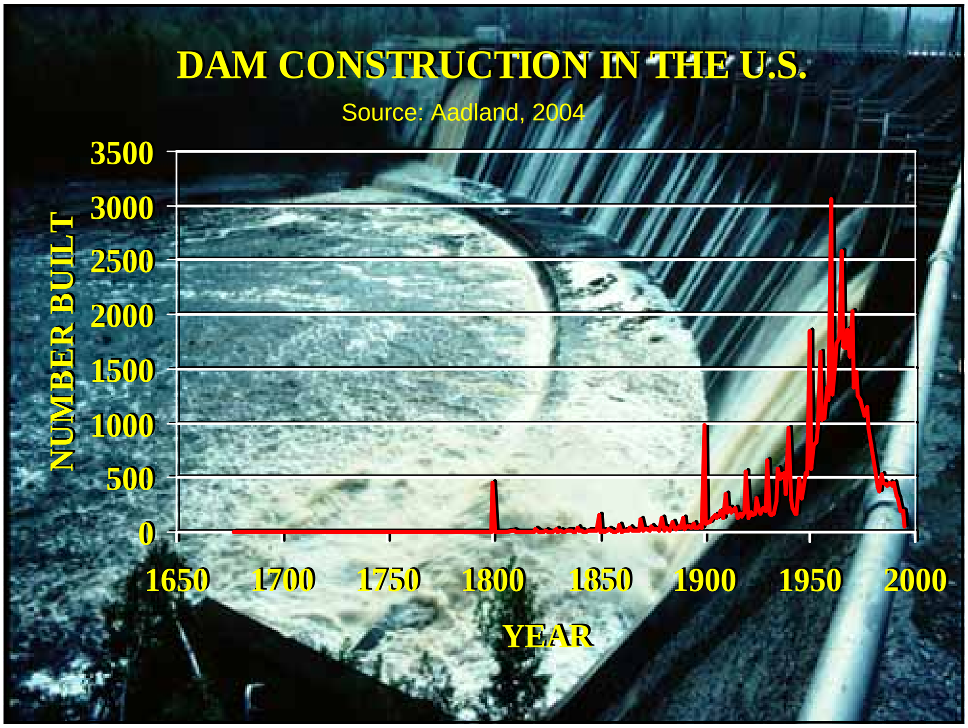


Figure 1. Total harvest of American shad from all Atlantic states, 1880-1999 (Limburg et al. 2003).

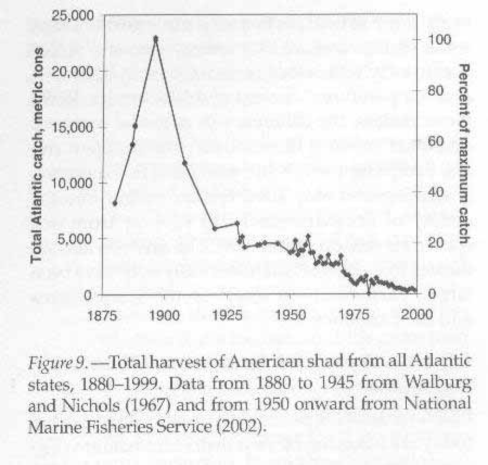


Figure 9.—Total harvest of American shad from all Atlantic states, 1880–1999. Data from 1880 to 1945 from Walburg and Nichols (1967) and from 1950 onward from National Marine Fisheries Service (2002).

1940-1995 Fishery Management Priorities Evolve in the South

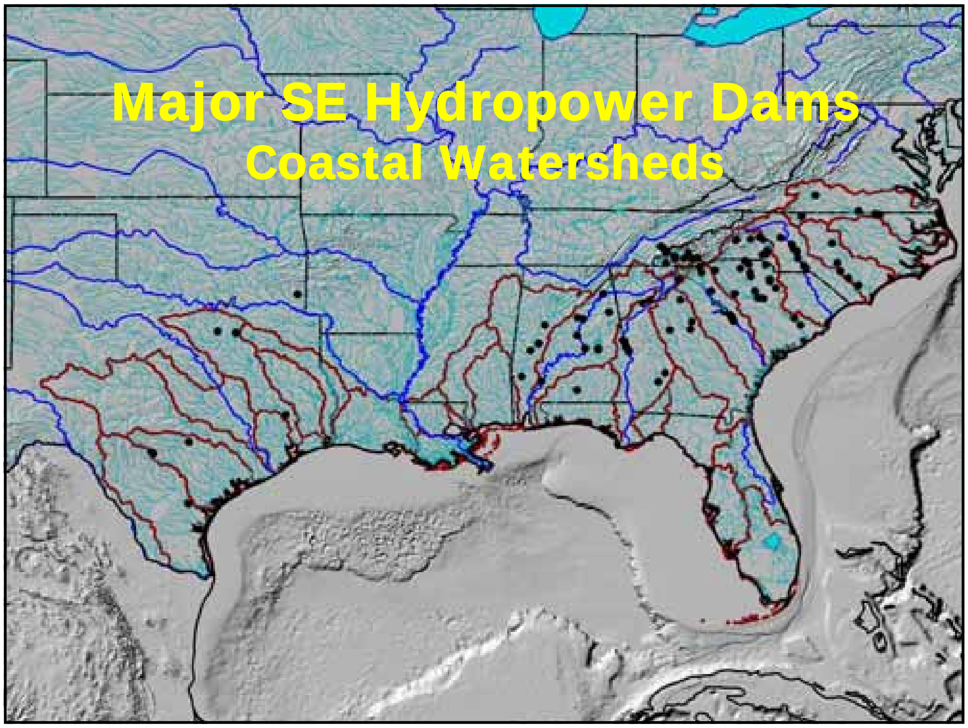
- Post-WWII: major dams completed blockage of fall-zone and piedmont spawning habitats.
- Rise of reservoir fishery management for resident species.
- Separate inland and marine fishery management and funding: inland vs marine.
- Fragmented watershed/river basin management. (Diadromous fish).
- Inland diadromous fisheries lower priority 1950-1995.

1950-95 FERC Licensing Participation Limited

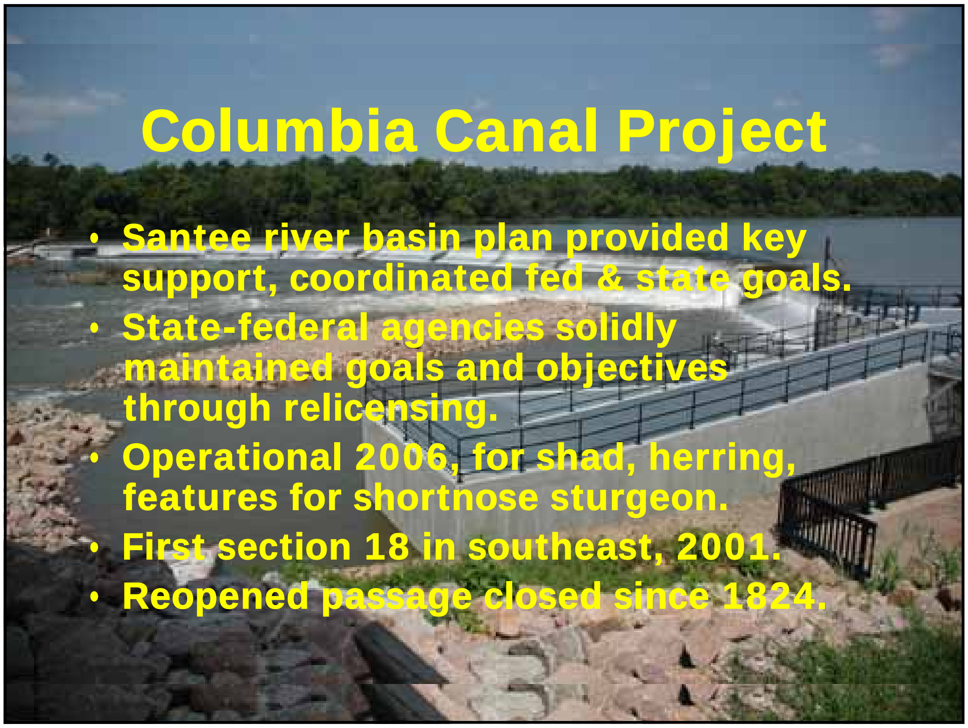
- Inland management dominated by resident species, reservoir management, exotic fish species introductions.
- Anadromous fish management amnesia.
- Limited knowledge of FERC process.
- Limited knowledge of fish passage designs.
- Many new dams constructed, passage not addressed or ineffective.
- No section 18 fishway prescriptions prior to 2000 in the south.

1985-2000: Renewal of Inland Diadromous Fish Restoration Priority Begins

- Many mainstem hydros up for relicensing.
- Ecosystem management concepts on the rise.
- Successful fish passage demonstrated on the Santee.
- Instream flow assessment / modeling technology available.
- FERC relicensing renews management priority for diadromous fish.



Major SE Hydropower Dams
Coastal Watersheds

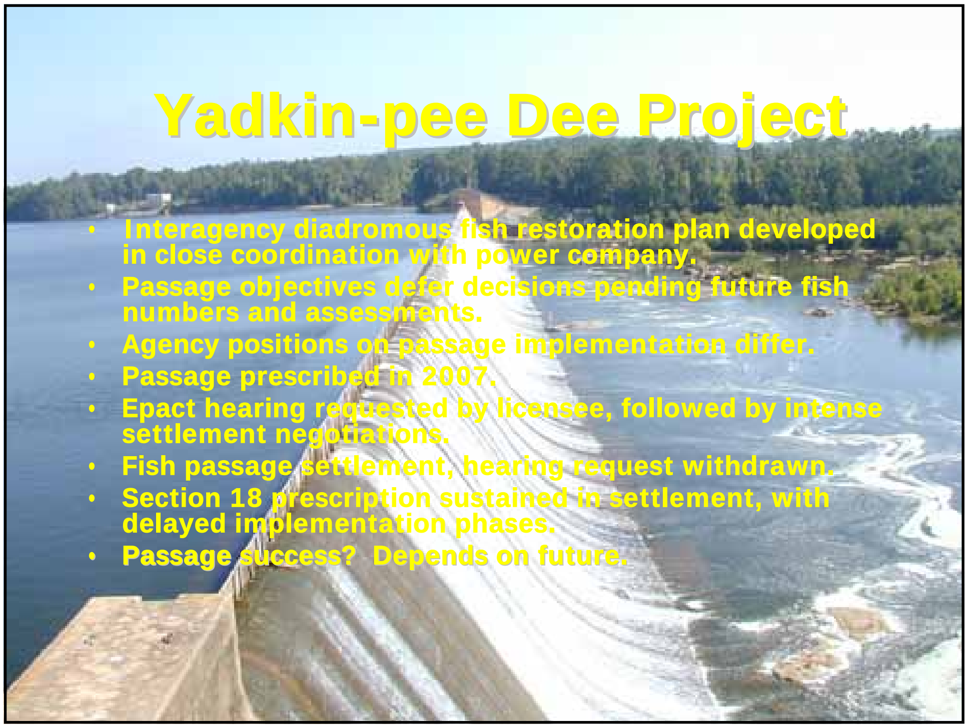


Columbia Canal Project

- Santee river basin plan provided key support, coordinated fed & state goals.
- State-federal agencies solidly maintained goals and objectives through relicensing.
- Operational 2006, for shad, herring, features for shortnose sturgeon.
- First section 18 in southeast, 2001.
- Reopened passage closed since 1824.

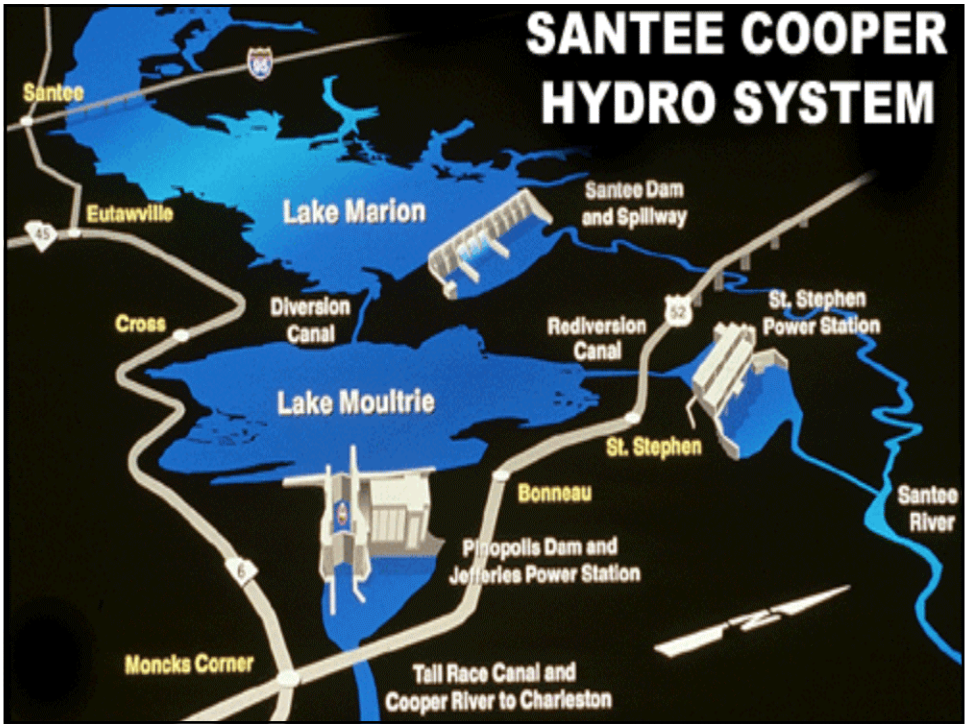
Roanoke-Gaston Project

- Draft diadromous fish restoration plan, goals and objectives.
- FERC alternative process, large stakeholder group, settlement process.
- Intense pressures on state and federal goals and objectives, particularly fish passage.
- Agency staff unprepared for intense negotiations.
- Agency positions differ on fish passage implementation.
- Fishway prescription issued by NMFS, consistent with settlement, phased approach, includes adaptive provisions.
- Implementation of phases contingent on fish numbers and future justification…”prove as you go” approach.
- Successful passage implementation? Depends on future.



Yadkin-pee Dee Project

- Interagency diadromous fish restoration plan developed in close coordination with power company.
- Passage objectives defer decisions pending future fish numbers and assessments.
- Agency positions on passage implementation differ.
- Passage prescribed in 2007.
- Epact hearing requested by licensee, followed by intense settlement negotiations.
- Fish passage settlement, hearing request withdrawn.
- Section 18 prescription sustained in settlement, with delayed implementation phases.
- Passage success? Depends on future.



SANTEE COOPER HYDRO SYSTEM

Augusta Canal Project
Savannah River

- FERC licensing proceedings since 1979.
- An interagency diadromous fish restoration consensus document prepared in 1995 includes goals and objectives for passage.
- Settlement process off and on since 2001.
- Section 18 fishway prescription 2005, prior to the new EPAct hearing process.
- CWA 401 requires passage.
- Settlement agreement January 2008
  - City of Augusta
  - Georgia and South Carolina
  - USFWS and NMFS
- Provides vertical slot fishway, flow restoration in Augusta shoals.
- License order pending.

2000-2008: FERC Licensing Comes of Age in the South

- 2001 First successful Section 18 Fishway Prescription. (Columbia Project, operational in 2006)
- State and Federal agencies establish hydropower/diadromous fish programs.
- Fish passage and instream flows routinely addressed in major FERC proceedings.

Building Fish Passage Success: Potential Setbacks

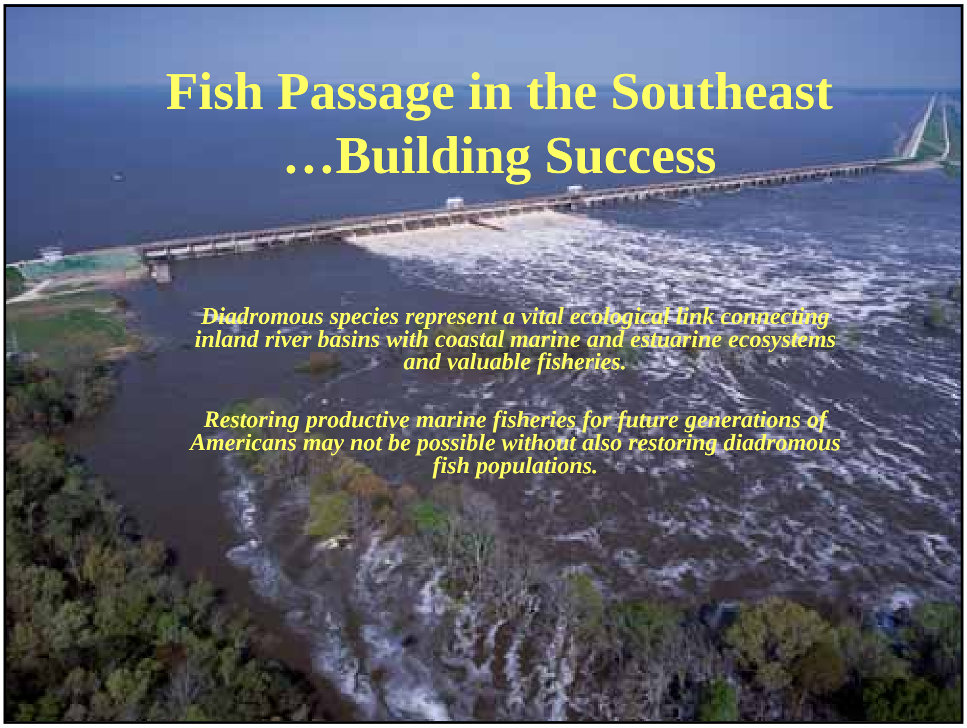
- Failure to achieve strong state-federal consensus on fishery resource protection goals.
- Agency negotiations separately with licensees.
- Limited agency staff / resources vs. relatively unlimited resources for licensees.
- Availalable science support insufficient due to lack of funding or elimination of research programs.
- Failure to support management goals with science support.
- Lack of training (negotiation skills, instream flow assessment, fish passage design, FERC process).
- Lack of Essential Fish Habitat / critical habitat designation for diadromous species (MSA loophole).
- Single species approach vs. ecosystem approach.

What Works: Building Success in Hydropower licensing

- State-federal river basin restoration plans, goals, objectives in advance of licensing proceedings.
- Build science-based restoration targets for each species, in each river basin, given sufficient funding.
- Bridge the inland / marine jurisdiction gap.
- Establish state / federal diadromous fish programs, trained staff. (fish passage bioengineering, instream flow assessment, FERC process)
- Integrate CWA Section 401 with fish passage and flow objectives.
- Present well founded goals, mitigation measures with clear “nexus” to continuing project effects.
- Move from single species to ecosystem based approach.
- Effectively use existing tools: EFH, HAPC, FWCA, Sec. 7 ESA.

Role for ASMFC: Help Build Coordinated State/federal Fish Passage Success

- Coastwide restoration goals, objectives and strategies.
- Encourage state-federal river basin habitat protection, restoration and fishery management plans.
- Provide strong policy support for state-federal fish passage programs.
- Document economic and ecological benefits.
- Assist in training program development and implementation. (Fish passage, instream flow assessment, negotiation skills, FERC).
- Encourage funding/appropriations for diadromous fish conservation, restoration, fish passage programs.
- Promote designation of essential/critical fish habitats for diadromous species (ASMFC requests DOC to prepare complementary federal plan, and designate EFH).



Fish Passage in the Southeast …Building Success

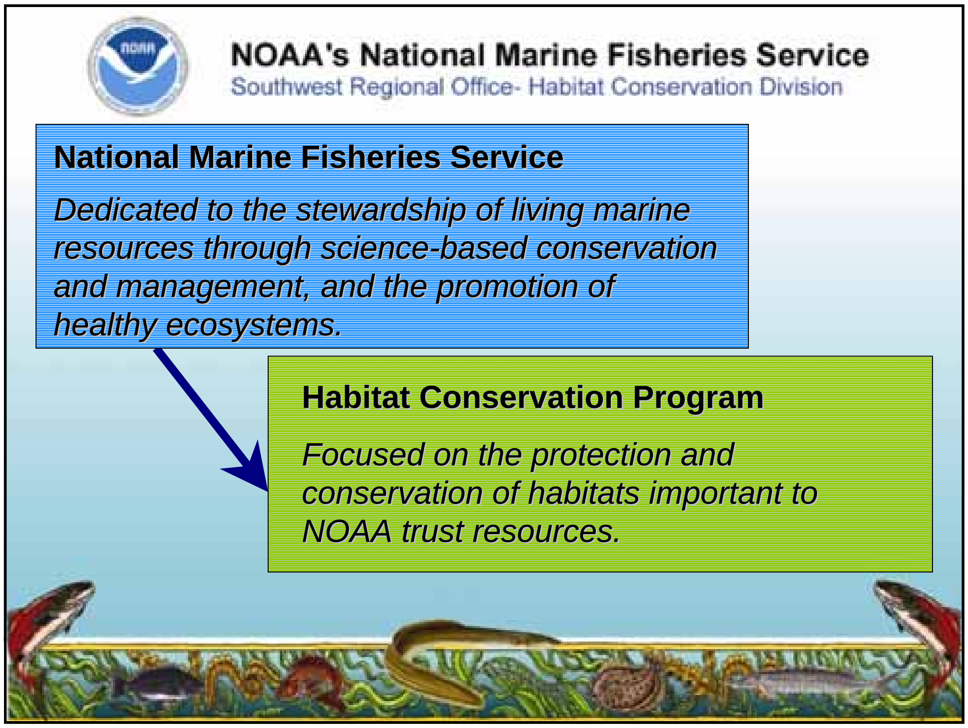
Diadromous species represent a vital ecological link connecting inland river basins with coastal marine and estuarine ecosystems and valuable fisheries.

Restoring productive marine fisheries for future generations of Americans may not be possible without also restoring diadromous fish populations.

NOAA's National Marine Fisheries Service
Southwest Regional Office- Habitat Conservation Division

Comprehensive Fish Passage Mitigation in the Context of FERC Relicensing

The Southwest Region Perspective



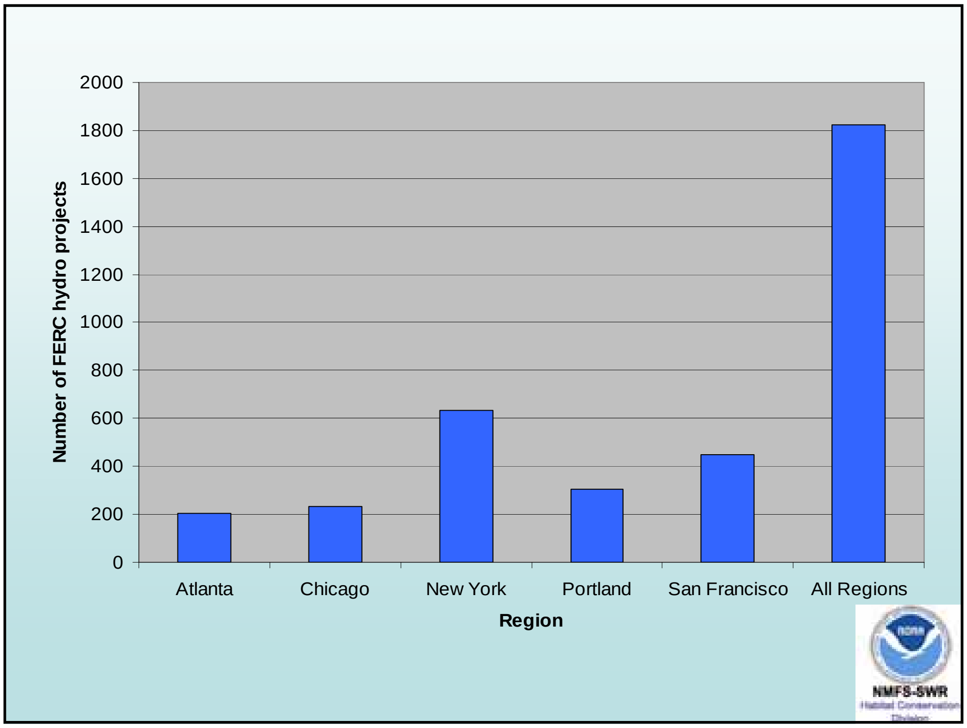
NOAA's National Marine Fisheries Service
Southwest Regional Office- Habitat Conservation Division

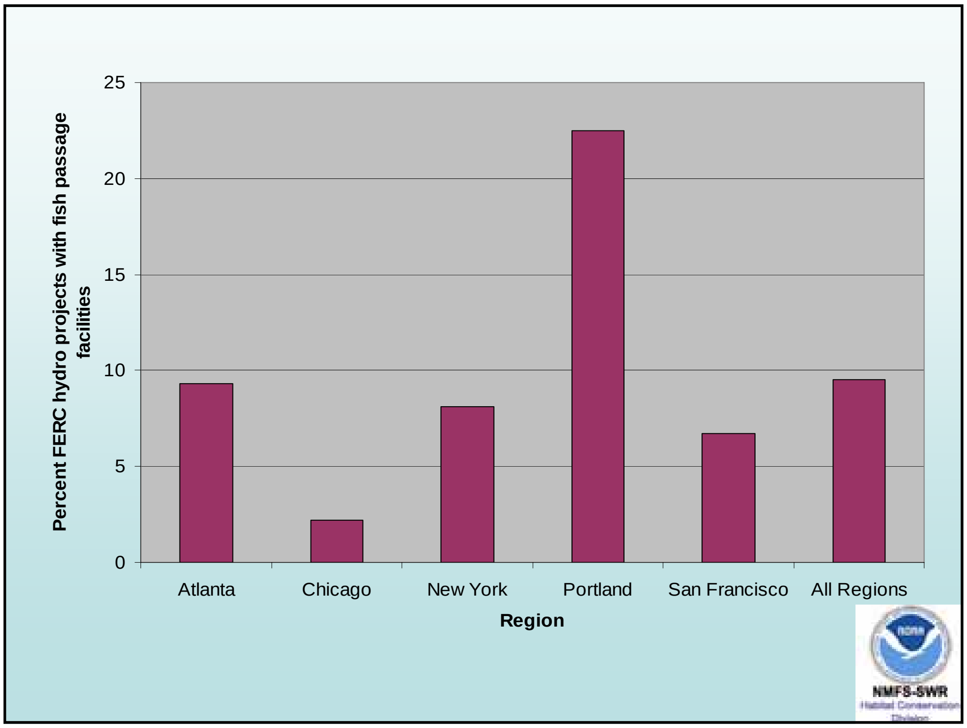
National Marine Fisheries Service

Dedicated to the stewardship of living marine resources through science-based conservation and management, and the promotion of healthy ecosystems.

Habitat Conservation Program

Focused on the protection and conservation of habitats important to NOAA trust resources.

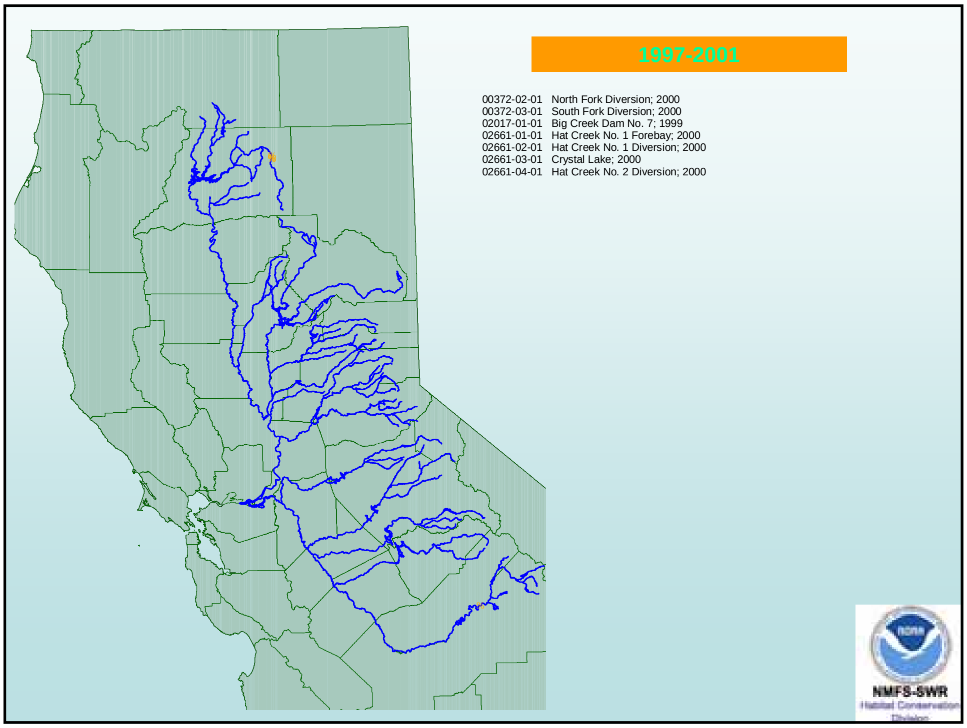

Number of FERC hydro projects
2000
1800
1600
1400
1200
1000
800
600
400
200
0
Atlanta
Chicago
New York
Portland
San Francisco
All Regions
Region
NMFS-SWR
Habitat Conservation


Percent FERC hydro projects with fish passage facilities
25
20
15
10
5
0
Atlanta
Chicago
New York
Portland
San Francisco
All Regions
Region
NMFS-SWR
Habitat Conservation

The Opportunity Is There

Hundreds of FERC licensed dams up for renewal…

NMFS-SWR
Habitat Conservation Division



1997-2001

00372-02-01	North Fork Diversion; 2000
00372-03-01	South Fork Diversion; 2000
02017-01-01	Big Creek Dam No. 7; 1999
02661-01-01	Hat Creek No. 1 Forebay; 2000
02661-02-01	Hat Creek No. 1 Diversion; 2000
02661-03-01	Crystal Lake; 2000
02661-04-01	Hat Creek No. 2 Diversion; 2000

NMFS-SWR
Habitat Conservation Division

2002-2006

00178-01-01 00372-01-01	Kern Diversion; 2005 North Fork Diversion; 2000	00233-04-01	Pit No. 5 Open Conduit; 2003
00184-01-01 00372-02-01	Echo Lake; 2002 South Fork Diversion; 2000	00344-03-01	East Fork Diversion; 2003
00184-02-01 02017-01-01	Caples Lake Main; 2002 Big Creek Dam No. 7; 1999	00344-04-01	South Fork Diversion; 2003
00184-02-02 02661-01-01	Caples Lake Auxiliary; 2002 Hat Creek No. 1 Forebay; 2000	00344-05-01	Black Wheel Creek Diversion; 2003
00184-03-01 02661-02-01	Silver Lake; 2002 Hat Creek No. 1 Diversion; 2000	00382-02-01	Kern River Diversion Weir; 2005
00184-04-01 02661-03-01	Medley Lakes Main; 2002 Crystal Lake Dam; 2000	00382-03-01	Borel Settling Basin Dike; 2005
00184-04-02 02661-04-01	Medley Lakes Auxiliary No.; 2002 Hat Creek No. 2 Diversion; 2000	00382-03-02	Borel Settling Basin Overf; 2005
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00233-03-01	Pit No. 5 Diversion; 2003	02174-01-02	Portal Forebay Dike; 2005

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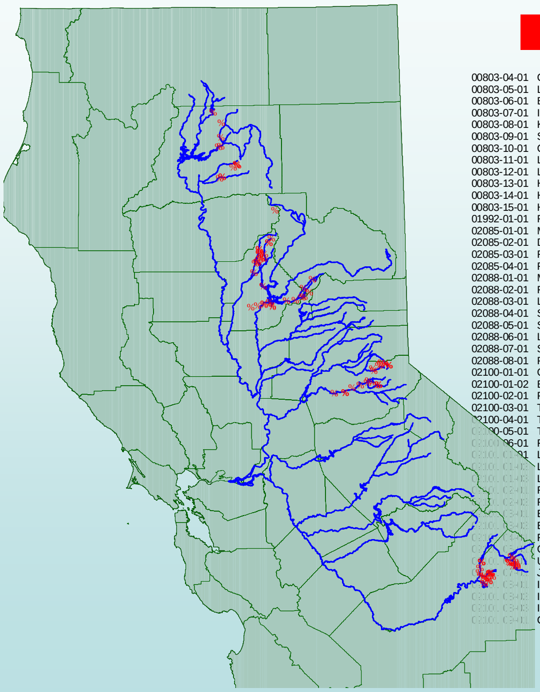
2007-2011



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02085-02-01	Daulton Creek Diversion; 2007	02175-04-01	Balsam Creek Diversion; 2009
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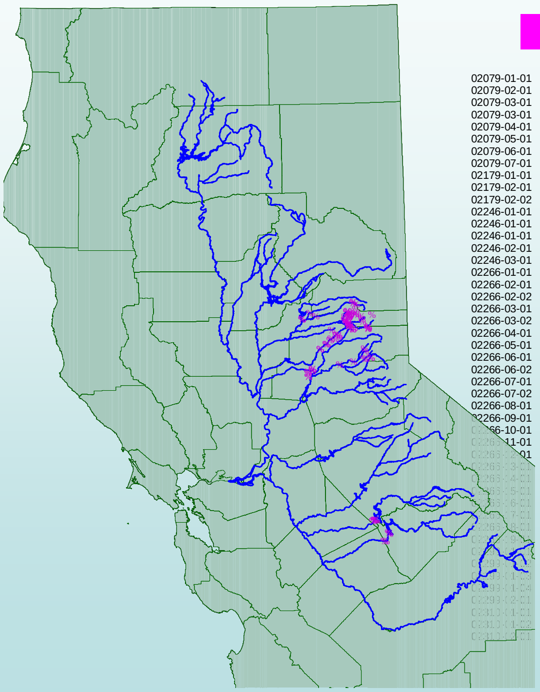

2012-2016

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02299-01-03	Don Pedro Dike B; 2016	02310-33-01	Wise Forebay; 2013
02299-01-04	Don Pedro Dike C; 2016	02310-34-01	Deer Creek Forebay; 2013
02299-02-01	Gasburg Creek Dike; 2016	02310-36-01	Towle Canal Diversion; 2013
02310-01-01	Upper Rock Lake Main; 2013	02310-37-01	Alta Forebay; 2013
02310-01-02	Upper Rock Lake Auxiliary; 2013	02467-01-01	Merced Falls; 2014
02310-02-01	Lower Rock Lake; 2013		

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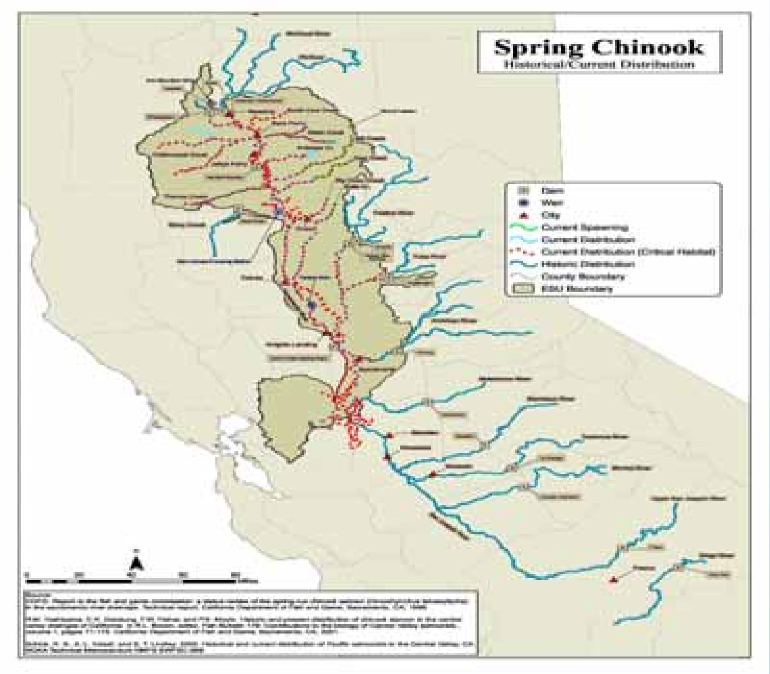
The Problem With Dams

- Dams and diversions the single biggest cause of fish declines in California (Moyle and Williams 1990).
- Dams block roughly 95% of original spawning habitat in Central Valley (Yoshiyama et. al 2001).
- Downstream passage has been prominent technical hurdle in restoration of anadromous fish to their historic habitats above large reservoirs.
- Valley-floor habitats can be significantly different from tributary streams, which can lead to fish hybridization and other genetic changes.



Spring Chinook
Historical/Current Distribution

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Habitat Conservation Division

Spring Chinook
Historic Distribution

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This is a coarse, watershed-level analysis undertaken as a planning exercise to identify staffing needs for participation in FERC relicensing looking at the following criteria:

- Miles of historic anadromous habitat blocked by dams.
- FERC licenses that are either undergoing (including amendments) or soon to be relicensed or contain adequate re-opener provisions to provide the opportunity to gain or improve habitat through fish passage or operational modifications.
- The presence of large-storage reservoirs that could provide additional flows to improve or extend habitat (including water quality improvements).
- Land ownership. We are assuming that allowing fish to move from habitat on the valley floor (below dams) to federally managed, historic habitat (above dams) provides for more sustainable populations. This is due to long-term management certainty (greater federal oversight), increased amount of habitat, and higher habitat quality.

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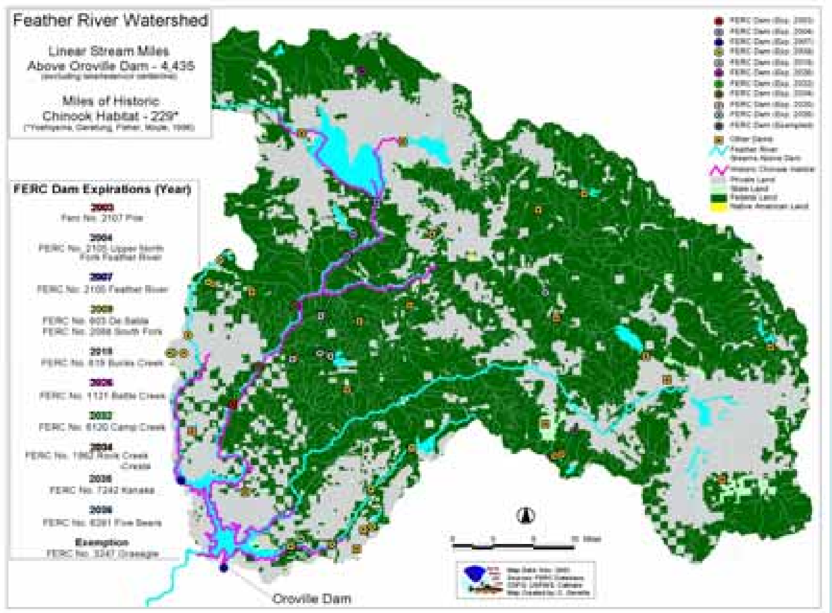

Feather River Watershed

Linear Stream Miles
Above Oroville Dam - 4,435
(excluding lake/reservoir centerline)

Miles of Historic
Chinook Habitat - 229*
(*Yoshiyama, Gerstung, Fisher, Moyle, 1996)

FERC Dam Expirations (Year)

2003
Ferc No. 2107 Poe

2004
FERC No. 2105 Upper North Fork Feather River

2007
FERC No. 2100 Feather River

2009
FERC No. 803 De Sabla
FERC No. 2088 South Fork

2016
FERC No. 619 Bucks Creek

2026
FERC No. 1121 Battle Creek

2032
FERC No. 6120 Camp Creek

2034
FERC No. 1962 Rock Creek -Cresta

2035
FERC No. 7242 Kanaka

2036
FERC No. 6281 Five Bears

Exemption
FERC No. 3247 Graeagle

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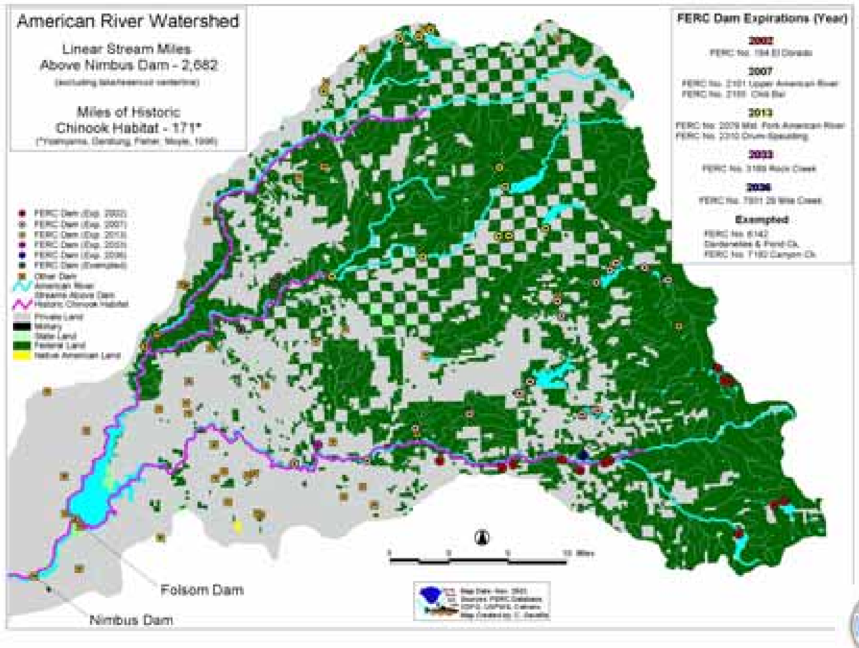

American River Watershed

Linear Stream Miles
Above Nimbus Dam - 2,682
(excluding lake/reservoir centerline)

Miles of Historic
Chinook Habitat - 171*
(*Yoshiyama, Gerstung, Fisher, Moyle, 1996)

FERC Dam Expirations (Year)

2002
FERC No. 184 El Dorado

2007
FERC No. 2101 Upper American River
FERC No. 2155 Chili Bar

2013
FERC No. 2079 Mid. Fork American River
FERC No. 2310 Drum-Spaulding

2033
FERC No. 3189 Rock Creek

2036
FERC No. 7931 28 Mile Creek

Exempted
FERC No. 6142
Dardanelles & Pond Ck.
FERC No. 7193 Canyon Ck.

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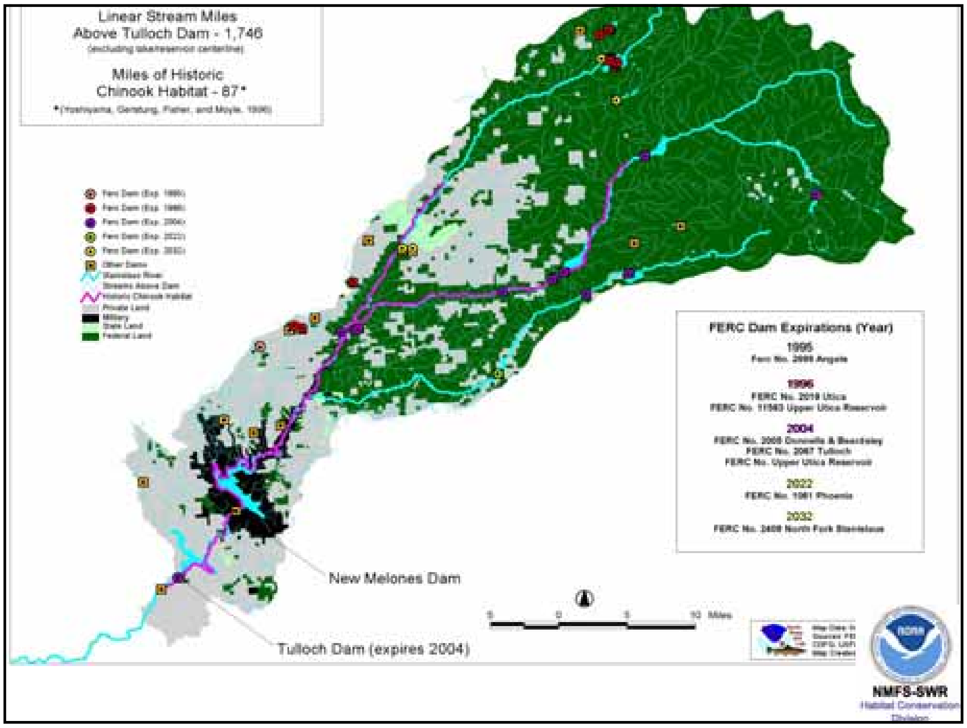


Linear Stream Miles
Above Tulloch Dam - 1,746
(excluding lake/reservoir centerline)

Miles of Historic
Chinook Habitat - 87*
*(Yoshiyama, Gerstung, Fisher, and Moyle, 1996)

FERC Dam Expirations (Year)

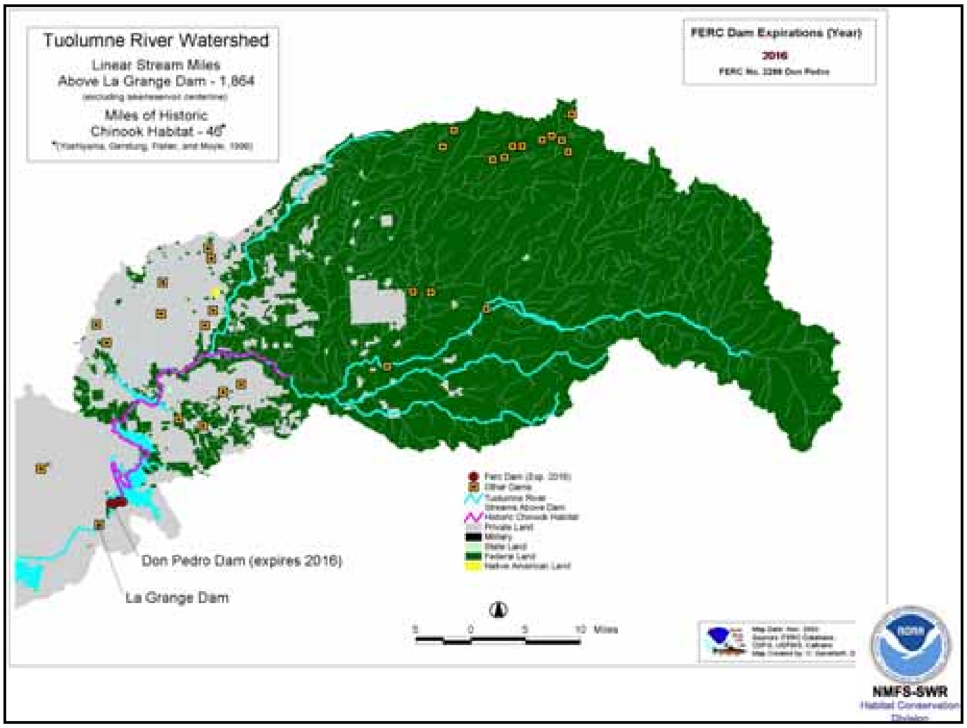
1995
Ferc No. 2699 Angels

1996
FERC No. 2019 Utica
FERC No. 11563 Upper Utica Reservoir

2004
FERC No. 2005 Donnells & Beardsley
FERC No. 2067 Tulloch
FERC No. Upper Utica Reservoir

2022
FERC No. 1061 Phoenix

2032
FERC No. 2409 North Fork Stanislaus



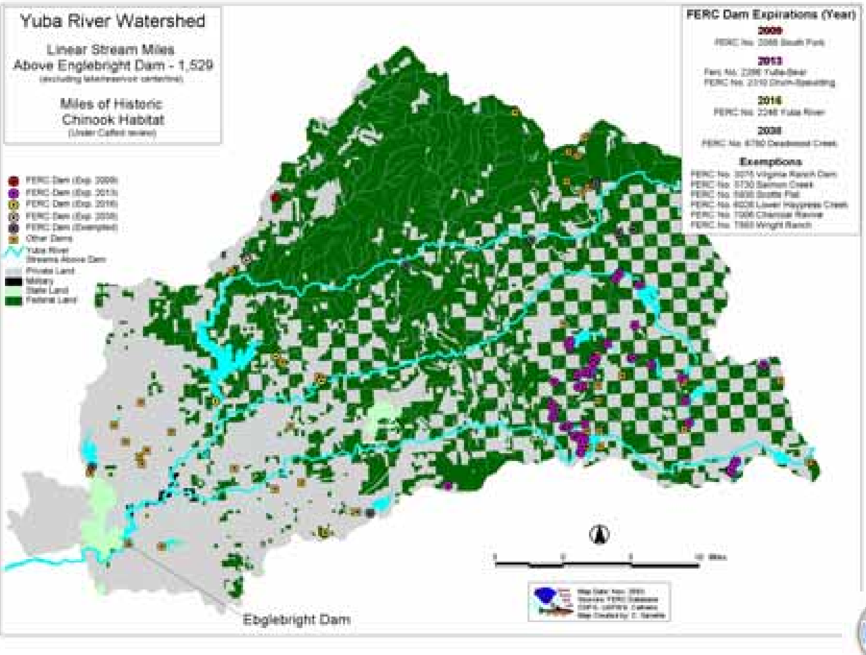
Tuolumne River Watershed

Linear Stream Miles
Above La Grange Dam - 1,864
(excluding lake/reservoir centerline)

Miles of Historic
Chinook Habitat - 46*
*(Yoshiyama, Gerstung, Fisher, and Moyle, 1996)

FERC Dam Expirations (Year)

2016
FERC No. 2299 Don Pedro



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Fish Passage Decision Analysis

Sequential analysis for determining appropriateness of fish passage

- Determine if there is an appreciable quantity of historic habitat partially or completely blocked.
- Determine if the blocked habitat is potentially viable.
- Determine if fish passage is technologically feasible.
- Determine the quantity of viable habitat and whether access to this habitat will contribute to resource goals for this watershed or fishery. Require appropriate fishways.

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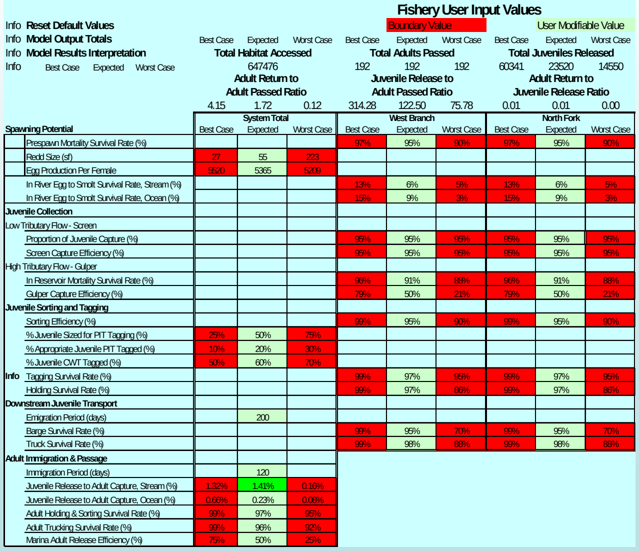
Passage is Biologically Feasible

Output from Odenweller Model:

Brood Year:	Ocean Surv.:
1997	0.7760
1998	1.8623
1999	1.5817



Fishery User Input Values

🟥 Boundary Value 🟩 User Modifiable Value

Info **Reset Default Values**

Info **Model Output Totals**

	Best Case	Expected	Worst Case	Best Case	Expected	Worst Case	Best Case	Expected	Worst Case
Info **Model Results Interpretation**	**Total Habitat Accessed**			**Total Adults Passed**			**Total Juveniles Released**		
Info Best Case Expected Worst Case		647476		192	192	192	60341	23520	14550
	Adult Return to Adult Passed Ratio			**Juvenile Release to Adult Passed Ratio**			**Adult Return to Juvenile Release Ratio**		
	4.15	1.72	0.12	314.28	122.50	75.78	0.01	0.01	0.00

	System Total			**West Branch**			**North Fork**		
Spawning Potential	Best Case	Expected	Worst Case	Best Case	Expected	Worst Case	Best Case	Expected	Worst Case
Prespawn Mortality Survival Rate (%)				97%	95%	90%	97%	95%	90%
Redd Size (sf)	27	55	223						
Egg Production Per Female	5520	5365	5209						
In River Egg to Smolt Survival Rate, Stream (%)				13%	6%	5%	13%	6%	5%
In River Egg to Smolt Survival Rate, Ocean (%)				15%	9%	3%	15%	9%	3%
Juvenile Collection									
Low Tributary Flow - Screen									
Proportion of Juvenile Capture (%)				95%	95%	95%	95%	95%	95%
Screen Capture Efficiency (%)				95%	95%	95%	95%	95%	95%
High Tributary Flow - Gulper									
In Reservoir Mortality Survival Rate (%)				96%	91%	88%	96%	91%	88%
Gulper Capture Efficiency (%)				79%	50%	21%	79%	50%	21%
Juvenile Sorting and Tagging									
Sorting Efficiency (%)				99%	95%	90%	99%	95%	90%
% Juvenile Sized for PIT Tagging (%)	25%	50%	75%						
% Appropriate Juvenile PIT Tagged (%)	10%	20%	30%						
% Juvenile CWT Tagged (%)	50%	60%	70%						
Info Tagging Survival Rate (%)				99%	97%	95%	99%	97%	95%
Holding Survival Rate (%)				99%	97%	86%	99%	97%	86%
Downstream Juvenile Transport									
Emigration Period (days)		200							
Barge Survival Rate (%)				99%	95%	70%	99%	95%	70%
Truck Survival Rate (%)				99%	98%	88%	99%	98%	88%
Adult Immigration & Passage									
Immigration Period (days)		120							
Juvenile Release to Adult Capture, Stream (%)	1.32%	1.41%	0.16%						
Juvenile Release to Adult Capture, Ocean (%)	0.66%	0.23%	0.08%						
Adult Holding & Sorting Survival Rate (%)	99%	97%	95%						
Adult Trucking Survival Rate (%)	99%	96%	92%						
Marina Adult Release Efficiency (%)	75%	50%	25%						

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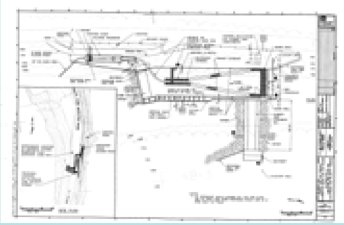
Engineering Feasibility



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Fish Passage Facility Types

Generic List of Types of Passage Facilities Employed at FERC Hydro Projects

Upstream

Passive
- fish ladders
- canals
- dam removal

Directed
- fish lifts
- trap and haul

Downstream

Passive
- fish ladders
- canals
- flumes
- screens (v-screens, barrier nets, eichers, angled bar racks)
- notches
- spill
- behavioral guidance
- louvers
- dam removal

Directed
- trap and haul
- surface collection (traps, gulpers, salvage devices)

Collaborative Process

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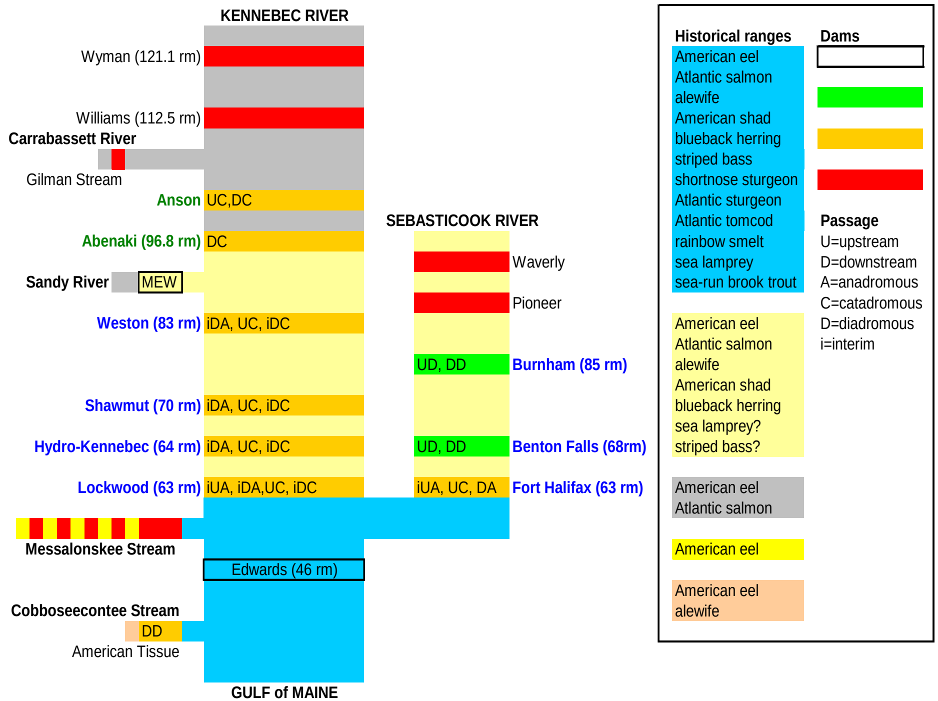
Division

FERC Case Studies
Kennebec River

Gail Wippelhauser, Ph.D.
Maine Department of Marine Resources



KENNEBEC RIVER

Wyman (121.1 rm)

Williams (112.5 rm)

Carrabassett River

Gilman Stream

Anson UC,DC

Abenaki (96.8 rm) DC

Sandy River MEW

Weston (83 rm) iDA, UC, iDC

Shawmut (70 rm) iDA, UC, iDC

Hydro-Kennebec (64 rm) iDA, UC, iDC

Lockwood (63 rm) iUA, iDA,UC, iDC

Messalonskee Stream

Edwards (46 rm)

Cobboseecontee Stream

DD

American Tissue

GULF of MAINE

SEBASTICOOK RIVER

Waverly

Pioneer

UD, DD **Burnham (85 rm)**

UD, DD **Benton Falls (68rm)**

iUA, UC, DA **Fort Halifax (63 rm)**

Historical ranges

American eel
Atlantic salmon
alewife
American shad
blueback herring
striped bass
shortnose sturgeon
Atlantic sturgeon
Atlantic tomcod
rainbow smelt
sea lamprey
sea-run brook trout

American eel
Atlantic salmon
alewife
American shad
blueback herring
sea lamprey?
striped bass?

American eel
Atlantic salmon

American eel

American eel
alewife

Dams

⬜

🟩

🟧

🟥

Passage

U=upstream
D=downstream
A=anadromous
C=catadromous
D=diadromous
i=interim

Highlights of 24 years

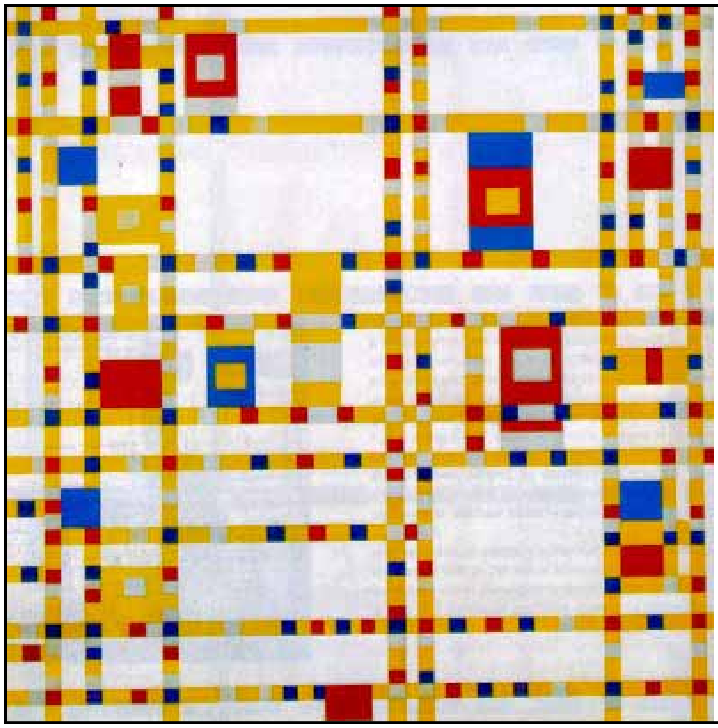
- License expirations: Edwards (1993), Lockwood (2004), Hydro-Kennebec (1993), Shawmut (2021), Weston (1993), Anson (1993), Wyman (1993), Fort Halifax (1993), Benton Falls (built 1986), Burnham (jurisdictional issue)
- 1984 State petitions FERC for passage, KHDG forms?
- 1985 Kennebec River Restoration Plan
- 1987 DMR, DIFW, ASC, KHDG sign Settlement Agreement
  - 5/1/99 to 5/1/01upstream passage at 7 KHDG dams
  - Funding for DMR for restoration
- 1987-1998 DMR stocks shad and alewives
- 1987ish consultation for Edwards Project begins
- 1994 FERC notice of intent to prepare an EIS and conduct public scoping meetings
  - Edwards, Fort Halifax, MEW, Weston, Wyman, Messalonskee projects
- 1995 FERC issues draft EIS
- 1997 FERC issues EIS

- 1998 Multiple parties sign Settlement Accord
  - Removal of Edwards Dam and funding for continued restoration
  - Interim fishlift at Lockwood by 5/1/2006
  - US passage at Lockwood and Hydro-Kennebec 2 years after 8000 shad passed at Lockwood, but no sooner than 5/1/2010
  - US passage at Shawmut 2 years after 15,000 shad at H-K, after 5/1/2012
  - US passage at Weston 2 years after 35,000 shad at Shawmut, after 5/1/2014
  - Fishlift at Fort Halifax by May 1, 2003 or partial breach or removal of dam
  - US passage at Benton Falls and Burnham 1 year after passage at four upriver nonhydro dams, after 5/1/2002
  - Eel passage studies by DMR for three years, then recommendations
- 1999 Edwards removed
- 1999-2006-2008 DMR stocking shad and alewife
- 1999-2008 DMR and/or licensee eel studies
- 1999-2003 DMR provides passage at 4 nonhydropower dams
- 2002 Multiple parties submit Settlement for Anson and Abenaki projects (APEA process)
- 2003-2008 FERC process and appeals for decommissioning and breach of Fort Halifax
- 2006 fishlifts operational at Benton Falls, Burnham, Lockwood
- 2006 MEW dam removed

Lessons learned by GSW

may not represent the opinions of the management

- Remove a dam whenever you can
- Multi-party settlements (hydropower owners, state and federal agencies, tribes, conservation groups) allow comprehensive and logical fish passage
  - Get the most important thing done first
  - Look for a hook
  - Luck is important (right time, place, people, energy prices)
  - The settlement will never be perfect
  - Share your letters (recommendations), argue in private, agree in public
- Everything takes longer than it should
- “Date certain” or “triggered” passage is equally likely to be challenged

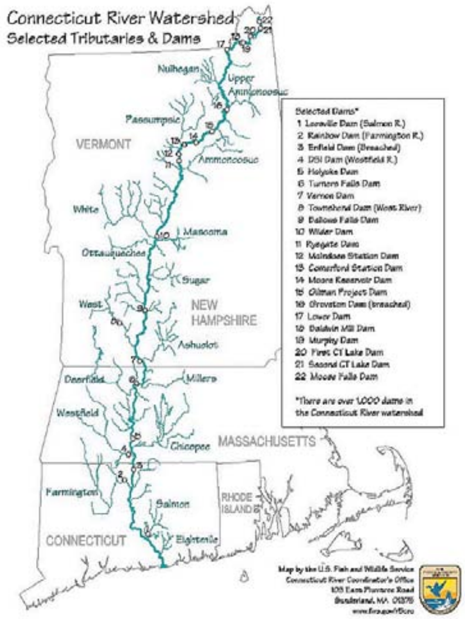


P. Mondrian

Broadway-Boogie-Woogie

FERC Case Study:
The Connecticut River

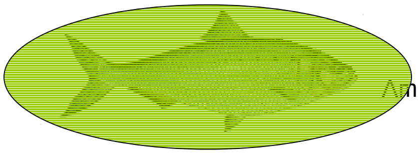
Melissa Grader, Fish and Wildlife Service



Connecticut River Watershed

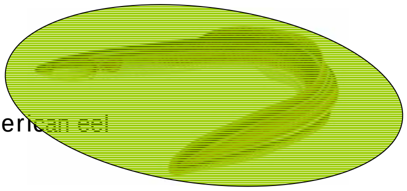
- Over 400 miles long
- 11,000 sq. mile drainage
- 38 major tributaries
- Home to 142 kinds of fish
- In CT, MA, NH and VT
- Home to 2.3 million people

Ct River Native Migratory Fish

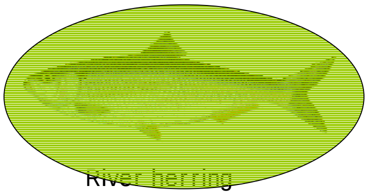


American shad

Atlantic salmon



American eel



River herring

Sea lamprey

Shortnose sturgeon

Why do we need fishways ?

on CT River: 87 FERC projects covering 100 dams

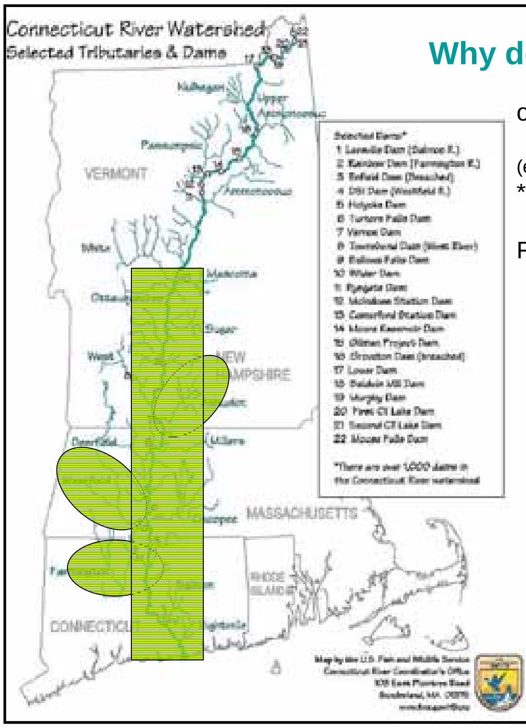
(excludes canal projects, pump storage, conduits)

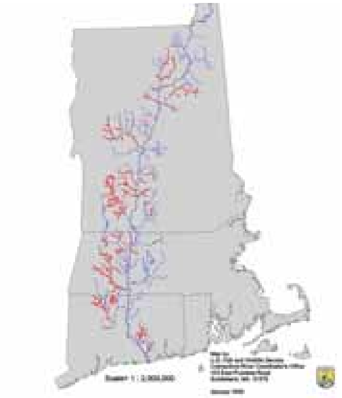
** over 2,700 dams in river basin**

FERC Projects with fish passage:

7 projects with u/s passage

40 projects with d/s passage





Fisheries Management on the Connecticut River

Shad & River herring

1. Hatchery program
   - ➢ Currently no hatchery program for Alosines
2. Adult returns
   - ➢ Shad trapped and trucked from Holyoke to upstream reaches (Vernon and Ashuelot River) and outside basin (Maine, CT coastal)
     - ➢ River herring were T&Ted also until #s dropped too low
3. Research
   - ➢ Genetics study/management ongoing to determine if different stocks of blueback herring inhabit different rivers
     - ➢ results to be used in making decisions on where donor stock would come from now & in future
   - ➢ Some fish collected at Holyoke or in river below dam to study fish passage design, swimming performance, etc. (Conte Lab)
   - ➢ UConn study of predator-prey interactions for herring/shad & SB
4. Fish Passage
   - ➢ On rivers targeted for Alosine restoration, secure fish passage via FERC process or in cooperation with dam owners at non-FERC dams

Fisheries Management on the Connecticut River (cont'd)

American eel

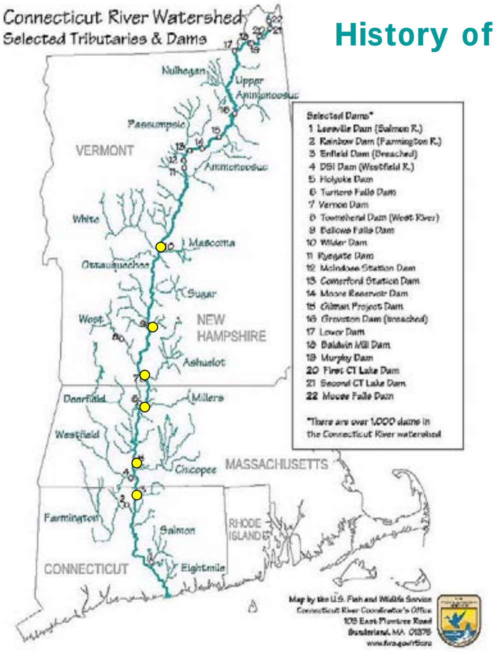
1. Research
   - ➢ Downstream passage studies at Turners Falls

2. Fish Passage
   - ➢ On rivers targeted for eel restoration, secure fish passage via FERC process or in cooperation with dam owners at non-FERC dams
   - ➢ For upstream passage, typically conduct assessment to determine areas of highest eel concentration for appropriate siting of fishway

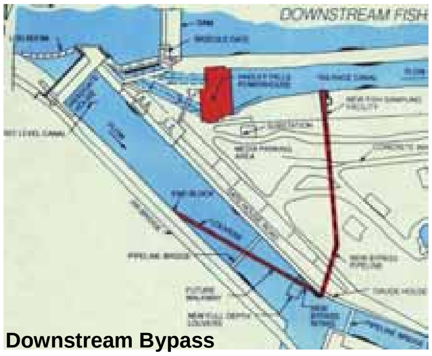
Shortnose Sturgeon (federally-listed species)

1. Research
   - ➢ ongoing to assess best method of safely passing sturgeon d/s

2. Fish Passage
   - ➢ Sturgeon trapped in lift are scanned for tags, weighed, measured then released back into tailrace UNTIL d/s passage figured out



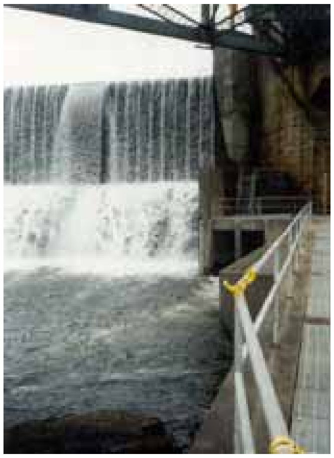
History of Mainstem Fish Passage



Downstream Bypass

Tailrace and Spillway entrances

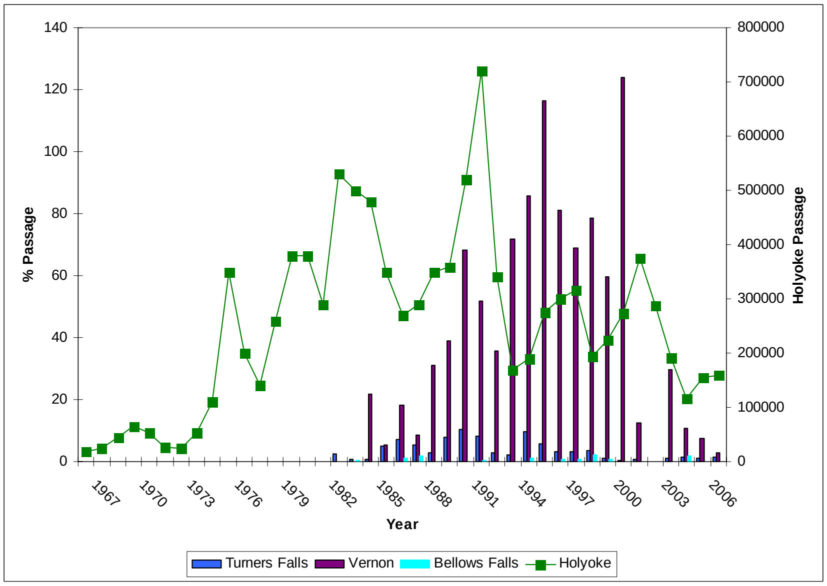
Holyoke eelway



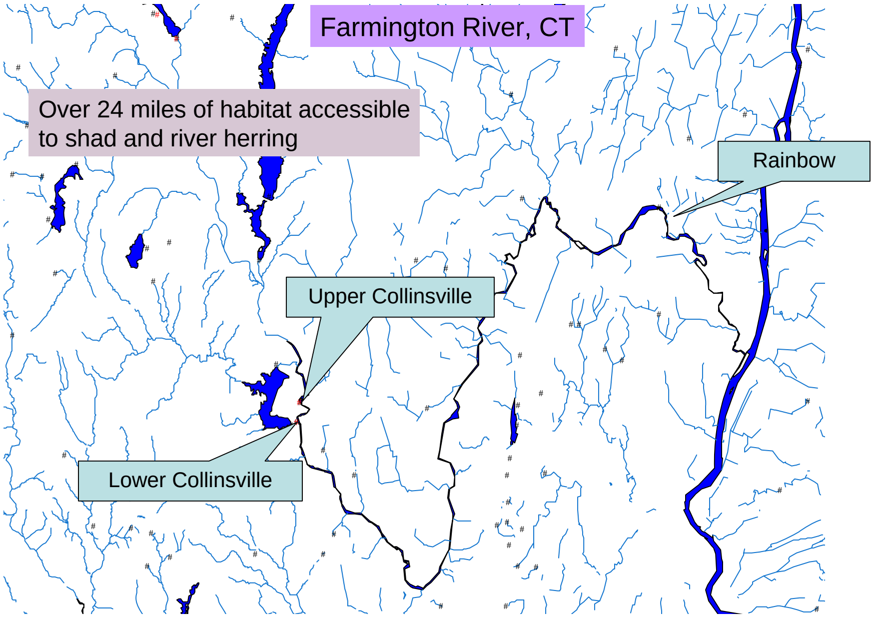
Turners Falls Station

Vernon Dam and Fishway

Shad Passage at Mainstem Dams

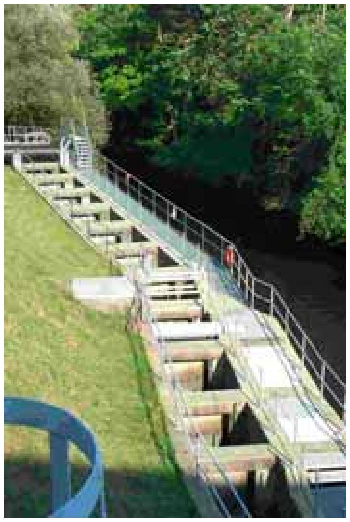


Farmington River, CT

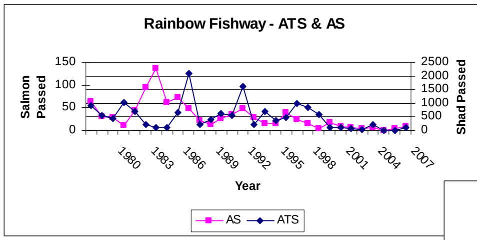


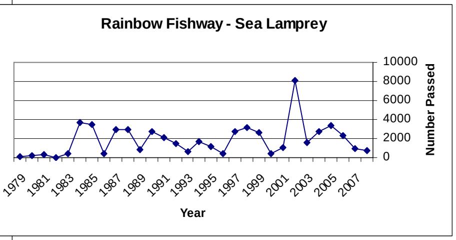
Over 24 miles of habitat accessible to shad and river herring

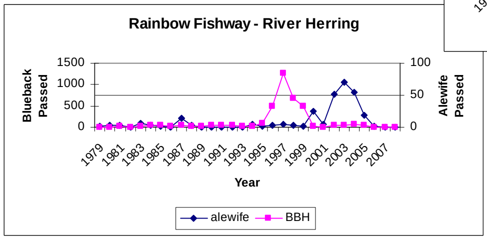
Rainbow Dam & Fishway, Farmington River, CT



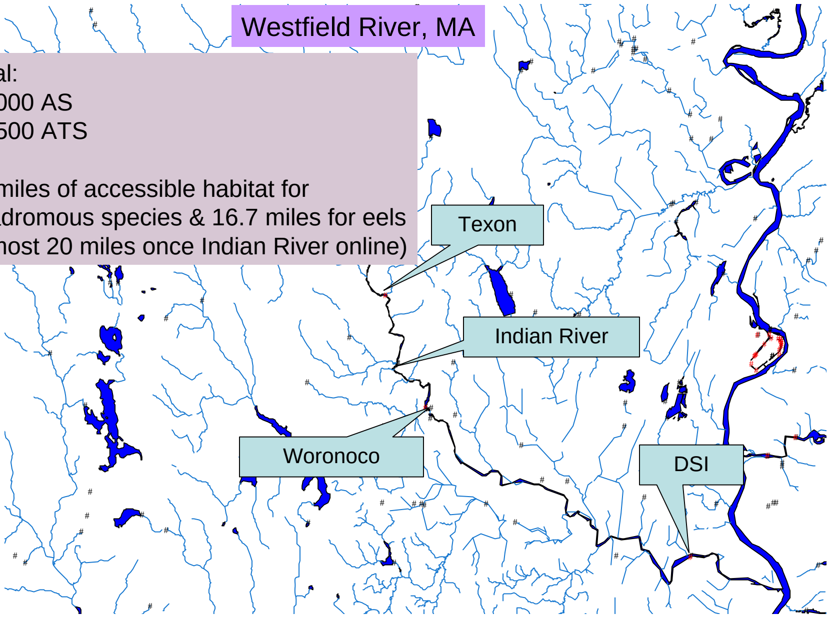
Rainbow Fishway, Farmington River, CT







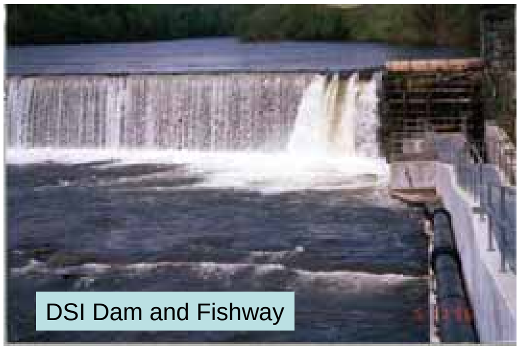
Westfield River, MA



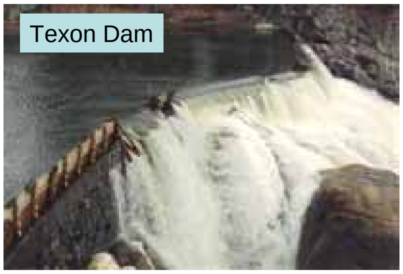
Goal:
15,000 AS
500 ATS

14 miles of accessible habitat for anadromous species & 16.7 miles for eels (almost 20 miles once Indian River online)


DSI Eel Ladder


DSI Dam and Fishway


Indian River Project

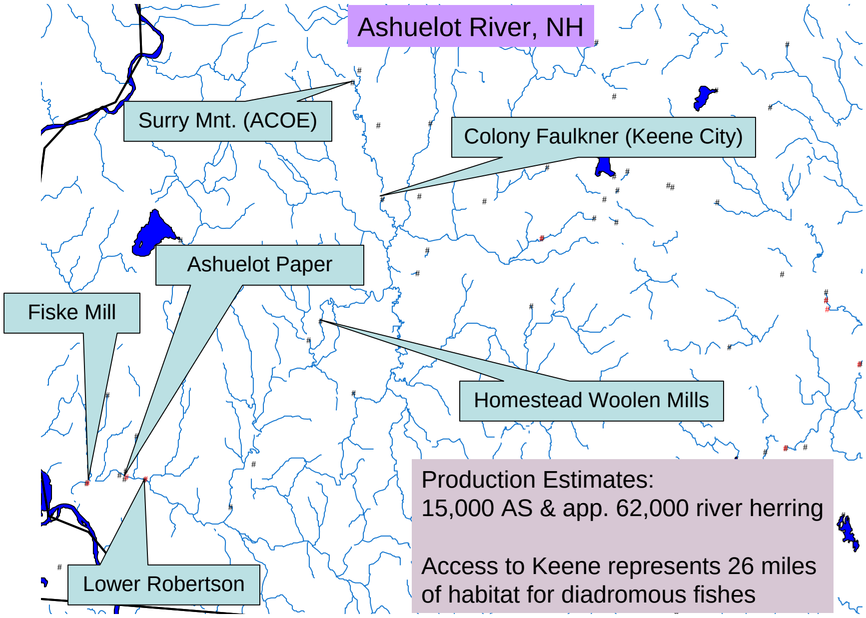

Texon Dam


Texon intake/bypass

DSI Fishway, Westfield River, MA

Year	Alewife	American eel	AS	ATS	BBH	Sea Lamprey
1996	0		1413	19	1	4699
1997	0		1012	37	0	2255
1998	0		2292	47	2	1756
1999	0		2668	17	0	643
2000	0		3558	11	0	2040
2001	0	465	4720	8	2	2345
2002	0	506	2762	5	4	3638
2003	4	313	1957	6	5	404
2004	0		913	12	1	1171
2005	0	329	1237	27	0	818
2006	0	2525	1534	34	0	1276
2007	0	131	4498	21	0	1797

Ashuelot River, NH

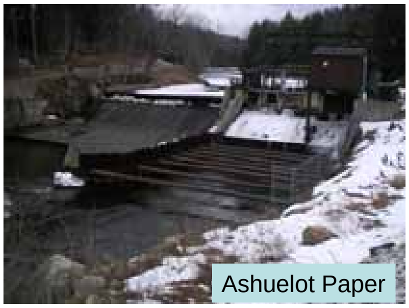


Production Estimates:
15,000 AS & app. 62,000 river herring

Access to Keene represents 26 miles of habitat for diadromous fishes

Ashuelot River Dams


Fiske Mill

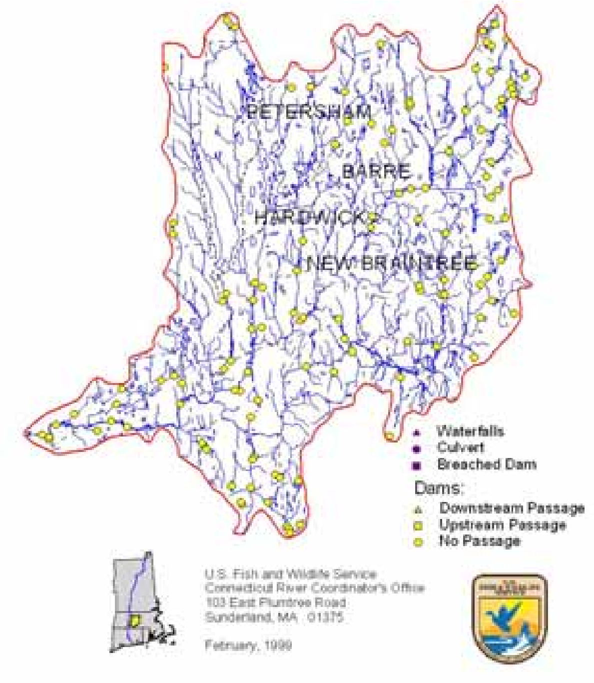

Ashuelot Paper


Lower Robertson

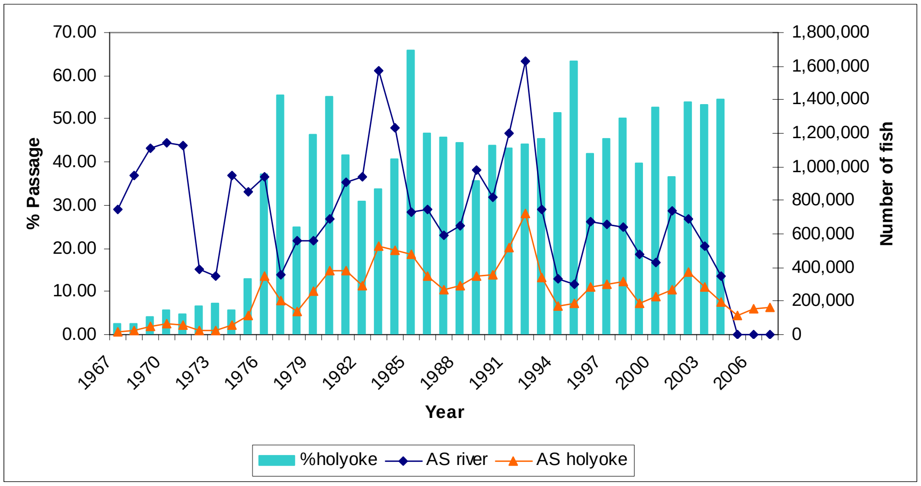

Homestead Woolen Mills

Where Do We Go From Here?

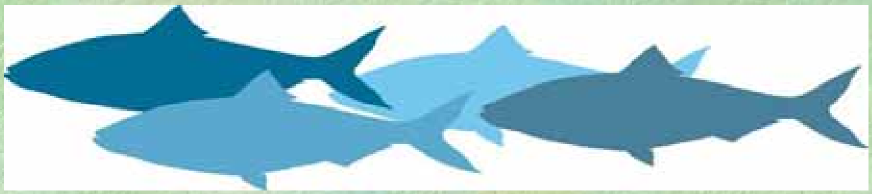
- Continue to improve passage efficiency at identified dams
- Continue T&T to selected mainstem/trib reaches
- Assess need/benefit of targeting additional tribs for Alosine restoration
- Assess need/benefit of starting donor stocking program for BBH



PETERSHAM
BARRE
HARDWICK
NEW BRAINTREE
Waterfalls
Culvert
Breached Dam
Dams:
Downstream Passage
Upstream Passage
No Passage
U.S. Fish and Wildlife Service
Connecticut River Coordinator's Office
103 East Plumtree Road
Sunderland, MA 01375
February, 1999



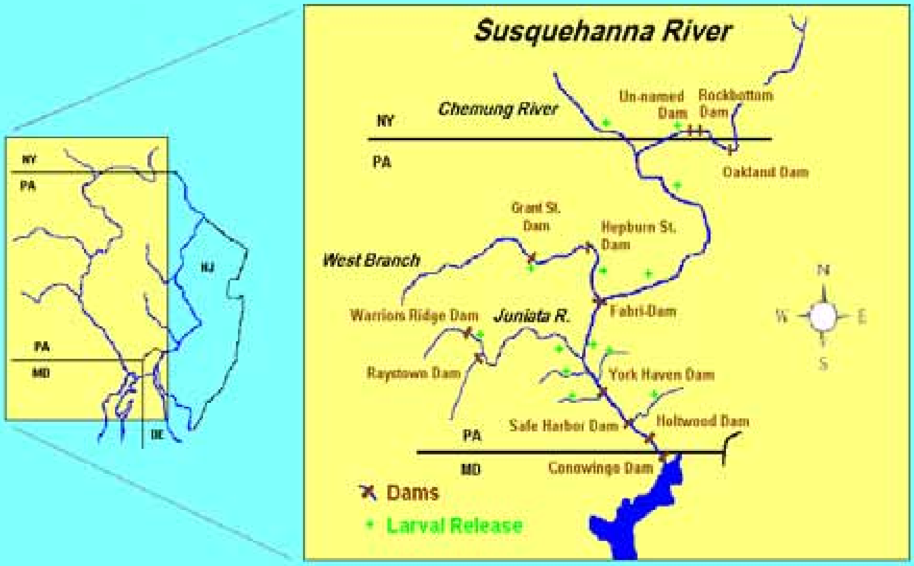
% Passage
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Number of fish
1,800,000
1,600,000
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
1967
1970
1973
1976
1979
1982
1985
1988
1991
1994
1997
2000
2003
2006
Year
%holyoke
AS river
AS holyoke

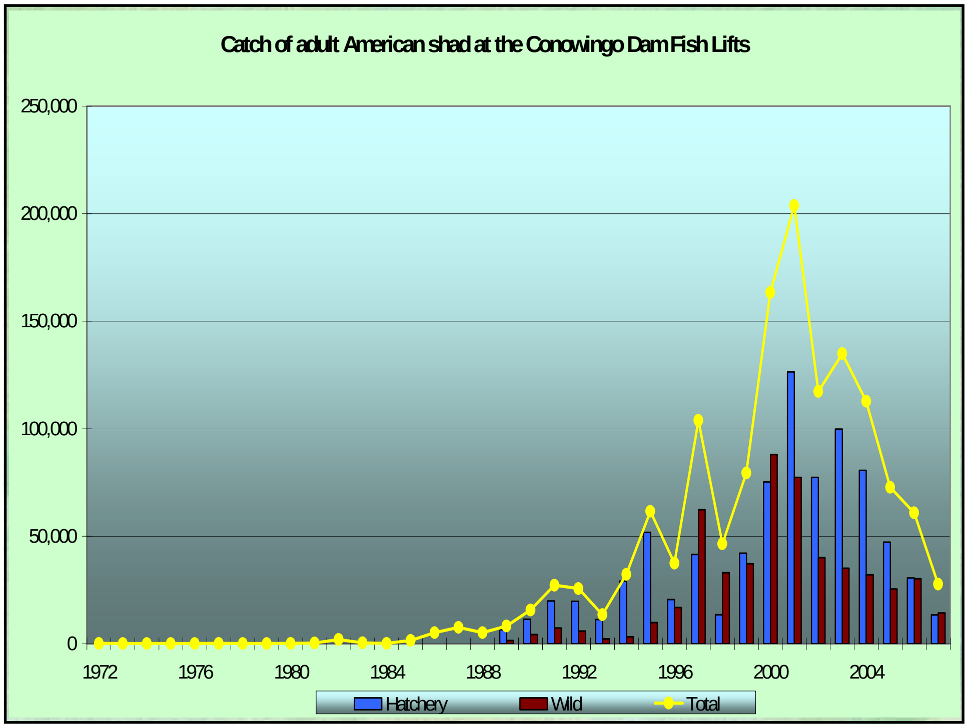


Susquehanna River Fish Passage Issues

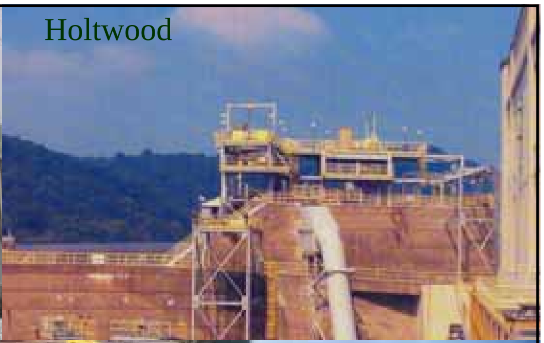
Michael L. Hendricks

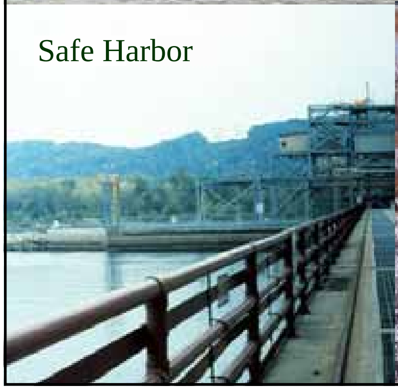
Pennsylvania Fish and Boat Commission

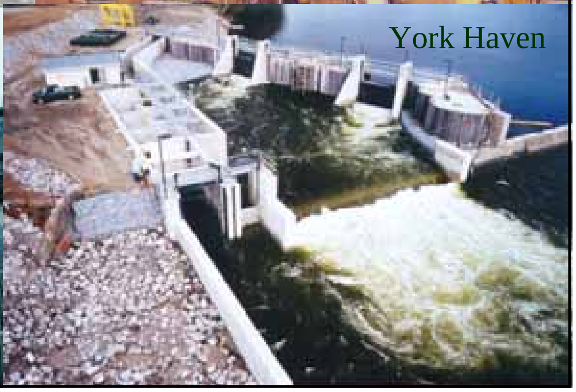


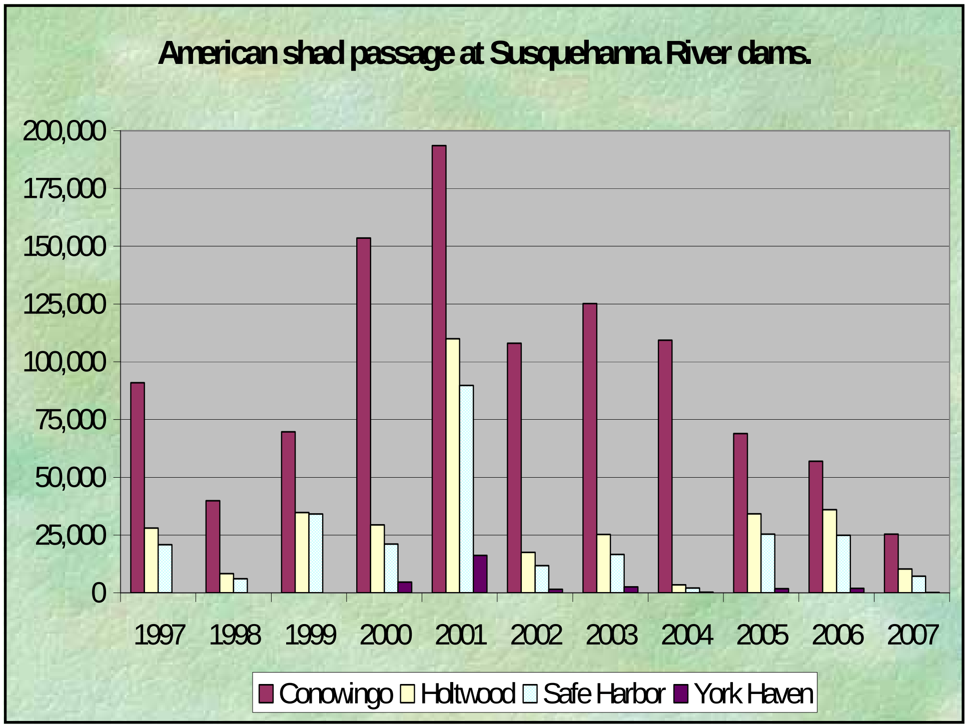

Catch of adult American shad at the Conowingo Dam Fish Lifts
250,000
200,000
150,000
100,000
50,000
0
1972
1976
1980
1984
1988
1992
1996
2000
2004
Hatchery
Wild
Total


Conowingo

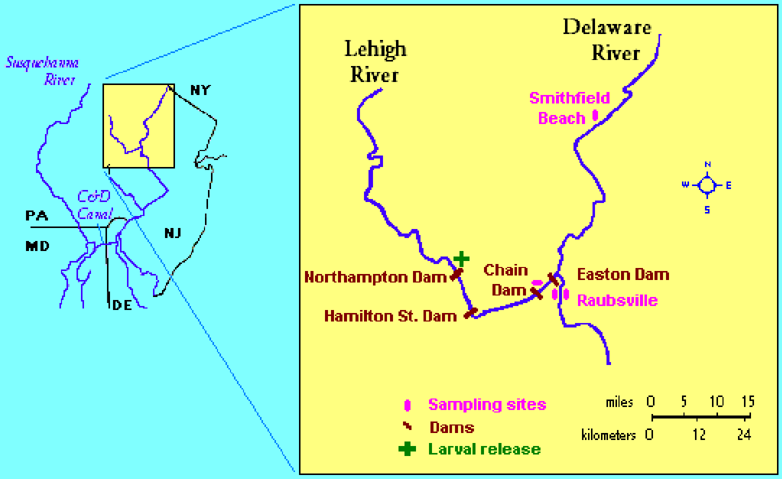

Holtwood

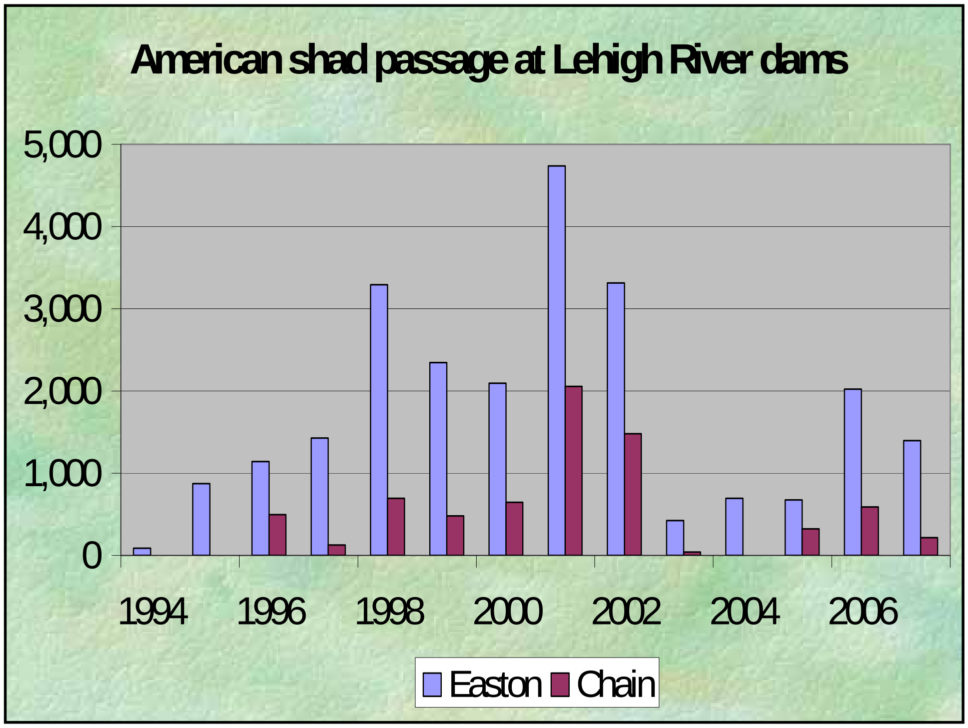

Safe Harbor


York Haven



American shad passage at Susquehanna River dams.





Susquehanna power plant FERC Re-licensing

2014 (process begins in 2009)

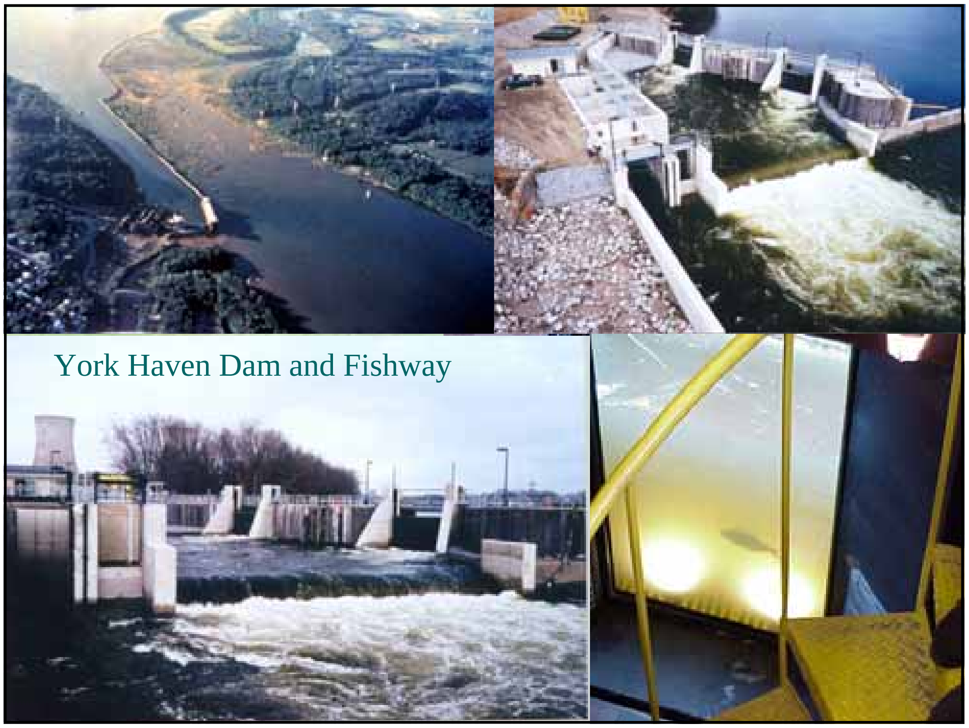
- ➢Conowingo
- ➢Muddy-Run Pumped Storage Station
- ➢Holtwood (unless re-development occurs)
- ➢York Haven

2030

- ➢Safe Harbor

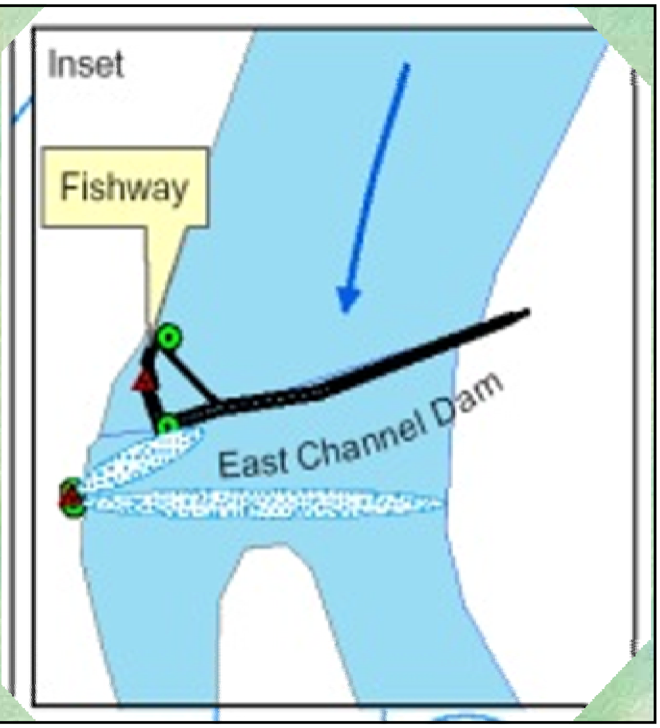
Conservation agency partners negotiating as one:

PFBC, PA DEP, PA DCNR, USFWS, SRBC, US ACE, MD DNR,



York Haven Dam and Fishway

York Haven Dam



Radio telemetry study

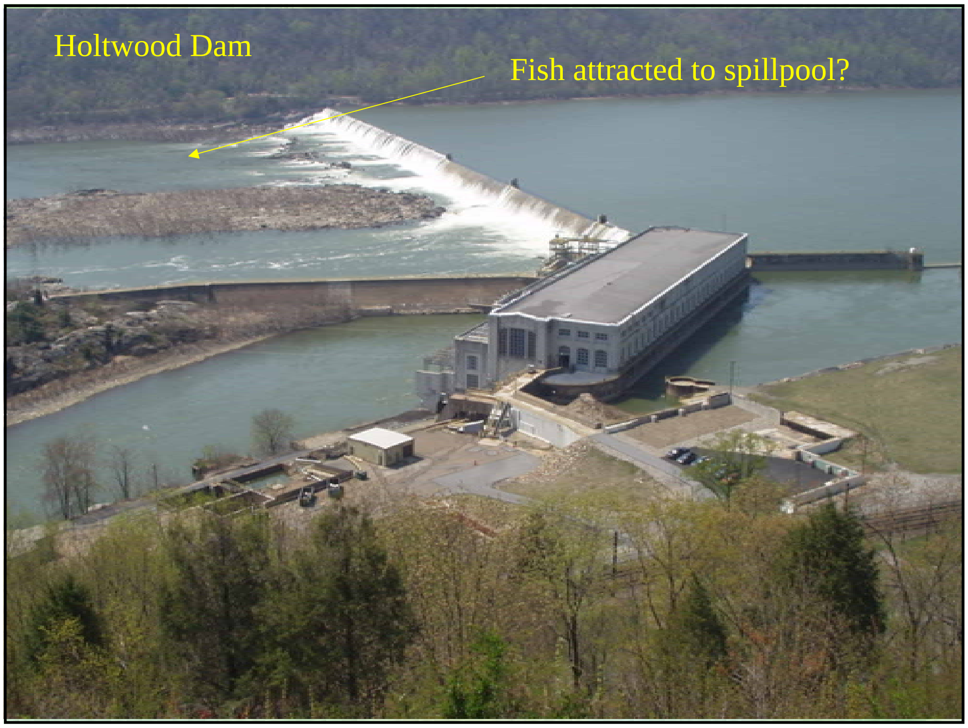
Radio telemetry results:

York Haven East Channel Fishway

1. 20 fish detected at East Channel Dam, 15 approached fishway

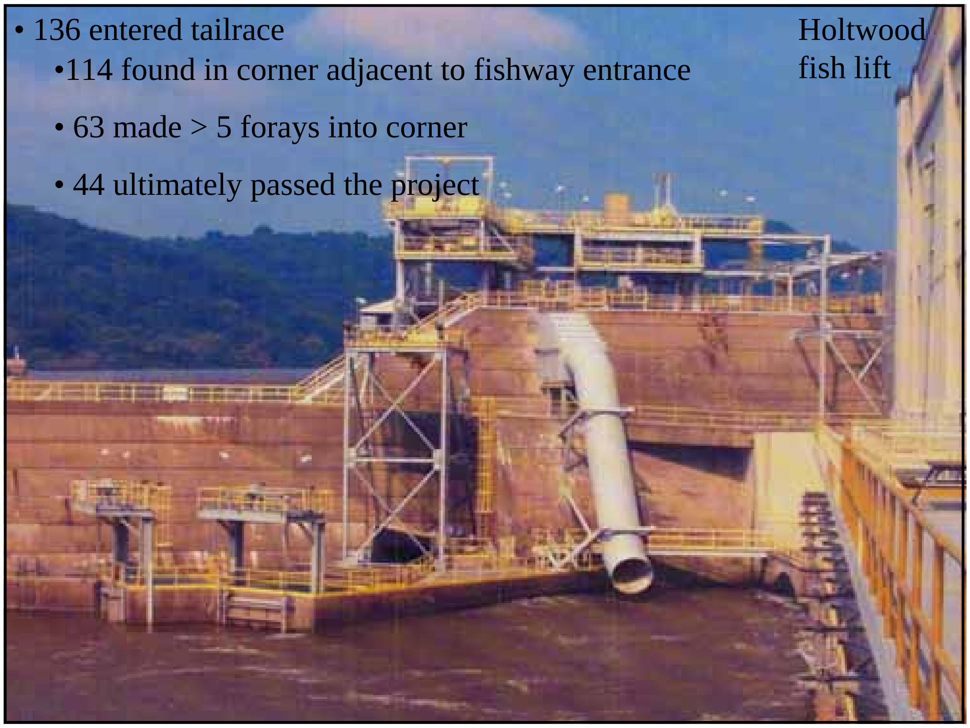
2. 15 fish approached fishway, 4 entered fishway

3. 4 fish entered fishway, only 1 passed



Holtwood Dam

Fish attracted to spillpool?



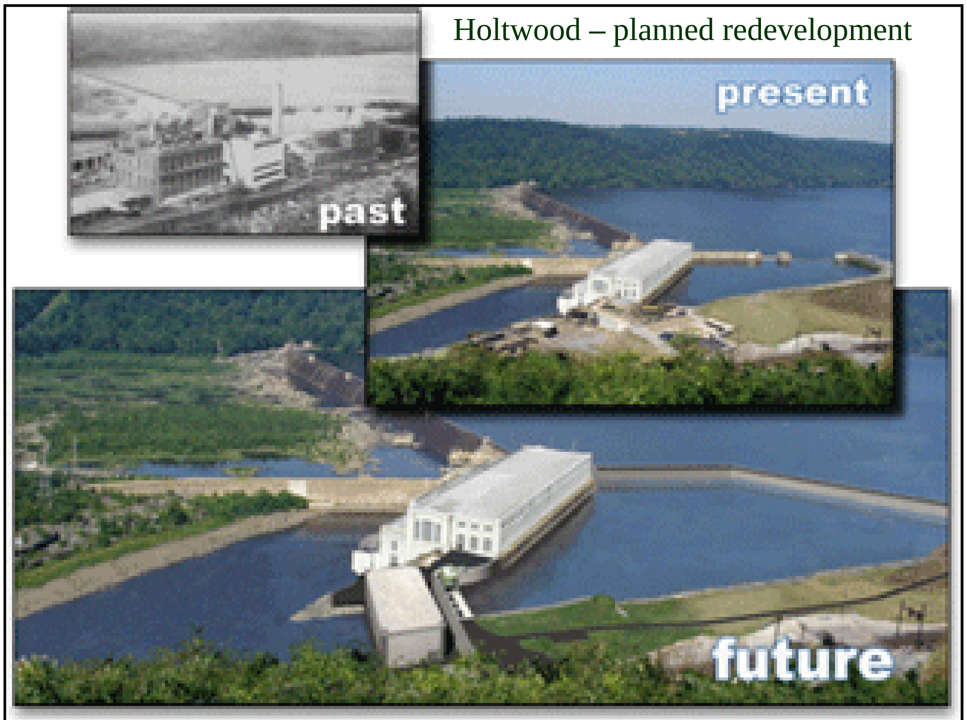
Holtwood
fish lift

- 136 entered tailrace
  - 114 found in corner adjacent to fishway entrance
  - 63 made > 5 forays into corner
  - 44 ultimately passed the project

Holtwood fish lift

- 86 fish entered fish lift, 46 (53%) passed

Holtwood – planned redevelopment



Holtwood Re-development

- ➢ Increase output from **107.2 MW** to **195.5 MW**
- ➢ Increase hydraulic capacity from **31,500 cfs** to **61,500 cfs**
- ➢ Reduce frequency of spill
- ➢ Tailrace excavation to improve unit efficiency and eliminate fish migration velocity barriers
- ➢ Re-route Unit 1 under the existing retaining wall to Piney Channel to improve fish passage
- ➢ Piney Channel excavation
- ➢ Fish lift modifications
- ➢ Eel ramp installation
- ➢ Improve recreational access
- ➢ Minimum stream flow/Conservation releases

Holtwood Re-development

Upstream American shad Passage Performance Measures

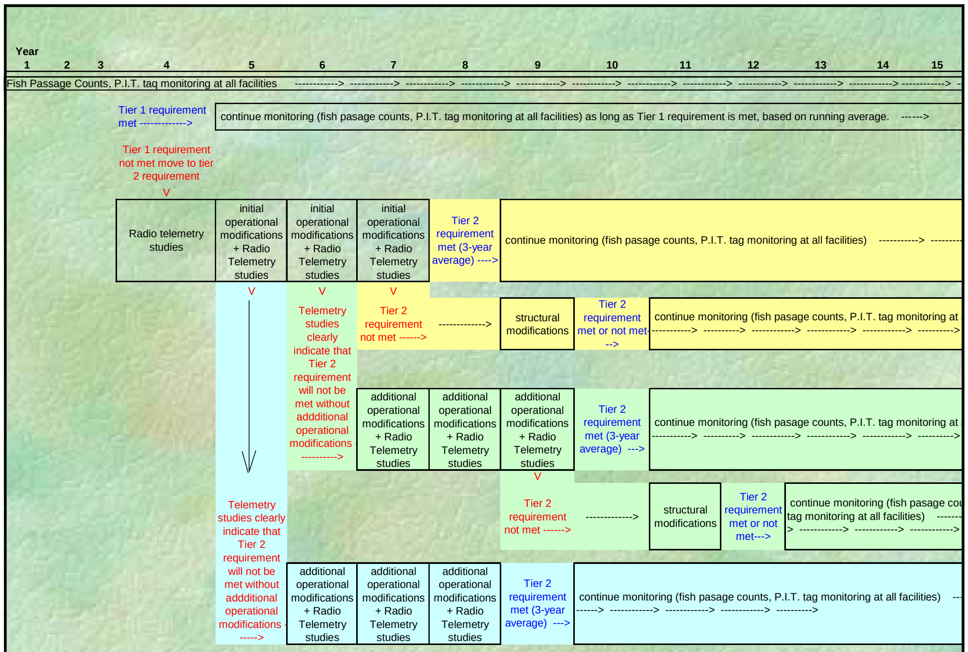
Tier I

- ➢ Holtwood must pass 75% of the shad that pass Conowingo
- ➢ Holtwood must pass 50% of those within 5d of passage at Conowingo, as measured by P.I.T. tagging

Tier II

- ➢ If Tier I goal is not met, Holtwood must pass 85% of the shad that enter project waters as measured by radio telemetry

---



Year
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

Fish Passage Counts, P.I.T. taq monitoring at all facilities ------------> ------------> ------------> ------------> ------------> ------------> ------------> ------------> ------------> ------------> ------------> ------------> -

Tier 1 requirement met -------------> continue monitoring (fish pasage counts, P.I.T. tag monitoring at all facilities) as long as Tier 1 requirement is met, based on running average. ------>

Tier 1 requirement not met move to tier 2 requirement
V

Radio telemetry studies | initial operational modifications + Radio Telemetry studies | initial operational modifications + Radio Telemetry studies | initial operational modifications + Radio Telemetry studies | Tier 2 requirement met (3-year average) ----> | continue monitoring (fish pasage counts, P.I.T. tag monitoring at all facilities) -----------> ---------

V Tier 2 requirement not met ------> -------------> | structural modifications | Tier 2 requirement met or not met---> | continue monitoring (fish pasage counts, P.I.T. tag monitoring at
-----------> ----------> ------------> ------------> ------------> ---------->

V Telemetry studies clearly indicate that Tier 2 requirement will not be met without addditional operational modifications ----------> | additional operational modifications + Radio Telemetry studies | additional operational modifications + Radio Telemetry studies | additional operational modifications + Radio Telemetry studies | Tier 2 requirement met (3-year average) ---> | continue monitoring (fish pasage counts, P.I.T. tag monitoring at
-----------> ----------> ------------> ------------> ------------> ---------->

V Tier 2 requirement not met ------> -------------> | structural modifications | Tier 2 requirement met or not met---> | continue monitoring (fish pasage co tag monitoring at all facilities) -------> ------------> ------------> ------------>

V Telemetry studies clearly indicate that Tier 2 requirement will not be met without addditional operational modifications -----> | additional operational modifications + Radio Telemetry studies | additional operational modifications + Radio Telemetry studies | additional operational modifications + Radio Telemetry studies | Tier 2 requirement met (3-year average) ---> | continue monitoring (fish pasage counts, P.I.T. tag monitoring at all facilities) ---------> ------------> ------------> ------------> ---------->

Holtwood Re-development

Upstream American eel Passage

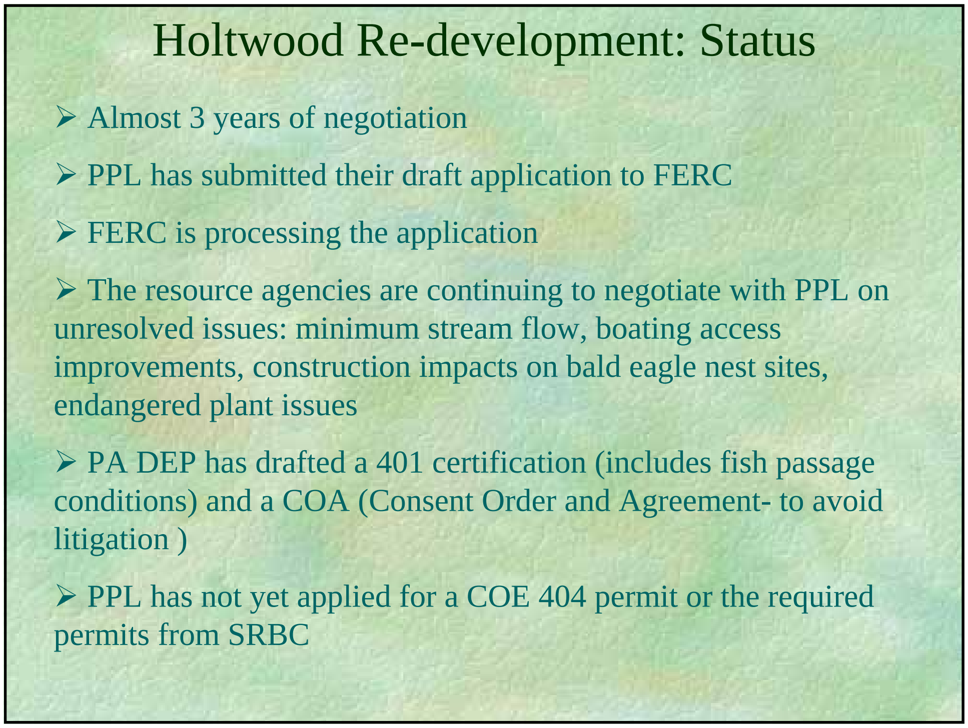
- Triggers: **1**. “The date on which upstream eel passage becomes operational at Conowingo Dam, or; **2**. The date on which eels begin being stocked into the Conowingo reservoir as part of an agency-approved stocking plan, or; **3**. The date on which the DEP, …determines … that eels are otherwise present below the Holtwood Hydroelectric Facility in numbers appropriate to require upstream eel passage.”
- “Study to determine where to site permanent eel passage fishway(s)”
- “Based on the results of the studies… PPL shall provide design plans and a schedule for installation of upstream eel passage fishway(s) to the resource agencies for review and approval.”
- “…a plan and schedule to monitor the effectiveness of upstream eel passage and to annually count and report the number of eels passing the Holtwood project…”

Holtwood Re-development

Downstream Passage Performance Measures

Downstream passage survival

- Adult American shad - **80%**
- Juvenile American shad - **95%**
- American eel – **85%**



Holtwood Re-development: Status

- Almost 3 years of negotiation
- PPL has submitted their draft application to FERC
- FERC is processing the application
- The resource agencies are continuing to negotiate with PPL on unresolved issues: minimum stream flow, boating access improvements, construction impacts on bald eagle nest sites, endangered plant issues
- PA DEP has drafted a 401 certification (includes fish passage conditions) and a COA (Consent Order and Agreement- to avoid litigation)
- PPL has not yet applied for a COE 404 permit or the required permits from SRBC

Fish Passage Restoration in The Santee Basin

Prescott Brownell, National Marine Fisheries Service
Habitat Conservation Division

ASMFC Workshop on Fish Passage Issues
Impacting Atlantic Coast States
April 3 & 4, 2008
Jacksonville, Florida

Overview

- Historical factors affecting diadromous fish in the Santee.
- Santee Basin Diadromous Fish Restoration Plan.
- Passage at Columbia Project.
- Santee Cooper Project relicensing and fish passage.
- Future passage opportunities in the Santee basin.

Santee Dam 1950’s

Fish Passage Begins

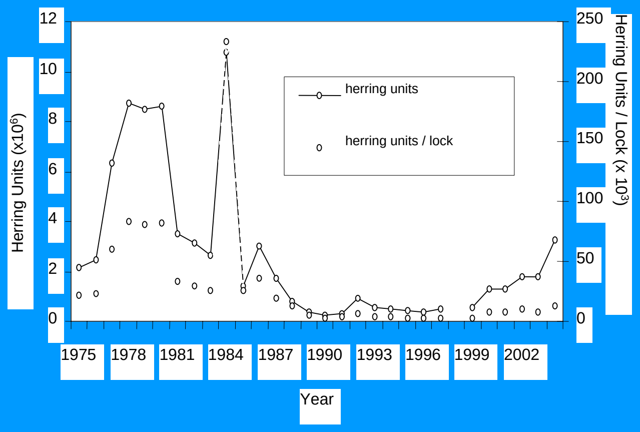
- (1950’s) Discovery of “landlocked” striped bass.
- Shad, herring runs relocate to Cooper.
- Beginning of herring passage at Pinopolis, as forage fish for stripers.
- Lock passage continued, large numbers of fish.
- 1980’s Discovery of “landlocked” shortnose sturgeon population.

Santee Diversion / re-diversion 1942 / 85

Cooper River Rediversion Project
St. Stephen Fish Lock

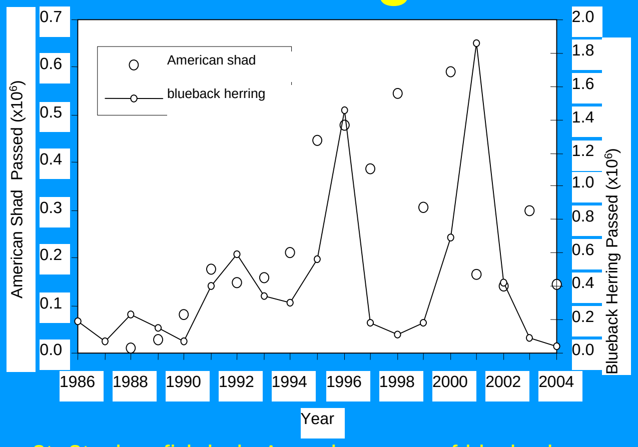
- Constructed by COE for Santee cooper PSA
- Operational since 1987
- Not included in FERC license

Pinopolis Lock Passage



Pinopolis Lock annual fish passage count and average count per lock operation.

St. Stephen Fish Lock Passage

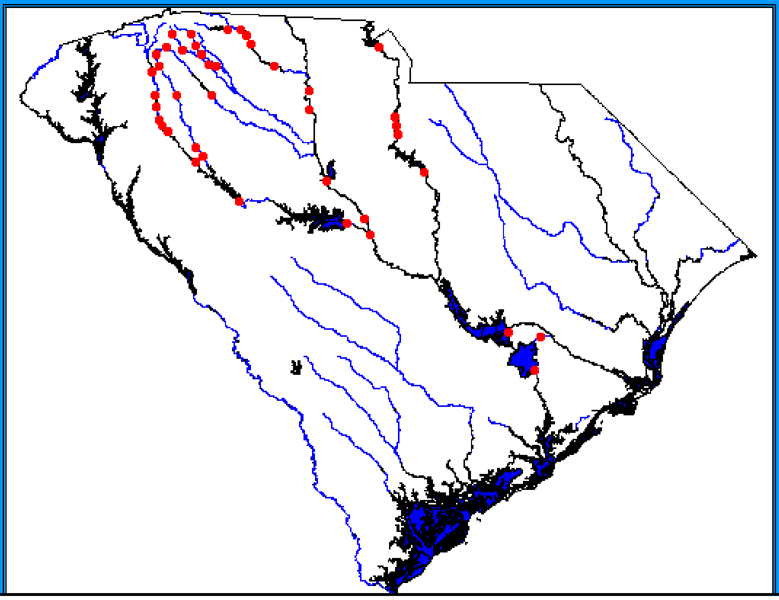


St. Stephen fish lock. Annual passage of blueback herring and American shad. Note: scales are different.

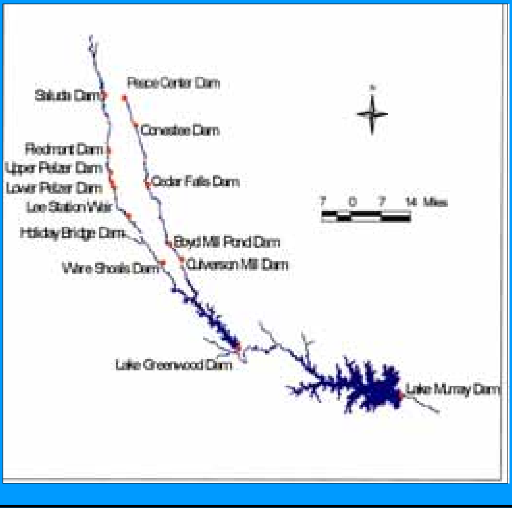
Santee Basin Diadromous Fish Passage Restoration Plan

- Impetus: upcoming FERC relicensings.
- DNR, USFWS, NMFS drafted the plan 1997-2000.
- Basinwide goals, objectives, approaches to fish passage.
- Filed at FERC as section 10(a) comprehensive plan 2001.

Santee-cooper Basin Plan Location of Dams

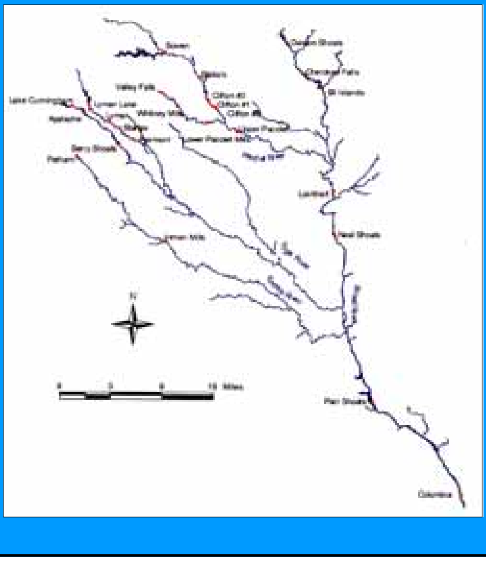


Saluda Sub-basin



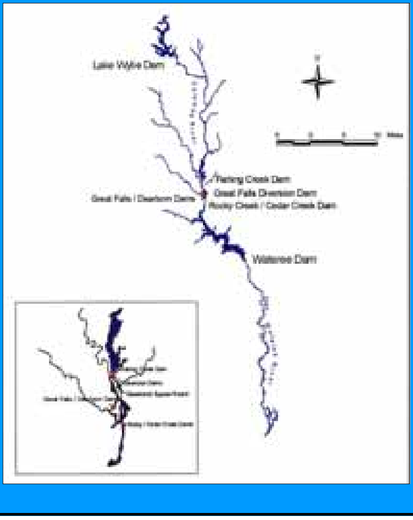
- 220 mi of river
- 13 dams
- 63,000 acres of habitat
- Lake Murray dam
  - 212 feet high
  - Cold water
  - Pressure

Broad River Sub-basin



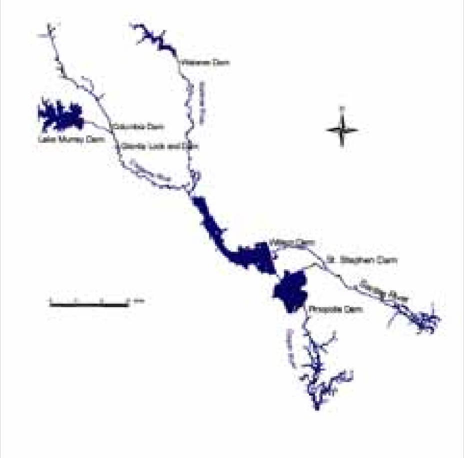
- Most promising
- Columbia dam (14 ft)
- 24 mi to Parr shoals
- 14,000 acres quality habitat
- Passage reservation on Neil shoals and Lockhart dams

Wateree-Catawba Sub-basin



- 92 mi of river
- 14,500 acres of habitat
- Number of dams complicate passage
- Considerable habitat that could be gained

Lower Santee Basin



- Gateway dams
- 147,000 acres
- Keystone area
- Columbia dam
- Granby dam

Columbia Canal Project

- First section 18 in southeast, 2001.
- Santee river basin plan provided key support, coordinated fed & state goals.
- State-federal agencies solidly maintained goals and objectives during process.
- Operational 2006, for shad, herring, features for shortnose sturgeon.

Santee Cooper Project FERC Relicensing

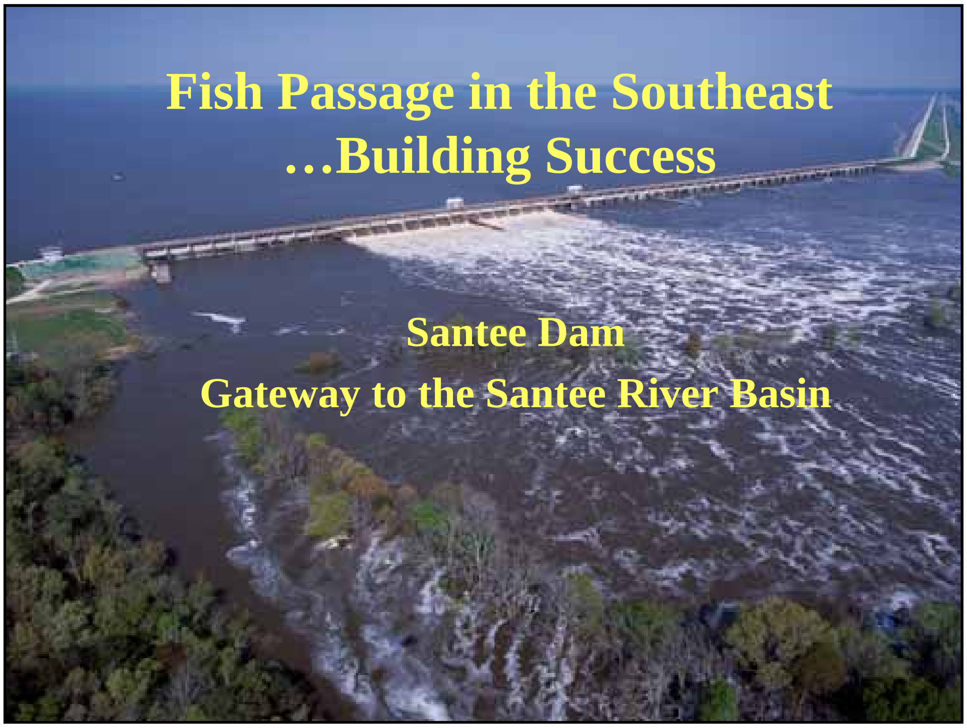
- Santee basin plan provided unified agency goals and objectives, supporting passage prescription, instream flow restoration.
- Passage prescribed for shad, herring, eels, shortnose and Atlantic sturgeon.
- Prescription includes new passage at Santee dam, improved passage at Pinopolis.
- EPAct hearing and settlement supported fish passage at the Santee Cooper Project.
- New license pending Formal ESA consultation, 401 Certification.

Santee Cooper Project Pinopolis Lock Passage

- Voluntary lock passage since 1950, for herring.
- Other species incidental.
- Section 18 fishway prescription issued 2006, includes passage at Pinopolis.

Santee Basin "Accord"

- Potential state-federal agreement with upper basin power companies undergoing relicensing proceedings.
- Duke Power Co., Catawba Wateree project.
- SC Electric & Gas Co., Saluda project.
- Deferral of fish passage in exchange for funding diadromous fishery enhancement & monitoring programs.
- Negotiations in progress.



Fish Passage in the Southeast
…Building Success

Santee Dam

Gateway to the Santee River Basin

NOAA’s Fish Passage Activities In the Northeast

John G. Catena NOAA Restoration Center
Gloucester, MA

NOAA’s Open Rivers Program

- On-the-ground barrier removal program
    - dam removals, culvert replacements
- Ecological and socio-economic benefits
- National and regional competitive grants processes
- Funding AND technical expertise
- Leverage through collaboration stewardship and greater local awareness

NOAA's Community-based Restoration Program

- Habitat Restoration technical assistance and grants program
  - Focus on tidal wetlands, diadromous fish and shoreline restoration actions
  - Creates partnerships with local constituencies
- National and regional competitive grants processes
- Fosters community support through hands-on citizen involvement in restoration projects
- Leverages technical expertise and funds
- Instills stewardship and conservation values

National and Regional Partnerships

The Nature Conservancy
Saving the Last Great Places

FishAmerica Foundation

Restore America's Estuaries
working together... Saving Our Coastal Heritage

American Rivers
Restore. Protect. Enjoy.

Gulf of Maine Council on the Marine Environment

National Fish and Wildlife Foundation

CONNECTICUT RIVER
WATERSHED COUNCIL, INC.

TROUT UNLIMITED

Damage Assessment, Remediation, and Restoration Program

- Authority to claim damages for injuries to natural resources from oil spills and hazardous waste discharges

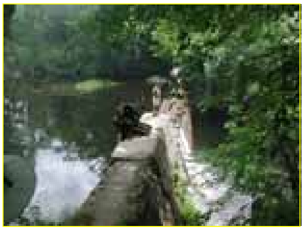
- OPA and CERCLA

- Use funds to restore injured resources

- “Trustees” – NOAA, USF&WS, and State agencies – joint decision-making

NOAA Restoration Center
Northeast Fish Passage Experience

- ➢Dam structure – average 8 ft height, most <18-ft height, <200-ft length
- ➢ Run-of-the river dams (non-hydroelectric facilities)
- ➢Impoundments – most less than 50 ac-ft, average depth <5 ft



Sennebec Lake Dam, ME

Saw Mill Dam, Acushnet River, MA

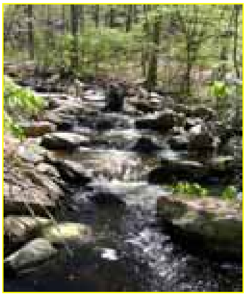
Dam Removals

- ➢Full or Partial Removals

Sandy River Dam
Removal
Madison, ME

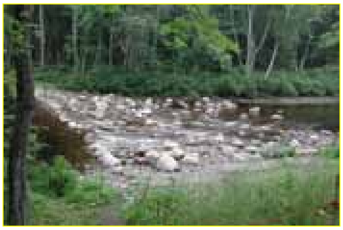
Nature-like Fishways

Saw Mill Dam Step-Pool Fishway, MA



Guilford Lakes Bypass, CT

Heishman's Bypass, PA



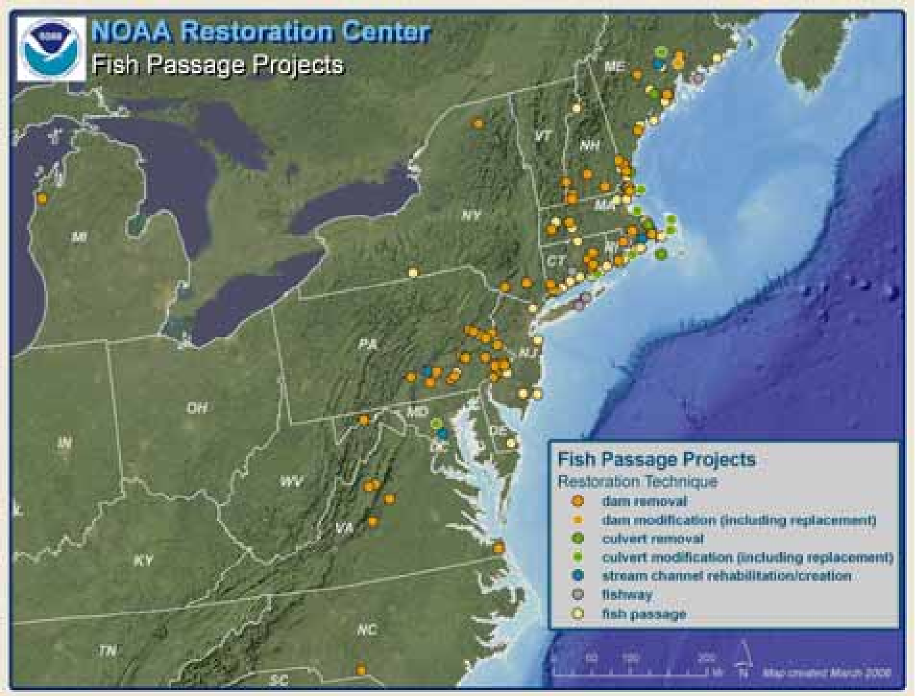
Sennebec Rock Ramp, ME

Structural Fishways

Kickemuit Denil Fishway, RI

Jordan Brook Steep Pass, CT

Indian Lake Pool-and-Weir Fishway, RI



NOAA’s Role

- Project identification and conceptual development
- Project management
- Partnership development
- Funding
- Technical assistance
- Monitoring
- Permitology

Penobscot River Restoration Project

Sawmill Dam, Acushnet, MA – Nature-like fishway

- 5-ft high dam;
  - wetland and water use issues associated with impoundment;
  - Step pool
- Construction Completed Fall 07
- NBH Settlement funds

Scotchman’s Creek Restoration, Cecil County, MD

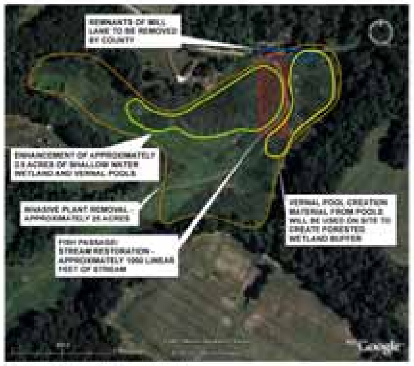
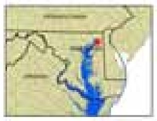


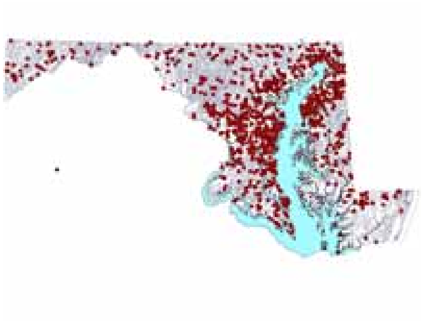
FIGURE 6. SCOTCHMAN CREEK RESTORATION PLAN - CONCEPTUAL LEVEL

- Stream Channel restoration
- Wetland/riparian habitat restoration
- Development of grade control for fish passage
- Beginning design stage
- Funding from Spectron NRD settlement



Maryland Fish Blockage Prioritization Effort

- 2,500 manmade blockages still exist in the watershed
- Federal, state and non-profits working together to prioritize fish blockage removals
- Ecological, cultural and cost criteria developed by working group to rank projects within Maryland – ultimate goal is for entire Chesapeake Bay region
- Priority status will be given to:
  - Projects which open larger stretches of high quality habitats;
  - Dam removals over fish passage construction, where practical;
  - Anadromous and/or Rare, Threatened or Endangered (RTE) species found below the blockage and suitable habitat upstream of the blockage

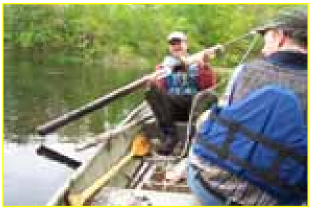


Fish Passage Project Issues and Constraints

- ➢Engineering and Technical
- ➢ Financial and human resource
- ➢ Social

Engineering and Technical Issues

- Dam structure and safety
- Sediment contamination
- Hydrology and hydraulics for fish passage
- Assessment of passage alternatives
- Erosion and sedimentation
- Wetland impacts
- Invasive species introductions
- Impacts to rare, threatened or endangered species
- Regulatory hurdles
- Post-removal restoration options



Financial and Human Resource Issues

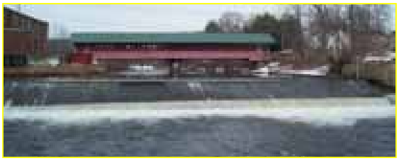
- Need for non-Federal sources of match

- Technical expertise in Federal and state agencies and NGOs

- Project Management – who's going to manage the project?

Potential Project Social Issues

- Cultural resources (historic, archaeological)
- Recreation – boating, fishing, swimming
  - Re-introduction of anadromous fish to locally important fishing areas
- Water supply – fire protection, agriculture, drinking water
- Existing infrastructure (sewer, water utilities, bridges)
- Misperceived changes in river flow and flood protection
- Aesthetic and sentimental values



Homestead Dam and Thompson Covered Bridge, NH

Homestead Dam, NH, circa 1860

RESTORATION CENTER

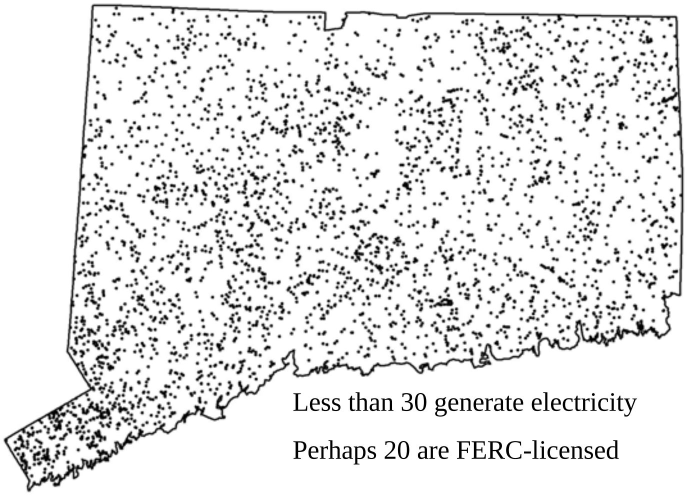
http://www.nmfs.noaa.gov/habitat/restoration/

A STATE PERSPECTIVE ON NON-HYDROPOWER DAMS

Stephen Gephard
CTDEP/Inland Fisheries Division
Old Lyme, CT

CONNECTICUT DEPARTMENT OF ENVIRONMENTAL PROTECTION

There are an estimated 7,000 dams in Connecticut



Less than 30 generate electricity

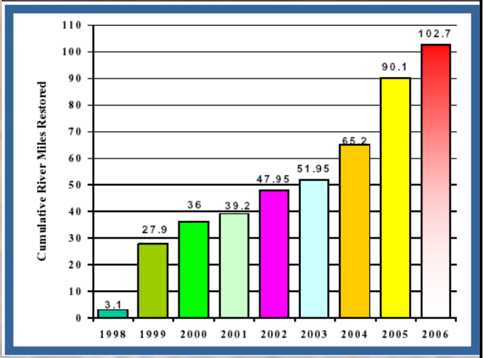
Perhaps 20 are FERC-licensed

If we only addressed hydro dams, fish restoration wouldn't progress far!

States often achieve fish passage at non-hydro dams through one of three avenues:

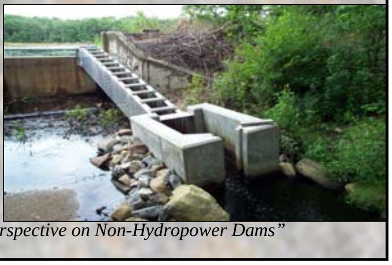
- Regulation
- Mitigation
- Voluntary projects

River Miles Re-connected for Diadromous Fish in Connecticut



Regulation

- **Fisheries regulations**- most states in the Northeast have ‘fishway’ regulations dating back to the 1700s or 1800s. Few enforce them.
- **Dam Safety regulations**- most states have regulations allowing agencies to mandate dam repairs to protect public health & safety. Some can order removal. Connecticut allows the Department to attach the construction of a fishway as a condition to a dam repair permit.



The Beaver Swamp Fishway in East Lyme, CT was a permit condition for repairing the dam.

The Inland Fisheries Division determines the need for fish passage and passes along its advice to the Dam Safety Unit.

When the City of Meriden, CT needed to repair the Hanover Pond Dam, the permit included the provision for a Denil fishway to pass American shad.

Even the DEP lives by its own regulations. When the State repaired the State-owned Bunnells Pond Dam in Bridgeport, the Inland Fisheries Division requested a steeppass fishway to pass alewives upstream.

Regulation (cont.)

- **Coastal Zone Management regulations-** many states have regulations controlling the development within the coastal zone. Connecticut allows the Department to attach the construction of a fishway as a condition to a coastal zone permits.

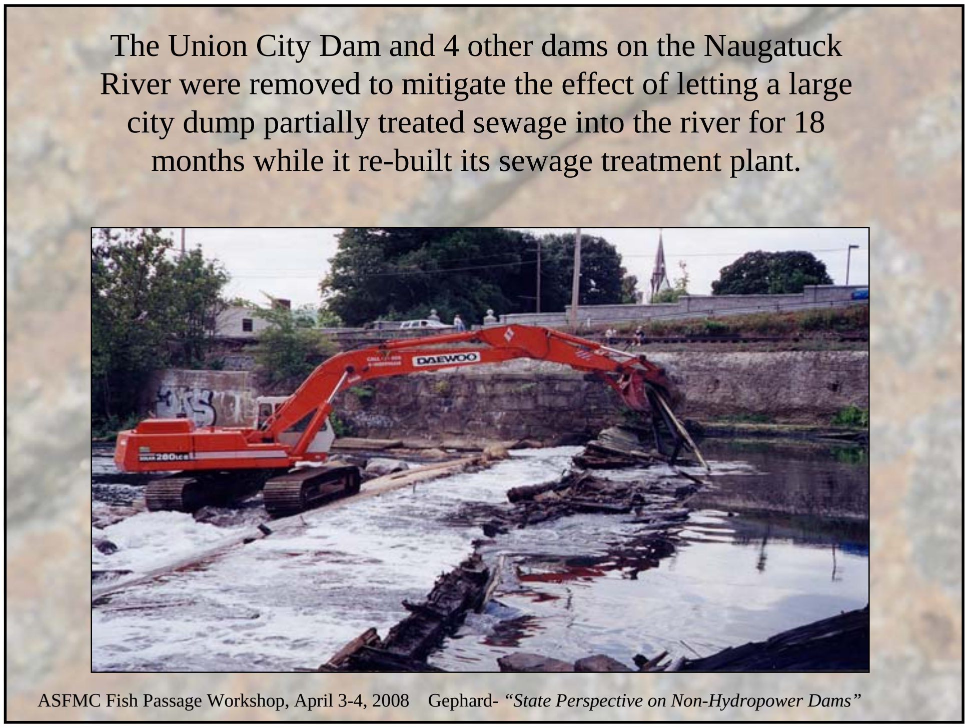
A Town was permitted to repair this tidegate but only if they included a steeppass fishway in the structure.

Mitigation

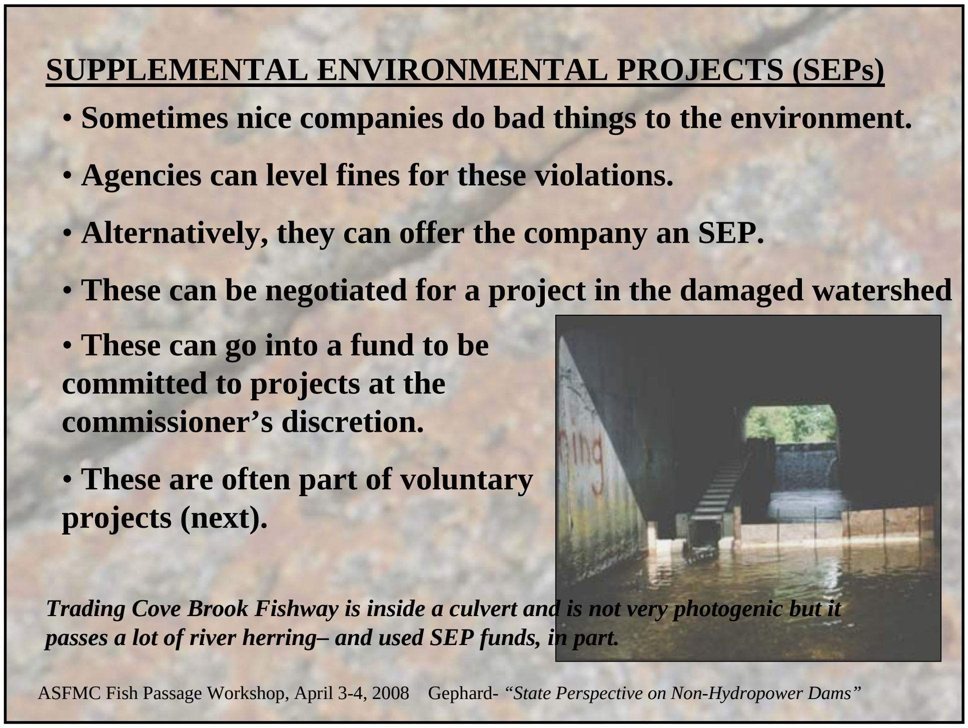
- Events occur that damage aquatic resources. Even when they don't involve an existing dam, getting migratory fish around that dam may be suitable mitigation for the deleterious event. States are ready with suitable fish passage projects when opportunities arise.

The Jordan Millpond fishway was funded with money from a settlement with the EPA involving an oil spill off the coast of Connecticut.

This fishway was funded by a mill that diverted water from the watershed to a sewage treatment plan outside the basin. The diversion degraded the river habitat and the fishway was constructed to help mitigate the impact.



The Union City Dam and 4 other dams on the Naugatuck River were removed to mitigate the effect of letting a large city dump partially treated sewage into the river for 18 months while it re-built its sewage treatment plant.



SUPPLEMENTAL ENVIRONMENTAL PROJECTS (SEPs)

- **Sometimes nice companies do bad things to the environment.**
- **Agencies can level fines for these violations.**
- **Alternatively, they can offer the company an SEP.**
- **These can be negotiated for a project in the damaged watershed**
- **These can go into a fund to be committed to projects at the commissioner's discretion.**
- **These are often part of voluntary projects (next).**

Trading Cove Brook Fishway is inside a culvert and is not very photogenic but it passes a lot of river herring– and used SEP funds, in part.

Voluntary projects

- perhaps the most common type of fish passage projects in Connecticut and many other Northeast states.
- communities WANT fish passage at their dams.
- NGOs realize that fish passage projects are consistent with their mission and help them promote river and watershed conservation.
- there are funds available to pay for these projects
- can preempt messy, controversial, enforcement actions.

Voluntary projects, (cont.)

- typically initiated by State fishery agency
- typically no line item in agency for fish passage projects (exceptions= MA Marine Fisheries with small coastal river herring fishways & PA FBC with dam removals.)
- technical guidance and support by agency is critical: confirm the benefit of the project
- broad partnerships among parties with resources to offer is critical
- local sponsor helps public acceptance

The Branford Water Supply Ponds Fishway in Connecticut was sponsored by the Branford Land Trust and had multiple partners. It won a national Partnership Award from Coastal America in 2006.

Voluntary projects, (cont.)

Who sponsors projects?

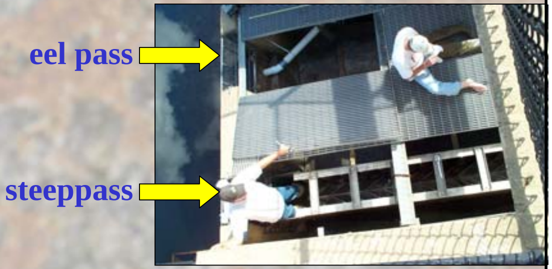
- municipalities
- land trusts
- watershed organizations
- fishing groups (e.g. TU)
- conservation groups
- homeowner associations

NGOs with professional staff are good candidates to help local sponsor manage projects, e.g. American Rivers, TNC, Save the Sound.

Voluntary projects, (cont.)

A typical project includes these steps:

1. **Feasibility/exploration**
2. **Developing a team, assigning roles**
3. **Applying for grants**
4. **Designing the project**
5. **Applying for more grants**
6. **Bidding the construction**
7. **Building the project**
8. **Operation & Maintenance**



Voluntary projects, (cont.)

Available funds:

- **NOAA Direct Solicitation**
- **NOAA Open Rivers Initiative**
- **NOAA Partnership programs**
  - **American Rivers**
  - **The Nature Conservation**
  - **Restore American Estuaries**
  - **local, e.g. in CT: Save the Sound**
  - **FishAmerica Foundation**
- **National Fish & Wildlife Foundation**
- **NRCS- WHIP program**
- **USFWS- Partners Fish & Wildlife**
  Nat'l Fish Habitat Initiative

Non-federal matches:

- **State Wildlife Grants**
- **State habitat grants, e.g. in CT- Long Island Sound License Plate grants**
- **319 grants** • **S.E.P.s**
- **Trout Unlimited: Embrace-a-Stream**
- **Corporate Wetland Restoration Partnership**

Random Thoughts:

1. **Technical support is critical. Building a fishway that doesn't work hurts your program and everyone else.**
2. **Once the fishway is built, it needs to be operated and maintained properly– technical support for NGOs is still needed.**
3. **Regional partnerships can be important: Connecticut River Atlantic Salmon Commission, Chesapeake Bay Foundation, Gulf of Maine Council, Save our Bay, Save the Sound– Atlantic States Marine Fisheries Commission???**

Funds from four different sources were used to built the Mary Steube Fishway in Old Lyme, a project of the local land trust to restore a run of alewives.

Closing Thoughts

- Each agency is different but ultimately, specialized staff trained in fish passage technology will probably be the best approach to move forward a State’s effort to implement fish passage statewide.
- Cooperation is needed between marine and inland fishery agencies.
- Cooperation is needed between dam safety and fishery agencies.
- Broad-based partnership (gov’t-private-NGOs) are important.
- Cooperation & collaboration are needed between States and feds.
- We need more government engineers!!! More USFWS! NOAA?
- Limiting factor will soon be non-federal match. This needs attention if voluntary projects are going to continue to be built.

American Rivers
Thriving By Nature

Fish Passage and River Restoration at Non-Hydropower Dams

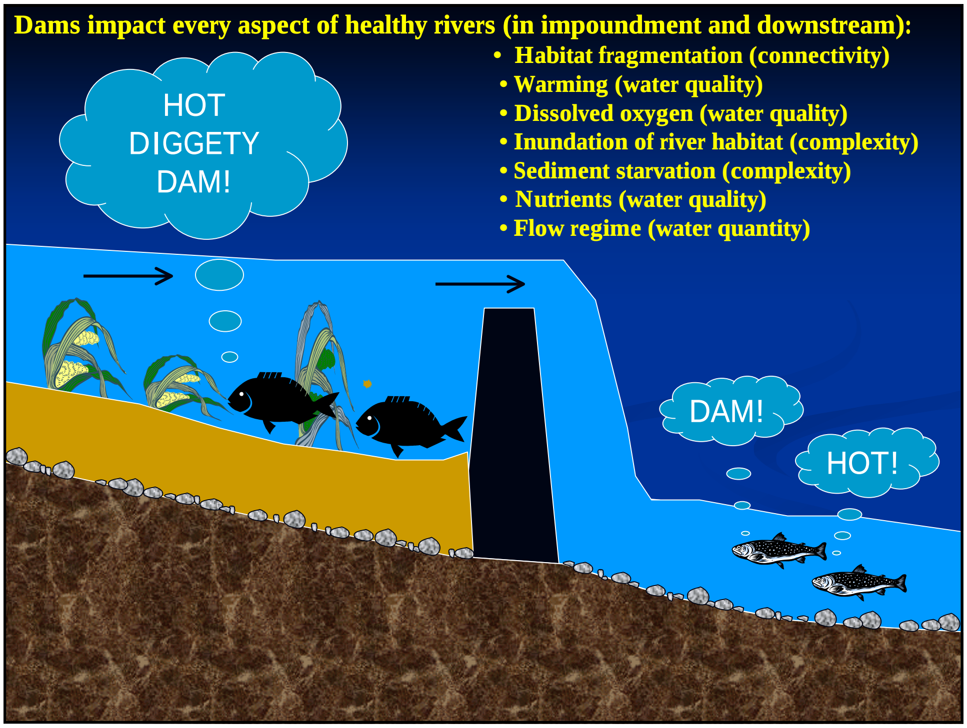
Brian Graber
American Rivers

American Rivers
Thriving By Nature

The Restoring Rivers Initiative of American Rivers specializes in selective dam removal as a reasonable, beneficial and cost-effective option for restoring rivers and eliminating public safety hazards.

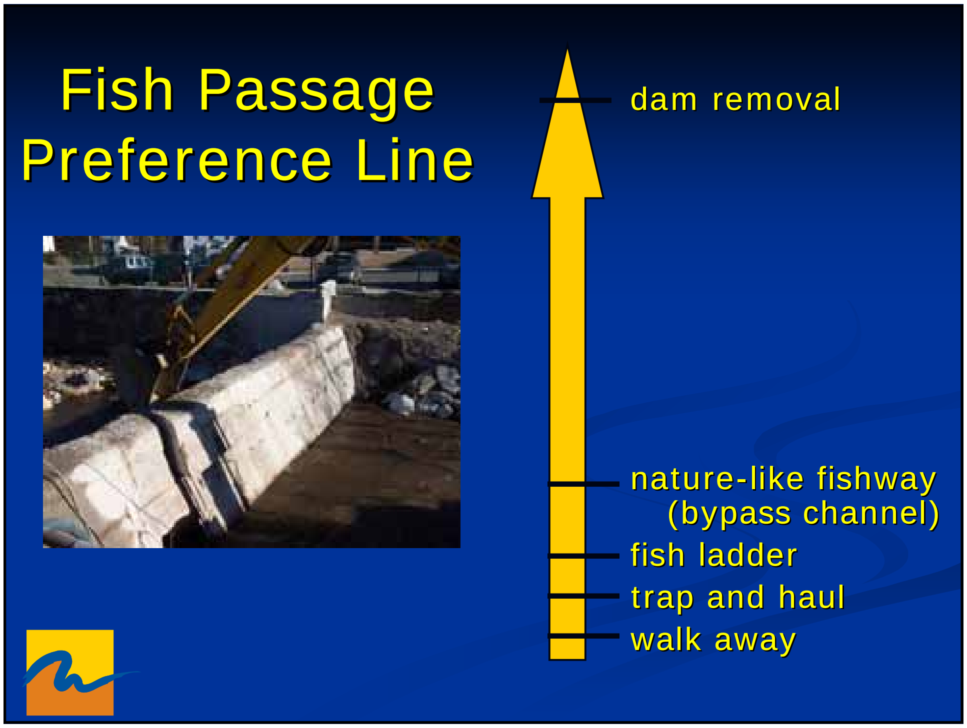
On the east coast, we have offices in:

- Northampton, MA
- Albany, NY
- Glastonbury, CT
- Harrisburg, PA
- Washington, DC
- Columbia, SC



Dams impact every aspect of healthy rivers (in impoundment and downstream):

- **Habitat fragmentation (connectivity)**
- **Warming (water quality)**
- **Dissolved oxygen (water quality)**
- **Inundation of river habitat (complexity)**
- **Sediment starvation (complexity)**
- **Nutrients (water quality)**
- **Flow regime (water quantity)**



Fish Passage Preference Line

Relative Benefits of Dam Removal

Structural Fish Passage	Dam Removal
Lower passage efficiency	Greatest passage efficiency
Fewer species and life stages	Multiple species and life stages
Requires regular maintenance	Maintenance-free
Will require future repair at some point	One-time cost for long-term solution
Habitat dependent on human action	Self-sustaining habitat

Inconsistent Maintenance and Future Repairs

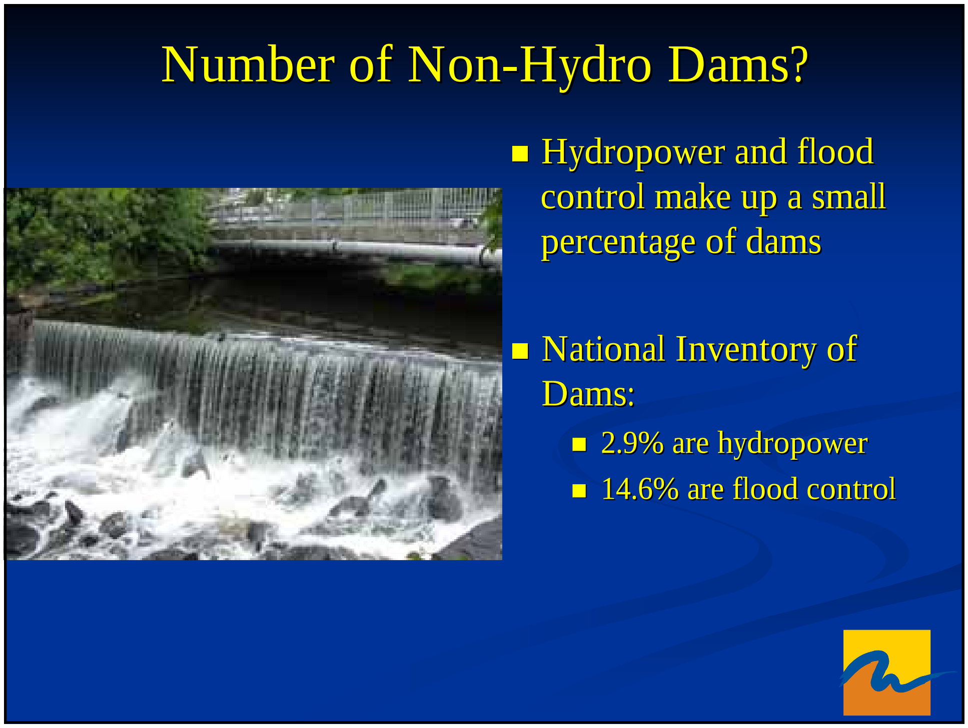
"Sometimes it's a matter of switching a 6-inch board for a 4-inch board and then suddenly seeing herring burst through. Then you think: I haven't been out here for several days. Have they been backed up and waiting that long?

Do you know how much maintenance the town has had to do at the Billington Dam removal site? Zero."

-David Gould, Environmental Manager, Town of Plymouth, MA

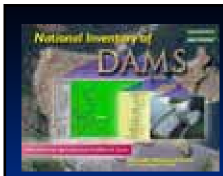
Structural Approaches Can Fail

- Design floods are exceeded
- Design uncertainty
  - Untested design techniques
  - Poor design
- Rivers are dynamic, even volatile



Number of Non-Hydro Dams?

- Hydropower and flood control make up a small percentage of dams
- National Inventory of Dams:
  - 2.9% are hydropower
  - 14.6% are flood control



National Inventory of Dams

- **78,747 Dams** >25 ft w/ 15ac-ft capacity or >6ft w/ 50ac-ft capacity

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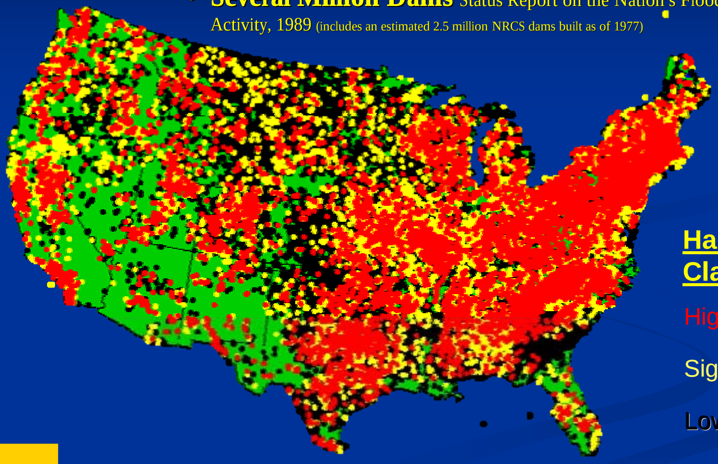
- **~99,000 Dams** regulated by states & in the USFWS Barrier Database
- **Several Million Dams** Status Report on the Nation's Floodplain Management Activity, 1989 (includes an estimated 2.5 million NRCS dams built as of 1977)



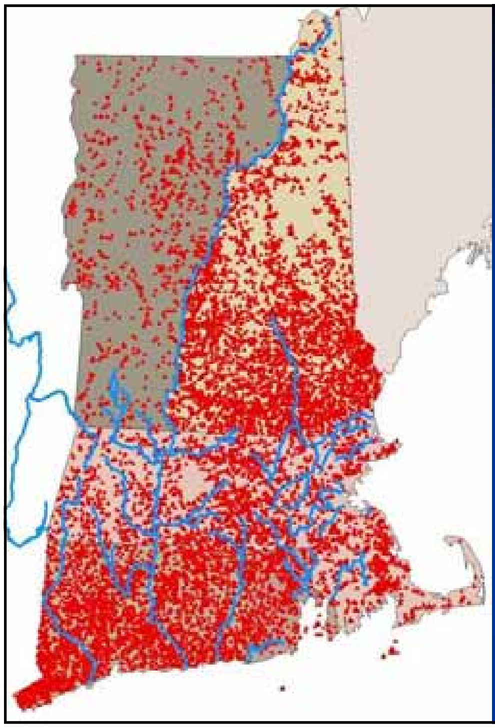
Hazard Classifications

High Hazard

Significant Hazard

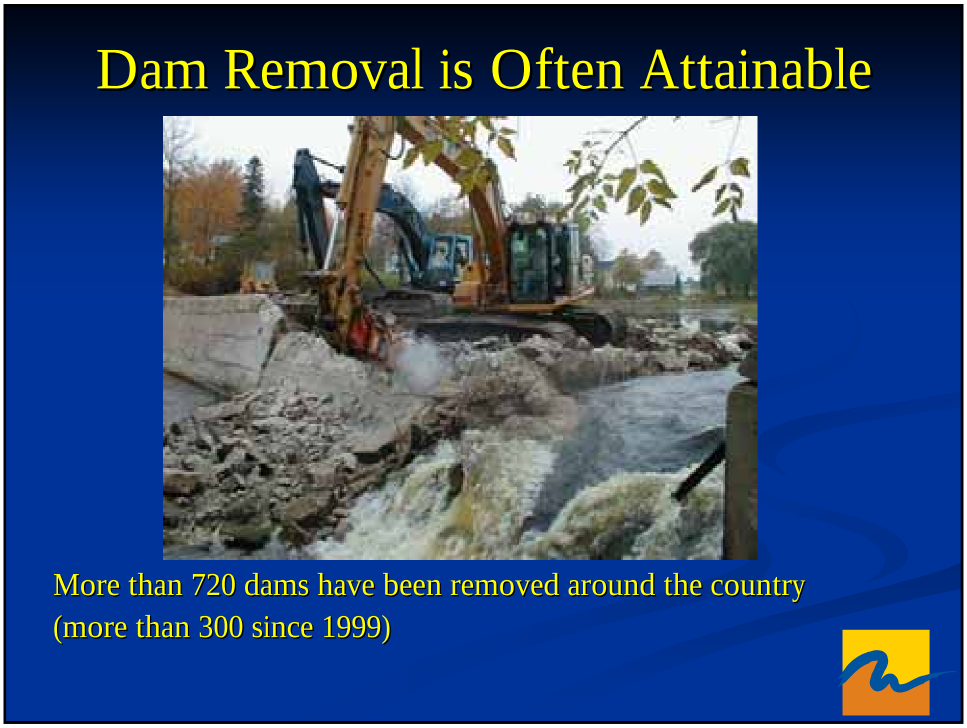
Low Hazard

Slide source: modified from Michael Grounds ASDOS 2006 presentation on Dams Safety Performance Measures and NID



13,126 Dams in CT, RI, MA, VT, NH (databases)

Land Area
CT,RI,MA,VT,NH = 31,900 sq.mi.
MI = 56,804 sq.mi.



Dam Removal is Often Attainable

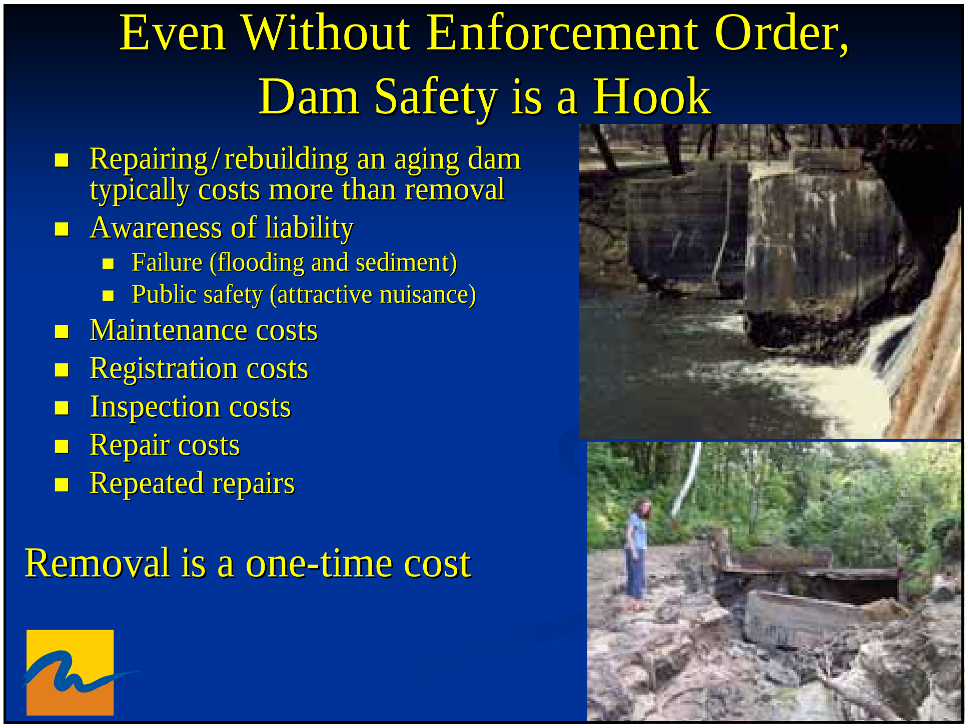
More than 720 dams have been removed around the country (more than 300 since 1999)

Dam Removal Initial Reconnaissance

- * Dam owner must be on-board or mandated *
- Preliminary Assessment:
  1) Threatened and endangered species
  2) Contaminants
  3) Infrastructure
  4) Replacing dam uses
  5) Land ownership around impoundment
  6) Public interest
  7) Potential funding “hooks”

Regulatory Hooks for Non-Hydro Dam Removal

- Fish passage laws
  - seldom enforced or dams are grandfathered
- Dam safety – most common regulatory hook
  - Repair or remove



Even Without Enforcement Order, Dam Safety is a Hook

- Repairing/rebuilding an aging dam typically costs more than removal
- Awareness of liability
  - Failure (flooding and sediment)
  - Public safety (attractive nuisance)
- Maintenance costs
- Registration costs
- Inspection costs
- Repair costs
- Repeated repairs

Removal is a one-time cost

Long-Term Costs

Many owners find dam ownership a financial burden

Grant Funding for River Restoration

- Few grants available for repair
- Many federal, state, and private grants are available for river restoration
- May be most significant determining factor in dam removal economic equation

Some Funding Sources

- NOAA – several grant programs including partnership with American Rivers
- USFWS – several grant programs
- NRCS – WHIP and other grant programs
- Army Corps of Engineers (ACOE) – Section 206 Restoration Program (for big projects)
- Corporate Wetlands Restoration Partnership
- State Funds – match and fund early project stages
    - MA restoration program built around the idea that of funding early project stages – leverages 3 dollars for every 1 the state contributes
- Dam owner
- Private foundations
- Many partners also provide service assistance

Recent Massachusetts* Project Costs

Total cost of removal:

Billington Street Dam, Plymouth (2002): (8-foot dam, included $135,000 for contaminant management)	$275,000
Silk Mill Dam, Becket (2003): (15-foot dam, included infrastructure challenges)	$210,000
Upper Cooks Canyon Dam (2006): (9.5-foot dam, no sediment or infrastructure challenges, in-kind permitting and oversight)	$45,000
Robbins Dam, Wareham (2006): (6-foot dam, no sediment or infrastructure challenges, in-kind permitting and design, donated construction)	$41,000
Ballou Dam, Becket (2006): (10-foot dam, includes significant clean sediment management and infrastructure challenges, includes $62,000 to replace water supply)	$355,000

*Massachusetts costs have been high-end relative to other states due to regulatory process and greater percentage of work done by consultants rather than in-house

Shawsheen River Example: Just Ask

- 3 dams on major tributary to Merrimack River
- Middle dam owner had hydropower evaluation
  - Found to be uneconomical
- Simply asked upstream and downstream dam owners
  - Downstream interested loosely due to environmental reasons
  - Upstream interested because of maintenance/repair costs
- Now working toward three dam removals to open entire river system
- Awareness of dam safety was essential

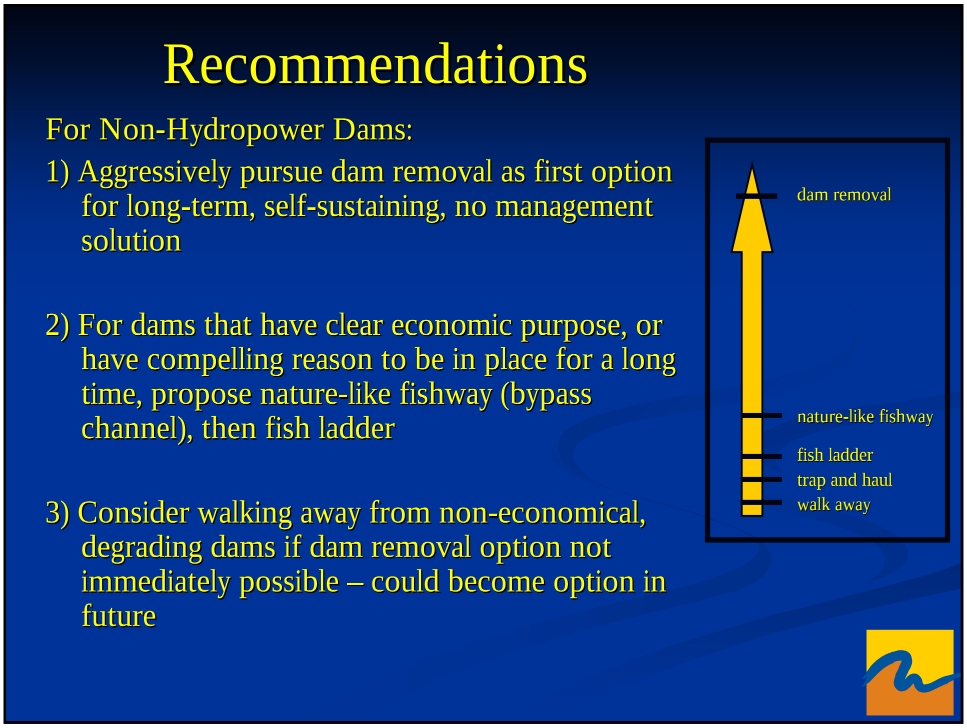
Pennsylvania State Program Example

- Pennsylvania removing 25 to 35 dams per year
- Other northeast states remove 0 to 3 per year
- What works in PA?
  1) State level leadership: PA Fish & Boat Commission
  2) Effective Dam Safety: Dam owners aware of liability/cost
  3) State funding for dam removal: Growing Greener Program
  4) Regulators actively engaged and involved early
  5) Project managers at state and non-profit level
  6) Momentum

Ward Dam removal, Prairie River, WI

Dam Removal Project Challenges

- Community/stakeholder involvement
  - Contentiousness is unpredictable
- Historic issues
- Large, upfront effort; but is one-time expense
- Timeframe: 3-year process
  - Year 1: reconnaissance and feasibility
  - Year 2: design and permitting
  - Year 3: implementation



Recommendations

For Non-Hydropower Dams:

1) Aggressively pursue dam removal as first option for long-term, self-sustaining, no management solution

2) For dams that have clear economic purpose, or have compelling reason to be in place for a long time, propose nature-like fishway (bypass channel), then fish ladder

3) Consider walking away from non-economical, degrading dams if dam removal option not immediately possible – could become option in future

"There's not one thing any of us in resource management can do that will restore fish and aquatic habitat faster than removing a dam."

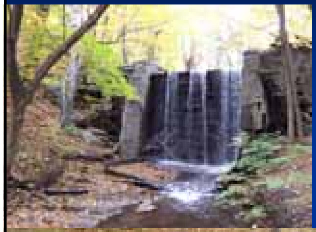
John Nelson, WI Fisheries Biologist

For more information:
Brian Graber, bgraber@americanrivers.org

Dam Removal Clearinghouse:
http://www.lib.berkeley.edu/WRCA/damremoval/index.html

American Rivers
Thriving By Nature

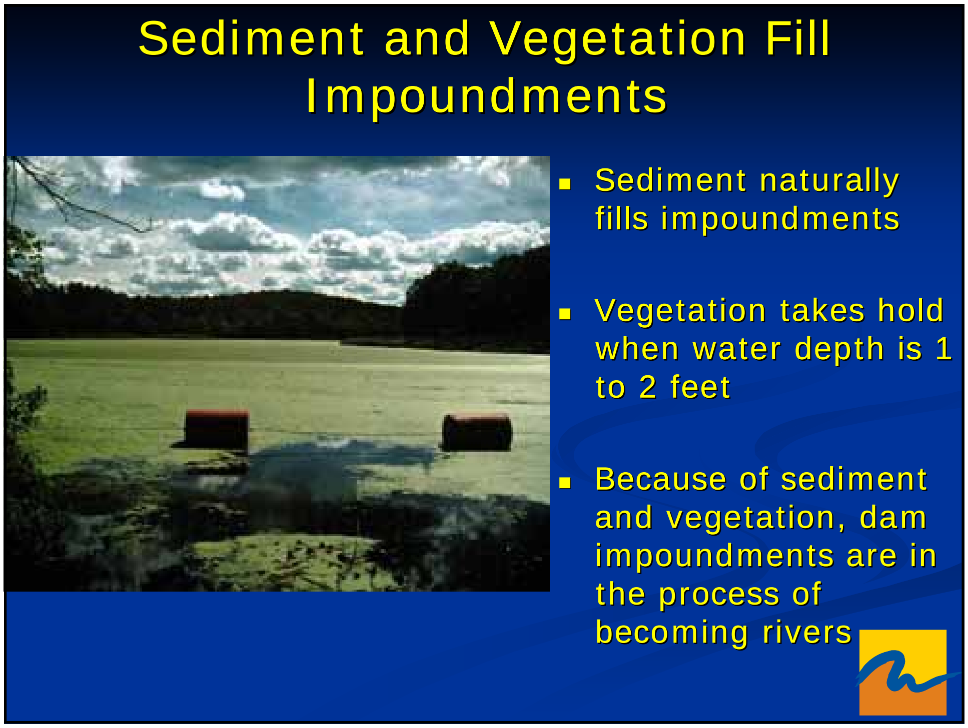
Dam Impoundments Have a Finite Life



Dam impoundments do not function like natural lakes:

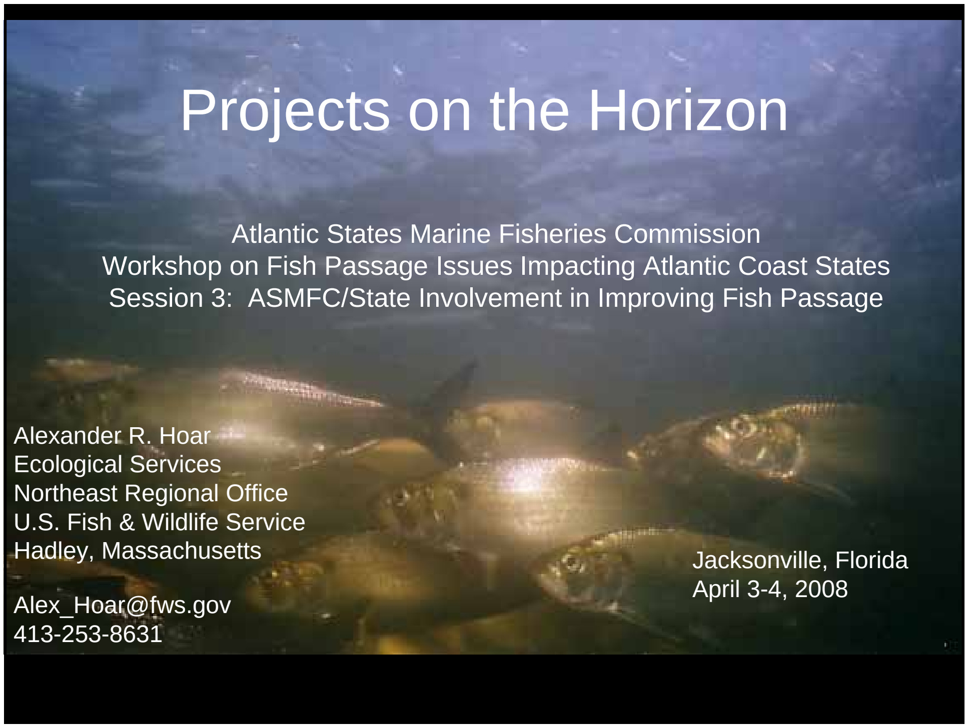
- Lakes are deep holes
- Dam impoundments are shallow by nature

- Dams trap up to 95 % of the sediment that enters from upstream



Sediment and Vegetation Fill Impoundments

- Sediment naturally fills impoundments
- Vegetation takes hold when water depth is 1 to 2 feet
- Because of sediment and vegetation, dam impoundments are in the process of becoming rivers



Projects on the Horizon

Atlantic States Marine Fisheries Commission
Workshop on Fish Passage Issues Impacting Atlantic Coast States
Session 3: ASMFC/State Involvement in Improving Fish Passage

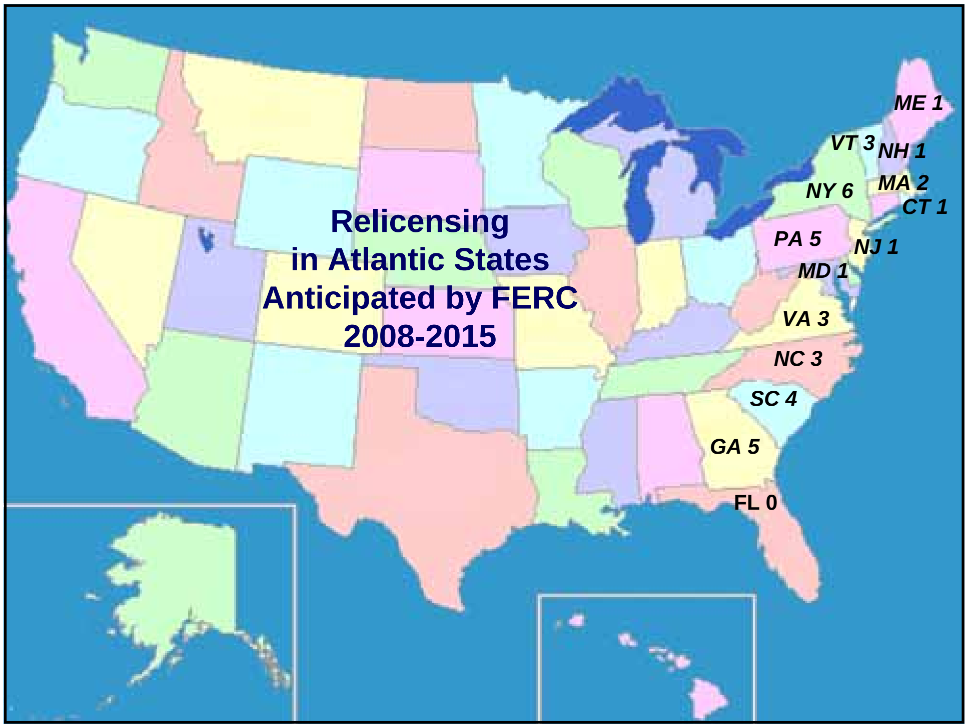
Alexander R. Hoar
Ecological Services
Northeast Regional Office
U.S. Fish & Wildlife Service
Hadley, Massachusetts

Alex_Hoar@fws.gov
413-253-8631

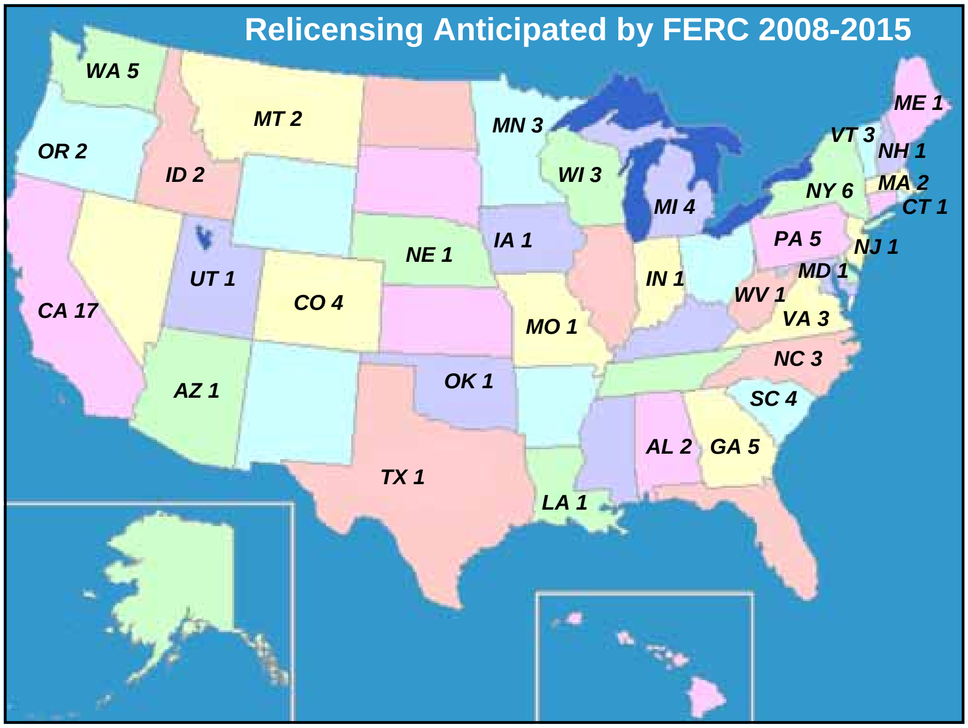
Jacksonville, Florida
April 3-4, 2008

What will be Discussed

- FERC Relicensings in Atlantic States 2008–2015
- What is fish passage?
- What is a fishway?
- Statutory tools
- Opportunity on the Horizon
- Call to action - federal/state coordination, participate in FERC process from the beginning (respond to PAD), raise fish passage and all other issues from the get go, require rigorous studies, maintain institutional capabilities like engineering.



Relicensing in Atlantic States Anticipated by FERC 2008-2015



Relicensing Anticipated by FERC 2008-2015

FERC Licenses Expiring 2008 – 2015

Source: FERC web site

Atlantic Drainage States (C-N)

Last updated 2/25/08

Project No.	Project Name	Waterway	State	MW	Issued	Expires
02662	SCOTLAND	**SHETUCKET RIVER**	**CT**	2.0	1982	**2012**
02237	MORGAN FALLS	**CHATTAHOOCHEE RIVER**	**GA**	16.8	1959	**2009**
02655	EAGLE & PHOENIX MILLS	**CHATTAHOOCHEE RIVER**	**GA**	27.7	1975	**2009**
00485	BARTLETTS FERRY	**CHATTAHOOCHEE RIVER**	**GA**	165.0	1978	**2014**
00659	LAKE BLACKSHEAR	**FLINT RIVER**	**GA**	15.2	1980	**2008**
09988	JOHN P. KING MILL	**SAVANAH RIVER**	**GA**	2.1	1989	**2009**
02801	GLENDALE	**SUM**	**MA**	1.1	1979	**2009**
02985	WILLOW MILL	**ZAVESKY**	**MA**	0.1	1981	**2011**
02615	BRASSUA	**MOOSE RIVER**	**ME**	4.2	1977	**2012**
04093	BYNUM DAM	**HAW RIVER**	**NC**	0.6	1985	**2015**
02206	YADKIN-PEE DEE	**PEE DEE RIVER**	**NC**	108.6	1958	**2008**
02197	YADKIN	**YADKIN RIVER**	**NC**	216.4	1958	**2008**
06597	MONADNOCK PAPER MILLS	**HSU**	**NH**	1.9	1984	**2014**
02309	YARDS CREEK	**YARDS CREEK**	**NJ**	364.5	1963	**2013**
00013	GREEN ISLAND	**HUDSON RIVER**	**NY**	6.0	1977	**2011**
02713	OSWEGATCHIE RIVER	**PUGLESE**	**NY**	28.5	1983	**2012**
07320	CHASM	**SALMON RIVER**	**NY**	3.4	1985	**2015**
02851	NATURAL DAM	**ST. LAWRENCE RIVER**	**NY**	1.0	1982	**2012**
02850	EMERYVILLE	**ST. LAWRENCE RIVER**	**NY**	3.5	1982	**2012**
07518	HOGANSBURG	**ST. REGIS RIVER**	**NY**	0.5	1985	**2015**

FERC Licenses Expiring 2008 - 2015

Source: FERC web site

Atlantic Drainage States (P-V)

Last updated 2/25/08

Project No.	**Project Name**	**Waterway**	**State**	**MW**	**Issued**	**Expires**
00405	CONOWINGO	**SUSQUEHANNA RIVER**	**PA**	0.5	1980	**2014**
01881	HOLTWOOD	**SUSQUEHANNA RIVER**	**PA**	107.2	1980	**2014**
02355	MUDDY RUN	**SUSQUEHANNA RIVER**	**PA**	880.0	1964	**2014**
01888	YORK HAVEN	**SUSQUEHANNA RIVER**	**PA**	19.6	1980	**2014**
02280	KINZUA	**ALLEGHENY**	**PA**	451.8	1965	**2015**
04362	RIVERDALE	**ENOREE RIVER**	**SC**	1.2	1982	**2012**
02621	PACOLET	**PACOLET RIVER**	**SC**	0.8	1982	**2012**
00516	SALUDA	**SALUDA RIVER**	**SC**	207.3	1984	**2010**
02232	CATAWBA-WATEREE	**WATEREE RIVER**	**SC**	804.9	1958	**2008**
00906	CUSHAW	**JAMES RIVER**	**VA**	7.5	1980	**2008**
00739	CLAYTOR	**NEW RIVER**	**VA**	75.0	1980	**2011**
02210	SMITH MOUNTAIN	**ROANOKE (STAUNTON) R**	**VA**	636.0	1960	**2010**
07528	CANAAN	**DEUBERT**	**VT**	1.1	1984	**2009**
02629	MORRISVILLE	**MUKHERJEE**	**VT**	5.1	1981	**2015**
02558	OTTER CREEK	**OTTER CREEK**	**VT**	18.1	1976	**2012**

Fish Passage - What is it?

- Fish passage means: the movement of fish in an aquatic corridor to access habitat for a variety of life cycle purposes; e.g. spawning, rearing, feeding, growth to maturity, seasonal use of habitat, annual migration, etc.
- Fish passage is directional - linear (downstream & upstream) or lateral (overbank).
- Fish passage involves more than anadromous and catadromous fish. For example, many riverine species have life cycle requirements that prompt them.
- Providing fish passage is in the public interest, and is a responsibility, legitimate purpose, and cost of doing business, for a hydroelectric project regulated under the Federal Power Act. That is why the FPA provides prescriptive authority to DOI and DOC.

What is a fishway?

- A fishway is an aquatic corridor (pathway) made by humans.
- A fishway should provide fish with an effective way over, around, or through a manmade impediment or barrier.
- Examples of barriers and impediments include physical structures, dewatered and low-flow reaches, thermal/velocity zones, impoundments.
- Effective means fish that want to pass can/do in a safe and timely way.
- A fishway consists of:
  - **facilities** (down-stream migrant facility),
  - **physical structures** (constructed things like a screen, rack, hopper, dam, guide walls, excavated channels),
  - **devices** (pump, pulley, computer, light, vehicle), operations (generation, first turbine on and off, schedules), and
  - **measures** necessary accomplish effective passage (location and design, spill, amount and timing of flows, effectiveness evaluations).

Public Trust

- In ancient times, the sovereign had the responsibility under common law to protect the fishery and ensure that fish can pass as necessary in navigable waters. (fish = food.)
- The miller could not block the migratory run that people depended on for sustenance and it has always been the miller’s responsibility to provide passage for fish.
- There was tension between the miller (dam owner) and the fisherman over fish passage.
- This followed to the new land in the 1600s, became the responsibility of the colonial sovereign, transferred to the states at independence, and was codified in many states.
- Congress gave fish passage responsibility for non-federal hydro to DOI and DOC in the FPA, which preempts states law. Congress gave the states authority in the CWA to require fishway at FERC regulated hydro through issuance of Section 401 certification.

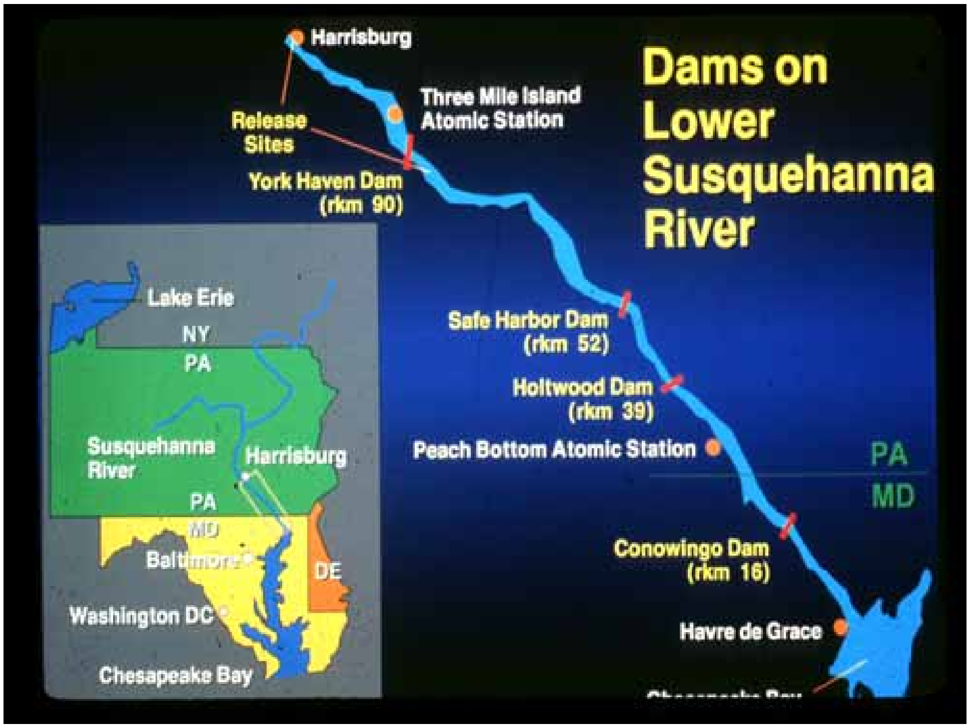
Statutory tools

- Fish and Wildlife Coordination Act
  - Action agency must consult with state fish and wildlife agencies, USFWS and NMFS.
  - Resource agency purpose is to recommend means and measures to protect, conserve, and increase the fish and wildlife resources impacted by the project.
  - Coordination should occur as a matter of practice between state and federal agencies.
- FPA sections 18, 4(e), 30(c) - DOI & DOC have broad mandatory conditioning authority for fishways (18), reservations (4(e)), exemptions (30(c))
  - Reservations of authority – should be in every license and exemption and can be acted on when there is just cause
- CWA section 401 – states have broad mandatory conditioning authority regarding quality and quantity of water for designated uses.

Opportunity on the Horizon

Relicensing on Susquehanna River

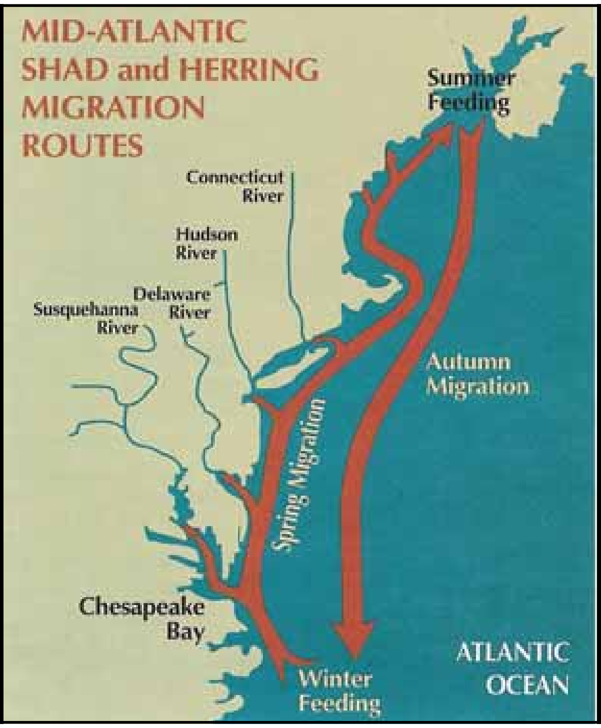
Conowingo, Muddy Run, and York Haven licenses expire 2014.



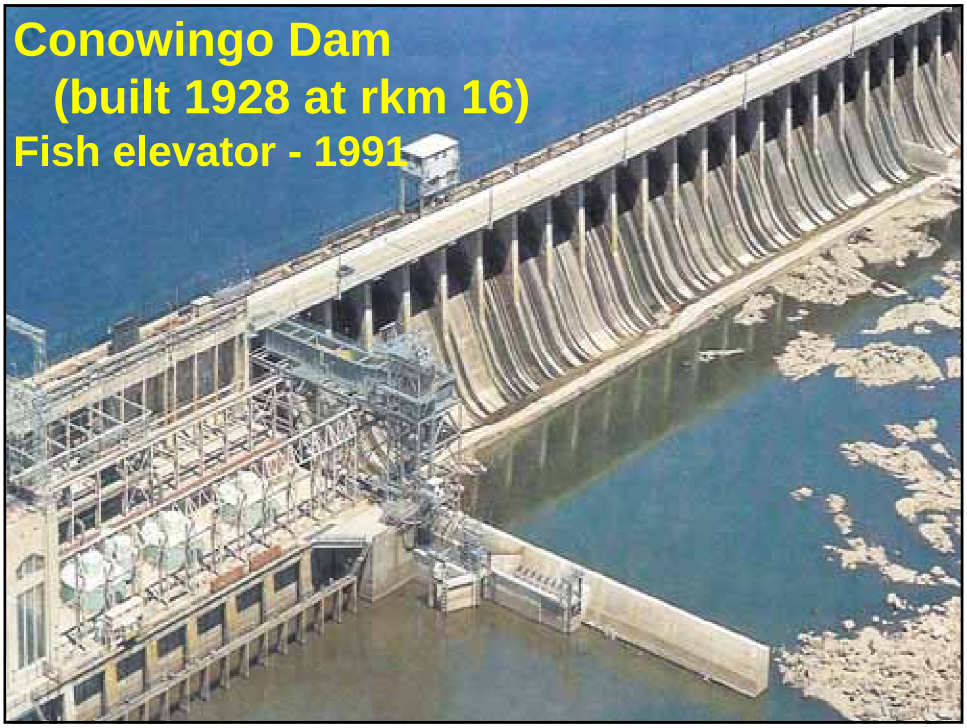
Dams on Lower Susquehanna River

Susquehanna River mouth - ca 1900

Shad ranked 2nd only to cod in U.S. food fish harvest



Anadromous fish need miles and miles of clean, fresh water to spawn and thrive during the early phases of their life cycle. Shad prefer clear, moving water free of excess nutrients and sediment, and free of pollution from heavy metals, toxics, acid mine drainage and other contaminants.

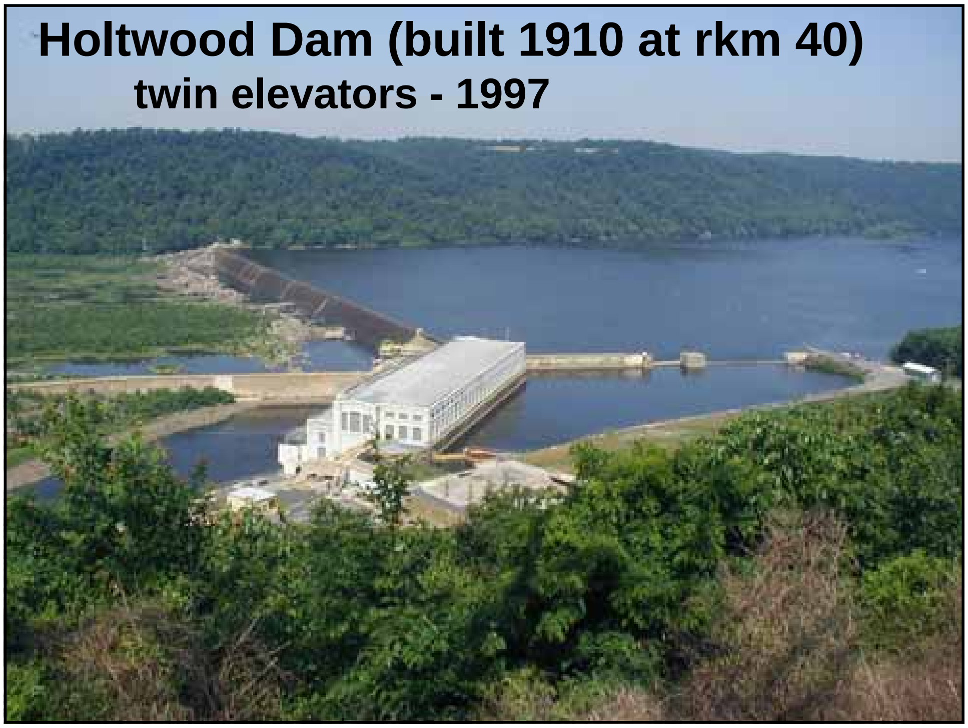


Conowingo Dam
(built 1928 at rkm 16)

Fish elevator - 1991

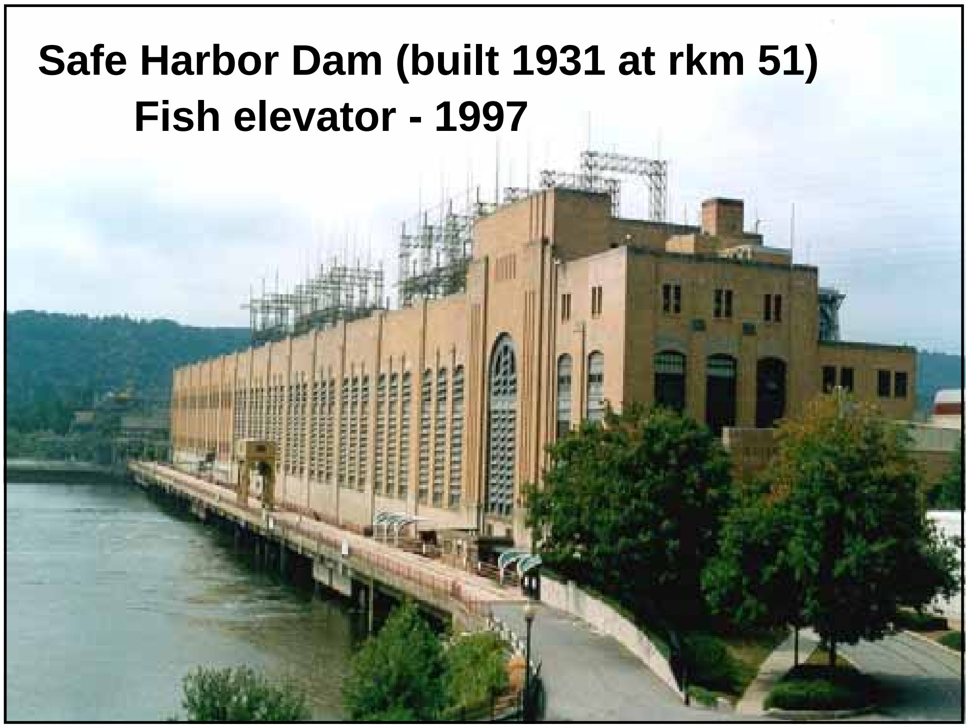
Conowingo - FERC Project No. 405

- Lower most impoundment and dam on Susquehanna River - the largest tributary to the Chesapeake Bay, confluence is about 4 miles downstream from the dam;
- One of the largest non-federal dams in the U.S. -105 ft. high; 4,048 ft long
- Impounds 14 miles of Susquehanna River.
- Since going on-line in 1928, increased generation from 252 to 573 MW;
- Operates under FERC license issued in 1980 - expires 2014;
- Impoundment is lower water source for Muddy Run Pump Storage Project; same owner; and source for cooling water and point for thermal discharge for Peach Bottom Atomic Power Plant;
- Fish passage has been an issue sine 1950s, early 1980s fishways raised by USFWS under FPA section 18 authority; case went before an ALJ at FERC and was disputed for years through the 1980s.



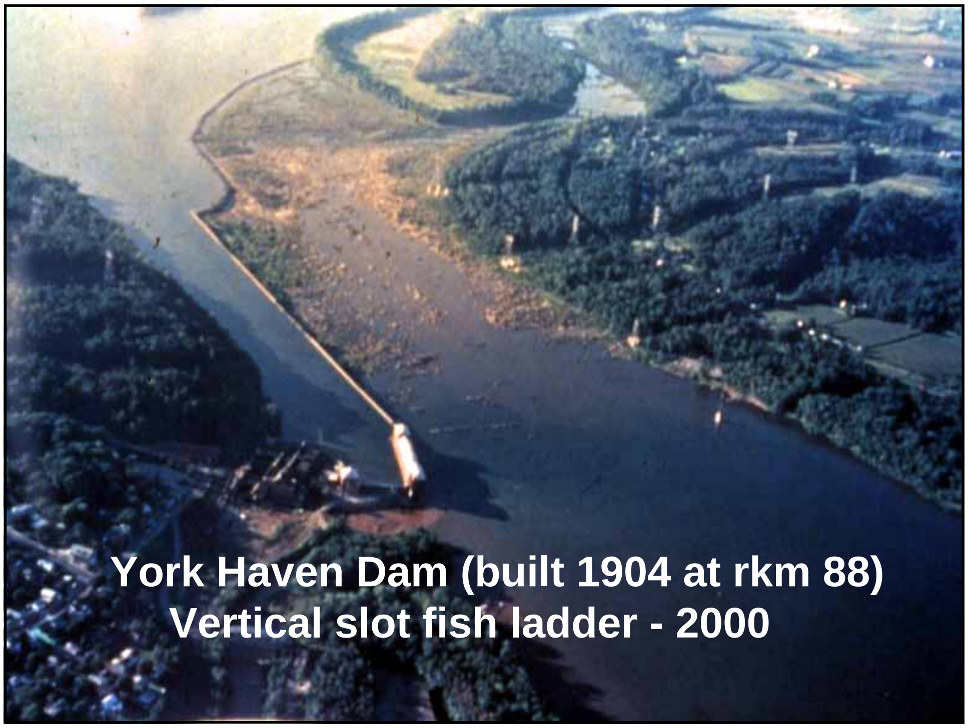
Holtwood Dam (built 1910 at rkm 40)

twin elevators - 1997

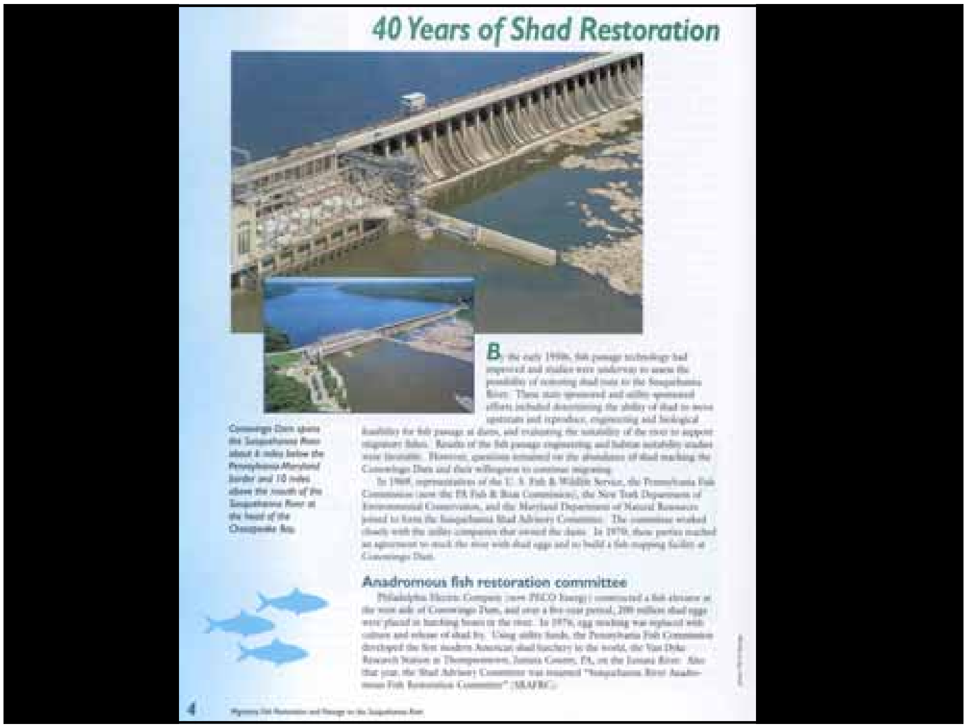


Safe Harbor Dam (built 1931 at rkm 51)

Fish elevator - 1997



York Haven Dam (built 1904 at rkm 88)
Vertical slot fish ladder - 2000

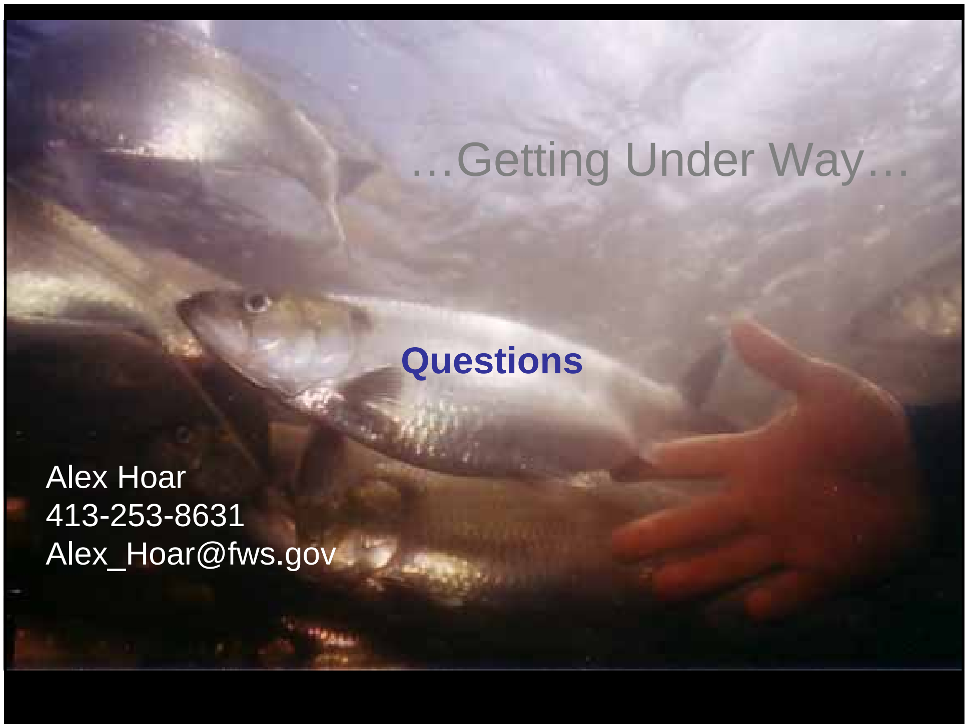


40 Years of Shad Restoration

Anadromous fish restoration committee

Likely Resource Issues

- Improved shad passage up and downstream;
- Fish Passage at dam for eels - essentially absent in fish community in watershed; shad passage improvement
- Timing and amount of flow to the Bay – effect on aquatic resources; e.g., shell fish
- Operation in peak power generation mode;
- Passage impediments due to project structure, impoundment and operations;
- Effects of operations on fish below the dam – well known birding spots for gulls and eagles;
- Impacts to FWS refuge near confluence in Bay



…Getting Under Way…

Questions

Alex Hoar
413-253-8631
Alex_Hoar@fws.gov

Small Barriers, Large Impacts: Impacts on American Eel Distribution in New York State

Leonard S. Machut
Tunison Laboratory of Aquatic Sciences
Cortland, NY

Collaborators and Funding

- Karin E. Limburg – SUNY ESF
- Robert E. Schmidt – Bard College at Simon's Rock
- Dawn Dittman, James H. Johnson, James McKenna, Michelle Henry – Tunison Laboratory of Aquatic Science

NYS Department of Environmental Conservation

USGS
science for a changing world

HUDSON RIVER FOUNDATION
for Science & Environmental Research

Talk Outline

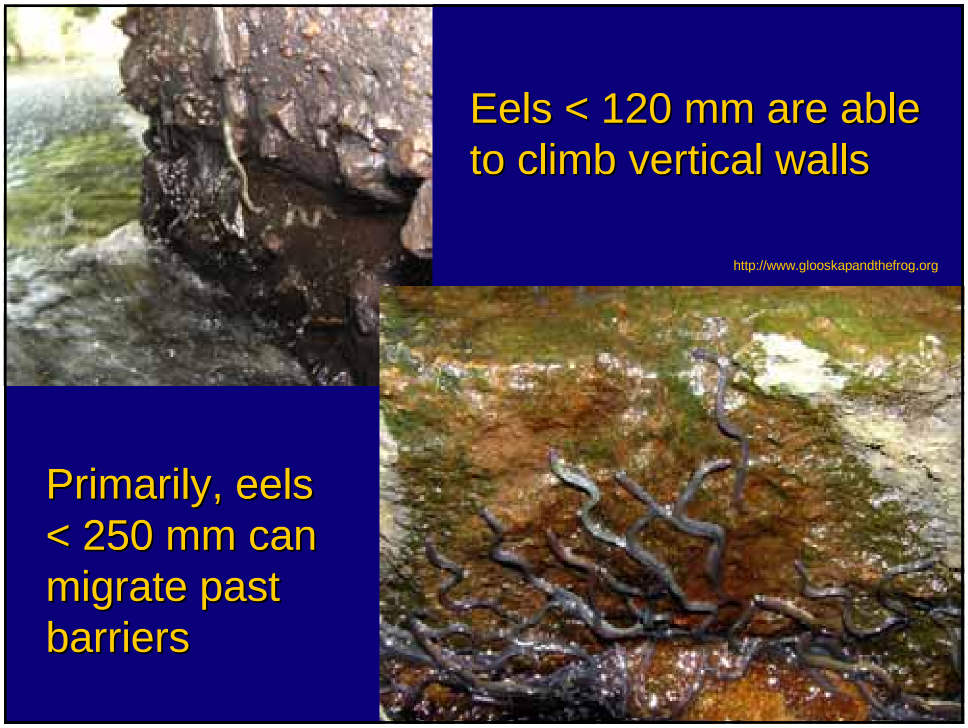
- What makes eels so unique & important
- Masters Research
- NYS DEC Eel Management Plan – American Eels, Data Assimilation and Management Options for Inland Waters

Why Are Eels So Cool?

a.k.a. – Why spend three years being a poor graduate student trying to grab hold of an ugly, slimy fish?

Why Are Eels So Cool?

- They are unique compared to other fishes



Eels < 120 mm are able to climb vertical walls

http://www.glooskapandthefrog.org

Primarily, eels < 250 mm can migrate past barriers

Life Cycle

Uwe Kils, Rutgers University

- Facultative catadromous, semelparous
- Spawn in Sargasso Sea
- 170-300 day drift of leptocephalus larvae

Why Are Eels So Cool?

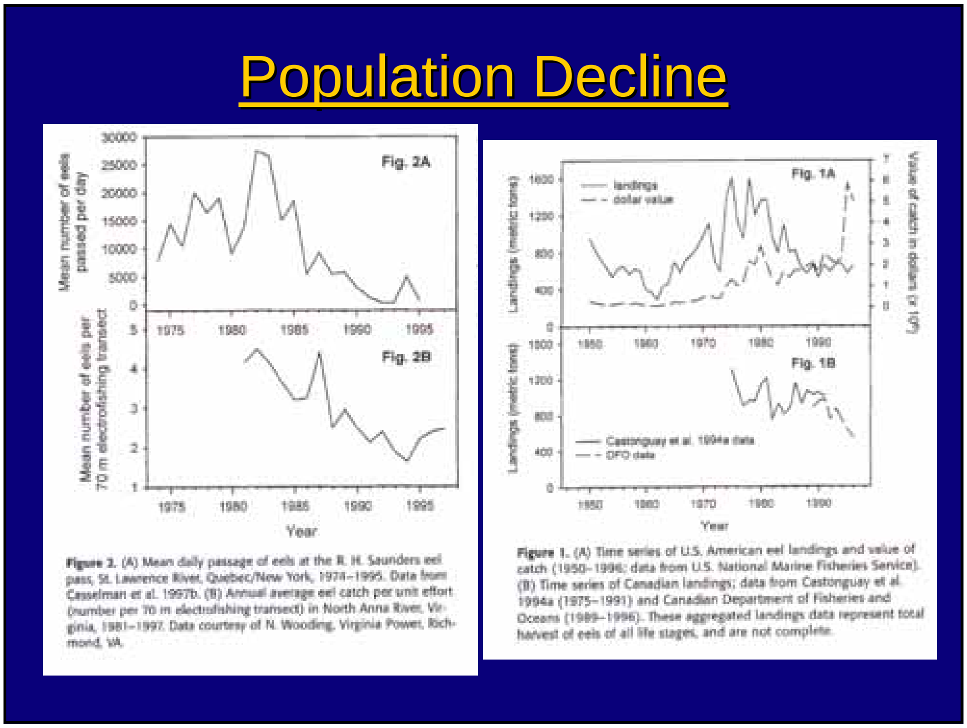
- They are unique compared to other fishes
- They are nutritionally/economically valuable to humans

The Incredible Edible Eel

- Historical importance
  - Essential to Native Americans (Casselman 2003)
  - Early fisheries (e.g. Adams and Hankinson 1928)
- Modern history
  - Commercial fisheries worldwide
    - ~$30 for a 650gm smoked eel in UK
    - Japan Imported ~$800 mil (US) during 2004 & 2005
  - Aquaculture worldwide
  - Black market

Why Are Eels So Cool?

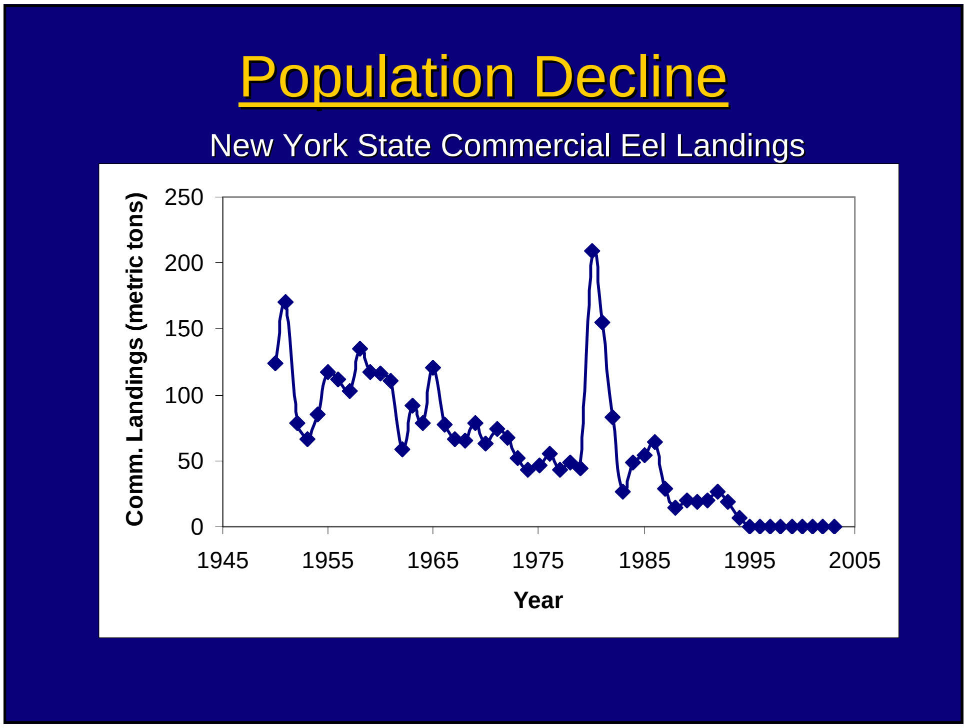
- They are unique compared to other fishes
- They are nutritionally/economically valuable to humans
- They are in serious decline worldwide



Population Decline

Figure 2. (A) Mean daily passage of eels at the R. H. Saunders eel pass, St. Lawrence River, Quebec/New York, 1974–1995. Data from Casselman et al. 1997b. (B) Annual average eel catch per unit effort (number per 70 m electrofishing transect) in North Anna River, Virginia, 1981–1997. Data courtesy of N. Wooding, Virginia Power, Richmond, VA.

Figure 1. (A) Time series of U.S. American eel landings and value of catch (1950–1996; data from U.S. National Marine Fisheries Service). (B) Time series of Canadian landings; data from Castonguay et al. 1994a (1975–1991) and Canadian Department of Fisheries and Oceans (1989–1996). These aggregated landings data represent total harvest of eels of all life stages, and are not complete.



Population Decline

New York State Commercial Eel Landings

Why Are Eels So Cool?

- They are unique compared to other fishes
- They are nutritionally/economically valuable to humans
- They are in serious decline worldwide
  - Significant local regional declines
  - Petition to list American eel under the Endangered Species Act

Why Are Eels So Cool?

- They are unique compared to other fishes
- They are nutritionally/economically valuable to humans
- They are in serious decline worldwide
- They are very photogenic

Even National Geographic Wants a Close-up

© David Doubillet, National Geographic

Impacts of small barriers on eel abundances, distributions, and condition in small tributaries

Does size really matter?

- Any barrier more than 15m (more than 50ft) in height is classed as a large barrier
- Any barrier less than 5m (15 ft or less) in height is classed as a small barrier
- Large dams (e.g. Moses-Saunders, Cannonsville) = only 2.7% of NY dams
- Small dams = 72.8% of NY dams
- Hydrodams = 3.5% of NY dams

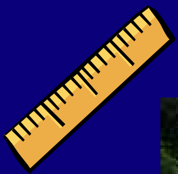
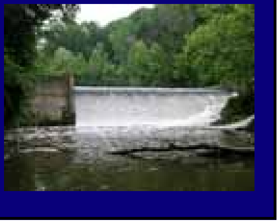
Goals/Research Questions

- Expand upon research performed in the main stem of the Hudson River (e.g. Morrison and Secor 2003, 2004)
- Document eel use of smaller streams
- Identify impacts of small barriers on eel

Eel Population Dynamics

- Where are they?
- What is their condition?
- How fast are they growing?
- Are anthropogenic impacts important?
  - Barriers
  - Urbanization





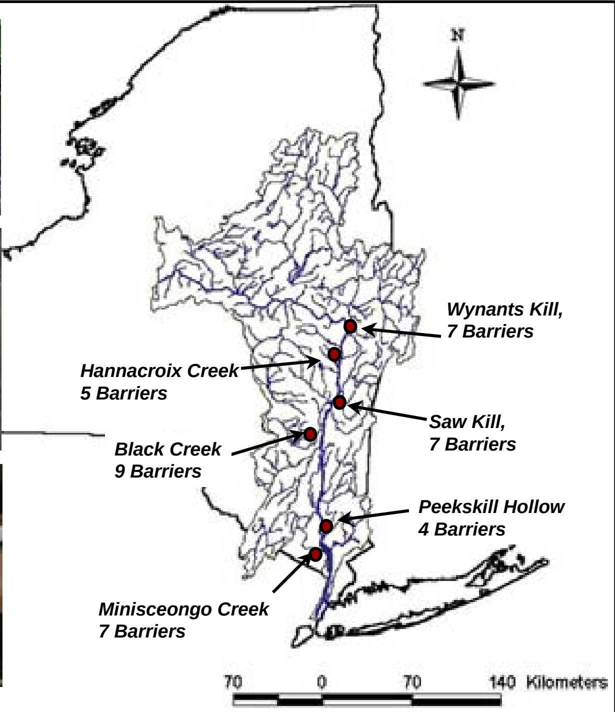
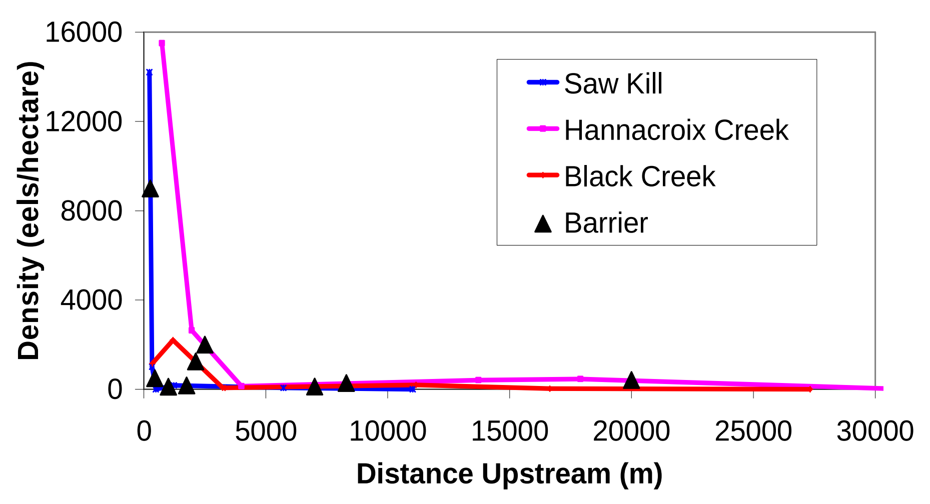



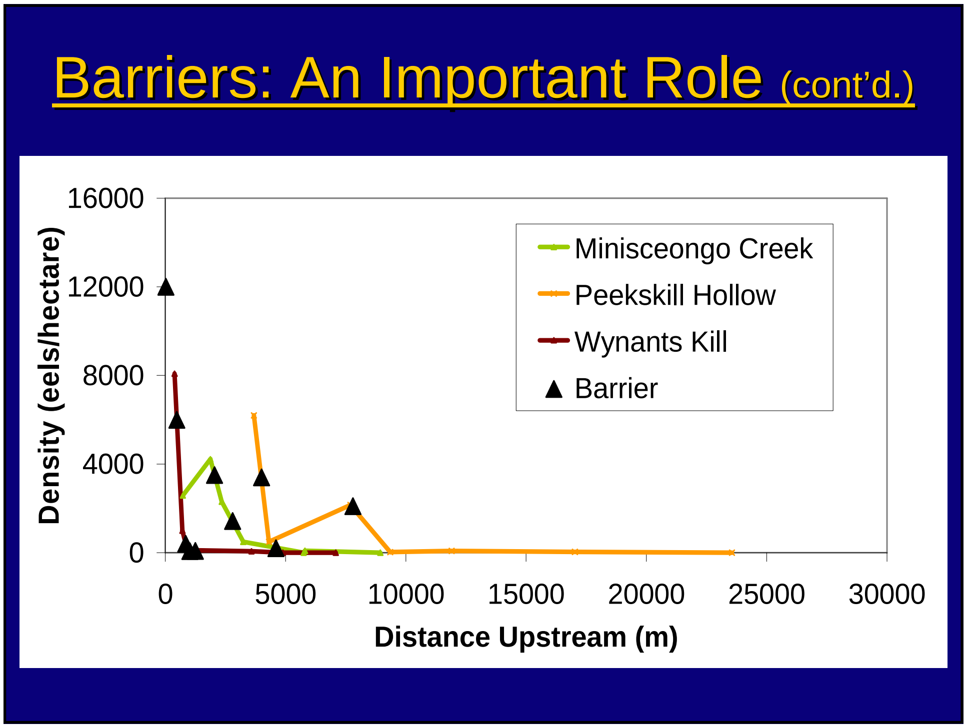
Table 1: Watershed Characteristics for Censused Hudson River Tributaries

Tributary Name	Watershed Area (km²)	Stream Length (km)	Eel Penetration (km) [a]	Number of Barriers	Distance to 1st Barrier (m)	% Artificial Barrier
Wynants Kill	85.47	25.95	5	7	20	43
Hannacroix Creek	166.24	37.81	31	4	1985	40
Saw Kill	66.29	22.62	11	7	255	43
Black Creek	87.77	29.55	27.5	9	2620	22
Peekskill Hollow	135.51	28.11	23.5	4	3825	100
Minisceongo Creek	47.9	18.86	9	6	1900	100

[a] - Approximate distance upstream at which no eels were collected. We take this as an index of the degree to which eels penetrate and occupy a particular tributary.

Barriers: An Important Role





Barriers: An Important Role (cont'd.)

Tributary Populations

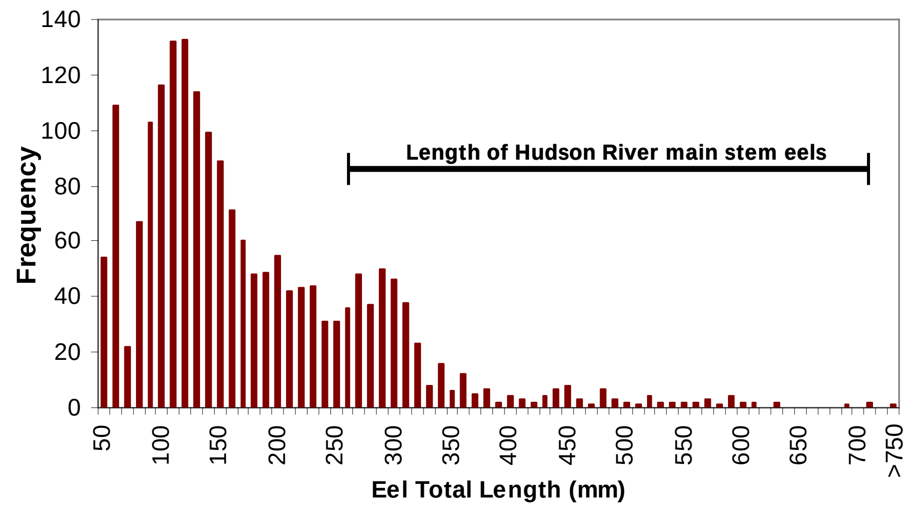
- Multiple Regression

$$Ln(P) = 26.166 - 2.730*Ln(B) - 0.165*D + 1.359*U$$

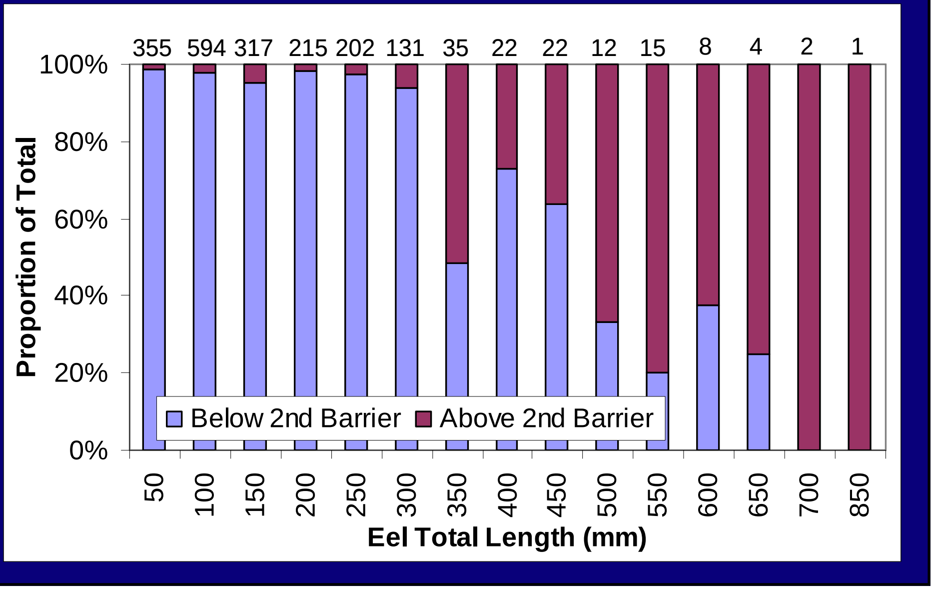
where: P = Population
B = Number of Barriers
D = Distance Group
U = Sub-catchment urbanization

– $r^2 = 0.65, p < 0.001$

Size Distribution



Size matters!



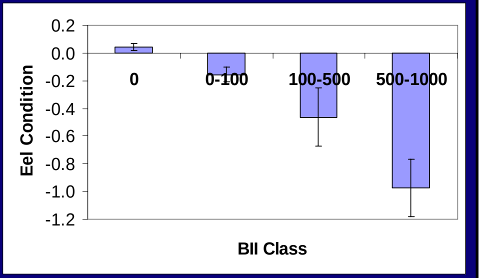
Eel Condition

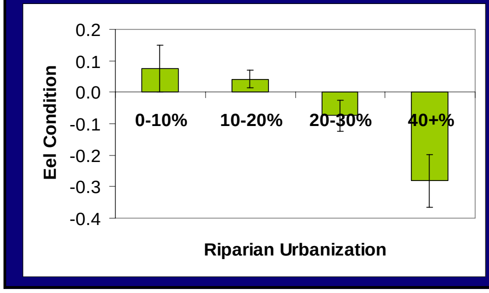
- Standardized residuals of eel wet weight regressed against total length
  - Ex.) An eel of -1 is 1 S. D. lighter than average

Eel Condition

BII = Barrier Intensity Index

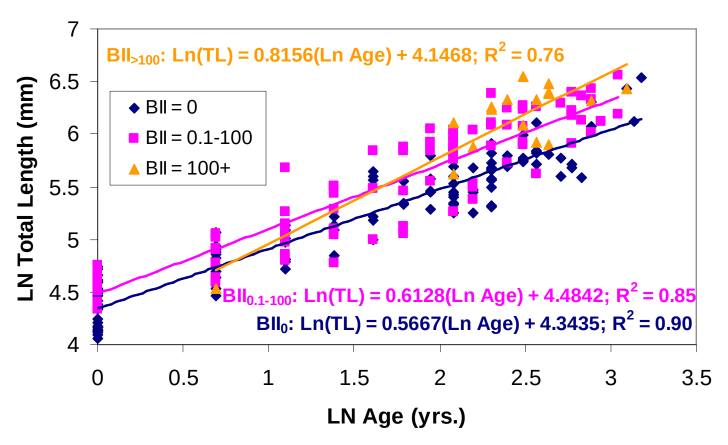
$$BII = \left(Barriers/km\right)*\left(Cumulative\ Barrier\ Height^{2}\right)$$





Percent Riparian Urbanization Determined by Gap Analysis

Impacts of Barrier Intensity



- As barrier intensity increases, eels able to reach these habitats exhibit faster growth rates

---

Barrier Impacts on Sex

- Below 1st migratory barrier

  female : male ratio = 1.1 : 1.0

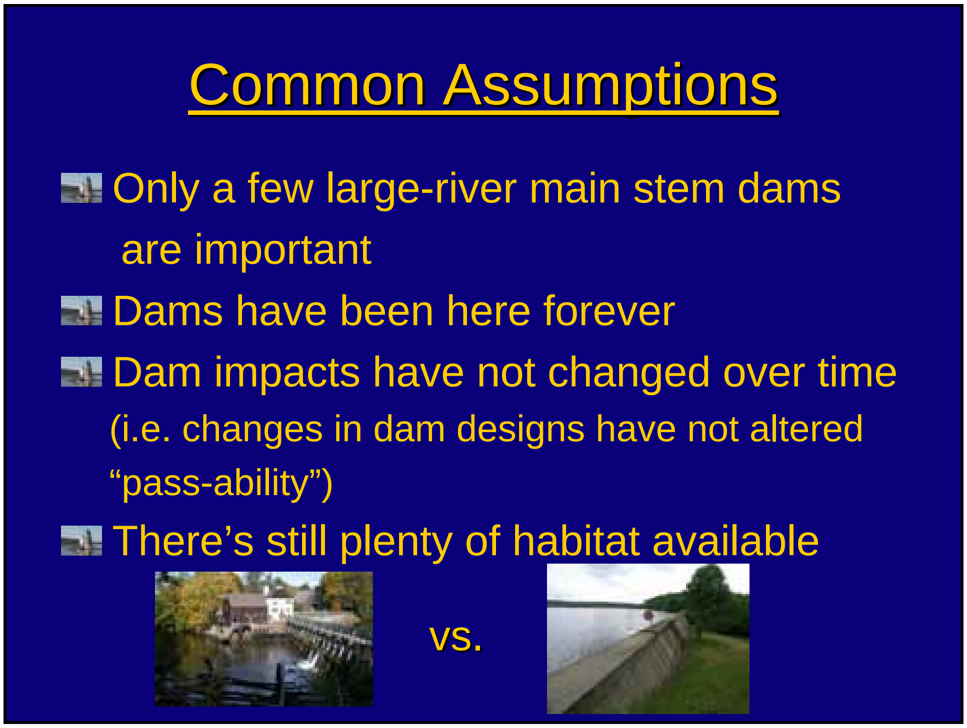
- Above 1st migratory barrier

  female : male ratio = 8.8 : 1.0

So, how can this data be extrapolated throughout the Hudson River watershed and other portions of New York?

The Next Logical Step

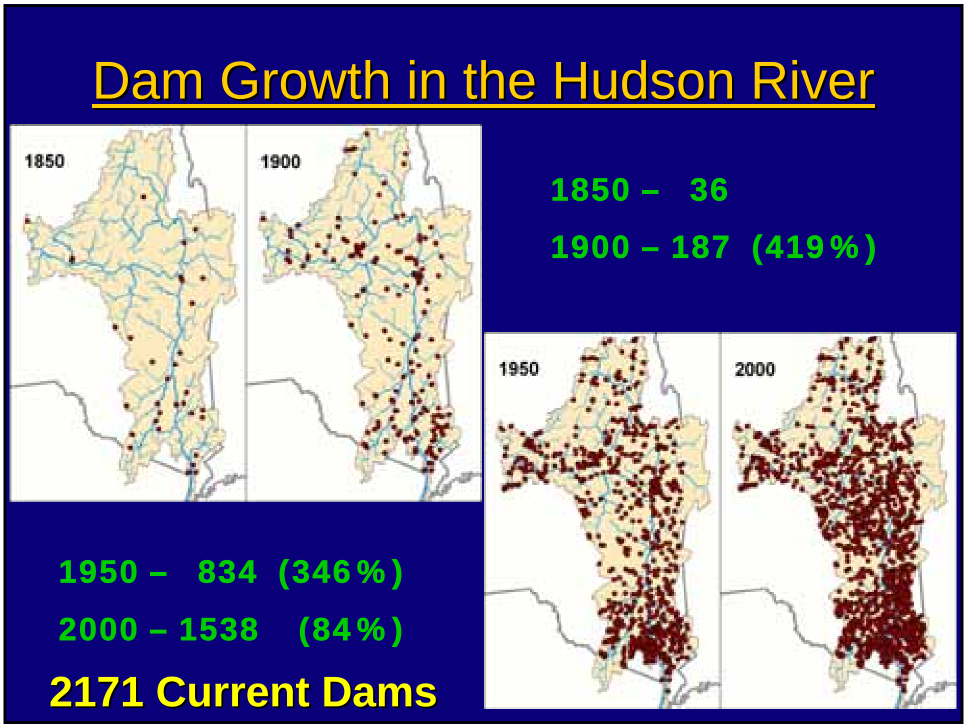
- State Wildlife Grant (SWG) funding
- Development of NYS DEC freshwater eel management plan
  - Dam growth over time to present day
  - Total number of man-made barriers in NY
  - How much open habitat is left?



Common Assumptions

- Only a few large-river main stem dams are important
- Dams have been here forever
- Dam impacts have not changed over time (i.e. changes in dam designs have not altered "pass-ability")
- There's still plenty of habitat available

vs.



Dam Growth in the Hudson River

1850 – 36

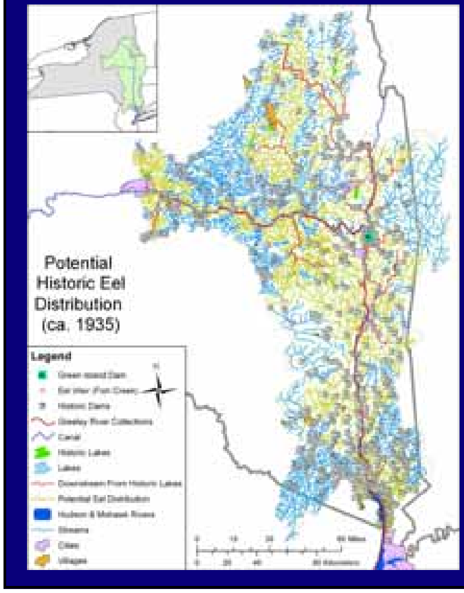
1900 – 187 (419%)

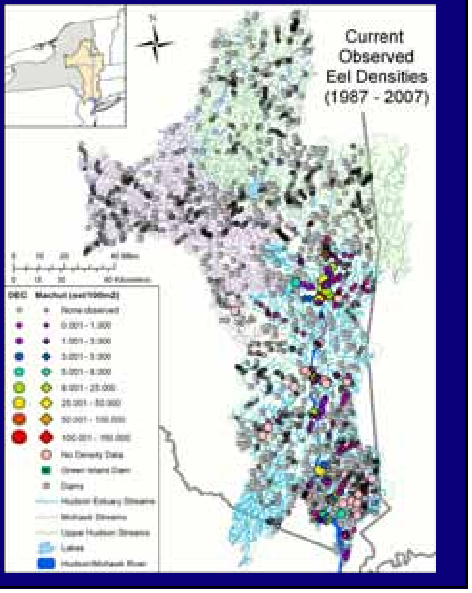
1950 – 834 (346%)

2000 – 1538 (84%)

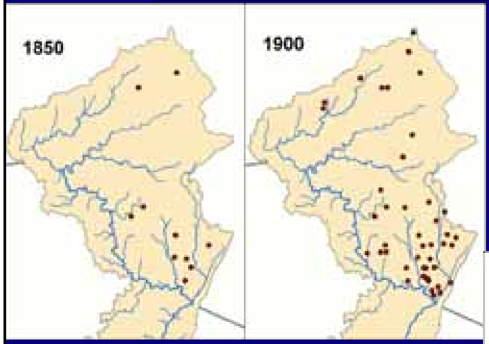
2171 Current Dams

Current Hudson Eel Distribution



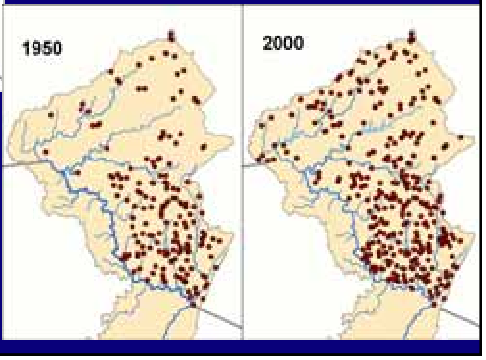


Delaware R. Dam Growth



1850 – 10

1900 – 46 (360%)

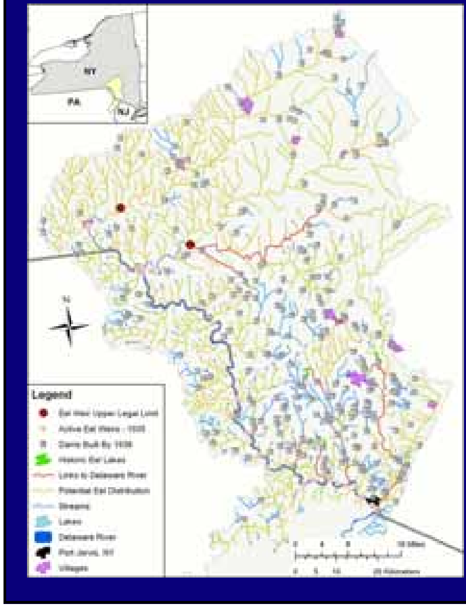


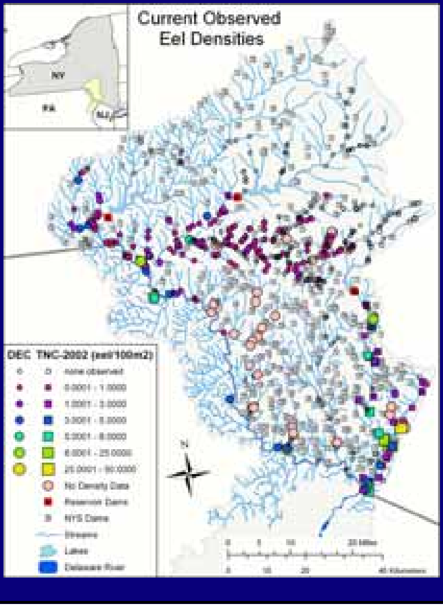
1950 – 186 (304%)

2000 – 344 (85%)

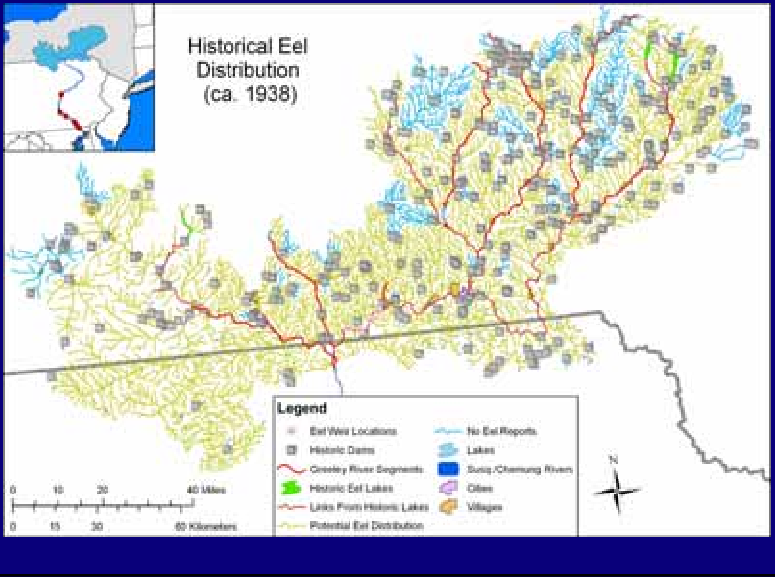
452 Current Dams

Current Delaware Eel Distribution

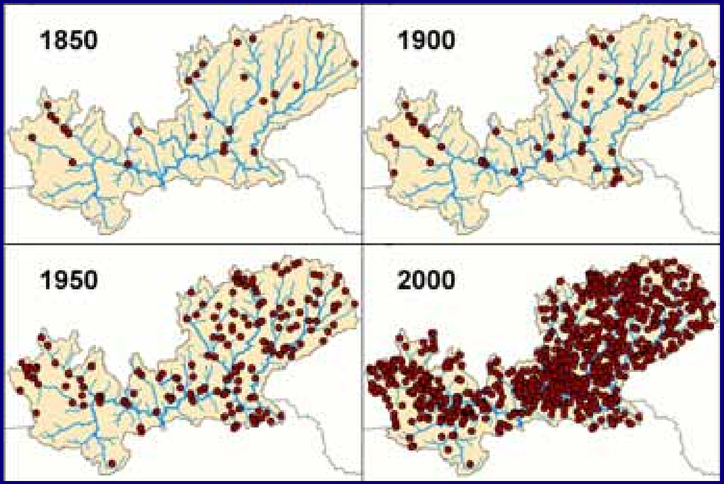




Historic Susquehanna Eel Distribution



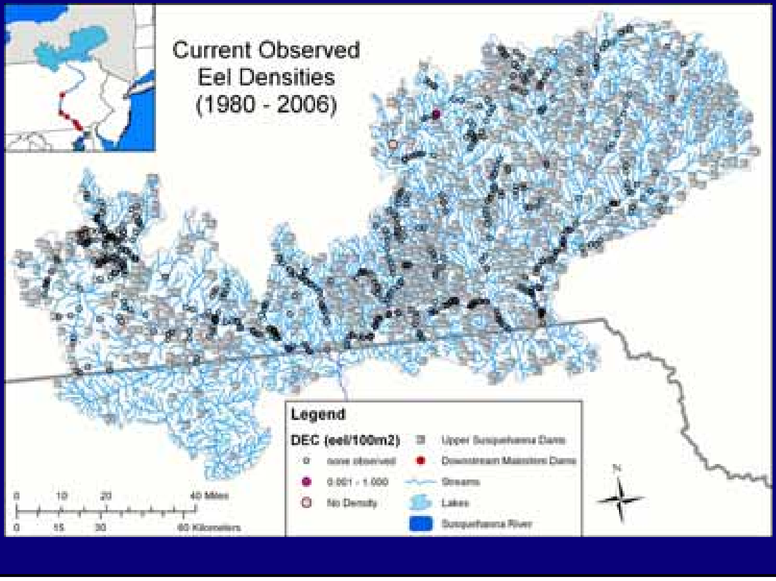
Susquehanna River Dam Growth



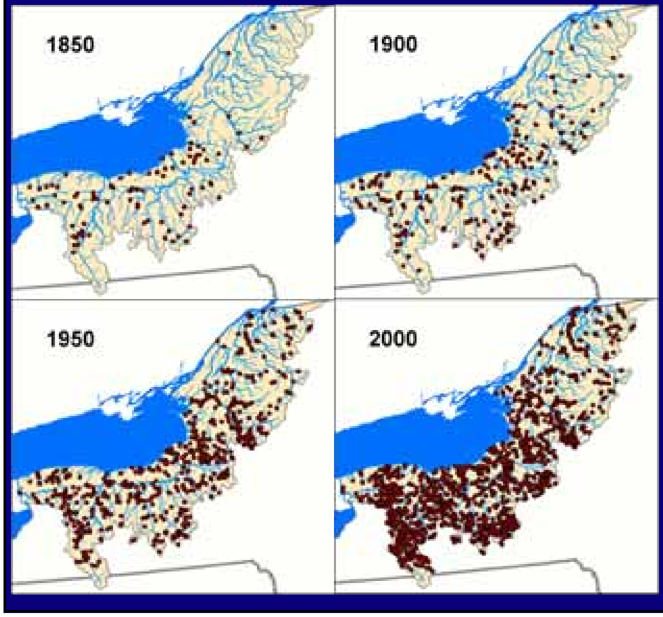
1089 Currently Identified Barriers in NY

- (does not include out-of-state dams)

Current Susquehanna Eel Distribution



Dam Growth in the LO-SLR Basin



1850 – 99

1900 – 261 (164%)

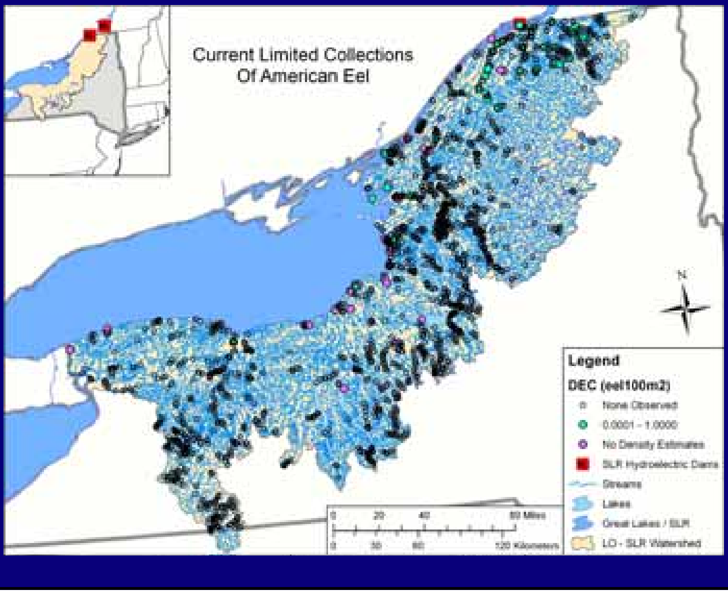
2051 Dams

Currently

1950 – 677 (160%)

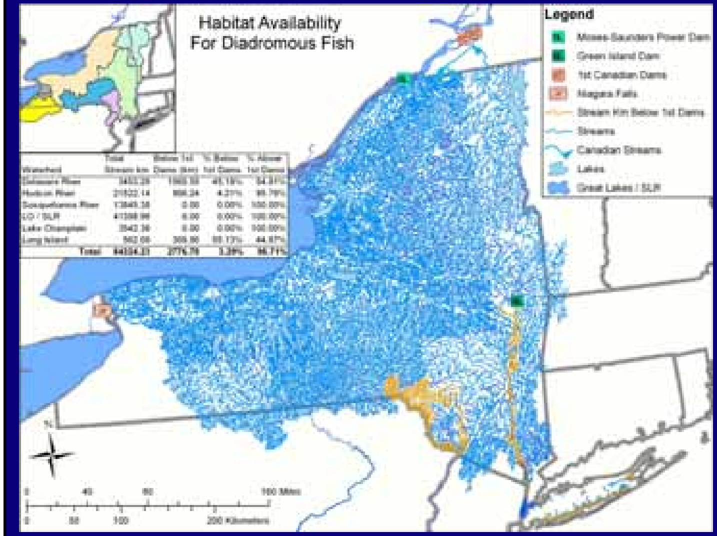
2000 – 1502 (122%)

Current LO-SLR Eel Distribution



So, what do we have left?

It’s All About Access



Watershed	Total Stream km	Below 1st Dams (km)	% Below 1st Dams	% Above 1st Dams
Delaware River	3453.29	1560.33	45.19%	54.81%
Hudson River	21522.14	908.24	4.21%	95.79%
Susquehanna River	13849.38	0.00	0.00%	100.00%
LO / SLR	41398.98	0.00	0.00%	100.00%
Lake Champlain	3542.38	0.00	0.00%	100.00%
Long Island	562.08	309.96	55.13%	44.87%
Total	84324.21	2776.79	3.29%	96.71%

Historic Access

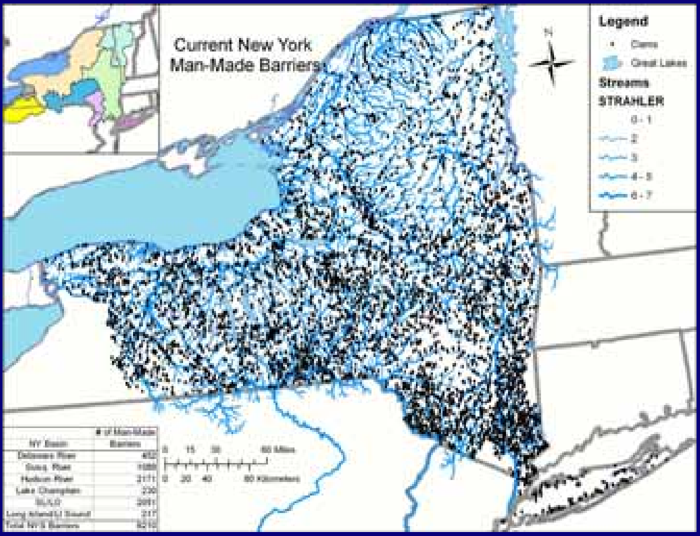
- **~ 21% of Hudson River** **(4.2% now)**
- **~ 45% of LO-SLR** **(10.4% now)**

That’s a Lot of Concrete

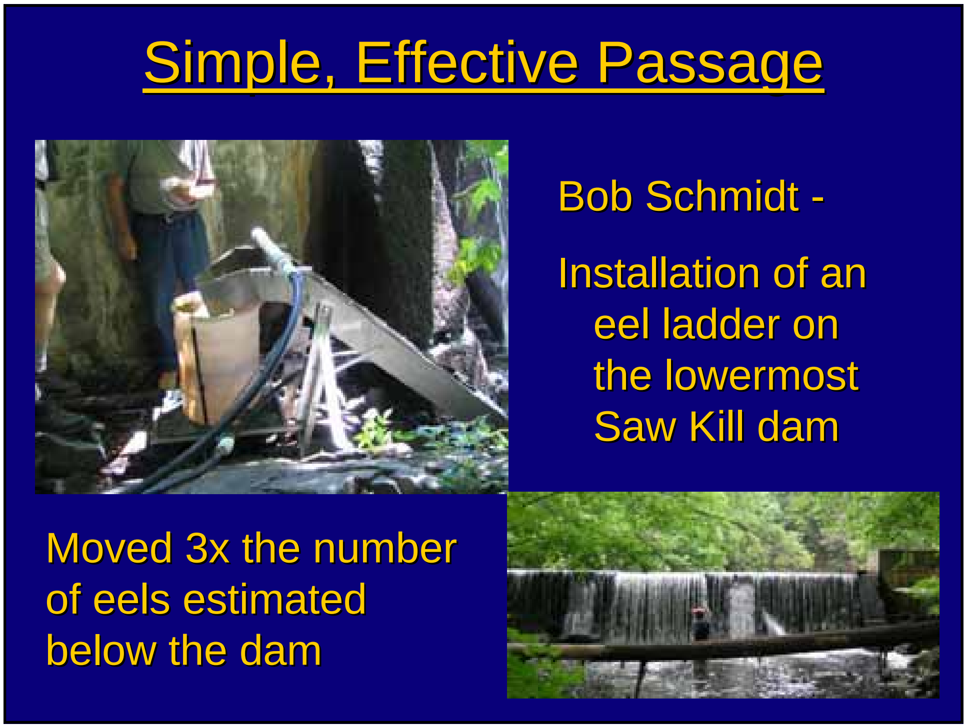
Table 2: Habitat Fragmentation in New York State Eel Basins

Basin	Number of Dams	Dams/ km^2	Km of Stream/ Dam	Historic Below 1st Barrier	Current Below 1st Barrier
Delaware River	452	0.070	7.6	95+%	45.2%
Susquehanna R.	1089	0.058	10.6	95+%	0.0%
Hudson River	2171	0.067	9.9	20.5%	4.2%
Hud Riv Est.	1280	0.094	6.5	44.0%	10.7%
UpHuds/Mhwk	891	0.048	14.9	5.7%	0.0%
Lake Champlain	230	0.029	14.5	31.4%	19.2% [a]
LO-SLR	2051	0.041	20.0	40.1%	10.1% [a]
Lake Ontario	257	0.018	16.3	46.3%	10.6% [a]
St. Lawrence R.	1794	0.051	45.0	27.5%	8.1% [a]
Long Island	136	0.038	4.0	100%	55.1%
	Average	0.052	13.3		

That’s a Lot of Concrete (cont’d.)



NY Basin	# of Man-Made Barriers
Delaware River	452
Susq. River	1089
Hudson River	2171
Lake Champlain	230
SL/LO	2051
Long Island/LI Sound	217
Total NYS Barriers	6210



Simple, Effective Passage

Bob Schmidt -

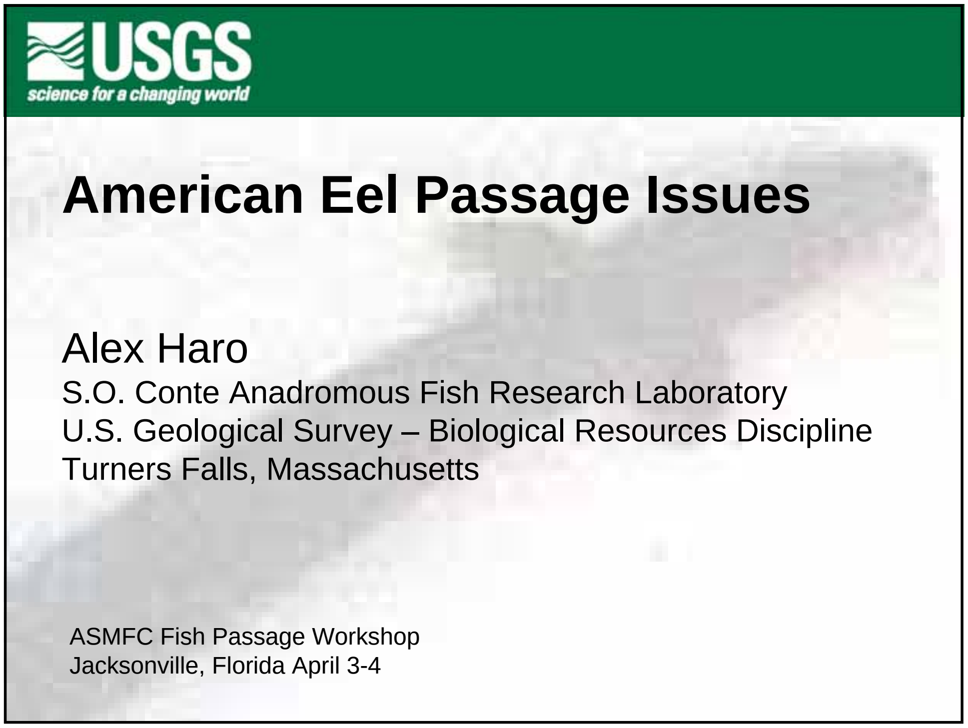
Installation of an eel ladder on the lowermost Saw Kill dam

Moved 3x the number of eels estimated below the dam

In Summary

- There are approximately 7000 dams in NYS
- Over 70% are 15 feet or less in height
- The first barrier appears to reduce eel densities by at least a factor of 10
- Increased barrier intensity negatively affects eel condition
- Statewide the number of dams doubled from 1950 - 2000
- Access to valuable historic habit is limited

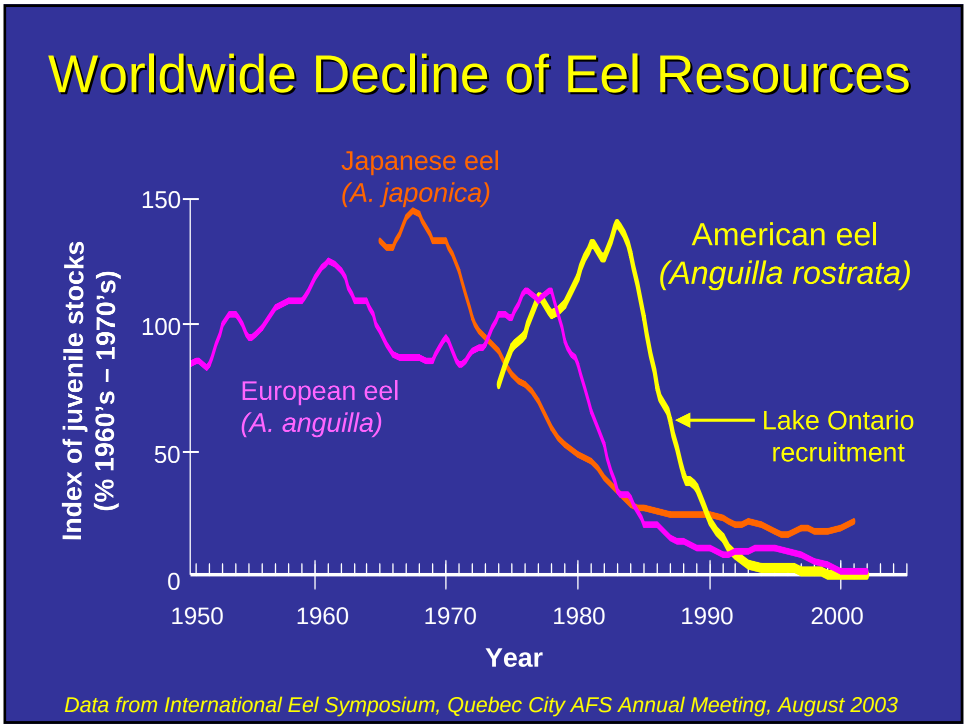
http://www.glooskapandthefrog.org



American Eel Passage Issues

Alex Haro
S.O. Conte Anadromous Fish Research Laboratory
U.S. Geological Survey – Biological Resources Discipline
Turners Falls, Massachusetts

ASMFC Fish Passage Workshop
Jacksonville, Florida April 3-4



Worldwide Decline of Eel Resources

Data from International Eel Symposium, Quebec City AFS Annual Meeting, August 2003

What is causing the decline?

Major Potential Threats:

- Habitat Loss
- Disease
- Parasites
- Ocean Conditions
- Pollution
- Fragmentation/Barriers
- Turbine mortality

Upstream Migration

Eels have complex migrations and movements

- Not all eels enter freshwater – “facultative catadromes”
- Otolith microchemistry verifies that eels can be exclusively marine or migrate between marine and freshwater habitats
- Telemetry studies document seasonal movements between estuary and freshwater
- Continued upstream migration for several years after freshwater entry
- Regular movements within freshwater; diel foraging, older eels which have established a home range

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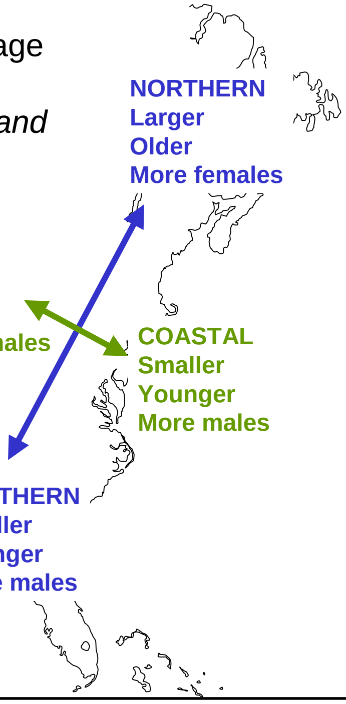
Paradigm for sex/size/age distribution:
Latitude & Distance Inland



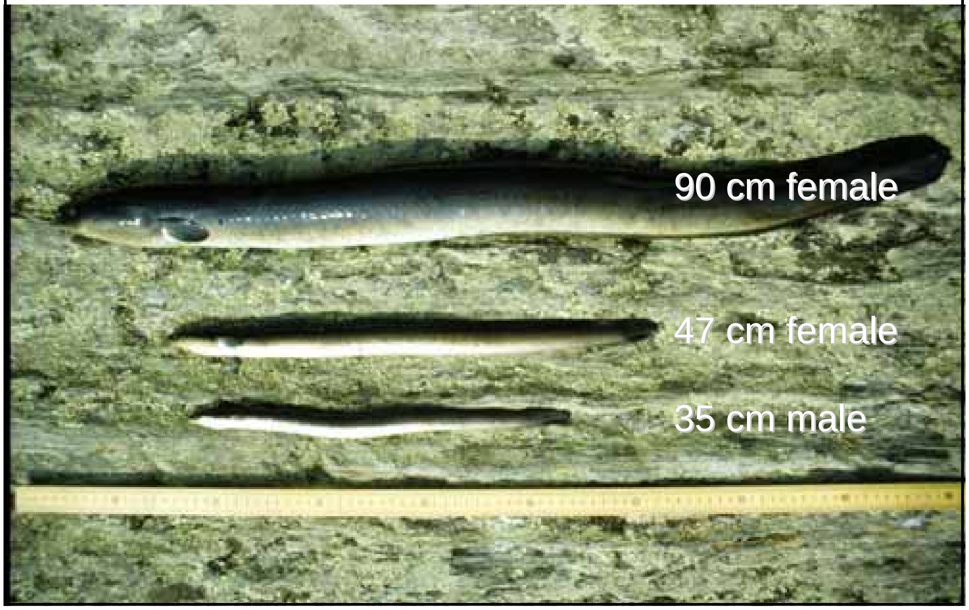
NORTHERN
Larger
Older
More females

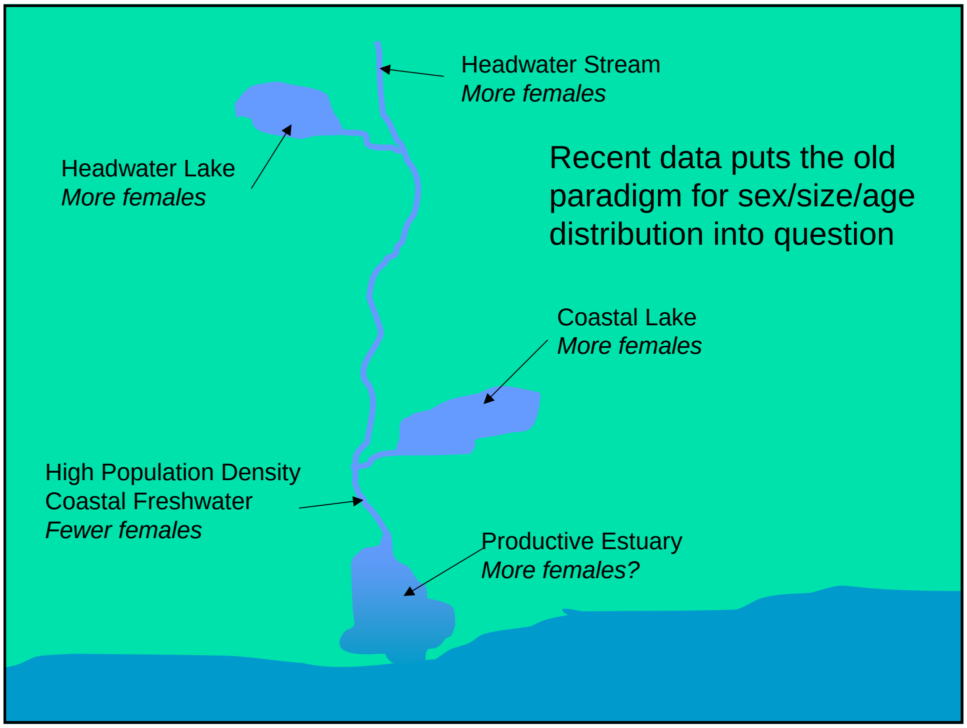
INLAND
Larger
Older
More females

COASTAL
Smaller
Younger
More males

SOUTHERN
Smaller
Younger
More males

Variability in size and reproductive value of males and females





Headwater Stream
More females

Headwater Lake
More females

Recent data puts the old paradigm for sex/size/age distribution into question

Coastal Lake
More females

High Population Density
Coastal Freshwater
Fewer females

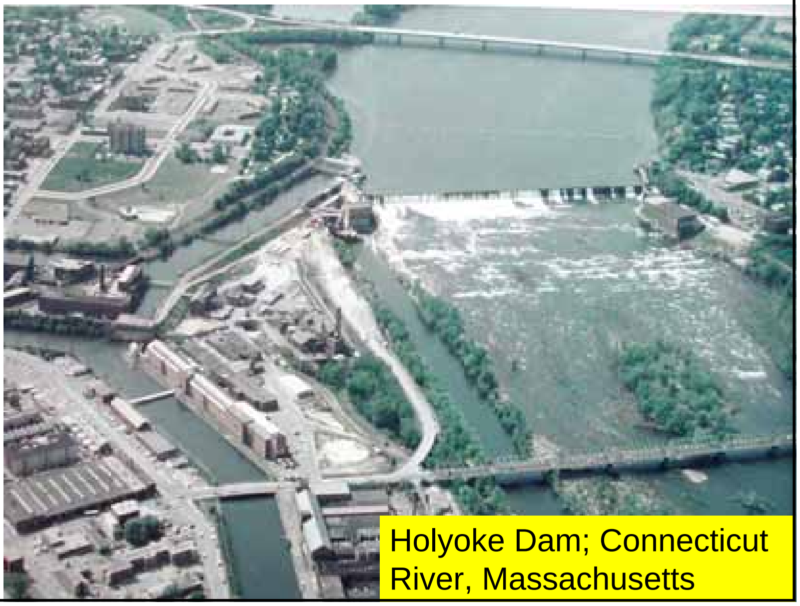
Productive Estuary
More females?

Natural barriers

What is the size of the population that will pass?
What proportion would be expected to pass “naturally”?

Young yellow phase eels of age 1+ to 5+
– *all upstream migrants*

Difficulties in assessing eel populations at large, complex dam sites


Holyoke Dam; Connecticut River, Massachusetts

Questions/Data Gaps – Upstream Migration

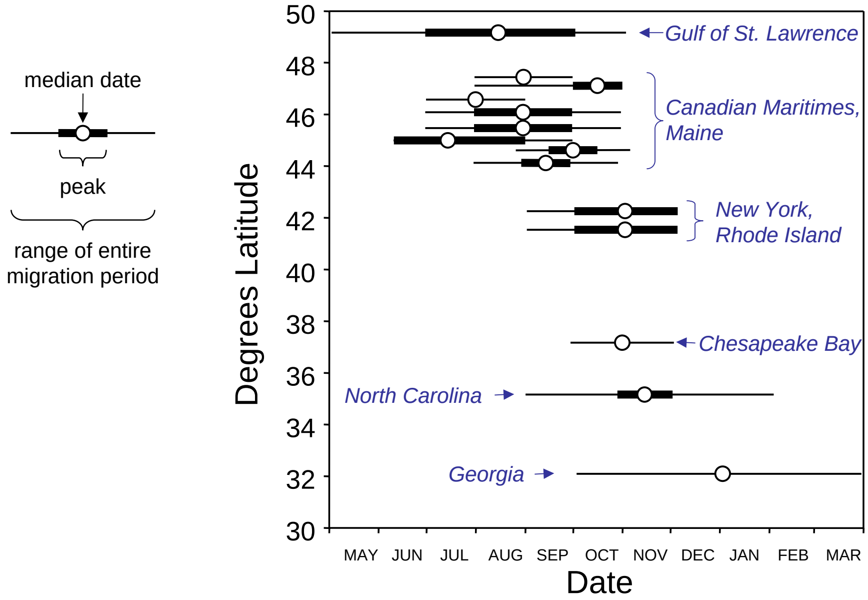
- What happens to eels that can’t pass a barrier?
- Do eels “have time” to pass a barrier?
- How best to quantify the population to be passed, and assess passage efficiency?
- Should we provide upstream passage without downstream passage?

Some Proposed Directions for Research – *Upstream Passage/Distribution & Demographics*

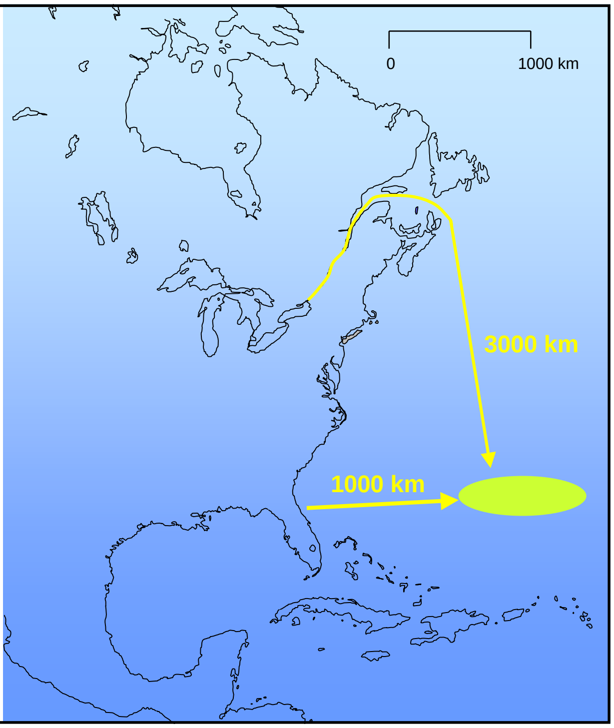
- Need better data on effects on sex determination/distribution (e.g., competition, productivity)
- Habitat availability/suitability modeling
- Barrier effects modeling
- Refine eel pass designs, evaluation of existing technical fishway designs
- Better passage efficiency estimation
- Assessment of the relative reproductive contribution of eels from different latitudes and/or distance inland

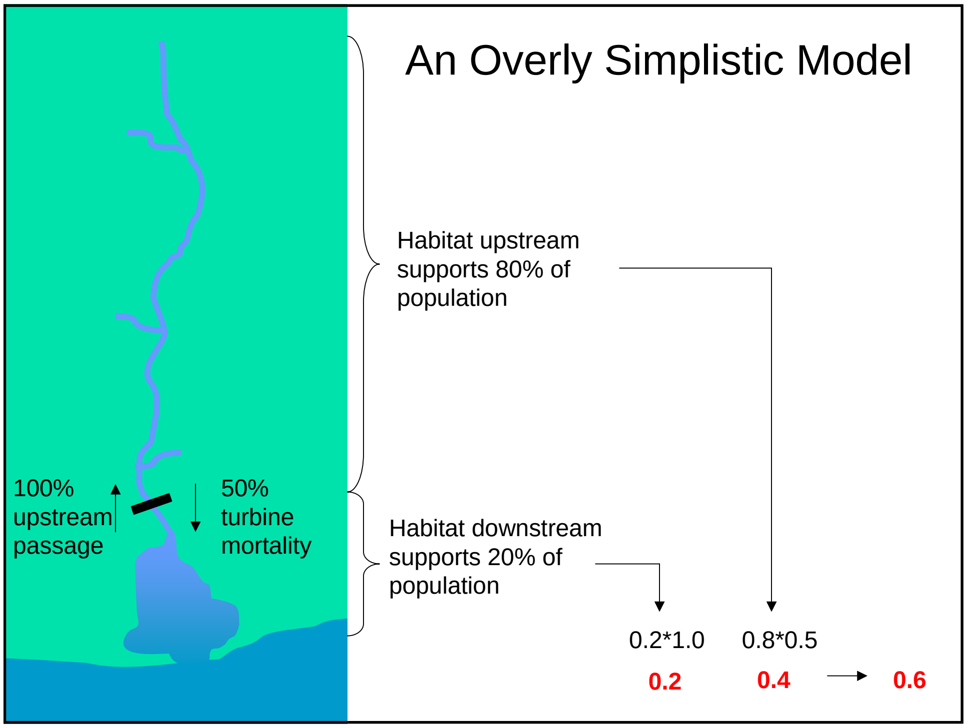
Downstream Migration

Date of emigration is variable



Distance to the spawning area is variable





An Overly Simplistic Model

100% upstream passage

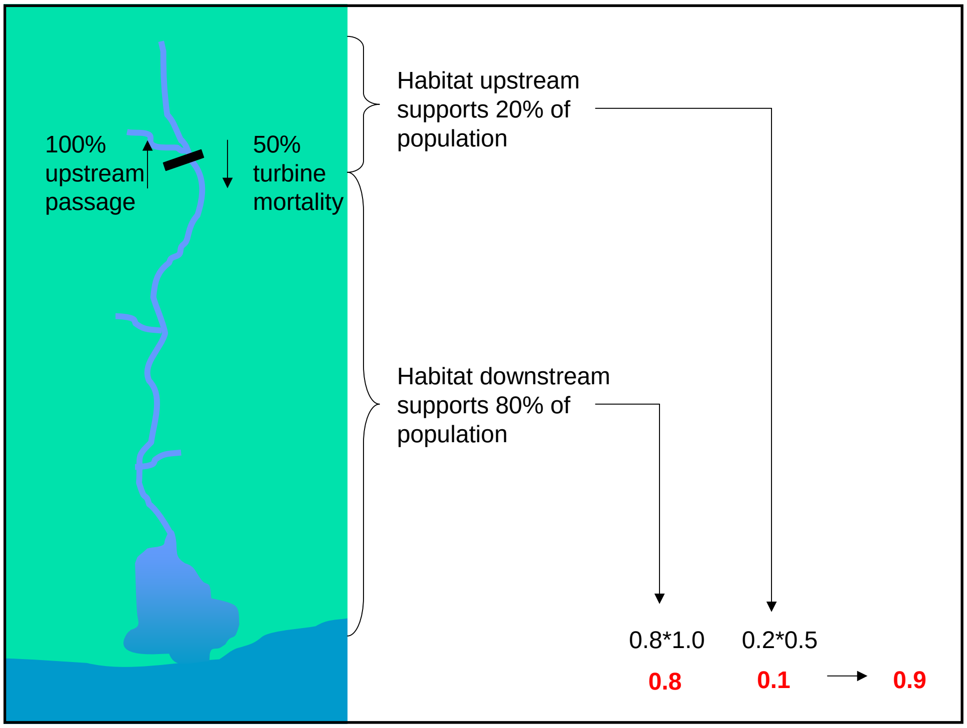
50% turbine mortality

Habitat upstream supports 80% of population

Habitat downstream supports 20% of population

0.2*1.0 0.8*0.5

0.2 **0.4** → **0.6**



100% upstream passage

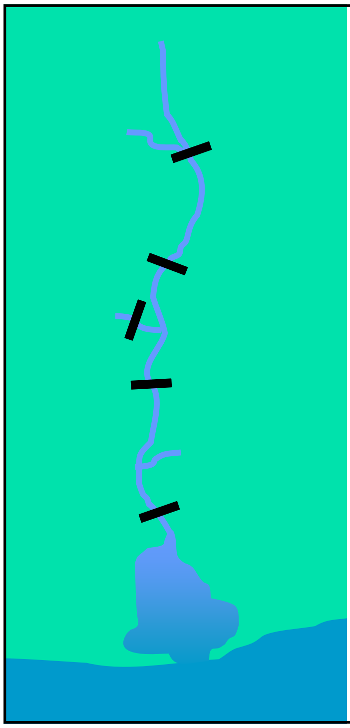
50% turbine mortality

Habitat upstream supports 20% of population

Habitat downstream supports 80% of population

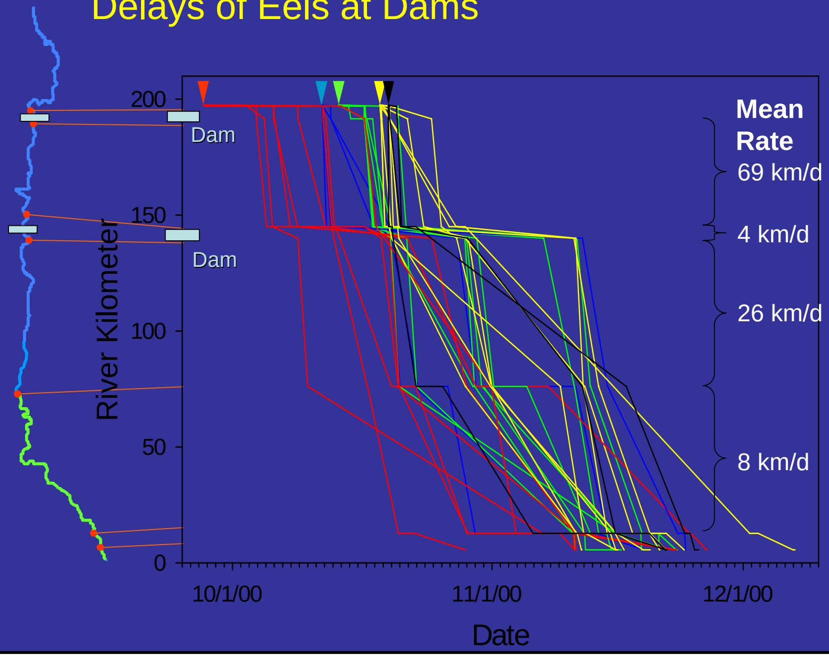
0.8*1.0 0.2*0.5

0.8 **0.1** → **0.9**



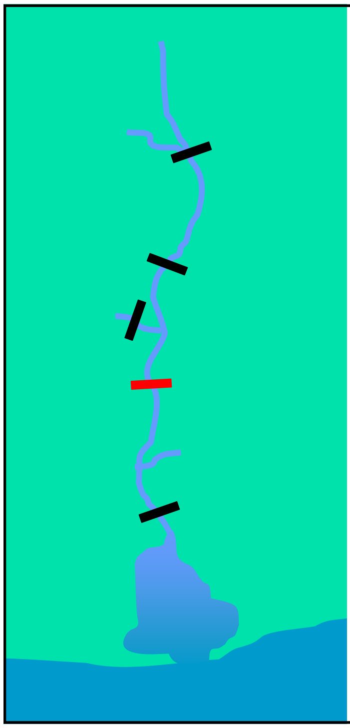
- Model gets very complex with more dams!
- Many parameters unknown (e.g., passage efficiency, potential density, spill mortality)
- Too many assumptions?
- May still be useful as an exploratory tool for comparing scenarios

Delays of Eels at Dams



Questions/Data Gaps – Downstream Migration

- Are migratory timing cues universal?
- What are current levels of “escapement”?
- What is the specific level of threat of barriers at different points in a watershed?
- What are the effects of migratory delay?
- What are the effects of spill mortality*?



Alex’s Crazy Idea #276

Assuming:

1. Downstream passage at a hydro dam cannot be implemented within a reasonable timeframe, and

2. Spill mortality at non-hydro dams is significant,

Mitigate by passage/removal of other dams in the watershed, *if there is a net reproductive benefit*

Some Proposed Directions for Research – *Downstream Passage*

- Quantify spill mortality
- Define extent and effects of migratory delay
- Barriers and guidance structures: current technologies either don’t work, are “too expensive” or “impractical” – what else can be developed?
- Different solutions at different sites
- Should we be developing downstream passage structures/technologies exclusively for eels?

Some Parting Thoughts

- Of all species, eels present the most extensive passage problems geographically
- Level of research effort has been minimal
- These are *international* and *global* problems
- Suggest a multinational research initiative to share information, perspectives and approaches, and to organize funding
- Industry and user groups must be active partners and sources of funding for research

American Eel population is in decline

- Once abundant, American Eel (Anguilla rostrata) numbers dropped sharply in recent times
- Atlantic States Marine Fisheries Commission Plan:

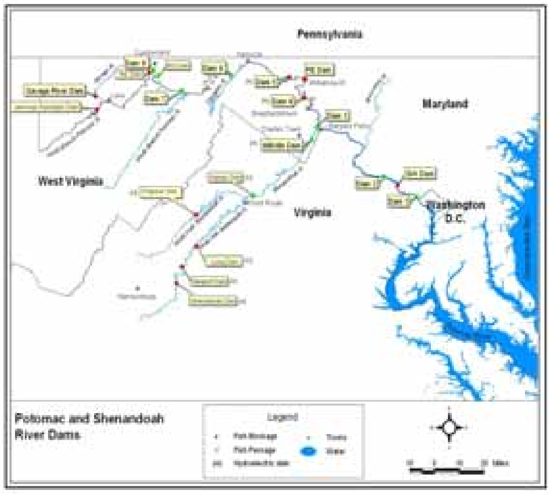
* protect /enhance eels where they still exist

* restore eels to historic habitats

Distribution of American Eel after spawning

- Eels spawn in the Sargasso Sea
- Larvae float on currents up the east coast
- Glass eels feed in estuaries
- Elvers (1yr +) migrate upstream
- Eels mature in fresh water up to 24 yrs before migrating to the sea to spawn

Obstacles to Eel Distribution



- Dams impede upstream migration of eels
- The Potomac River has 10 dams and 3 owners

* National Park Service

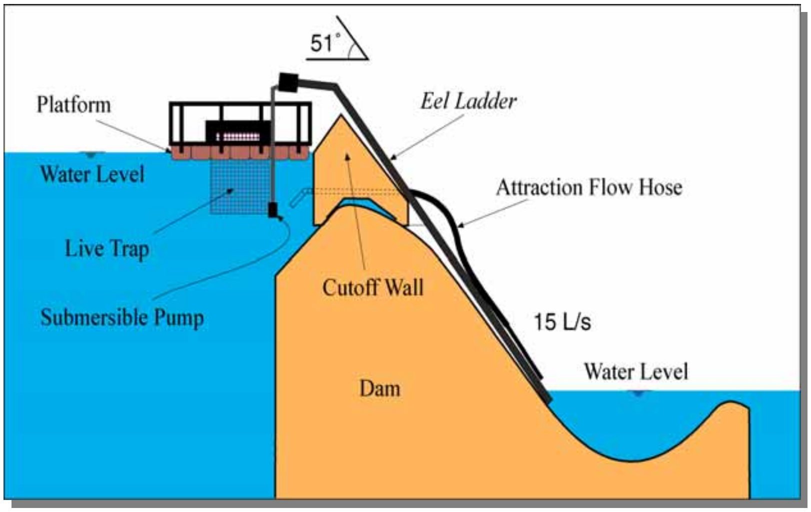
* Allegheny Energy Supply Company

* U.S. Corps of Engineers

- Good opportunity to fully implement ASMFC management plan for eels in the Potomac

Successful Eelways adapted to specific sites

Eel Passageway Components



Eel passage is effective

- Eelway at nearby Millville Dam on the Shenandoah has passed 6,000 eels to-date
- Many eelways are in operation across the eel's range

Chuck Simons, Allegheny Energy Supply Company LLC, with friends

Aqueduct Dam - above Great Falls Potomac River Maryland and Virginia.

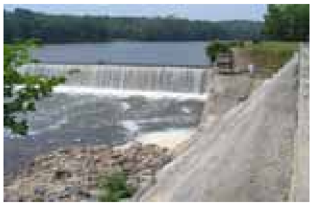
Eel Passage would be helpful at the dam and to keep silver eels from entering the large water intake on Maryland side.

Eel passage needed at Dams 4 & 5

- NPS Dams 4&5 need means to safely pass eels
- Allegheny Energy Supply Company, LLC owns and operates hydroelectric projects at both dams
- Opportunity to access 120 miles of Potomac River habitat for eels

Eelway Considerations at Dams 4 and 5

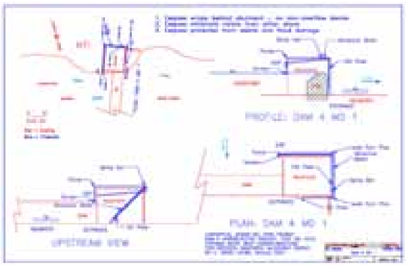
- Historic structures - visual and physical impacts
- Successful eel passage
- Flood and debris damage
- Access to construct, maintain, and monitor
- Power for pumps
- Long-term maintenance requirements
- Safety of staff and visitors

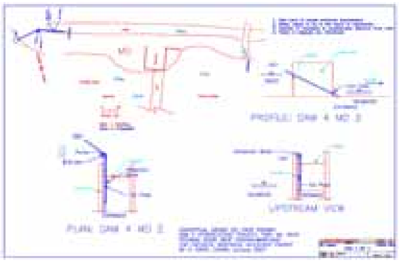


Potomac River Dam 4

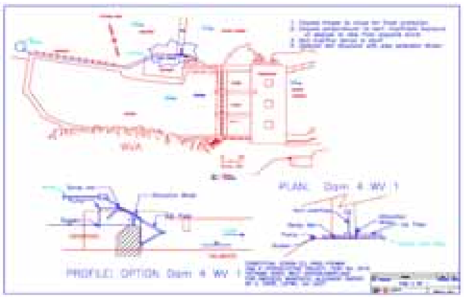
All Eelway Options

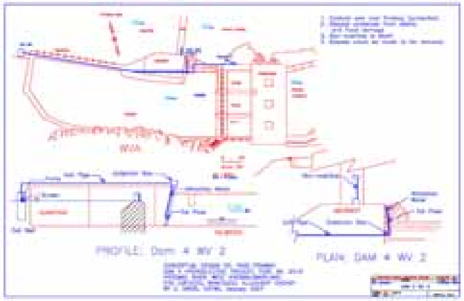
Dam 4 – Maryland Options





Dam 4 – West Virginia Options

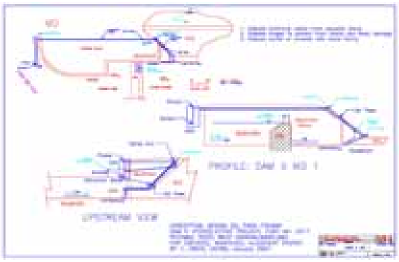


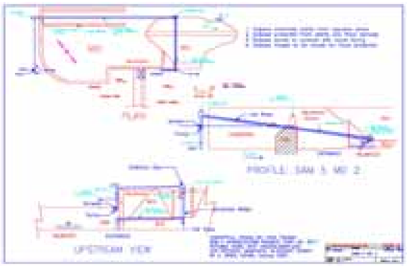


Potomac River Dam 5

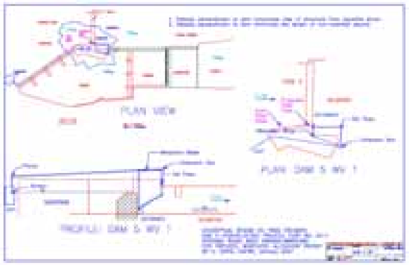
All Eelway Options

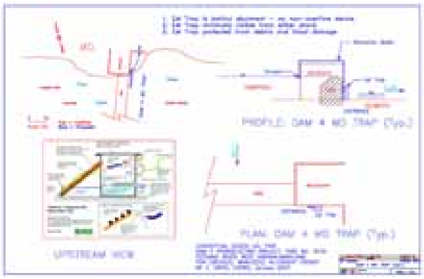
Dam 5 – Maryland Options





Dam 5 – West Virginia Options





Success is eels passing the dams