MINUTES
CHIEF OF ENGINEERS ENVIRONMENTAL ADVISORY BOARD
June 12, 2014
Concord, MA

1. CALL TO ORDER

Mr. John Furry, the Designated Federal Officer (DFO), called the Chief of Engineers Environmental Advisory Board (EAB) meeting to order at 0835 hours, June 12th, 2014 at the U.S. Army Corps of Engineers (USACE) New England District office in Concord, Massachussetts, with Dr. William L. Graf, EAB Chair, presiding. The following EAB members were present:

Dr. Sam Atkinson, Director of the Institute of Applied Science and Regents Professor in the Department of Biological Sciences at the University of North Texas;

Dr. Mary Barber, Senior Research Environmental Scientist at Research Triangle Institute International;

Dr. Melinda Daniels, Associate Research Scientist and Director of the Fluvial Geomorphology Section at the Stroud Water Research Center;

Dr. William L. Graf, Foundation University Distinguished Professor Emeritus of the Department of Geography at the University of South Carolina;

Dr. Rollin H. Hotchkiss, Department Chair, Hydraulics and Water Resources, Brigham Young University;

Mr. Robert S. Joe, City Councilman, South Pasadena, CA, Special Projects Manager, Metropolitan Water District of Southern California (Retired);

Dr. Tammy Newcomb, Senior Water Policy Advisor for the Michigan Department of Natural Resources;

Dr. Kurt T. Preston, Associate Vice Chancellor for Research, the University of Nebraska at Lincoln;

Mr. Charles Simenstad, Research Professor, University of Washington

Mr. Terry Cook was absent

Also present were: LTG Thomas Bostick, Chief of Engineers; Mr. John Furry, EAB DFO; Dr. Robert Brumbaugh, Alternate Designated Federal Officer, EAB; Dr. Elizabeth Fleming, Director, Environmental Lab, Engineer Research and Development Center (ERDC); and, Mr. Christopher Evans, Acting Chief of the Environmental Community of Practice.

2. Welcoming Remarks and Opening Discussion

Dr. Will Graf, who chaired the meeting, said that he looked forward to a good exchange between EAB members and LTG Bostick, the Chief of Engineers. The EAB has been working hard to deliver on the promises made in their work plan. Dr. Graf then asked LTG Bostick if he had any opening remarks for the Board.

LTG Bostick welcomed the new members, and expressed regret that some excellent members will also be departing after the meeting. He said that the Corps has learned a lot from the EAB. He recalled that LTG Frederick J. Clarke created the EAB in the 1970's when the Corps was viewed as an agency which only built infrastructure. Now the Corps values the environment and one of the major missions is to restore ecosystems. All Corps missions are all authorized by Congress on behalf of American people, then appropriations are made, also by Congress, and the Corps does the work. LTG Bostick recalled visiting the Kissimmee River early in his career when he was Executive Officer to the Chief. The Corps had straightened the river, and then Congress authorized the Corps to put the bends back into the river. The intent behind the EAB is to get the best minds in the country to advise the Corps on environmental matters, and to enable the Corps to do the best job possible.

LTG Bostick said that the Corps does not want to choose between environment and infrastructure; these must be balanced and consider the needs of all stakeholders. He mentioned a recent partnership with the Secretary of the Interior and U.S. Fish and Wildlife Service which has resulted in the rejuvenation of the sturgeon population.

LTG Bostick said that he looks forward to EAB's current Chair, Dr. Will Graf, making a presentation to incoming USACE leaders at the upcoming PreCommand Course. Most of these new District Commanders are brand new to the Corps. He thanked the EAB for suggesting this addition to the PreCommand Course, he emphasized that the course is looking for segments to eliminate and a new topic must be something he considers very important to be added. He also mentioned that he focused on the Environmental Operating Principles at his first Senior Leader Conference, and thanked the EAB for their work on those principles.

Dr. Graf reported that the Kissimmee River project is nearly complete now, and should be replicated in other areas. The project serves as a roadmap on how to do this effectively.

3. Introductions and Oaths for New EAB Members

Each person present introduced him/her self.

LTG Bostick reviewed his personal history, stating that he had spent most of his time on combat engineering, then served in Iraq, led a recruiting command, was Head of Personnel, and then became the Chief of Engineers. He feels he has the best job in the world. He again thanked the EAB for volunteering their time and talent to make a difference for the Nation.

Dr. Graf replied that it is a pleasure to work with the Chief. He also complimented Mr. Bill Hubbard and the rest of the New England District staff on their superb efforts in both the field visit and organizing the meeting. He stated that it was the best experience the EAB has had to date.

LTG Bostick led the following new members in a public Oath of Office ceremony (they were sworn in an earlier work session):

Dr. Mary Barber; Dr. Melinda Daniels; Dr. Tammy Newcomb; and, Mr. Charles Simenstad

4. Presentation of Environmental Flows Report

Dr. Graf described the EAB's concerted efforts to improve productivity, and the Environmental Flows Report is one result of this. The report discusses how the Corps can manage outflows from its water control structures to benefit ecosystems. The same structures which previously caused environmental damage can be used to improve the ecosystem, and the proposed adjustments are all within authorized purposes, and do not infringe on benefits to other water uses. The first recommendation in the report was to include the topic of environmental flows in the Pre Command Course, and the second recommendation was revision of water control manuals.

Dr. Graf recognized that there are still uncertainties about impacts of environmental flows. He acknowledged the research capability of the Corps at the Engineer Research and Development Center (ERDC) and the Hydrologic Engineering Center (HEC) at the Institute for Water Resources and suggested that these strengths could be used to solve the problems. The EAB will also apply its own deep thinking to any unforeseen problems. Dr. Graf cited the Sustainable Rivers Project as a showcase effort and recommended expansion of this program.

The Environmental Flows Report was submitted on 24 April 2014. Preliminary responses have been received from Corps staff and a full response is expected within 30 days of the EAB meeting.

LTG Bostick expressed a desire to share the EAB presentation from this year's Pre Command Course with current commanders who may have missed the opportunity to learn about environmental flows.

Mr. Robert Joe suggested that the EAB might also make a presentation at the Senior Leaders Conference. LTG Bostick replied that he would look into this for the August Senior Leaders Conference.

Following Dr. Graf's mention of changing water control manuals, LTG Bostick stated that a lot can be done within the current manuals. However, he was not averse to changing them if necessary. Many stakeholders are involved in the development of water control manuals. It can be difficult to make changes, but LTG Bostick thought the EAB might be able to help. He cited difficulties in California where there is great pressure on water issues. The Corps is in the middle, trying to do the right thing for all stakeholders. He stated that this year the Corps was able to issue some waivers on water control manuals in California.

LTG Bostick described issues encountered during the 2012 drought. There was intense pressure to change releases from Missouri River reservoirs, and much conflict. He said that there is a lot to be learned in this area.

Dr. Graf cited a Savannah River example in which water control manuals were revised to account for a drought plan, and environmental flows were coupled with that change. The Savannah District put together a joint cost agreement, in partnership with The Nature Conservancy, resulting in both a drought management plan and environmental flow rules. Mr. Stan Simpson, of Savannah District, is leading the effort. LTG Bostick suggested highlighting this example and sharing it throughout the command. He asked Savannah District to put together a one-page fact sheet on this.

Dr. Sam Atkinson recounted a discussion on managing low flows which the EAB had with Mr. John Hickey of HEC on the previous day and a suggestion on pulse-release experimentation.
Dr. Elizabeth Fleming stated that it is good to embed a conscious realization of environmental flows into the operations community. She mentioned the Corps Water Management System (CWMS), developed by HEC, and suggested that this might be used along with ERDC models, thus combining a knowledge of hydraulics and ecology. She suggested that water control manuals might be revisited with the aid of

CWMS. She also mentioned a workshop coming up in July at which staff from both HEC and ERDC will be discussing environmental flows.

Dr. Graf stated that the watershed scale is a key to success, and this is the basis of CWMS. He stated that this was much better than the earlier focus on individual projects.

Dr. Fleming mentioned alternative financing and how the Savannah example cited earlier has used this. Dr. Rollin Hotchkiss observed that many Corps employees see the value of and are eager to embrace environmental flows; they just need information and guidance on how to implement the concept and of course the authority to implement the changes.

LTG Bostick replied that for example, that on the Columbia River, many including the lock and dam operators understand salmon issues and needs. He also emphasized the inadequacy of federal dollars for all work that needs to be done, and thus the need to find other sources of funding. He mentioned an April meeting with experts on alternative financing. He stated his commitment to alternative financing, and his intention to put a person in charge of this who does it every day, and to provide them with staff support. He cited the example of the Army's Residential Communities Initiative which is building and improving Army base housing. There is a need to find other public private partnerships. LTG Bostick stated that he is leading this effort in USACE and looks forward to working with the EAB on this.

5. Remarks by EAB on New Tasks the Board is initiating

Task 1 - Managing Ecosystem Restoration projects.

Sub-Task 1-1. Prioritization Criteria for Ecosystem Restoration Projects. Dr. Sam Atkinson reported that this task is focusing on how the Corps can select specific projects that are top priority. Criteria will also be proposed for prioritization of all the approximately 600 authorized projects and how to find the top 10%. The EAB is working on criteria that would be useful at both District and HQ levels.

Sub-Task 1-2. Defining the Federal Interest for Aquatic Ecosystem Restoration Projects. Dr. Atkinson reported that this task is focused on defining the federal interest. The EAB is considering this in terms of systems.

Sub-Task 1-3. Redefinition of Economic Value for Ecosystem Restoration Projects: Ecosystem Goods and Services. Dr. Mary Barber reported that this task is focusing on measuring the economic value of ecosystem goods and services. It is not limited to just economic, or dollar, values but all values. The EAB is reviewing work of ERDC and IWR on this topic. The EAB will have input from USACE experts on ecosystem goods and services at the next work session. They will also keep in mind the cross-cutting themes of climate change and invasive species as they consider this task. The EAB will be scoping with the Corps on what would be the best thing for EAB to do, and how their reporting would be most meaningful. The EAB is at the beginning of this process now.

LTG Bostick replied that this is an important area, and he looks forward to the EAB's outside look on this. He stated that he needs to articulate these values to Congress, and this is a challenge. It is often difficult to defend the budget, and he appreciates anything the EAB can provide.

Dr. Fleming mentioned that ERDC did a retrospective look at which benefits have been realized from ecosystem restoration projects already completed. This effort measured the actual impacts of ecosystem restoration.

Dr. Tammy Newcomb commented on the need to incorporate social, economic, and environmental benefits, and the importance of quality of life benefits. She stated that local impacts of an improved environment spill over into quality of life for the residents.

LTG Bostick echoed the real value of quality of life, and reprised the Army housing example. He cited the Army's Residential Communities Initiative as a good example.

Task 2. The Nation's Aging Infrastructure and Aquatic Ecosystem Integrity. Dr. Melinda Daniels reported on this task. The EAB intends to meet with the Corps' asset management team, and discuss how plans are made to handle aging infrastructure. The EAB will look for opportunities to improve the ecosystem as these improvements to infrastructure are made. Ecosystem restoration may be a selling point for upgrade and replacement of infrastructure – an additional benefit. The EAB is just beginning work on this task.

LTG Bostick expressed support for this task and looks forward to the results.

Task 3. STEM (Science, Technology, Engineering, and Mathematics): Increasing the Corps' Outreach. Dr. Kurt Preston provided an update on the EAB's STEM activities. He thanked Carla Shamberger (Corps Lead Human Resources Specialist) for her help. Dr. Preston stated that the U.S. ranks 14th in world for engineer production, so STEM efforts are needed. President Obama's administration is working to consolidate all federal stem programs, since there are over 100 of them. However, none of these focus on departing veterans who have STEM degrees to encourage them to pursue graduate studies in STEM fields. Both military service and higher education are important social mobility pathways for minorities. And Dr. Preston reported that the Veterans Administration benefits now do include graduate studies. As the Associate Vice Chancellor for Research, the University of Nebraska, he has submitted a proposal to the National Science Federation to fund a study which looks at this issue. Dr. Preston suggested that the Chief is in an excellent position to promote this initiative.

LTG Bostick concurred. He stated that he is passionate about this and will do whatever he can in this area. He mentioned that the Corps has brought in wounded warriors as employees. On the proposal to target soldiers who are leaving military service -- LTG Bostick said that the Corps/Army would need to contact them before they leave and inform them of these options for further study.

Task 4. Cross-Jurisdictional Options for Partnerships. Dr. Tammy Newcomb reported that the EAB will be making recommendations for implementing successful partnerships in the ecosystem restoration areas. They will be looking at the Corps in various roles, including as a leader, a facilitator, and sometimes just as a partner. The effort intends to capitalize on joint funding and outside expertise. At this time the task is just starting. EAB members are collecting baseline information and talking to key partners who have worked with the Corps.

LTG Bostick responded that this is another important area, which he also strongly supports. He stated that the Office of Management and Budget (OMB) doesn't fully appreciate the benefits of partnering and working at the watershed level, and we need to try to understand their concerns. LTG Bostick believes partnering is the way to go. He cites as an example the Folsom Dam partnership with the Bureau of Reclamation.

6. Ongoing Tasks – EAB Remarks and Expert Presentations

Removal of Low-Head Dams. Dr. Rollin Hotchkiss summarized the EAB's work in this area. It is focused on the Corps 404 permitting process. EAB is suggesting a nationwide permit for dam removal. At this time some dam removals can be processed under Nationwide Permit 27, but this permit is not specific to dams and many people do not realize that it can be applied to dam removal.

Presentations were then made by two invited experts. The first was "Assessing Dams for their Effects on Aquatic Connectivity in the Eastern United States" by Eric Martin, an Analyst/GIS Specialist with The Nature Conservancy. (PowerPoint presentation is attached)

In the discussion which followed the presentation, several questions were posed by EAB members.
First, "How did The Nature Conservancy build a partnership on dam removal? Answer: We contacted state agencies, and asked each to assign a biologist to the effort.
Second question: Is this connected to national fish habitat initiative? Answer: Not directly
Third question: How did you do removal prioritization? Answer: by many iterations
Fourth question: Have you thought about the cost of removal, or done an economic analysis relating benefits to costs? Answer: no
It was mentioned that ERDC has prepared a portfolio analysis. Dr. Hotchkiss asked if a copy could be provided.

The second presentation was "Local and Watershed Scale Impacts of Dams and Dam Removal in the Connecticut River Basin" by Dr. Frank Magilligan of Dartmouth College. (Powerpoint presentation is attached)

Dr. Magilligan emphasized that most dam removal at the present time is driven by opportunism. A question was asked, "Why do you see the Corps as leading the monitoring following dam removal? Answer: It is a national issue and the Corps has the capability.
LTG Bostick commented on this that a Corps mission on monitoring following dam removal would need to come from Congress. The Corps would need to be authorized to do this.
It was clarified that the Corps does have the authority to remove dams for ecosystem restoration under the Section 206 Continuing Authorities Program, and that a special Continuing Authorities Program for dam removal could be proposed.

7. Comments by Departing EAB Members.

Mr. Robert Joe thanked the Chief and the Corps. Serving on the EAB was a wonderful experience, and he had wanted to be on the EAB, since he worked at the Corps. He thanked the Chief for his true commitment.

Dr. Will Graf stated that serving on the EAB gave him an opportunity to see his science and research made real by interacting with Corps staff and the Chief. It was a good feeling. He thanked the Chief and the Corps.

LTG Bostick stated that it was a bittersweet day for him. He recalled his first EAB meeting, and said that he always looks forward to EAB meetings because he learns so much. Mr. Joe, Dr. Graf, and Mr. Cook (who was not able to be present) have all made a difference and he thanked them for their service.

8. Presentation of Awards.

LTG Bostick presented the Outstanding Civilian Service Medal to Dr. Graf, Mr. Joe, and Mr. Cook (in absentia).

9. Public Comments.

Mr. John Furry (DFO) asked if anyone wished to make a public comment. There were none.

10. Closing Remarks and Adjournment

Dr. Graf and the EAB recognized Mr. John Furry, the Designated Federal Official, who had provided invaluable support to EAB, and is scheduled to retire from federal service on 1 August 2014. Mr. Furry helped the EAB to navigate the bureaucracy and it has always been a pleasure to work with him.

Dr. Graf transferred the EAB Chair to Dr. Rollin Hotchkiss, effective 20 July 2014. Dr. Sam Atkinson will assume the position of Vice Chair.

LTG Bostick stated that it had been a great session. He then mentioned the Hurricane Sandy Comprehensive Study, which examined the future on the northeast coast in terms of building resilient communities. He stated that the lessons learned there will help us inland as well, and suggested that the EAB be given a briefing on this draft report.

LTG Bostick thanked the presenters and complimented the EAB on their progress on their work plan. He expressed deep appreciation to the EAB members for contributing their time. He also thanked the New England District for an outstanding job on the field visit and meetings.

The DFO adjourned the meeting at 11:35 AM.

Wm L. Graf date 7/18/2014
WILLIAM L. GRAF, Ph.D.
Chairman, Chief of Engineers Environmental Advisory Board

Posted to:
The CoE EAB webpage & The Federal Advisory Committee Act (FACA) databases on 7/21 2014
John C. Furry, Designated Federal Officer
Chief of Engineers Environmental Advisory Board

Aquatic Connectivity Assessments & Tools

Erik Martin
The Nature Conservancy, Eastern Division
emartin@tnc.org

June 12, 2014
USACE Chief of Engineers Environmental Advisory Board

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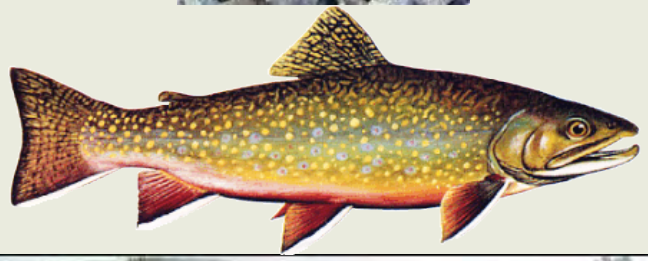
Fish and Wildlife Need to Move

- Dams provide many societal benefits
  - Recreation, electricity, flood control

F&W need access to different habitats for:

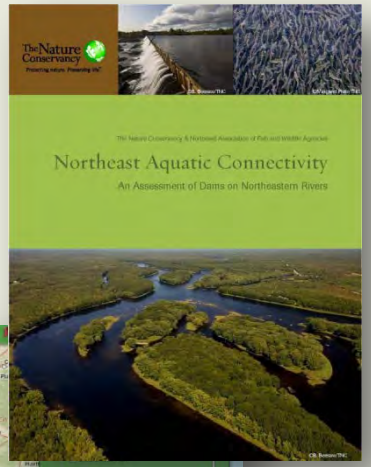
- Lifetime needs
  - spawning habitat
  - nursery habitat
  - adult habitat
- Seasonal needs
  - refuge from heat or cold
  - different food sources

- Humans introduce barriers
  - Legacy of industrial past
- How do we prioritize?
  - Limited funds

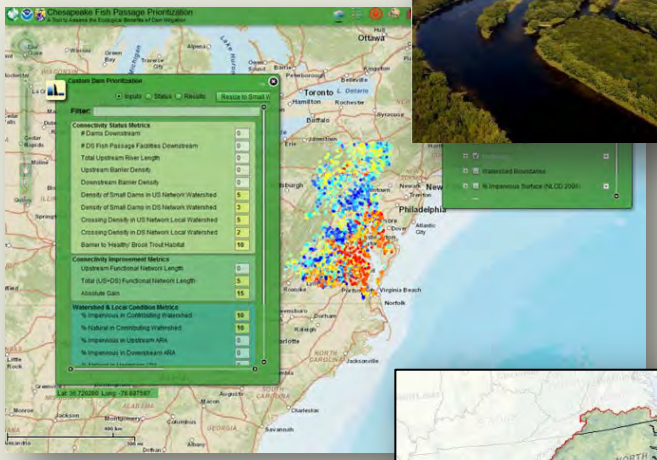


TNC Eastern Division
Aquatic Connectivity Projects

- Northeast Aquatic Connectivity
  - http://rcngrants.org/content/northeast-aquatic-connectivity



- Chesapeake Fish Passage Prioritization
  - http://maps.tnc.org/EROF_ChesapeakeFPP



- South Atlantic Aquatic Connectivity Assessment & Tool
  - http://www.southatlanticlcc.org/page/projects-1?projectid=1465119

Purpose & Goals

- Help states to move from *opportunistic to* "***ecological-benefits***" approach to dam removal / fish passage improvement
- Produce a ***tiered list*** of dams based on their potential ecological benefit if removed / improved passage
- Develop a ***tool*** that allows managers to re-rank dams at multiple scales (state, HUC, etc) or using attribute filters (river size class, dam type, etc)

Workgroup

- Workgroup engagement critical at every step of the process
  - Data collection
  - Key decisions
  - Result review

Methods

Image: imjustcreative\Flickr Creative Commons

Conceptual Approach

- Calculate a host of metrics for every dam & allow users to weight the relative importance of each metric for their purposes

On a size ‘3b’ river

15 miles connected river upstream

2 rare mussel spp in watershed

40 total river miles upstream

Current habitat for 3 Anadromous species downstream of dam

2 other dams downstream

3 road crossings/acre in upstream watershed

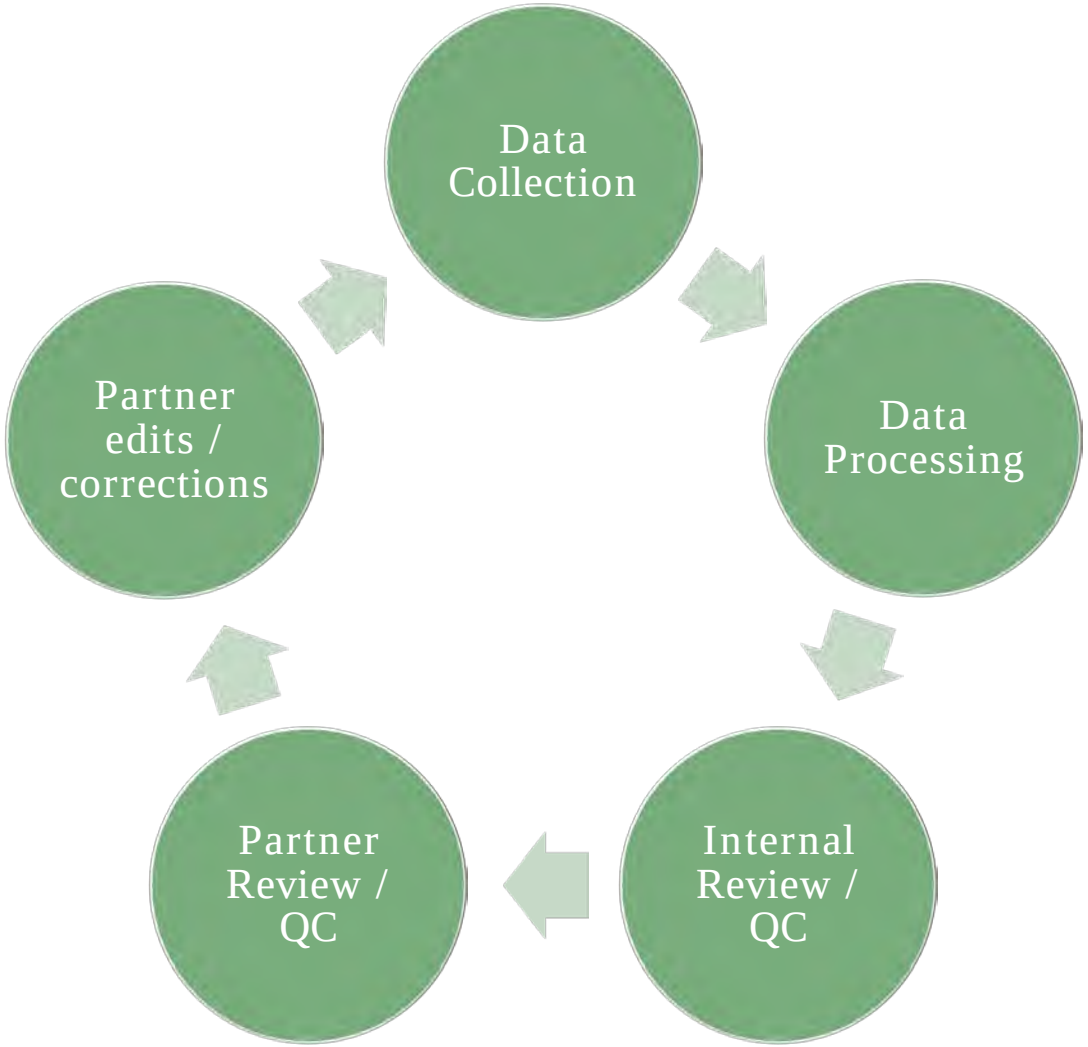
4% Impervious in upstream watershed

90% natural LC in upstream watershed

In a watershed with healthy brook trout populations

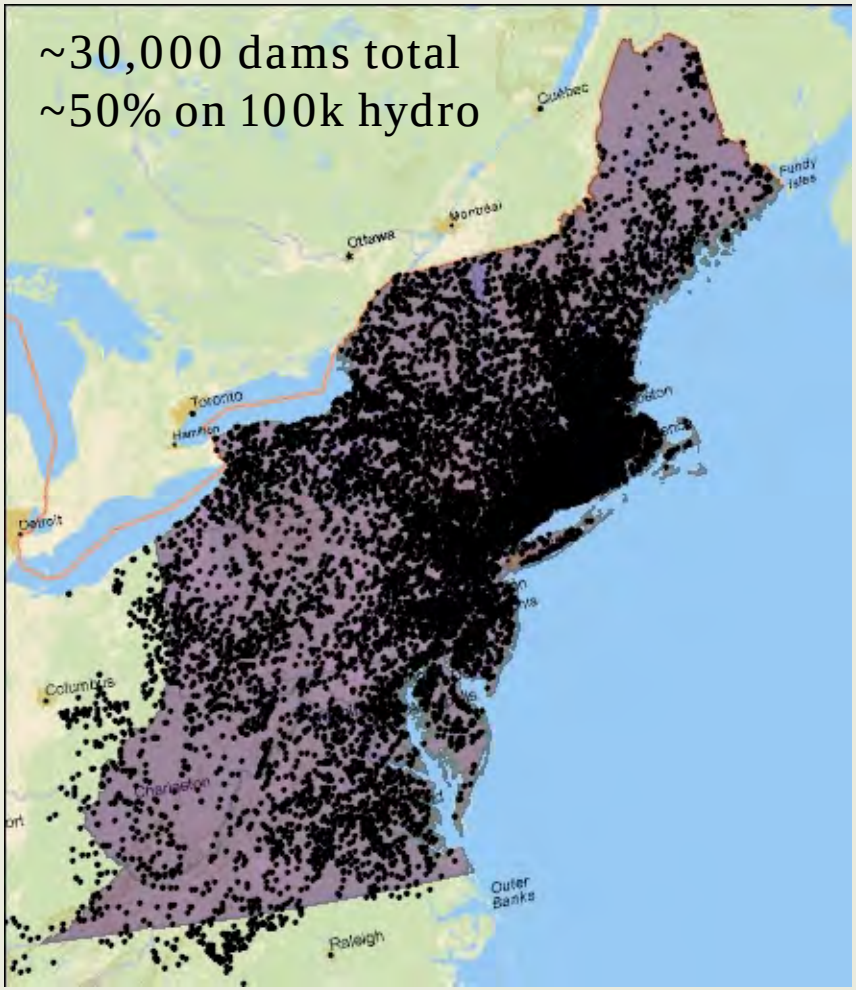
Data Preparation - GIS

- Dams
- Natural Waterfalls
- Anadromous Fish Habitat



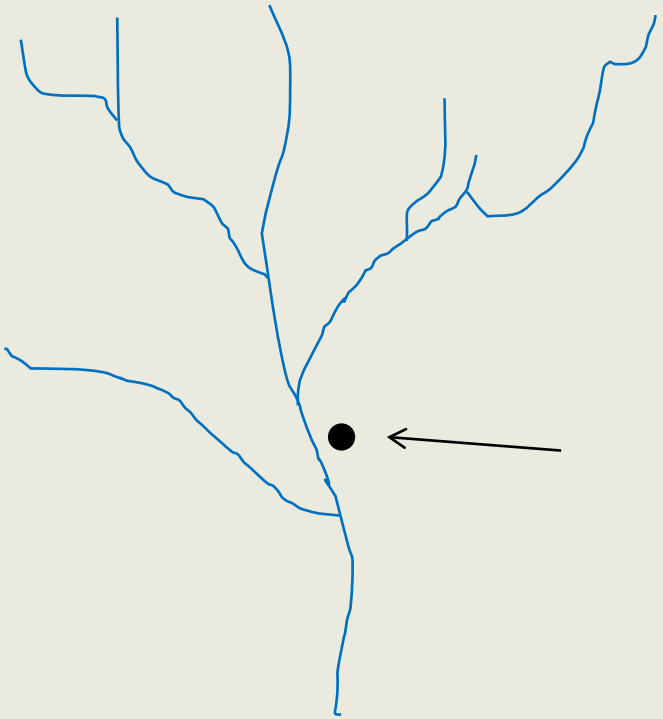
Dams – Primary Unit of Analysis

- Sources:
  - State databases
  - NID
  - GNIS
- 'Snapped' to 1:100k NHD Plus
  - Has the potential to introduce error: farm pond next to a mainstem river
- TNC manually reviewed flagged dams
- Sent to state contacts for additional review / where TNC unable to make a determination



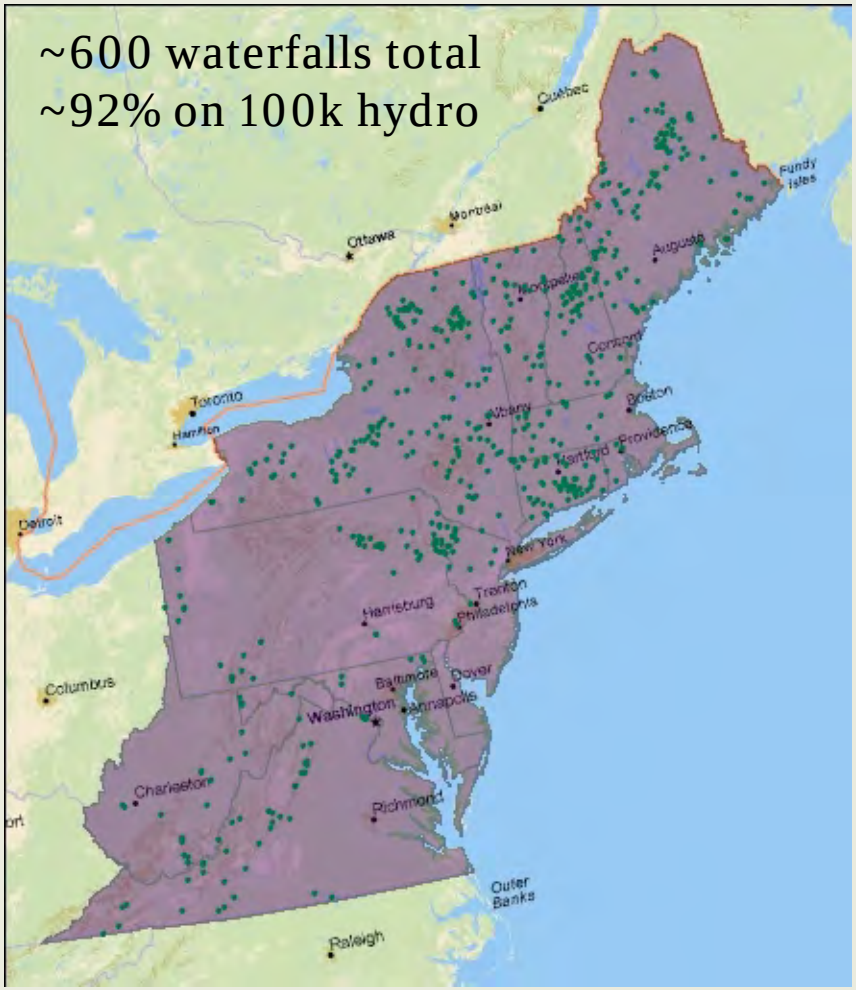
‘Snapping’ Dams

- ‘Snapped’ Hydrography
  - Has the potential to introduce error: farm pond next to a mainstem river
- Automatic review flags → manual review
- Sent to state contacts for additional review / where TNC unable to make a determination

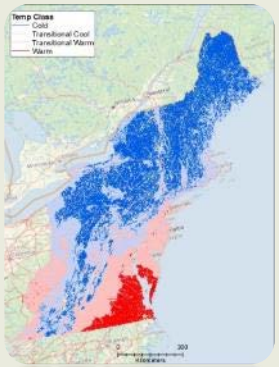


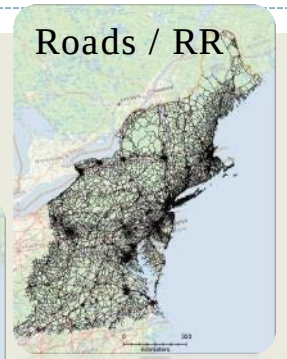
Waterfalls

- Sources
  - GNIS database
  - State biologists
- Snapped to 100k NHDPlus
- More limited review
  - Fewer attributes available (e.g. no RiverName to compare)
  - Less comprehensive data

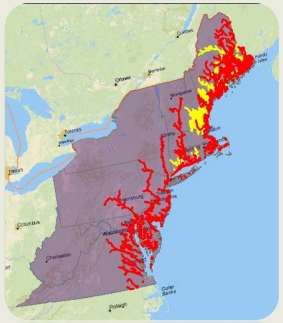


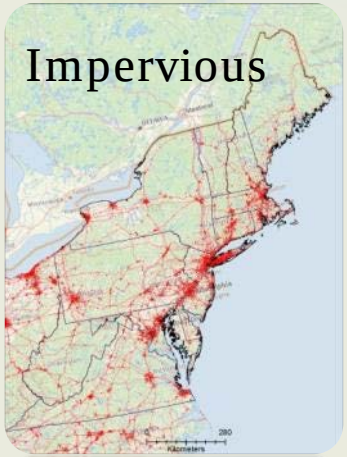
Additional Data





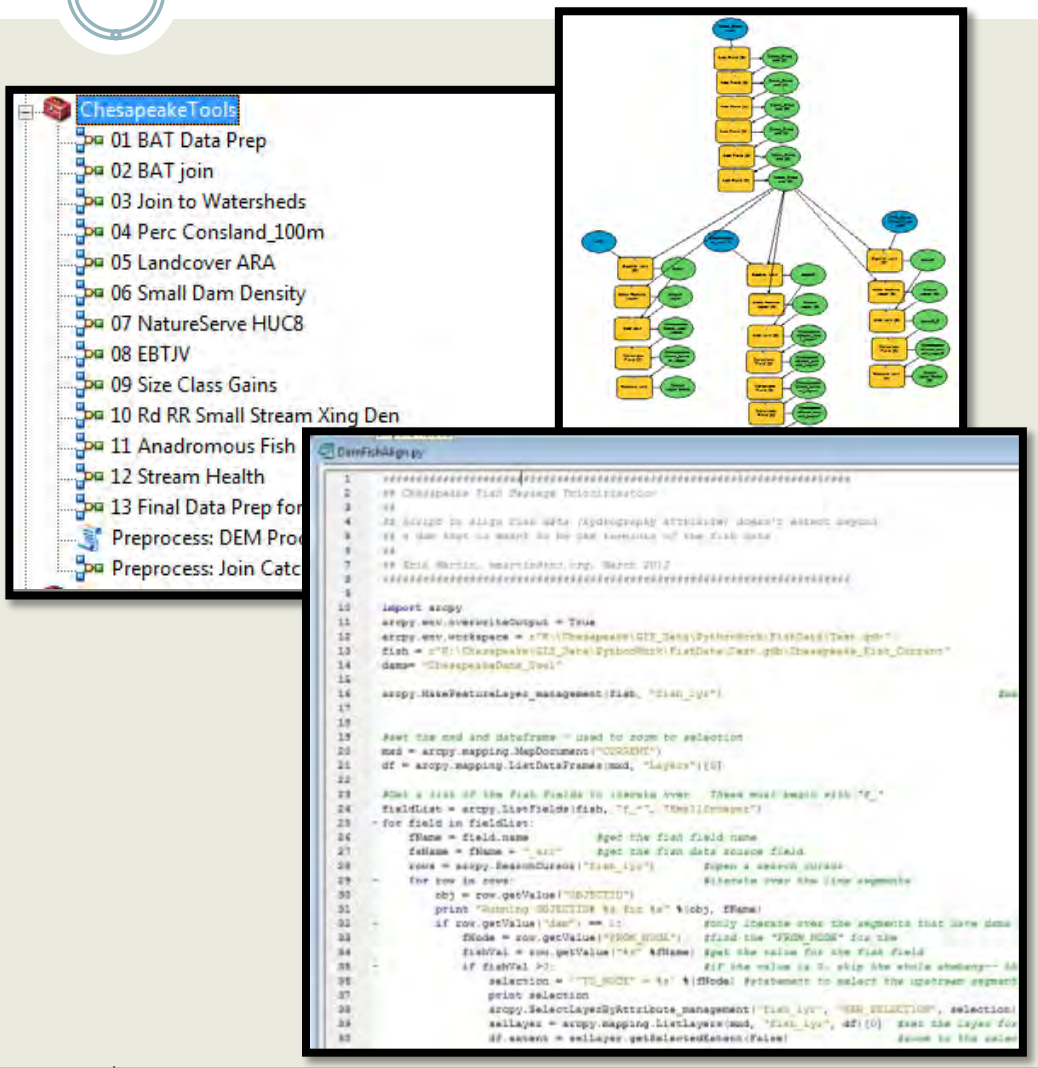
Eastern Brook Trout JOINT VENTURE
A Fish Habitat Partnership





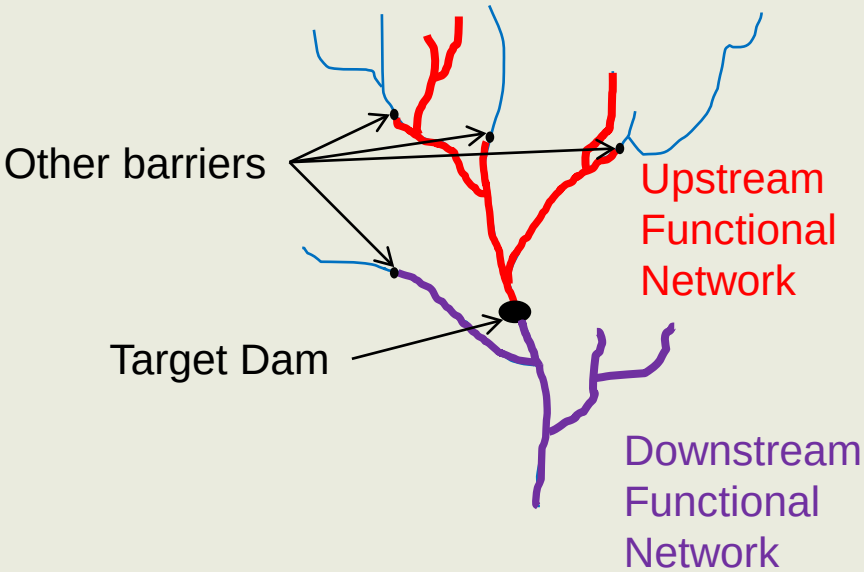
Metric Calculation (Desktop GIS)

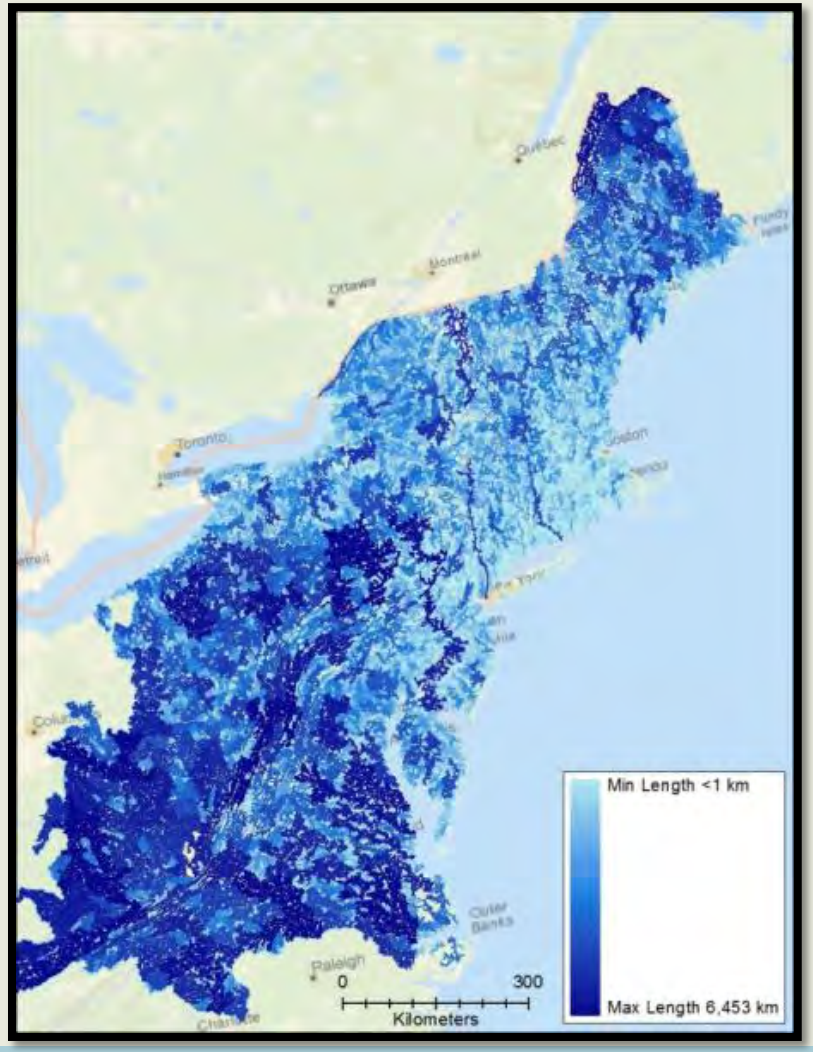
- Metrics: **Descriptive attributes** for all dams
- Lots of geoprocessing. Automated/documented with models & scripts
- Result: table where each **row is a dam**, each **column is a metric**



Metrics Assigned to Dams

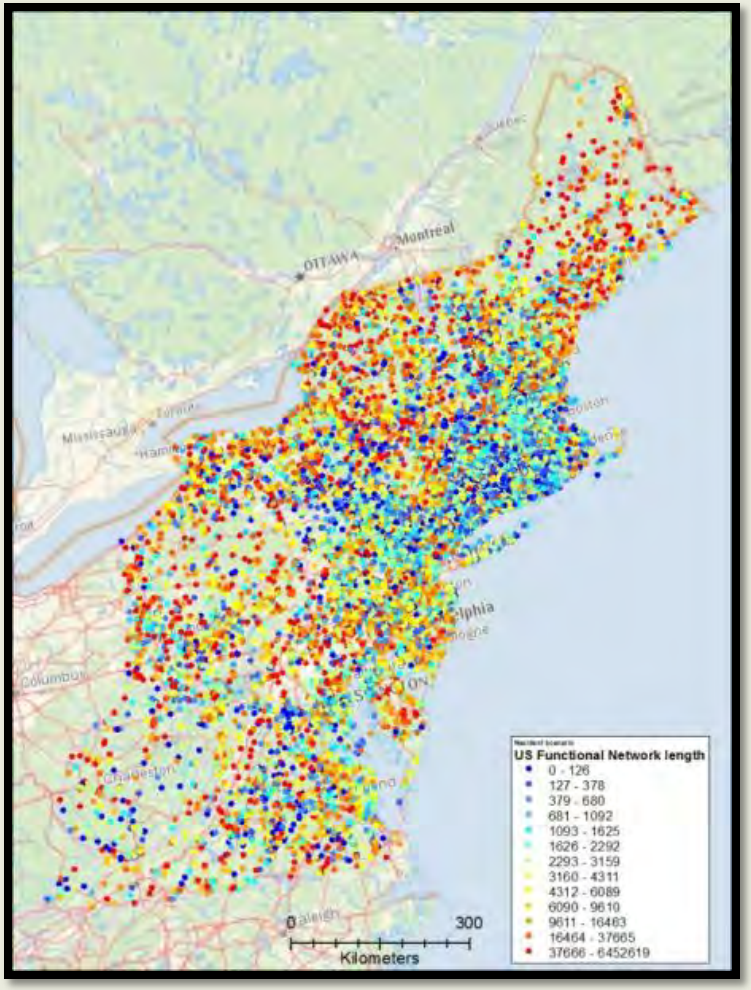
- "Functional" River Network length





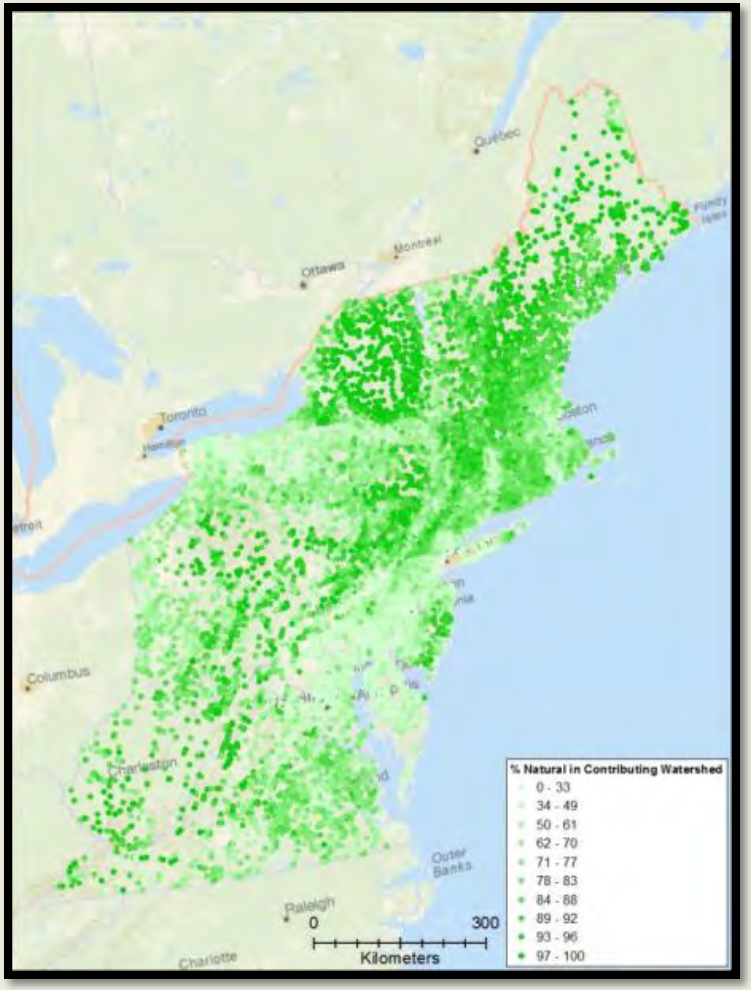
Metrics Assigned to Dams

- Upstream Functional Network Length



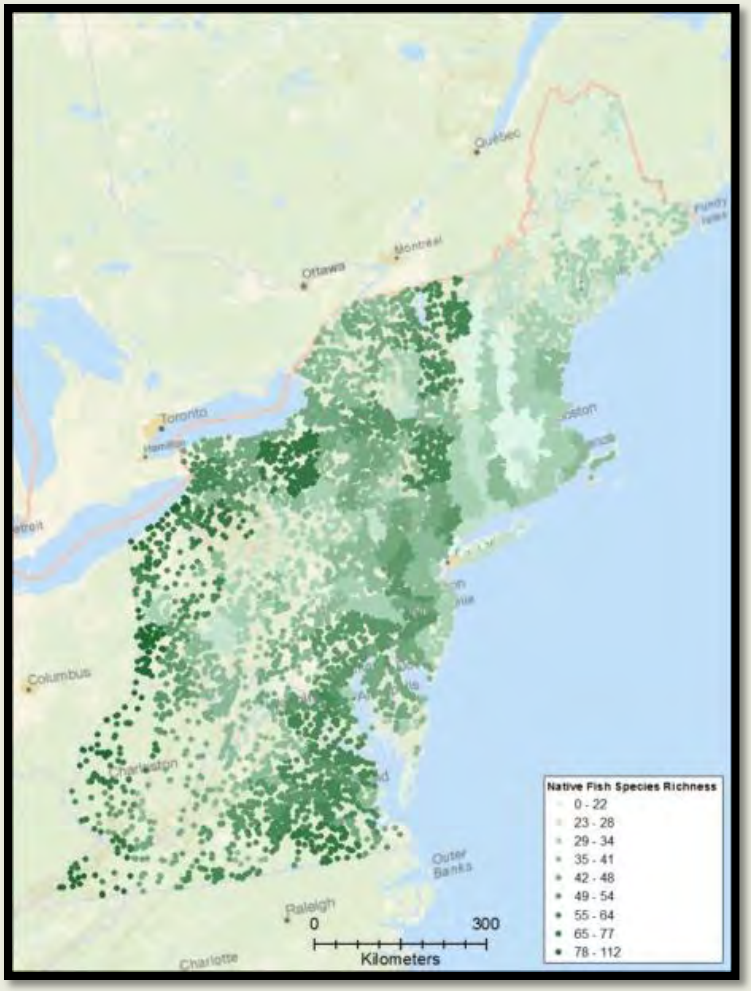
Metrics Assigned to Dams

- % Natural Landcover in Watershed



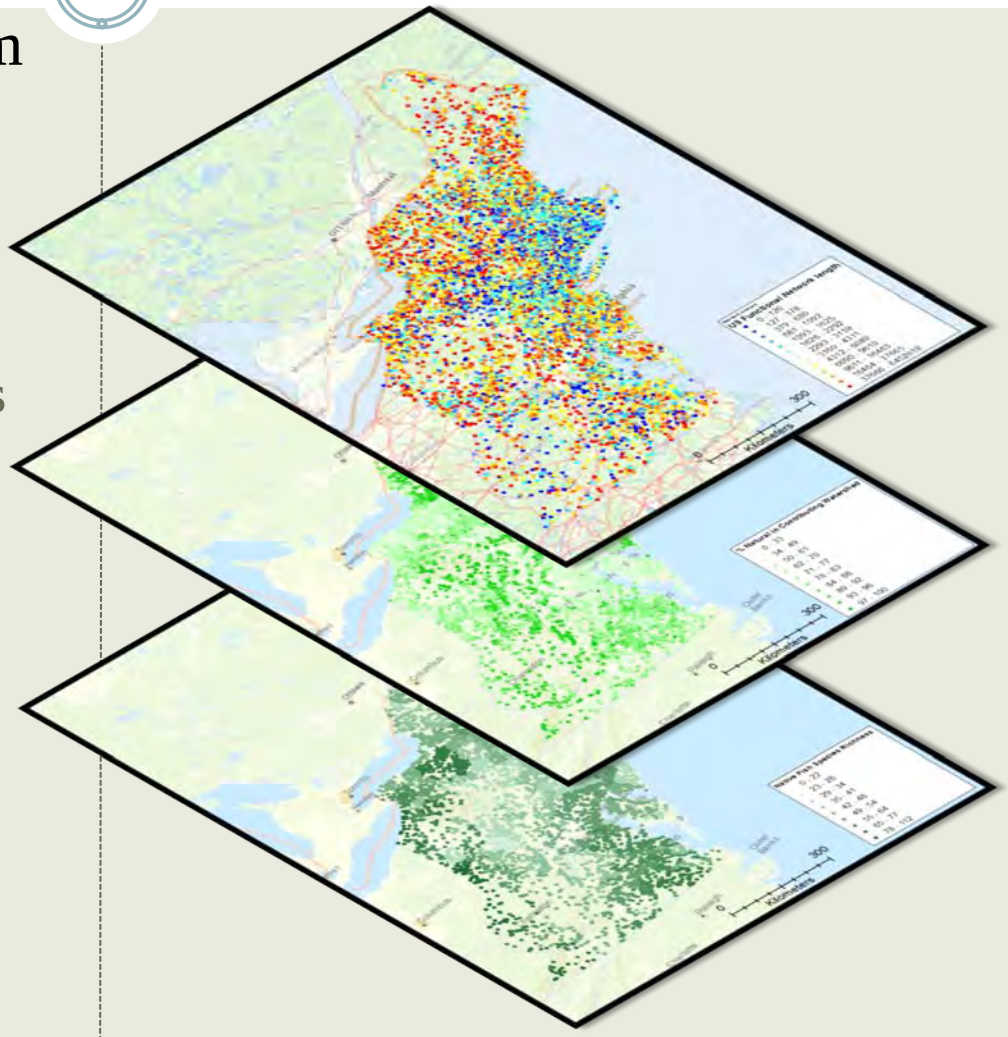
Metrics Assigned to Dams

- Native Fish Species Richness



Metrics Combined

- The hypothetical ‘best’ dam would have….
  - The longest functional networks
  - 0% impervious surface in its watershed
  - 100% natural landcover
  - All anadromous species downstream
  - The most rare fish
  - The greatest diversity of native fish
  - Etc., etc., etc.,



But… Not all metrics are of equal importance

Metric Weights

Metric Category	Metric	Diadromous Weight
Connectivity Status	Density of Road & Railroad / Small Stream Crossings in Upstream Functional Network Local Watershed	5
	# Dams Downstream	10
	Total Upstream River Length	10
	# Fish Passage Facilities Downstream	5
Connectivity Improvement	Upstream Functional Network Length	10
Watershed / Local Condition	% Impervious in Upstream Network Active River Area	5
	% Natural in Upstream Network Active River Area	5
	% Impervious in Contributing Watershed	5
Ecological	# Diadromous Spp in DS Network (incl Eel)	10
	Presence of Anadromous Spp in DS Network	20
	CBP Stream Health	10
Size / System type	# Upstream Size Classes >0.5mi gained	5

Subjective process: *Defining & quantifying your objectives*

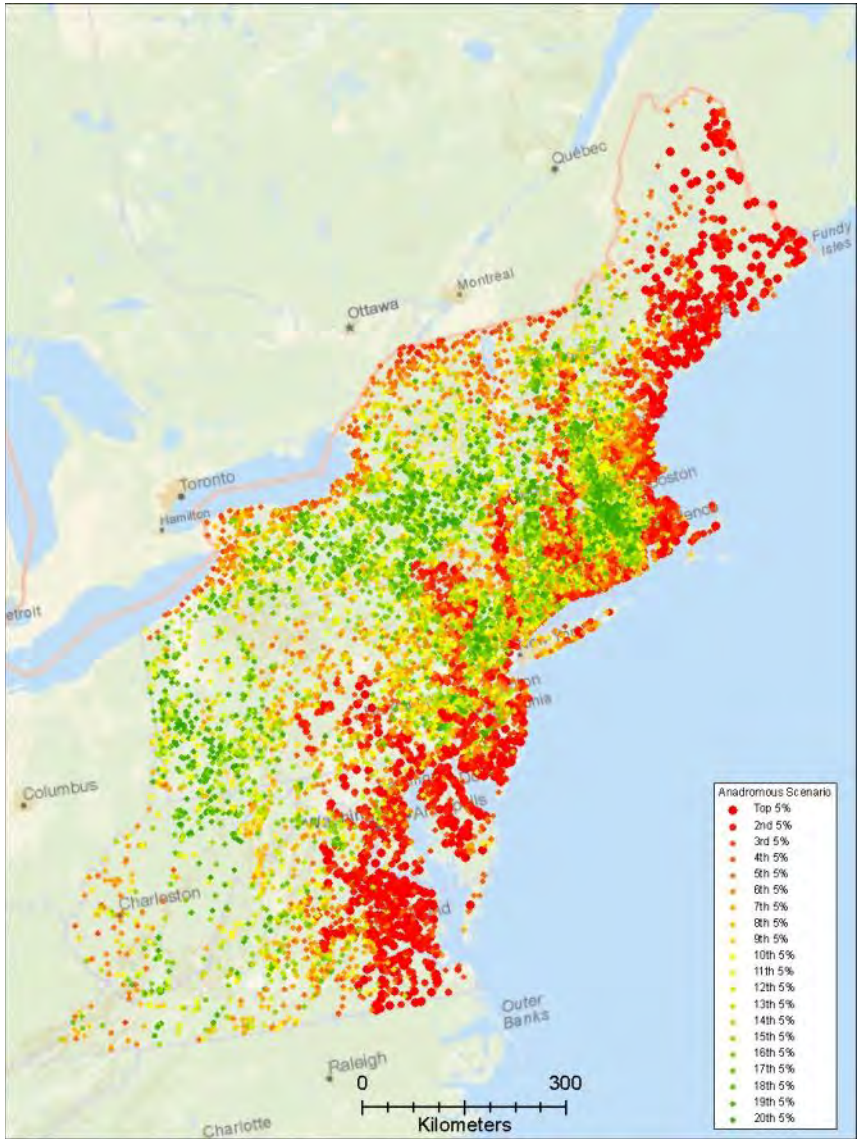
Anadromous fish weighting scenario

Results tiered into 5% bins-- the precise order isn't as meaningful as the broad order

Driven by

Anadromous fish data

Upstream network length

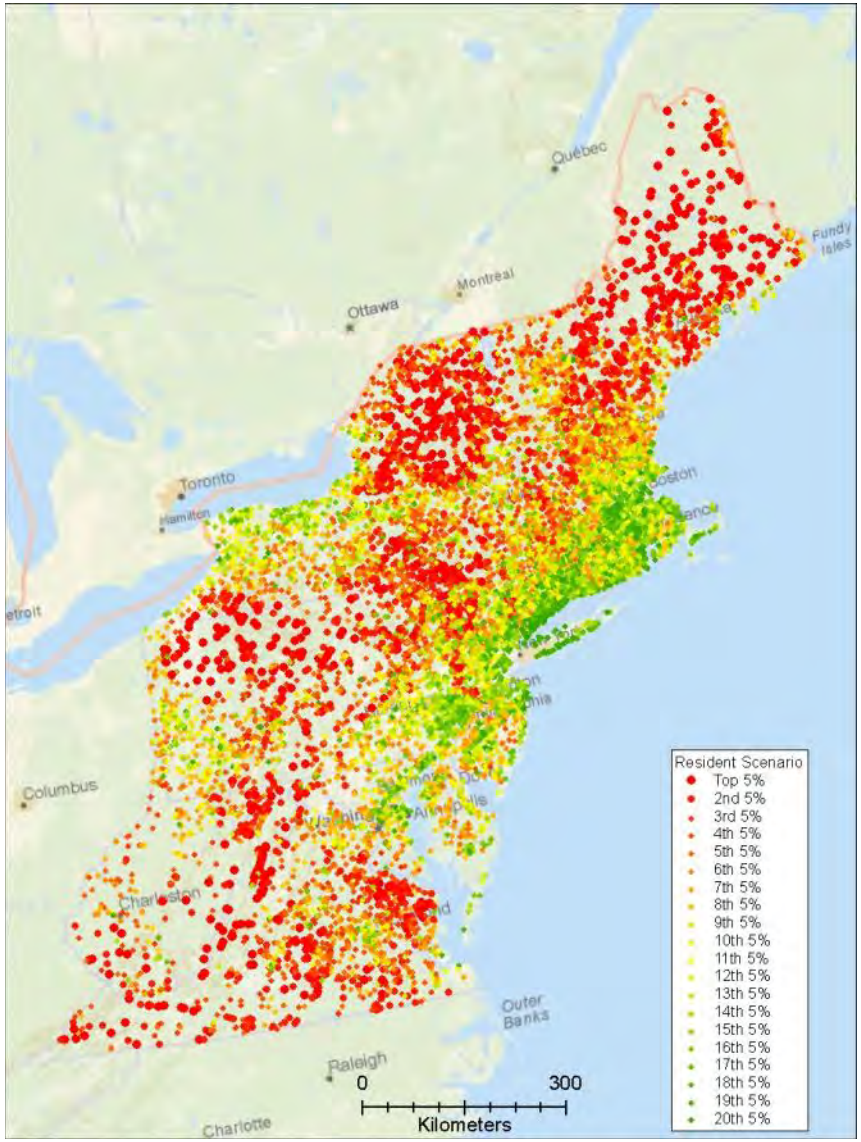


Resident Fish Weighting Scenario

Driven by:

Total length of re-combined connected network

Watershed metrics (e.g. landcover, impervious surface)



Caution: these results…

- Are **not** a hit list of dams
- Are **not** a replacement for site-specific knowledge and field work
- Do **not** incorporate any social, economic, or feasibility factors
- Do **not** incorporate every possible aspect of potential ecological benefit

- **Are** a screening-level tool
- Use the **best available** data
- **Help** inform on-the-ground decision making

Result Uses

- Database of ecologically relevant metrics
- Project evaluation
  - Basis for state-specific work (CT – Steve G)
  - American Rivers (Chesapeake)
- Communicating with owners/funders
- Grant writing / Fundraising
  - TNC CT Basin
- Bring attention to new projects that may not have been looked at before
- Developing basin-level plans
  - Conte refuge
- Local-level communication
- Inform advocacy efforts
- Stimulate proactive action rather than opportunistic removals
- ASMFC Uses

Long term vision

- A **unified database** of dams along the eastern seaboard
  - Re-run Northeast &
  - Merge with SE
- host of **network and ecological characteristics** calculated for all dams
- **ranked** by their potential to benefit diadromous fish species.
- A web-based tool for running **custom analyses** based on user-defined parameters & extent

Local and Watershed Scale Impacts of Dams & Dam Removal in the Connecticut River Basin

A. National trends in dam removal

B. Census of dam removals in New England

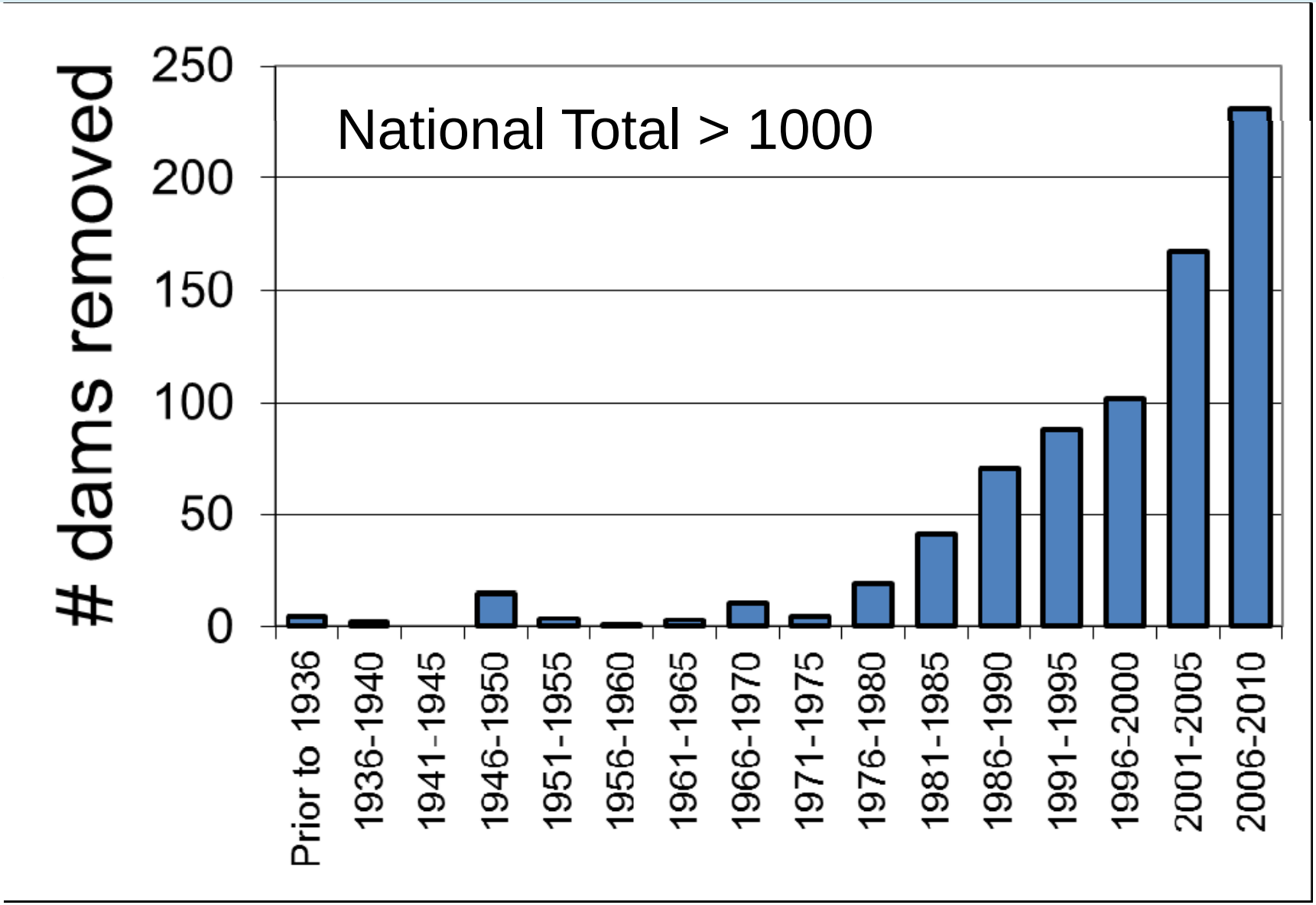
A. Dam Removal as river restoration strategy in New England

D. Geomorphic Attributes of New England
1. *Boundary conditions*
2. *Initial conditions*

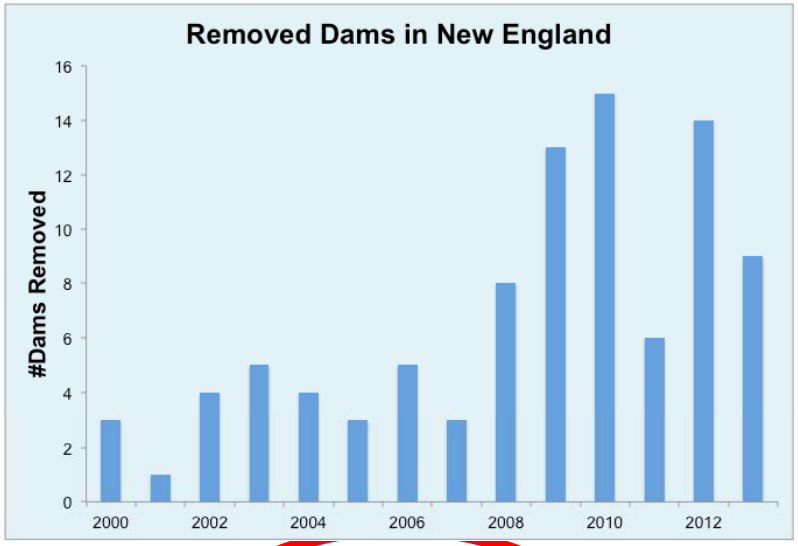
E. Role of the Corps in river restoration

Frank Magilligan, PhD
Department of Geography, Dartmouth College
magilligan@dartmouth.edu

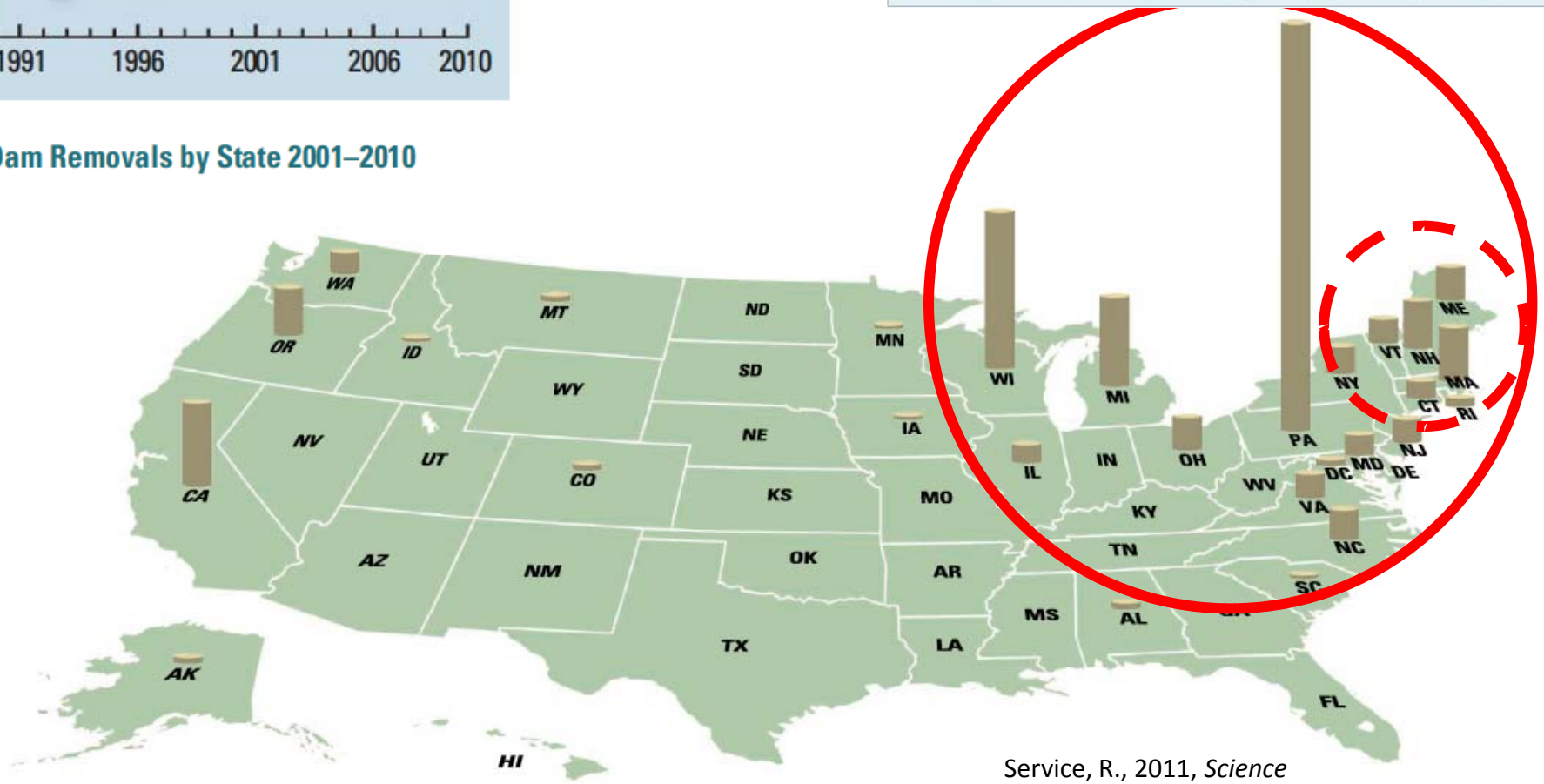
Dam removal is not new nationally, but rapid growth is new



U.S. Dam Removals by Year

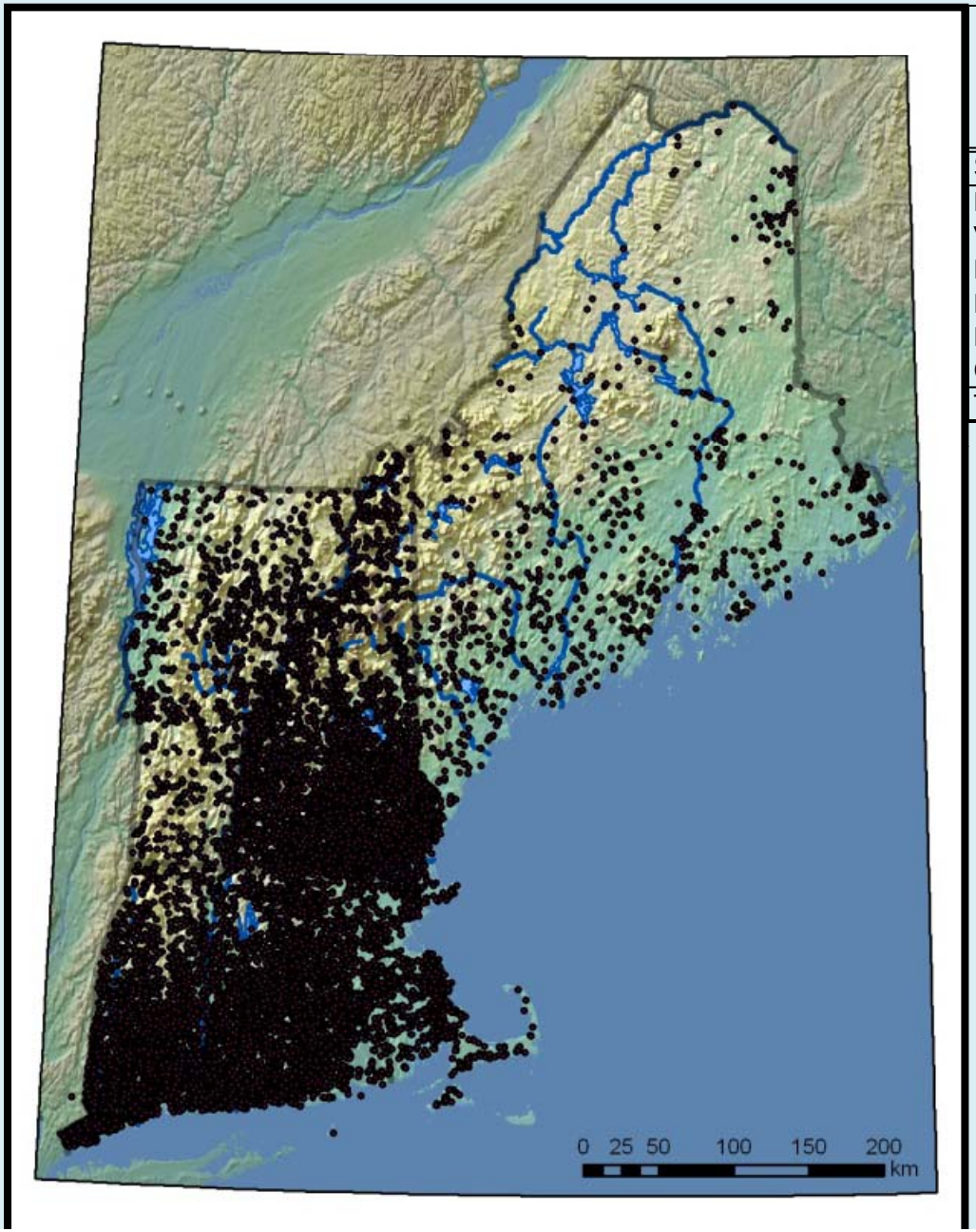


Dam Removals by State 2001–2010



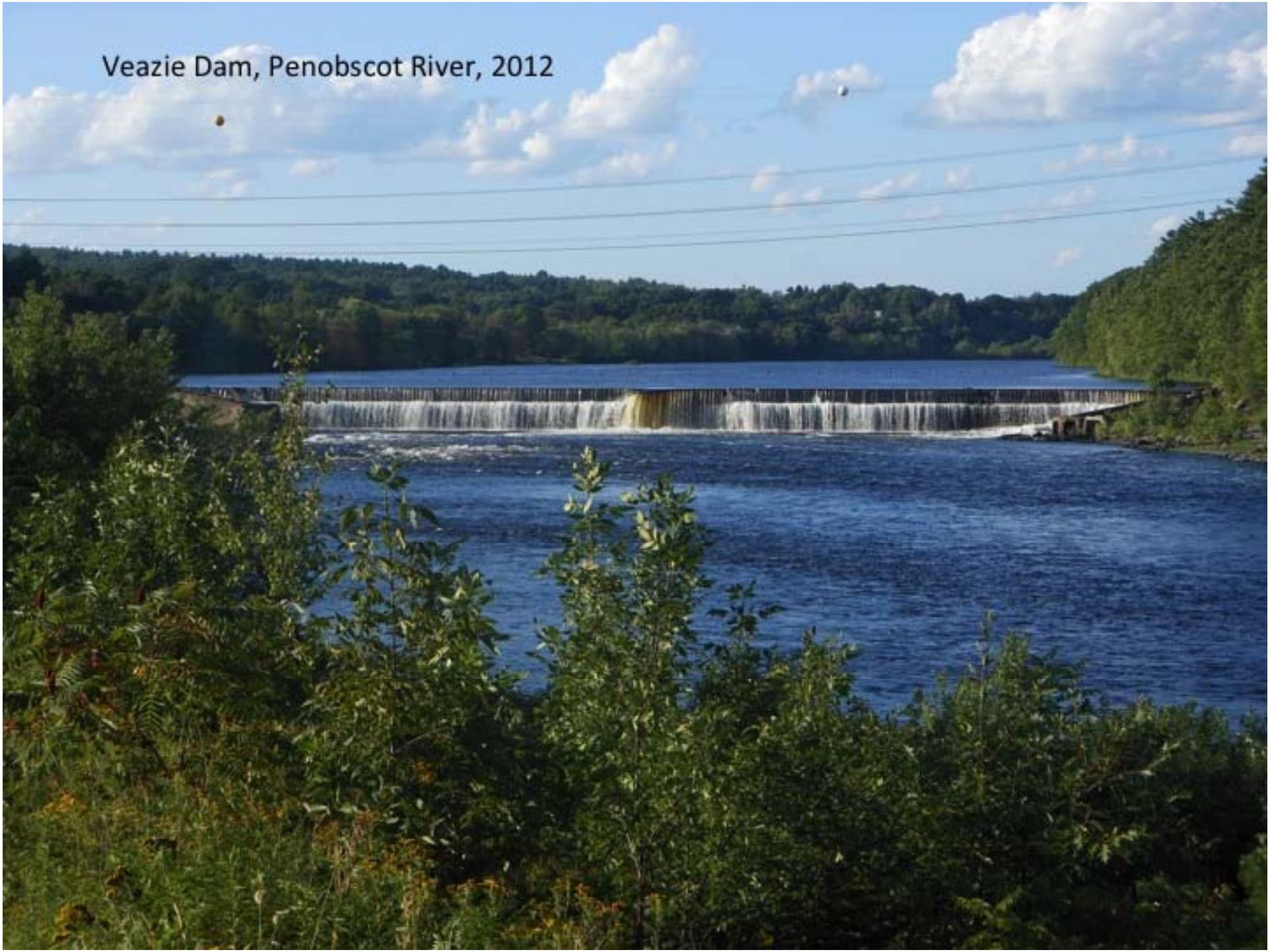
Service, R., 2011, *Science*

Dams in New England



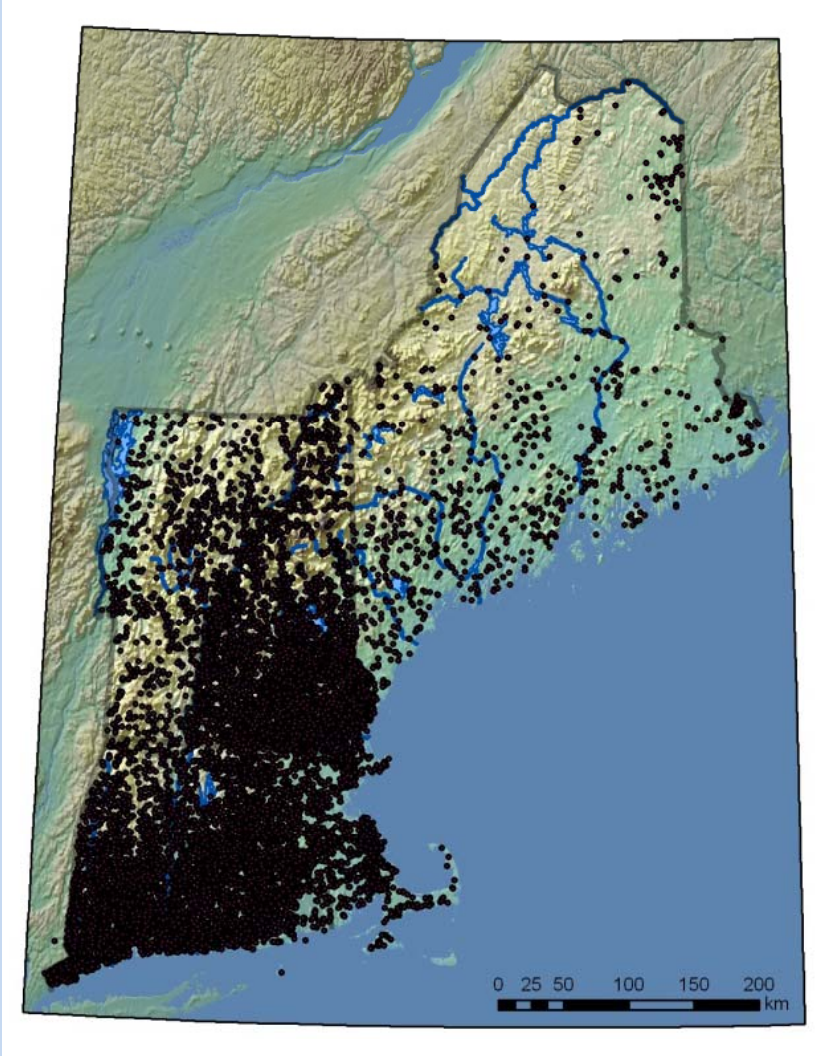
	From National Inventory of dams (NID)		% of NID Dams with High or Significant Hazard Potential
State	#Dams	> 15 m	
ME	647	20	26.43%
VT	367	31	52.86%
NH	653	35	44.10%
MA	1602	62	70.04%
RI	215	2	74.88%
CT	726	52	93.94%
Total:	4210	202	62.19%

Homestead Woolen Mills Dam, NH


Veazie Dam, Penobscot River, 2012

Veazie Dam, Penobscot River, 2014

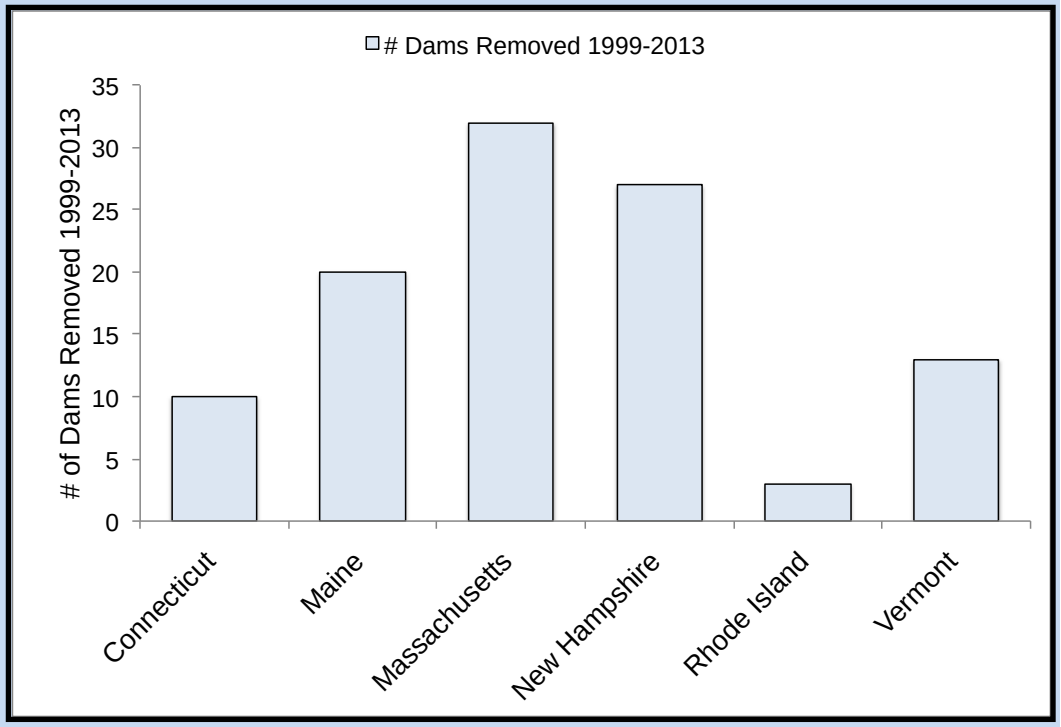
Henry Bridge Dam, N. Bennington, VT

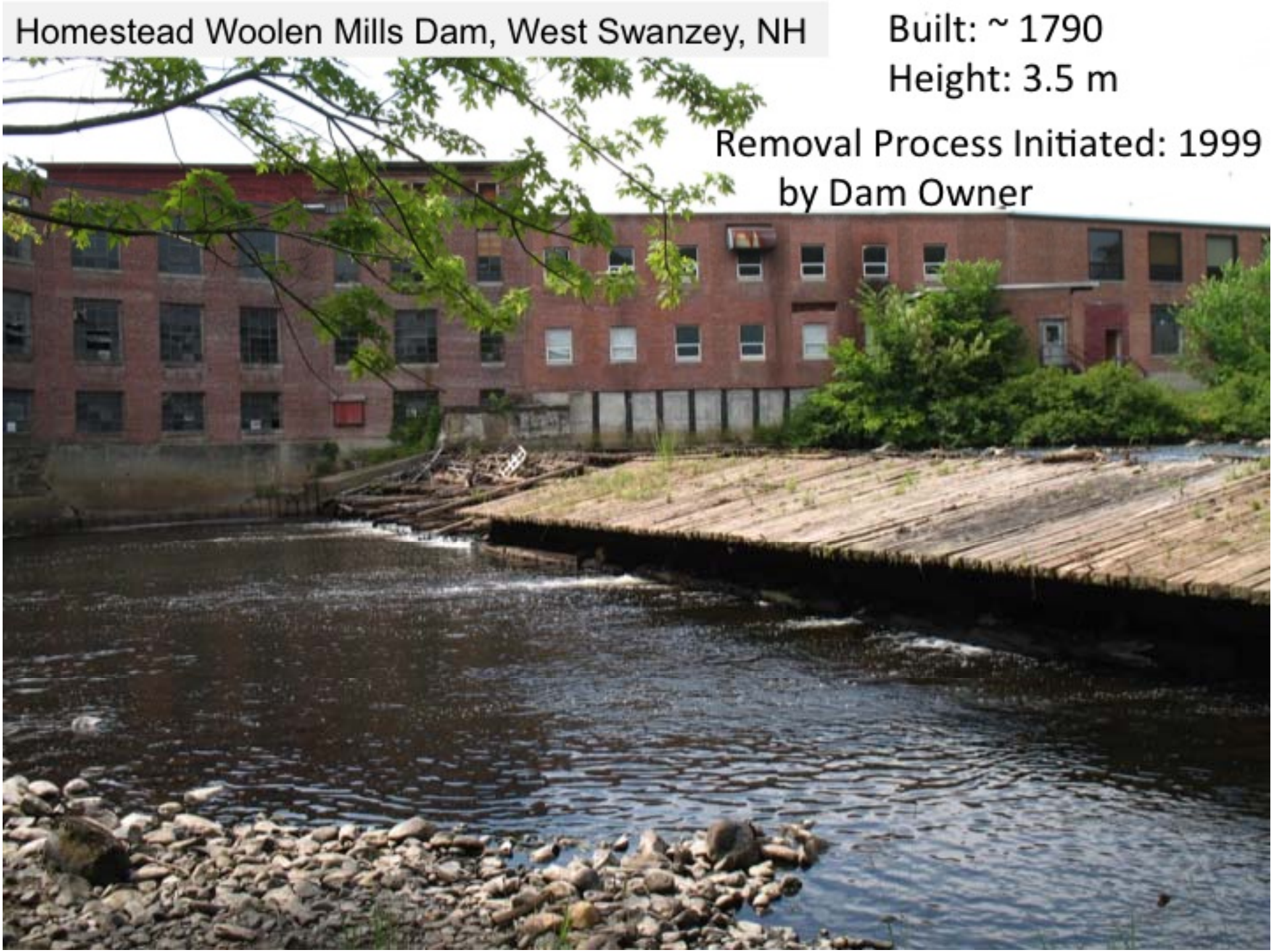


Management goal of dam removal:

1. Restoring Anadromous Migratory Runs
2. Diminishing Habitat Fragmentation & Improving Longitudinal Connectivity
3. Top Down vs. Ad hoc

How does it vary by State?



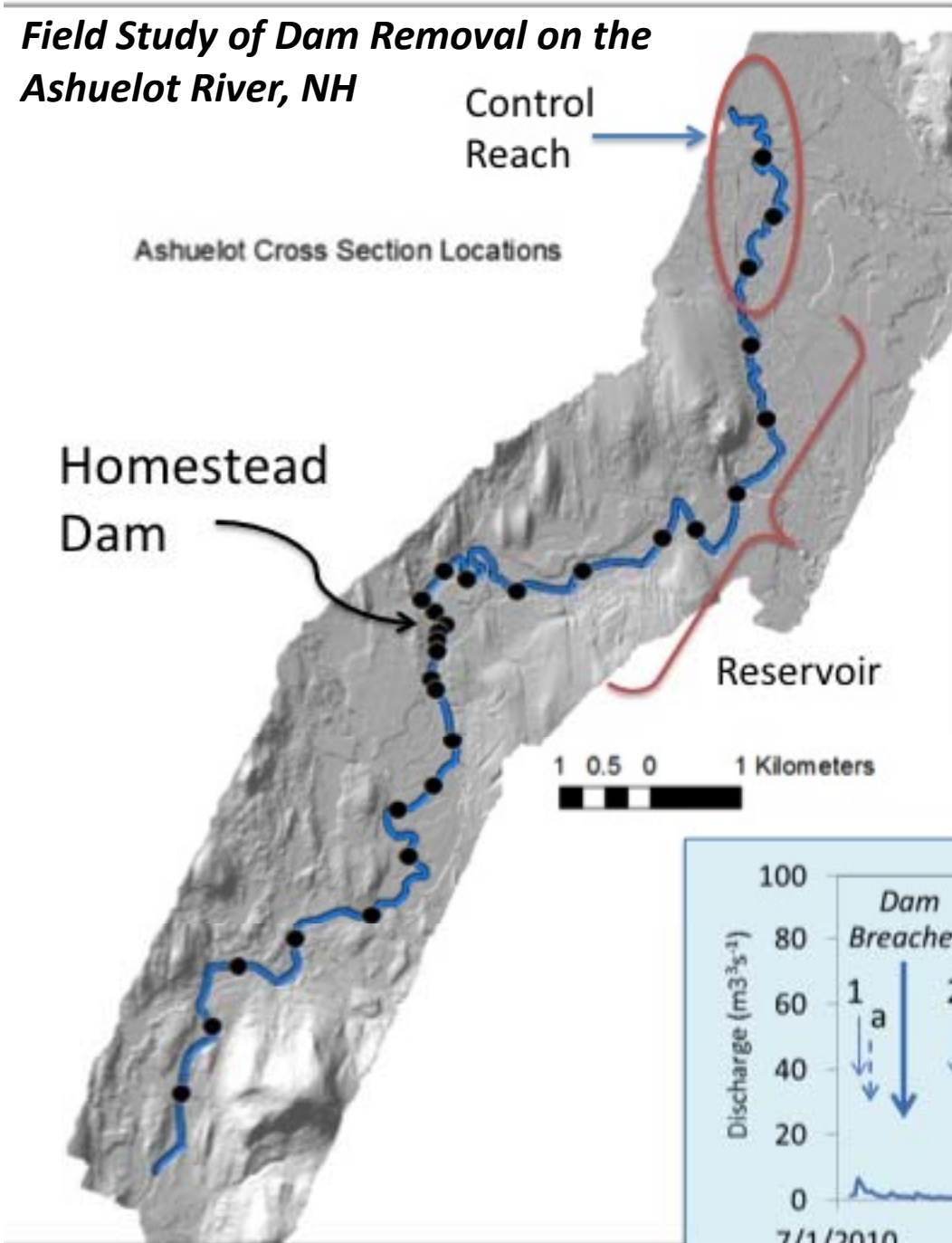

Homestead Woolen Mills Dam, West Swanzey, NH
Built: ~ 1790
Height: 3.5 m
Removal Process Initiated: 1999
by Dam Owner

New England: Average Time of Dam Removal = ~7 years!!!

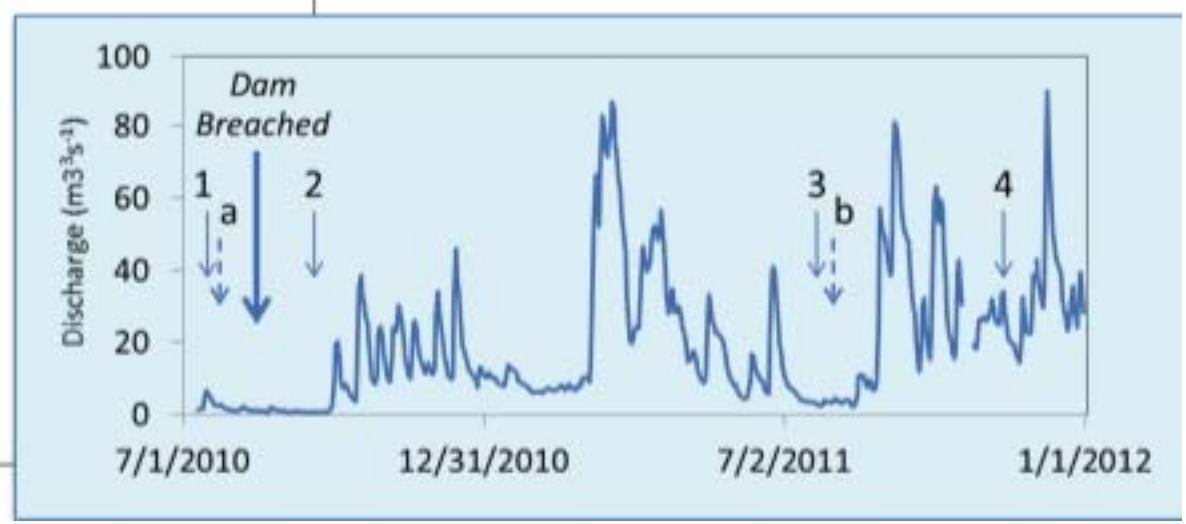
Removed: 2010
Time to Removal: 11 yrs

→ Of the 129 Dams Removed, Very Few (< 10%?) Have Had Any Post-Removal Monitoring with Less Having **Both** Pre-Removal and Post-Removal Monitoring

Field Study of Dam Removal on the Ashuelot River, NH

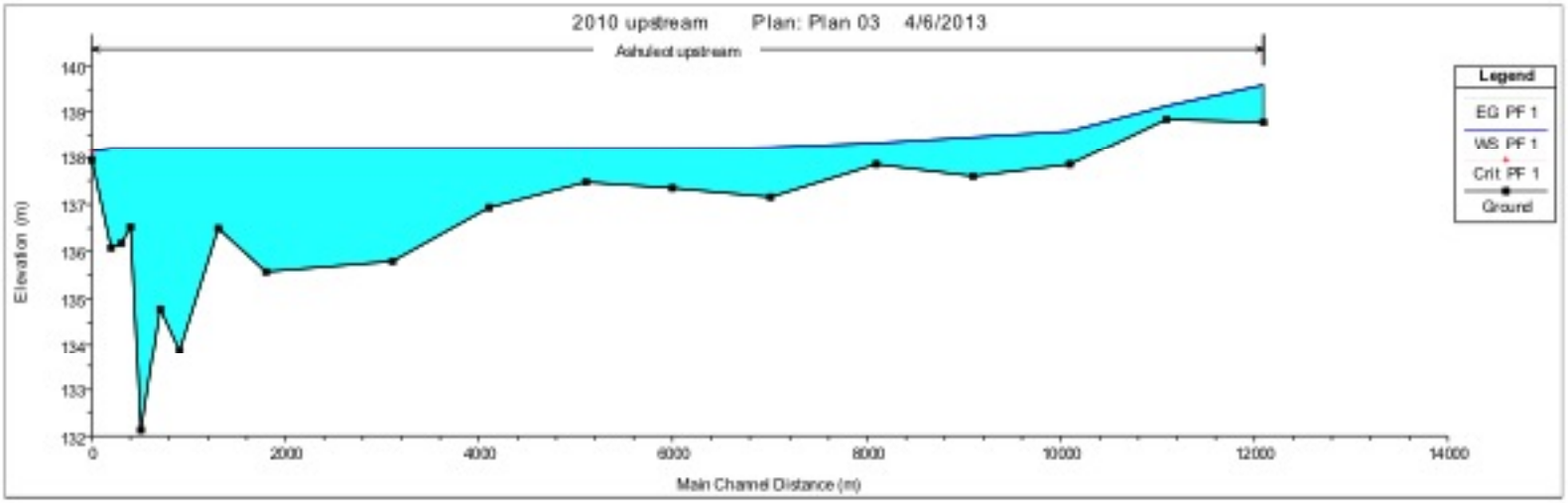


a, b: dates of lidar
1,2.3,4: dates of field surveys



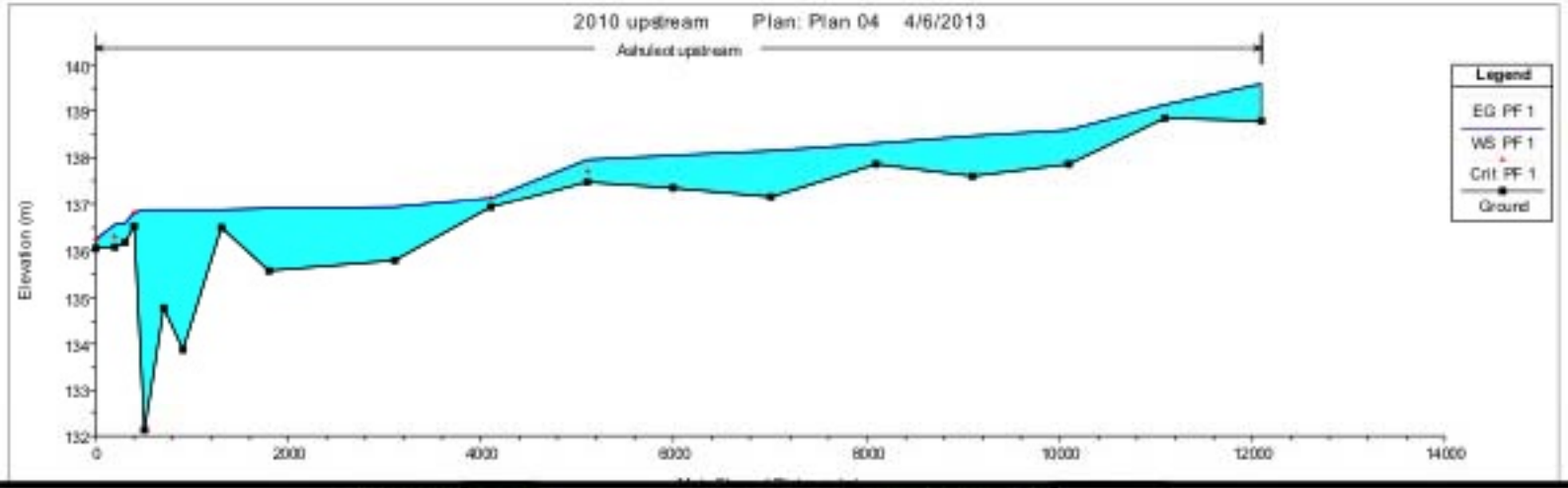
Gartner, Magilligan, & Renshaw, In Rev., *Geomorphology*

Pre removal
Bed profile and water surface



Gartner, Magilligan, & Renshaw, In Rev., *Geomorphology*

Immediate Post removal
Bed profile and water surface



CONCLUSIONS

Dam removal is a critical component of river restoration in New England

From a geomorphic perspective, due to the extant boundary conditions of the New England landscape:

- The spatial extent of upstream propagation of the knickpoint is spatially limited.
- The re-connected sediment flux has not led to significant downstream deposition, but where sediment has accumulated, it has improved spawning habitat for diadromous fish.

The Corps can have an important pro-active role in river restoration:

- Facilitate the CWA 404 wetland mitigation process.
- Take a leadership role in providing resources for pre-removal and post-removal monitoring.
- Help coordinate the strategy for identifying which dams, once removed, can have significant effects on restoring watershed connectivity.
- Maintain and perhaps expand its active role in re-introducing environmental flow prescriptions.
- Work with states to enforce dam safety laws and standards.