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Abstract

The Hudson River estuary supports numerous diadromous fish. Tributaries to the Hudson River provide critical spawning, nursery and foraging habitat for these migratory fish. Previous studies made recommendations for fish passage and were limited to determining the upstream fish movement at the first and second barriers on each of 65 tributaries to the tidal (Lower) Hudson River (e.g., dams, culverts, natural falls/rapids) or to multiple barriers for a small subset of tributaries. Our effort expands the spatial coverage beyond the first two barriers for a total of 65 tributaries and assesses the current state of passage using a variety of available tools. Our findings demonstrate the importance of re-evaluating field conditions and study objectives to meet present day and future restoration goals.

Diadromous Fish Species Using Lower Hudson Tributaries for Spawning Anadromous



Approach to Determining Fish Passage Obstruction and Opportunity

- Objectives
 - Expand spatial scope of barrier survey beyond previous studies
 - Investigate changes to fish passage impediments since last known surveys
 - Create an inventory of barriers for use as a decision making tool
 - Analyze the collected data to determine where opportunities exist to improve or expand fish passage
 - Make determinations based on biological and physical limitations of passage
- Scope of Effort
 - Expand spatial extent to low and moderate gradient reaches of 65 tributaries
 - Update prior efforts (Schmidt et al 1996, Halavik and Orvis 1998, Machut et al. 2007)
 - Not Limited to Number of Barriers per Tributary
 - Desktop Tools
 - Google Earth, Bing, Digital USGS 7.5 Series Topographic
 - Digital NYS Dam Inventory
 - Ground-truthing – 51 of 65 tributaries all or partially field verified to date
 - GPS, Video, Photography, Notes
- Proposed Action
 - Dam Removal and Culvert Upgrades (Preferred)
 - Eelways, Fish Ladders, Rock Ramps, By-pass Channel (Less Preferred Alternative)
 - No Action (e.g., No Benefit, Owner Opposition, FERC Licensed, Regulatory Obstacle)
- Survey Period To Date
 - 2009-2012

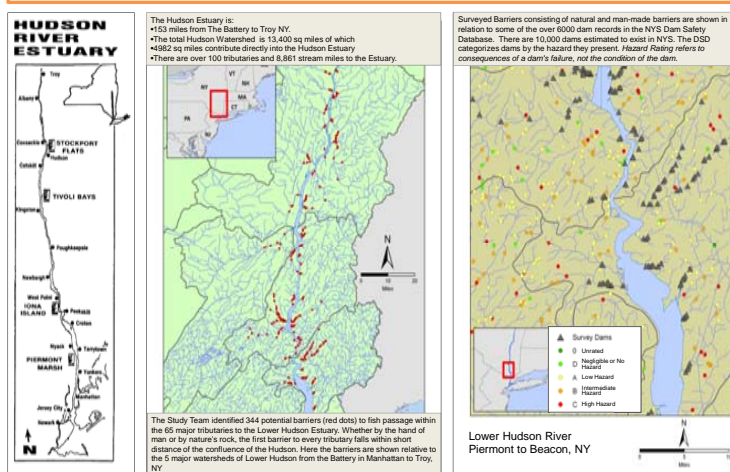
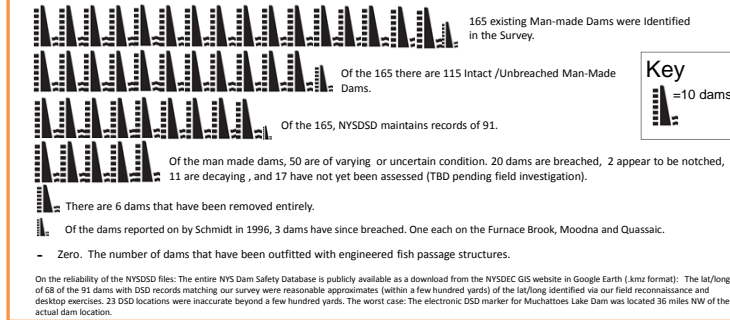
Physical and Biological Limitations to Fish Passage Opportunity

- Assumptions: Access based on known biological limitations of Alosids and American eel to pass steep grades and vertical structures.
- Alosids (shad, blueback herring, alewife)
 - Passable: Consistent slope <3% gradient and slopes of 3-5% for short distances that require additional burst speed and deeper pools.
 - Limited Passage: Consistent grades 3-5% and slopes of 5-7% for short distances that require additional burst speed and deeper pools.
 - Seasonal or Tidal Passage: Seasonally or tidally low flow fluctuations, shallow water and lacking deep pools; Higher seasonal flows allows passage past low (<=2 ft high) head dams and weirs.
 - Impassable: >2 ft high dams and steep vertical faces. Seasonal high velocity flows overtopping >2 ft dams
- Eel
 - Eel passage was determined by barrier height and gradient, surface roughness and wetness on steep vertical structures
 - Unlimited Passage: No barriers, lack of multiple barriers
 - Limited Passage: Dams, natural falls and ledges <=3.0 m high
 - Passage Greatly Diminished: Dams, natural falls and ledges 3.0-5.0 m high within a short horizontal distance (steepness); # and size classes greatly reduced w/ multiple barriers (Machut et al. 2007); 10-100 fold reduction of eel beyond the first barrier 5 HR trib (Machut et al. 2008)
 - Impassable: Dams >5.0 m high precluding 90% eel passage

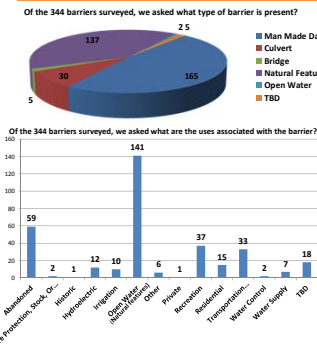
Results of Physical Surveys of Lower Hudson Tributary Barriers

- 344 Barriers Identified on 65 Tributaries (224 miles)
- 165 Dams, 35 Culverts/Bridges, 139 Natural, 5 TBD
- Dams Constructed 1800-1999
- Dam Height Range of 1 ft to 141 ft. Highest Natural Falls is 200 feet. Dam Length Range of 6 ft to 2,300 ft.
- Spillway Width Range of 6 ft to 950 ft
- Includes as barriers stream segments where slopes exceed 1:40
- 64.7 Tributary Miles Currently Estimated Available to Diadromous Fish

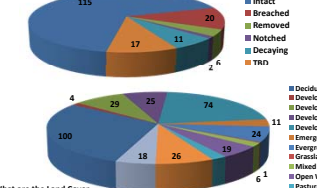
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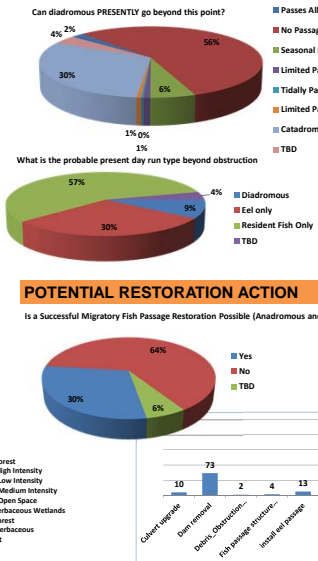
Barrier Types, Uses, Conditions



Barrier Effectiveness

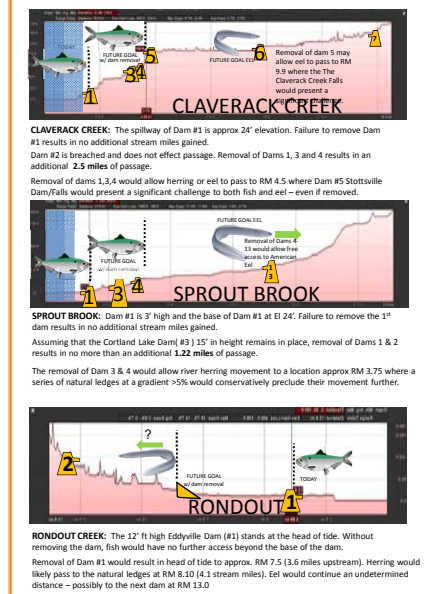


Potential Restoration Action



Visualization Graphics

Google Earth Elevation Profile Tool Demonstrating Three Examples of Potential Stream Miles Gained with Dam Removal



Conclusions

- 344 impediments to fish passage identified including barriers downstream and upstream of the 1st and 2nd barriers identified in Schmidt 1996.
- Natural barriers are a significant impediment to anadromous fish passage comprising almost 60% of the first barriers on lower HR tribs, narrowing the scope of potential restoration.
- The presence of natural and anthropogenic barriers restricts diadromous fish to approximately 64.7 river miles on 65 Lower Hudson River tributaries.
- Dams are almost 5.5 times more prevalent as barriers to fish passage as undersized or improperly installed culverts.
- Only 9% of fish runs upstream of the first barrier are potentially accessible to diadromous fish.
- An estimated 32 additional tributary miles could potentially be made available to diadromous fish and another 59 miles for catadromous via restoration actions at 30% of the total identified barriers.
- Man-made barriers are dominantly abandoned, or used as recreation and transportation infrastructure.
- Currently there are no permanent fish passage structures at any of the identified barriers.
- To date no dams have been removed from the 65 tributaries for the purpose of restoring habitat.

Next Steps

- Conduct field reconnaissance/ground-truthing of unvisited barriers to fish passage
- Complete research of historic and current use by diadromous fish
- Research biological limitations to access for striped bass and rainbow smelt
- Reconcile field observations and desktop with NYSDSD
- Develop higher precision tools in GIS to help determine where fish can pass based on terrain, hydrographic data, barrier information and opportunities for restoration
- Example: Apply newly available 1 ft LIDAR survey to refine the analysis
- Update and publish catalog of tributary barriers.

References

Schmidt et al. 1996. A Catalog of Barriers to Upstream Movement of Migratory Fishes in Hudson River Tributaries. Report to Hudson River Foundation, http://www.hudsonriver.org/report_archives.htm

Machut et al. 2007 Anthropogenic Impacts on American Eel Demographics in Hudson River Tributaries, New York Trans. Am. Fish. Soc. 136:1699-1713.

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