Tributary Connectivity and Barriers

TEC Significance

The Hudson Valley's more than 90 tributary rivers and streams are critical components of the ecology and physical functioning of the river's greater watershed. They provide spawning and nursery habitats for numerous fish and other species while delivering water, nutrients, and sediment from higher elevations to the estuary. However, large numbers of barriers along these tributaries reduce connectivity among stream reaches, and so hinder the life cycles and reduce the distributions and abundances of many organisms, as well as impacting natural river systems, their habitats, species, and water quality.

Dams and culverts, especially, retard or inhibit many migratory or highly mobile fish species that travel from the sea to rivers and that require access to upstream areas to spawn. In the Hudson watershed, these include the anadromous Alewife, Blueback Herring, and Sea Lamprey (Waldman 2006). Also, juveniles of some anadromous mainstem spawners such as Striped Bass and American Shad often occupy the lower reaches of tributaries as nurseries. The Hudson's only catadromous species, American Eel, is heavily reliant on tributaries to grow and mature after being spawned at sea (Machut et al. 2007). Potamodromous species are another, often overlooked component of migratory fish populations in the Hudson (Schmidt and Lake 2006). Potamodromous fishes are those that occur in the main stem Hudson as adults but migrate into tributaries to spawn. Examples include Smallmouth Bass, White Sucker, Tessellated Darter, and White Perch.

Improving connectivity in the greater Hudson River watershed will also augment the benefits of other TEC efforts and the broader Hudson River Estuary Action Agenda (HREAA 2015). There is a strong link between re-opening tributaries and supporting the Fisheries TEC and the Action Agenda's Vision for Fish, Wildlife and Habitats since reproduction of both fished and prey species will be increased. For the Resilient Plant and Animal Communities TEC, in addition to benefiting migratory species, re-establishing connectivity within tributaries will provide greater seasonal access to feeding, spawning, and refuge habitats for resident fish and invertebrate populations. Several freshwater mussel species (i.e., Family Unionidae) may also benefit from improved fish passage, as they are dependent upon fish movement for larval dispersal. Also, the goals of both the Hudson River Shorelines and Riparian Areas TEC and the Sediment TEC will be supported by generating more free-flowing drainage of water and sediments. Such normalization of these processes should also improve habitat quality, which will then contribute to the goals of the Fisheries and Resilient Plant and Animal Communities TECs.

Goal

The primary purpose of this TEC is to allow by 2070 free movements of the Hudson River system's biota within its freshwater tributaries and between them and its main stem and estuary and, secondly, to provide a broad range of suitable habitats within tributaries to these aquatic organisms that augment these movements.

TEC Context

Historical Context

Before regional electrification, flowing water was a major source of power for mills, feeder canals, and industry in the Hudson Valley, a need which prompted the construction of dams throughout the watershed (Swaney et al. 2006). Later, dams were built for flood control, reservoirs for potable water, and for hydropower to generate electricity. Though the main stem Hudson is lightly dammed compared with the main stems of many other Atlantic rivers, the Federal Lock and Dam at Troy blocks most anadromous fish from accessing tributaries farther upriver. For instance, American Shad once ran another 40 miles to Glens Falls and entered the Battenkill (Stevenson 1899). Blueback Herring use the Mohawk River (historically inaccessible) from the main stem Hudson in the 20th Century by passing through the locks at the federal dam, with this subpopulation having swelled to the large numbers seen today. Thus, the Upper Hudson River itself, including the tributary Mohawk, should be viewed as an important tributary to the tidal Hudson.

The heavily populated Hudson Valley, with its many roads and rail lines, also has many culverts to allow streams to pass under them. Most were built without concern for movements of aquatic species and, because of poor design or hydrological modifications, became partial or complete barriers to fishes and amphibians.

Current State

Today, the connectivity of tributaries in the Hudson River watershed is greatly impaired. Though approximately 65 miles of tributaries are accessible to river herring south of Troy, there is a need to restore connectivity to a Hudson River watershed that is severed by more than 1,600 dams—many of which provide limited contemporary benefits—and by numerous impassable culverts. Moreover, the habitat quality of large portions of the Hudson's watershed is compromised and would profit from proactive restructuring to allow for fish passage. Some dams do provide local communities with water supply, recreation, or hydropower, or have historic value, but many are no longer needed for their original uses and yet their impassibility continues to segment rivers. To date, there have been only a few cases of conservation driven dam removals or construction of fishways in the entire Hudson watershed. Importantly, this includes two small, but precedent setting dam removals in 2016 by NYSDEC and its partners.

Many culverts under roads or rail beds present migration barriers due to an excessive drop at the culvert outlet, high velocity or turbulence or inadequate water depths within the culvert barrel, or debris or sediment accumulation (Gibson et al. 2005). Efforts have begun to identify and remediate poorly performing culverts in the watershed, with approximately 25% of culverts assessed to date. Of these, 10% showed significant and 40% moderate impairment. These road stream crossing barriers are also often hydraulically undersized, creating road infrastructure and emergency response vulnerabilities during flood events, because they can lead to overtopping, overtaking, and closure of roads. Barriers may also degrade in-stream and riparian habitat, creating a need to restore tributaries sections. For instance, a dam removal project may degrade in-stream habitat and riparian zones adjacent to where the water was previously impounded.

Trends and Drivers

A variety of eco-social considerations are linked to tributary connectivity. There is widespread concern about population abundances of many diadromous and resident fishes; improved connectivity should promote recovery and provide adequate habitat as populations increase due to external management efforts. There is a growing movement in the U.S. to remove dams for ecological benefits. However, many dams in the Hudson Valley are becoming aged and in disrepair, which also argues for removal because of the threats they pose to human communities downstream (NYS Dam Inventory shows that for Hudson Watershed, 15.6% classified as Intermediate Hazard and 8.5% as High Hazard). And the danger imposed by failing dams and inadequate culverts will be exacerbated by the predicted greater frequency and intensity of storms from climate change and by increases in flooding brought on by land use changes. Fish ladder designs continue to evolve and have proved effective at passing sustainable numbers of river herring in other watersheds across the Northeast (lower in the estuary, fish ladders have been built on dams on the Bronx and Raritan Rivers). Hydropower dams in the Hudson watershed provide only modest amounts of electricity; it may be possible to remove such dams and replace the power foregone with alternative energy sources. However, there is some interest among owners of small dams in using them for micro-hydro electricity generation.

Constraints

There are several constraints to increasing the connectivity of Hudson River tributaries. A key limitation is the lack of a tradition of dam removal and fish passage construction in the Valley, which makes it difficult to mobilize efforts. That is, there is, yet, no fully developed community of practice nor partnership of resource managers and grassroots organizations to advance these projects, though there is continually growing interest and some promising initial results. The development of such a community will make it easier to surmount the many site-specific challenges that often include overcoming dam and land owner resistance (e.g., because of desire for ponded water or micro-hydro production, concerns about flooding), gaining community support, obtaining funding, and fashioning optimal engineering designs.

Although unlikely to halt dam removals, there are concerns that may need to be addressed when planning such actions. These include that dam removal may release upstream (potentially contaminated) sediments which may cause (largely temporary) environmental issues, or, require in situ remediation before dam removal. Furthermore, dam removal could allow range expansion of some non-native species.

Action Table

Objective	Action	Complete by
Objective 1: Prepare for and facilitate an extensive watershed-wide tributaries connectivity program	1A. Enhance current survey information to include all barriers and consider options for remediation; make decisions as to preferred action	2020
	1B. Develop a working group of agencies, NGOs, consultants, and academics to advance tributary connectivity, including social, policy, and technical considerations	2020
Objective 2: Remove 3 or more dams per year	2A. Remove 3+ dams per year, with emphasis on first barriers	2030
	2B. Remove 30* dams by 2030 and 30* additional by 2070 for a total of 60* *These quantifiable goals were modified through the peer review process for the printed Hudson River CRP.	2070

	2C. Review regulations, permitting, and standard operating procedures towards developing a more efficient and predictable approach to support dam removal	
Objective 3: Build fishways at 3 or more dams per year in beginning; later, as needed	3A. Build fishways at 2 or more dams per year; emphasis on first barriers	2030
	3B. Build fishways at 40 dams which will support diadromous or significant potamodromous fish migrations	2070
Objective 4: Improve passability of 3 or more culverts per year	4A. Complete assessment and prioritization of culverts in the watershed for their passability to aquatic and riparian organisms	2020
	4B. Improve passability of 3 or more culverts per year; emphasis on reconnecting entire tributaries	2070
	4C. Review regulations, permitting, and standard operating procedures to include organism passage in all new and replacement culvert installations	2030

Action Narrative

Reconnecting estuary-tributary pathways can be accomplished by removing derelict or unnecessary dams, modifying barriers to promote fish passage (e.g., breaching, notching), or constructing fish passage structures (e.g., fish ladders, nature-like fishways). Whereas dam removal is the favored option, dams that currently provide a water supply, substantial community recreation, or safety function, or small historic dams that may be regarded as important historical or cultural resources, may be candidates for retrofitting with fish passage structures. Alewives, prefer to spawn in lentic waters and there are several ponds upstream of small dams suitable for Alewife reproduction and presently or potentially reachable from the mainstem Hudson that should be suitable for fish ladder access. It is estimated that removals, restorations, or installation of fishways at 27 barriers would reopen 35 miles of tributaries for River Herring within the Lower Hudson River watersheds (C. Alderson, unpublished).

Restoring in-stream habitat complexity (e.g., adding sunken timber, gabions, and weirs to stream reaches) and riparian habitat (such as forested floodplains and freshwater wetlands) would increase the overall habitat quality of a tributary watershed and might facilitate movements of organisms. Where possible, projects should attempt to include multiple components (i.e., in-stream habitat, riparian habitat, barrier removal) to increase the number of functional benefits and the ecological contribution of the tributary to the estuary. Although projects with multiple components are encouraged, small projects that aim to restore even one component may also provide substantial benefits and should be conducted.

Specific Project Example

A recent success for connectivity of Hudson River tributaries occurred in the Wynantskill in Troy, New York. The removal of an iron barrier in May 2016 from near the mouth of the Wynantskill by NYSDEC and its NGO partners was immediately effective, with hundreds of River Herring accessing this stream for the first time in 85 years, in addition to American Eel and various potamodromous fishes.

Research Needs

- Knowledge of contemporary and planned uses of all Hudson River watershed dams and their impoundments.
- Knowledge of condition and anticipated longevity of all Hudson River watershed dams.
- Assessment of identities and distributions of key fish and other species occurring in tributaries.
- Better understanding of potential benefits of improved connectivity of Hudson River tributaries and the main stem above the federal dam with the tidal Hudson below that dam.
- Innovations for fish ladders in low flow drainages or for assisting passage through culverts, including for eels at perched culverts.
- Monitoring of success of pre- and post-connectivity remediation projects.

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