Long Island Diadromous Fish Restoration Strategy

Seatuck Environmental Association

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Carlls River

1. Introduction

Populations of diadromous fish (those species that migrate between fresh and salt water) are greatly reduced from historical levels throughout Long Island's estuaries. This decline is the result of various factors, but a primary cause is the abundance of migration barriers – dams and culverts – throughout our coastal tributaries that prevent fish from reaching necessary freshwater spawning and developmental habitat.

Most of these barriers were constructed generations ago to aid commercial and residential development. The more than 120 tributaries across Nassau and Suffolk counties contain hundreds of dams, and hundreds more road and railway culverts. Almost none of these structures were designed with consideration for fish migration. The impact is significant. One study of six tributaries within the South Shore Estuary Reserve, for example, found some 30 barriers permanently blocking access to approximately 60 miles of stream habitat *("Inventory and Analysis of Barriers to Fish Passage for Six Long Island South Shore Estuary Reserve Tributaries," Nelson, Pope & Voorhis, LLP (2008))*.

The decline of diadromous fish has a major impact on the health of our coastal ecosystem, as these fish play a vital role in transferring ocean energy into estuarine, freshwater and upland habitats, and provide indispensable forage for countless other species. It is no exaggeration to say that they help to drive Long Island's entire coastal food web. Rebuilding their populations across the region is a critical component in restoring the health of our estuaries.

2. Long Island's Diadromous Fish

Diadromous fish are a category of unique species that divide their life cycles between fresh water and salt water. There are two general subcategories of diadromy: Anadromous fish (which hatch in fresh water, but spend the majority of their lives in salt water) and Catadromous fish (which hatch in salt water, but spend the majority of their lives in fresh water). While our region's marine waters host larger diadromous species (striped bass, Atlantic sturgeon, American shad, etc.), Long Island's smaller tributaries host only four species: Alewife and Blueback Herring (collectively known as "River Herring"), American Eel and Brook Trout.

Alewife

A. River Herring

1) Alewife – Alewife *(Alosa pseudoharengus)* are one of two species of river herring. They are generally 10-12 inches in length with slender bodies and deeply forked tails. They are generally silver in appearance, with a characteristic dark spot behind their gills on both sides.

They are anadromous species that spend the majority of their life in salt water but migrate annually into freshwater to spawn. They inhabit offshore areas during most of the year, occurring on the Continental Shelf at depths below 150 feet from Newfoundland to the Carolinas.

Alewives migrate into and stage in estuarine waters in late winter. Their movement into freshwater spawning habitat, which is governed by changes in tributary water temperature, occurs on Long Island from early March through mid May. They prefer to spawn in slower moving, "flat water" areas. Historically they took advantage of access to freshwater "kettle ponds".

Though the adults immediately return downstream after a spawning event, the newly hatched juveniles generally remain in freshwater and estuarine habitats for the first few months of their lives. Alewives generally live about eight to ten years and begin to spawn between the ages of three and five. They typically make four to six spawning migrations during their lifetimes.

2) Blueback Herring – Blueback Herring *(Alosa aestivalis)* are similar to Alewife in many ways, including their general appearance and life cycle, but there are some distinct differences. Their size is similar, but they have a thinner body shape. They lack the dark spot on their sides, but their backs (as their name suggests) have a darker blue/green color. Their eyes are slightly smaller and closer to their mouth.

Blueback Herring are found at similar offshore locations and depths as Alewife, but across a range that extends further south to the coast of Florida. Their migration generally occurs later in the season. Finally, where Alewife prefer calm or slow-moving water, Blueback Herring prefer to spawn in moving water with rocky bottoms.

B. American Eel

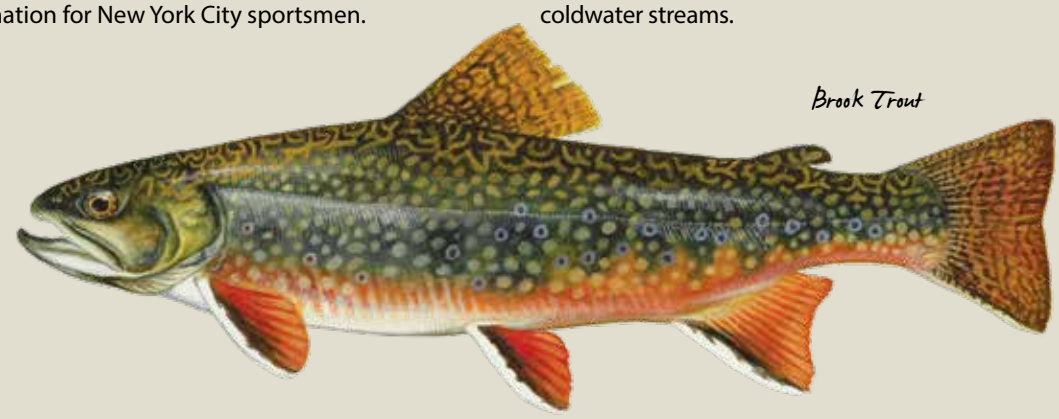
American Eel *(Anguilla rostrata)* are smooth, slender fish that are snake-like in appearance. They are catadromous, meaning they hatch in salt water, but spend most of their lives in fresh water (or, in some cases, brackish water). All American Eels start their lives in an area of the North Atlantic known as the Sargasso Sea. After hatching the leaf-like pelagic juveniles drift towards the coasts. As they approach shallow coastal waters they transform into translucent "glass eels". Later, as they move into estuarine waters they acquire pigmentation and become "elvers." The elvers, still only a few inches long, find their way into freshwater tributaries or brackish areas where they will spend the rest of their lives as adult, but sexually immature "yellow eels." Eventually, after as many as 40 years, they reach sexual maturity, become "silver eels" and return to the Sargasso Sea to spawn and die. Throughout their lives in freshwater tributaries, American Eels are primarily nocturnal, feeding at night on a diverse selection of prey. They can grow up to five feet in length.

American Eel

C. Brook Trout

Brook Trout *(Salvelinus fontinalis)* are freshwater fish native to eastern North America. Technically not a trout, they are a member of the char family. A "semi-diadromous" population evolved on Long Island and other parts of the North Atlantic Coast. These fish hatch and spend most of their lives in freshwater, but they migrate into estuarine waters to forage for months at a time. Access to abundant forage in the estuary allowed these sea-run or "salter" brook trout to grow large, making them a prized target for anglers. Their presence in the South Shore's coastal streams, including the Connetquot and Carmans Rivers, was part of the region's development as a popular destination for New York City sportsmen.

While River Herring and American Eel are tolerant species that can survive in a range of habitats and water quality conditions, Brook Trout are coldwater fish that require more particular conditions to thrive. In this regard they present additional restoration challenges. Most significantly, suitable Brook Trout habitat cannot be restored simply by reconnecting streams with fish passage structures. The shallow, warm impoundments common on Long Island tributaries present thermal barriers to Brook Trout; they will avoid them even where fish passage exists. In this regard, efforts to restore Brook Trout often require the removal of dams and the restoration of natural, free-flowing coldwater streams.



3. Ecological Role

Diadromous fish play a vital role in the coastal ecosystem. In particular, their movement from salt to fresh water is especially important in transferring ocean-derived energy into estuarine, freshwater and upland habitats. River Herring and American Eel also play an essential role as forage fish, providing prey for countless species during their annual migration.

Schools of river herring, for example, are preyed upon by whales, dolphins, tuna and many other pelagic predators while they're in the Atlantic Ocean. As they move into and stage in the estuaries in the late winter and early spring they provide forage for a host of estuarine predators, including seals, Striped Bass and Bluefish. As they run into the rivers and streams, they are a bounty for everything from river otters and raccoons to osprey and eagles.

Importantly, the early season migration of River Herring and Eels provides an indispensable source of energy for many other species that have just made it through winter or finished migrations and are readying for their own breeding seasons. In the case of River Herring, the millions and millions of eggs they deposit, and the young that hatch, also supply an important source of energy for countless species in the coastal streams and surrounding habitats.

4. River Herring Restoration Goals

A key component of this overall strategy is a set of general goals for River Herring restoration, the progress of which will be measured by quantifiable benchmarks. If met, these goals will ensure the establishment of a vibrant River Herring population on Long Island. Meeting these goals for River Herring will pay dividends for American Eel as well, as they will benefit from many of the re-connectivity projects that will be necessary to restore River Herring. Unfortunately, success in restoring River Herring and eels will not directly translate to gains for Brook Trout; because of their dependence on cold water, as mentioned above, they do not benefit from fish passes when thermal barriers remain. Rebuilding Brook Trout populations on Long Island will require removing dams and eliminating warm water impoundments.

We propose three interrelated goals as a metric to quantify progress in efforts to restore River Herring:

A. Total Number of Adult Herring:

Year		Total Size of LI River Herring Run
Current	2018	150,000
Five Year Goal	2023	475,000
Ten Year Goal	2028	750,000
Twenty Year Goal	2038	1,500,000

The total number of Alewives entering all of Long Island streams in 2018 is estimated at approximately 150,000 fish. Through the systematic implementation of the projects identified in the Restoration Priorities section (page 10), the ambitious benchmarks listed at left can be achieved.

B. Total Number of Runs:

Year		Tributaries with River Herring Runs
Current	2018	24
Five Year Goal	2023	30
Ten Year Goal	2028	40
Twenty Year Goal	2038	65

Over the past decade, the citizen-science efforts of the annual *Long Island Volunteer River Herring Survey* have documented two dozen streams in Nassau and Suffolk County with remnant river herring runs. While two of these runs – Southampton's Alewife Creek and the Little River branch of the Peconic River – boast runs over 50,000 fish, most are small, with only a few thousand or even several hundred fish struggling to persist in suboptimal conditions. Additional remnant runs are sure to be discovered in the coming years as the annual Long Island Volunteer River Herring Survey continues (four runs were found in 2017 alone!). And new runs will be established as restoration efforts add to the overall River Herring population and aid in the expansion into new rivers an streams. Given these realities, the targets outlined above are attainable over the coming decades.

C. Total Acreage of Spawning Habitat:

Year		Acreage of Spawning Habitat
Current	2018	550 acres
Five Year Goal	2023	750 acres
Ten Year Goal	2028	900 acres
Twenty Year Goal	2038	1,000 acres

River Herring currently have access to approximately 550 acres of suitable spawning habitat. This total will expand considerably with an increase in riverine connectivity across Long Island. Pursuit of Restoration Priority projects detailed at left would make the goals outlined in the table at left achievable.

5. Restoration Tools

There are a multitude of tools and techniques available for advancing diadromous fish restoration on Long Island, ranging from simple to complex, and cost-free to expensive.

A. Dam Removal

The overwhelming majority dams on Long Island are no longer serving their original purpose. Many were constructed to impound water to power mills, harvest ice or grow cranberries. Others were part of elaborate plans to establish water supply reservoirs. None of these uses are necessary today. Certainly some impoundments were established for recreational or aesthetic purposes and many still provide such services today. And many now obsolete impoundments have also become valued community recreational or aesthetic resources.

However, the social value of these impoundments must be weighed against their impacts, both ecological and economic. Dams impose significant ecological costs not only on rivers and streams, but also on downstream estuarine habitats and the surrounding ecosystem. The effect of dams on diadromous fish is obvious, but they have other, less intuitive impacts as well. For example, one important role of tributaries is the transportation of sediment from upstream habitats to the estuary. When storms wash sand and soil into rivers and streams it gets carried downstream into the bays where it is trapped by aquatic vegetation and deposited into the estuarine substrate. This supply of sediment is necessary for salt marshes to add elevation and keep up with rising sea levels. To the extent this ecological impact limits the ability of marshes to stay viable and play their role in storm attenuation, it could have significant economic impacts in coming decades.

Dam Removal

Dams also impose other, more direct economic costs on communities. They require regular maintenance, sometimes needing costly repairs as they age. Many of Long Island's dams, constructed decades or even centuries ago, are reaching the point that they will increasingly require attention and public expenditure.

And, as the dams trap sediment and impoundments silt in, another set of potential costs arise. Shallower water makes the waterways more hospitable to submerged aquatic vegetation, including invasive species that can quickly take over a pond or lake. As many communities already know, these plants can interfere with boating, fishing and other recreational and aesthetic values. The cost of addressing these species is not insubstantial. The Town of Brookhaven recently spent more than $4 million to address invasive aquatic vegetation in Upper Lake on the Carmans River. Similar spending is planned for the river's Lower Lake impoundment. Such situations are becoming increasingly common across Long Island.

Finally, it is important to remember that fish passes, while beneficial to some species, are an imperfect solution. Fish passes do not benefit all species – some mammals, fish and invertebrates will be unable to take advantage of the access they provide. Fish passes also fail to address the impacts of warm water impoundments. For some species, most importantly Brook Trout, the shallow water typical of Long Island impoundments is too warm to move through – they remain "thermal barriers" to migration even when fish passes are installed. Warm, shallow impoundments also have a negative impact on downstream habitat quality by increasing water temperatures.

For these and other reasons, from an ecological perspective, dam removal is always the preferred method for reconnecting and restoring a river or stream. It should always be evaluated as a potential option alongside other fish passage design alternatives.

B. Fish Passes

While dam removal should always be considered as the preferred option for reconnecting and restoring tributaries, we recognize that not all dams are good candidates for removal. In these cases, various fish passage approaches are available for reestablishing connectivity and improving access for some migratory fish. Fish passes (also known as fishways or fish ladders) generally fall into one of the following three categories:

1) Pool and Weir – Pool-and-weir fish passes are characterized by a series of pools separated by overflow weirs that break the total flow of the water coming out of an impoundment into discrete, passable increments. Fish moving through a pool

Peconic River, Grangebel Park rock ramp

and weir system alternate between bursts of swimming and rest periods. The spillway on Penataquit Creek (at Montauk Highway in Bay Shore) was altered with notches to create a pool and weir fish passage system.

2) Baffle-based – Baffle-based fish passes are an engineered solutions that utilize baffles to dissipate the speed of water flowing through a flume to create a low velocity zone of passage for migratory fish. These structures, which can be made of concrete, wood or sheet metal, are often referred to as Denil-style passes. An Alaskan Steeppass is a modular version of Denil fish pass. The fish pass on the Carlls River at Argyle Lake in Babylon Village is an example of a Denil-style pass. The fishway at Massapequa Lake is an Alaskan Steeppass.

Peconic River, Edwards Avenue peg-board eel pass – photo by Byron Young

3) Nature-like – Nature-like fish passes mimic the look-and-feel of a natural stream. They are constructed with boulders, cobble, and other natural materials to create appropriate hydraulic conditions for multiple species, including migratory fish. They fall into two general categories: *Rock ramps*, which provide a gently-sloped, rocky channel, and *step-pool systems*, which act like a series of pool-and-weir passes that give fish places to rest in between bursts of swimming. The fishway installed on the Peconic River in Riverhead's Grangebel Park is an example of a rock ramp.

FISH PASS RESOURCES:

> *This U.S. Fish & Wildlife Service publication provides extensive information on fish passage: USFWS (U.S. Fish and Wildlife Service). 2017. Fish Passage Engineering Design Criteria. USFWS, Northeast Region R5, Hadley, Massachusetts.*

> *This publication from the National Oceanic & Atmospheric Agency gathers the most up-to-date guidance on nature-like fish passes: Turek, J., Haro, A. J., & Towler, B. (2016). Federal interagency nature like fishway passage design guidelines for Atlantic coast diadromous fishes. NOAA National Marine Fisheries Service.*

C. Eel Passes

While not necessarily ideal in all cases, most of the fish passes described above will increase upstream access for American eels. However, there are simple methods to specifically increase upstream passage rates for eels. While these structures fall short of helping river herring or trout, their use is nevertheless encouraged where dam removal or general fish passage is not adopted. There are two general techniques for provided upstream access specifically for American Eel:

1) Assist Traps (ramp, floating, net and box types) – These structures temporarily trap migrating eels until they are manually emptied upstream beyond the barrier. They are also useful for assessing eel populations and passage needs in advance of larger passage projects. However, the fact that these devices temporarily hold eels makes them susceptible to poaching.

2) Passive Climbing Structures – There are a variety of options for modifying spillways to enhance the ability of eels to climb over impoundments. They include the following:

a) Delaware-type Pass: This type of eel pass involves a conduit (such as PVC pipe) bore through or installed over the dam with mesh climbing substrate inside.

b) Peg/studded Ramp: This engineered solution involves a sloped surface with a gentle flow of water and a series of pegs or studs that provide surface tension with which the eels can climb. The size and proximity of the pegs determines the size eels that can navigate the ramp. Year-old elvers, for example, require the pegs to be smaller and closer together than do

Undersized and perched culverts limit connectivity and restrict fish passage

adult yellow eels. These devices are widely used in Europe and many off-the-shelf peg-board products are available. The 2016 modifications to the Peconic River dam at Edward's Avenue include a peg-board eel pass, the first on Long Island.

c) Enhanced Substrate: The simple addition of a brushed or roughened substrate to a dam face can greatly increase passage rates for eels, which are very capable climbers provided that can "grip" the surface. Examples of possible enhancements include bristle strip, artificial turf, carpeting or discarded fishing nets. These simple solutions, which often are most successful when they are covered or hidden (in PVC piping, for example), can easily be applied to dams across Long Island.

EEL PASS RESOURCES:

> *Additional information about eel passage is available from the Atlantic States Marine Fisheries Commission: Haro, Alex. 2013. Special Report No. 90 of the Atlantic States Marine Fisheries Commission, Proceedings on a Workshop on American Eel Passage Technologies. Atlantic States Marine Fisheries Commission.*

> *This British publication provides detailed information on eel pass techniques and equipment suppliers (European Eels are nearly identical to American Eels): Solomon, D. J., & Beach, M. H.. 2004. Manual for Provision of Upstream Migration Facilities for Eel and Elver, Science Report SC020075/SR2. Environment Agency*

D. Culvert Improvements

While dams are generally the primary and most significant barriers to migration on Long Island tributaries, roadway and railroad culverts can also present permanent or provisional migration obstacles. These culverts, which are often undersized, impound upstream waters, create high flow velocities and can be perched above streams (especially during low tides in tidal areas). While little attention was historically paid to the impacts to tributaries from roads and railways, there has been considerable recent attention to the effects of these crossings and how they can be improved.

CULVERT RESOURCES:

> *The New York State Department of Environmental Conservation provides the following guidance on culverts: NYSDEC (New York State Department of Environmental Conservation). Stream Crossings: Guidelines and Best Management Practices.*

> *The Connecticut Department of Environmental Protection produced the following stream crossing guidelines: CTDEP (Connecticut Department of Environmental Protection). Inland Fisheries Division Habitat Conservation and Enhancement Program Stream Crossing Guidelines.*

> *The North Atlantic Aquatic Connectivity Collaborative maintains a website with detailed information on culverts: Levine, Jessica. 2014. Climate-friendly Streams Crossings Toolkit. North Atlantic Aquatic Connectivity Collaborative (NAACC). Retrieved by: https://streamcontinuity.org/resources/crossings_toolkit/index.htm*

> *The Nature Conservancy has reviewed the economic benefits of improved culverts: Levine, Jessica. 2013. An Economic Analysis of Improved Road Stream Crossings. The Nature Conservancy, Adirondack Chapter, Keene Valley, NY.*

E. Corridor Protection / Land Acquisition

An important component of stream health is the quality of the watershed surrounding and draining into the waterway. Especially critical is the corridor along the sides of the tributary. Natural streamside habitat buffers and shades the waterway and provides valuable habitat for countless wildlife species. A natural buffer or living shoreline mitigates damage from severe storms. For these reasons, the public acquisition of properties adjacent to these waterways should be a priority. Acquisition for open space purposes of undeveloped sites, and removal of select development at developed sites, will help to ensure the integrity and quality of these waterways for the benefit of River Herring and other wetland dependent wildlife. The five East End towns should target streamside parcels for acquisition through their Community Preservation Fund Programs, and for New York State, Suffolk County and other Long Island towns to do the same through their open space programs.

F. Maintaining Adequate Stream Flow

Long Island's tributaries are fed primarily by groundwater; they're a manifestation of the island's aquifers, the vast reserves of underground water. The top surface of the aquifer is known as the water table. Simply put, in places where the contours of the land surface dip below the water table, the aquifer is exposed and surface water bodies exist in the form of flowing tributaries or (more rarely on Long Island) natural kettle hole lakes and ponds.

Water table elevations naturally fluctuate, with the determinant historically being the amount of precipitation. The water table elevation rises in wet years and drops during drier periods. However, while these natural changes can be substantial on a geologic time scale, they are generally small from year to year and average out over time.

But humans can also impact the elevation of the water table. On one hand, by building roads, parking lots and structures that quickly funnel water through storm conveyance systems into rivers and bays, we prevent water from soaking into the ground and recharging the aquifers. On the other hand, we use a lot of groundwater – Long Island relies exclusively on its aquifers to provide more than 400 million gallons of water every year for domestic, industrial and irrigation purposes. In some areas, this level of pumping exceeds the ability of the aquifers to recharge and the water table drops. This is especially true in situations where water pumped from the aquifer is not recharged back into the ground. Municipal sewer systems, for example, rely on groundwater for flushing, but discharge used water to coastal or ocean outfalls.

In some places, including many parts of Nassau County and the southwestern portion of Suffolk County, extensive pumping combined with continued discharged to coastal waters has caused the water table to drop (in some places as much as ten feet). This lowering of the aquifer causes a host of problems (including salt water intrusion), but it has an especially dramatic impact on our freshwater wetlands and surface waters, especially our coastal tributaries. If the water table drops below the bottom a stream channel, the tributary – being primarily groundwater fed - simply ceases to exist in that location.

Storm Water Discharge

Meadow Brook in central Nassau County is one well-known example. Its upper reaches once extended above Hempstead Turnpike. Today, it generally doesn't begin to flow until Southern State Parkway, a distance of more than a mile. The channel of the stream still exists, but it's dry, except when temporarily filled by runoff from heavy rains. Milburn Creek, which runs between Baldwin and Freeport, is another similar example. More than a mile of its northernmost section is nothing more than a dry, empty (channelized) streambed for most of the year.

Not surprisingly, reductions in the water table have had similar adverse affects on dozens of rivers and streams across the region. It has eliminated stream sections that once provided valuable spawning, forage and rearing habitat for River Herring and other aquatic species.

To stem this trend, decision-makers should implement and encourage strategies that promote more efficient water use and groundwater recharge. These strategies include, but are not limited to, water reuse projects, ground discharge of sanitary wastewater, gray water systems, water rate structure improvements (to promote efficiency over consumption), water conservation outreach and education programs, permeable parking lots, bio-swales and rain gardens. We especially urge that any new sewer projects that rely on offshore outfalls (including those currently proposed for Suffolk County) be specifically paired with offsetting water conservation and /or water reuse programs.

G. Reducing Stormwater Runoff

Long Island's tributaries have long served as convenient conduits for rainwater running off from roadways, parking lots, and other impervious surfaces (generally referred to as "stormwater runoff"). Given the intensity of development on Long Island, crisscrossed as it is with thousands of highways and streets, there are few, if any, waterways on Long Island free of stormwater runoff.

This runoff, especially the first flush of water during a storm, carries pollutants such as oil, gasoline, heavy metals, road salt, dog waste, and floatables (coffee cups, plastic bottles, etc.). These pollutants degrade environmental conditions in the waterway and cause a range of adverse impacts to wildlife. In some cases these pollutants can directly kill organisms. But more often, exposure to pathogens and their effects (including low dissolved oxygen) have chronic and sub-lethal effects, reducing overall health and the ability of wildlife to thrive and prosper.

Stormwater runoff also has a negative thermal impact on tributaries, adding warm water to what are naturally groundwater-fed, coldwater tributaries. This is especially true during the summer when rainwater runs across pavement and other surfaces that have been warmed by the sun. In smaller systems and those with limited natural buffers, this thermal impact can be especially significant and can have severe impacts on the

success of myriad species, including Brook Trout, which are particularly sensitive to water temperature.

Municipalities on Long Island are legally responsible for controlling stormwater discharges within their jurisdictions. This effort is typically guided by the development and implementation of stormwater management plans. But even with this legal framework in place and municipalities working to stem contamination, much more is needed to comprehensively reduce the adverse impacts of stormwater runoff. In too many places our tributaries are still treated by municipalities as nothing more than an extension of the storm drain system. Municipalities should undertake persistent and prolonged programs to reduce direct discharge of stormwater into our rivers and streams. Doing so will improve water quality and complement efforts to improve connectivity and fish access.

6. Long Island Restoration Priorities

In an effort to focus municipal attention and restoration resources, Seatuck – together with our partners at the Peconic Estuary Program and the Long Island Sound Study – has generated a *Restoration Priority List*. This list includes one to six tributaries for each of the thirteen towns in Nassau and Suffolk Counties that should be targeted for restoration. Each tributary includes a series of recommended action items.

Implementation of these recommendations will achieve significant progress towards achieving the "River Herring Restoration Goals" outlined above. Making strides in restoring these important keystone species will also benefit American Eel and, in some cases, native Brook Trout. As detailed above, restoring Long Island's populations of diadromous fish will produce a cascade of ecological benefits and help improve the health of our entire coastal ecosystem.

A. Prioritization Process

The Priority List was generated from the master listing of all tributaries in Nassau and Suffolk County (a map of which can be found at Seatuck's River Revival Project: https://www.seatuck.org/index.php/tributary-project/river-revival-project-map). The listed tributaries are by no means the only waterways in need of attention and restoration, but the ones that rose to the top through the process outlined below.

Although no hard fast rules exist for prioritizing the restoration of diadromous fish habitat, a few accepted methods exist (Martin, 2013; Beechie et al 2008; Kocovsky et al. 2009). These methods were used as a framework for our analysis, although no mathematical formula or metric matrix was generated. These prioritization methods rely on a relative weighting scheme based on information about the biological, ecological, and functional capacity of each stream.

The prioritization criteria used for evaluating Long Island tributaries were as follows:

1) Ecological
- a. Presence/number of River Herring
- b. Presence of Brook Trout
- c. Presence of American Eel
- d. Historic presence of diadromous fish
- e. Potential suitability for diadromous fish

2) Connectivity
- a. Type of system
- b. Total length/size of system
- c. Acres of potential spawning habitat
- d. Number of migration barriers
- e. Existing connectivity projects

3) Functional Network (the combination of a tributary's upstream and downstream accessible habitat, i.e. the total distance a fish could theoretically swim if that particular barrier was removed (E. Martin 2013)
- a. Upstream length
- b. Downstream length

4) Habitat Suitability
- a. Thermal barriers
- b. Overall water quality

As this strategy is primarily focused on riverine connectivity for diadromous fish migration, the confirmed presence of diadromous fish in a given tributary was weighted most heavily. Where the presence of fish species was known to exist, the tributary's overall potential to provide suitable habitat became paramount.

In making recommendations about specific projects within a tributary, it was important to identify the most restrictive impoundments, i.e., those which have the capacity to open most suitable upstream habitat. In the case of diadromous fish that require access from marine systems, primary barriers obviously rated highest. Similarly, downstream barriers were given preference over upstream barriers on the same tributary.

Finally, after the above prioritization factors were applied, consideration was given to a host of outside factors, including size and historic nature of dams, community resource value of impoundments and feasibility of restoring connectivity, among others. In some cases, although dam removal was generally preferred, fish passage was recommended where strong reasons exist to maintain impoundments.

REFERENCES:

> *Martin, E. H. and Apse, C.D. 2013. Chesapeake Fish Passage Prioritization: An Assessment of Dams in the Chesapeake Bay Watershed. The Nature Conservancy, Eastern Division Conservation Science*

> *Beechie, T., G. Pess, P. Roni and G. Giannico. 2008. Setting River Restoration Priorities: a Review of Approaches and a General Protocol for Identifying and Prioritizing Actions. North American Journal of Fisheries Management 28:891–905. DOI: 10.1577/M06-174.1*

B. Restoration Priority List

BABYLON

Town of Babylon
Priority restoration sites: ***Carlls River*** and ***Sampawams Creek***

See full interactive map at www.seatuck.org

1) Carlls River – The Carlls River flows south from headwaters north of Geiger Memorial Park, through Belmont Lake State Park and down to the bay in the Village of Babylon. A Denil-style fish passage was installed at Argyle Lake in 2013, giving river herring and brook trout access past the dam for the first time in over 100 years. However, most of the river (which features a largely intact, protected corridor) remains inaccessible. Further, the thermal impact of Southards Pond reduces the quality of the accessible portion and significantly limits the potential of establishing a sea-run brook trout population in the river.

Recommendation: 1) Mitigate the impact of the impoundment at Southards Pond thorough dam removal and restoration, if feasible, or through the installation of fish and eel passage. 2) Target several privately owned parcels located in the northern reaches of the river corridor for public acquisition.

Southards Pond (Carlls River)

2) Sampawams Creek – Sampawams Creek starts in Deer Park and runs south between the Towns of Babylon and Islip, defining the border in places. It empties into the Great South Bay on the eastern end of the Village of Babylon. Its lower stretches were significantly altered by the construction of Route 231. It is obstructed near Montauk Highway by the dam at Hawley's Pond and a 400-foot underground passage.

Recommendation: 1) Modify the Hawley's Lake spillway to provide passage for herring and eel, and 2) assess options to daylight the long underground stream portion between spillway and the tidal canal. 3) Assess potential to provide access to Guggenheim Pond, just north of Southern State Parkway.

BROOKHAVEN

Town of Brookhaven
Priority restoration sites: ***Peconic River***, ***Carmans River***, ***Swan River***, ***Patchogue River*** and ***Setauket Mill Pond***

See full interactive map at www.seatuck.org

1) Peconic River – The Peconic River, the longest river on Long Island, runs west from its headwaters near Brookhaven National Laboratory to the Peconic Bay, draining large portions of the Pine Barrens Region. It forms the border between the Towns of Brookhaven and Riverhead for a significant stretch. Several impoundments exist within this segment, including Forge Pond (Peconic Lake). Reconnecting the river at Forge Pond would allow migratory access upstream to the recently installed fish and eel passage at Edward's Avenue.

Recommendation: 1) Mitigate the impacts of the impoundment at Forge Road thorough dam removal and restoration, if feasible, or through the installation of fish and eel passage. This will provide access to the 120-acre impoundment and several additional miles of the Peconic River. 2) Target several parcels on both sides of Forge Pond for public acquisition.

2) Carmans River– The Carmans River is one of the largest and most well protected rivers on Long Island. It runs from Cathedral Pines County Park south through South Haven County Park to its mouth in the Wertheim National Wildlife Refuge. Fish passage at Hard's Lake (2008) and Upper Lake (2017) have reconnected much of the river, but significant portions remain inaccessible to migratory fish due to the impoundment at Lower Lake.

Recommendation: 1) Mitigate the impacts of the impoundment at Lower Lake thorough dam removal and restoration, if feasible, or through the installation of fish and eel passage, which would allow migratory fish to access the entire length of the celebrated Carman's River. 2) Target several parcels on the south side of Lower Lake for public acquisition.

Carmans River

3) Swan River – The Swan River runs through East Patchogue and empties into Patchogue Bay. A portion of its lower section was restored as part of the recent Swan River Preserve project. Swan Lake, the only impoundment and significant barrier on the river, could provide considerable habitat for migratory fish. Fish and eel passage for Swan Lake have been designed and funded.

Recommendation: 1) Complete implementation of the connectivity project at Swan Lake, which would provide access to the 30-acre impoundment and several miles of upstream habitat. 2) Target privately owned properties along this stream for public acquisition, especially those with lake and stream bottom acreage.

4) Patchogue River – The river is the longest tributary in Patchogue Bay, but the impoundment at Patchogue Lake makes most of it inaccessible for migratory fish.

Recommendation: 1) Mitigate the impacts of the Patchogue Lake impoundment thorough dam removal and restoration, if feasible, or through the installation of fish and eel passage, which would open several miles of potential habitat. 2) Assess options to daylight 400' section of buried river downstream from Patchogue Lake.

Patchogue River (outfall at Patchogue Lake) – photo by John Turner

5) Setauket Mill Pond – The small tributary, which drains the area south of Conscience Bay, is impounded to form the Setauket Mill Pond in Frank Melville Park. Alewives have been seen at the base of the Setauket Mill Pond dam suggesting evidence of a viable remnant run.

Recommendation: Assess the feasibility of installing a fish and eel passage at this site.

EAST HAMPTON

Town of East Hampton
Priority restoration sites: ***Big Reed Pond, Alewife Brook/ Scoy Pond*** and ***Stepping Stones Pond***

See full interactive map at www.seatuck.org

1) Big Reed Pond – The Little Reed/Big Reed Pond system, which lies within Theodore Roosevelt County Park, drains to Lake Montauk. Several culverts and the expansion of phragmites restrict its connection to the lake.

Recommendation: 1) Modify the perched culvert under East Lake Drive adjacent to Lake Montauk to allow for better connectivity between Lake Montauk and the Little Reed Pond / Big Reed Pond system. 2) Clear phragmites from drain to Little Reed Pond and to Lake Montauk.

2) Alewife Brook / Scoy Pond – This short system drains large protected areas of Northwest Harbor, including Cedar Point

Alewife Brook / Scoy Pond (in East Hampton)

County Park, into the tidal Alewife Pond. River herring have been documented in the past (not surprising given its name!), but the current status of the run is not known. The tributary flows under Alewife Brook Road through a 12-inch diameter steel pipe, which is in disrepair and eliminates or severely restricts migratory access to Scoy Pond. Dense stands of phragmites may further impede access.

Recommendation: 1) Install new culvert at Alewife Brook Road and 2) clear and control growth of phragmites in tributary channel between Alewife Pond and Scoy Pond.

3) Stepping Stones Pond – This natural freshwater pond lies along the southwest side of Lake Montauk. It drains a small, forested area before emptying into the lake through a pair of small culverts under Old West Lake Drive. The undersized culverts likely restrict access to suitable habitat in the pond.

Recommendation: Restore access to Stepping Stones Pond from Lake Montauk by replacing the impassable culverts under Old West Lake Drive and removing debris.

HEMPSTEAD

Town of Hempstead
Priority restoration sites: ***Mill River, Bellmore Creek*** and ***Parsonage Creek***

See full interactive map at www.seatuck.org

1) Mill River – The Mill River is one of the larger tributaries in the Town of Hempstead, flowing from Garden City and West Hempstead down through Oceanside and East Rockaway. It includes the impoundments in Hempstead Lake State Park, as well as Rockville Centre's Smith Pond, which is the primary barrier on the river. A remnant run of alewives was confirmed in the Smith Pond spillway in 2016.

Recommendation: 1) Mitigate the impact of the Smith Pond impoundment thorough dam removal and restoration, if feasible, or through the installation of fish and eel passage. The installation of fish passage at Smith Pond should include modifications to lower the level of the impoundment. This would achieve a greater gradient between Smith Pond and the South Pond spillway, which would improve habitat and result in more flow between the impoundments. 2) Mitigate the impact of the impoundment at South Pond through dam removal and restoration, if feasible, or through the installation of fish and eel passage.

2) Bellmore Creek – Bellmore Creek flows from the Southern State Parkway south between Bellmore and Wantagh. It is bordered for much of its course by the Wantagh Parkway as it flows through Twin Lakes Preserve and Mill Pond County Park. The Mill Pond at Merrick Road is the primary barrier preventing upstream migratory access to the rest of the creek. A remnant run of river herring was confirmed in the creek in 2015.

Recommendation: Assess the dam at Mill Pond for potential installation of fish and eel passage, which would provide access to the 15-acre impoundment and additional upstream habitat.

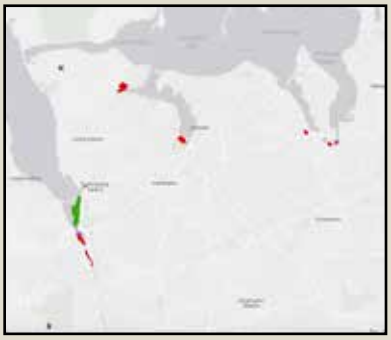
Twin Lakes Preserve (Bellmore Creek) – photo by John Wisniewski

3) Parsonage Creek – Parsonage Creek, which runs through mostly residential areas in Baldwin and Oceanside, flows through Lofts Pond and Silver Lake County Parks and empties into the Western Bays alongside the Town of Hempstead's Baldwin Park. River Herring, which were confirmed in the river in 2017, are able to pass the primary barrier at Silver Lake during very high tides.

Recommendations: 1) Mitigate the impacts of the unnamed impoundment on the north end of Silver Lake Park through the installation of fish and eel passage, which would allow migratory fish access to the small impoundment and upstream habitat. 2) Mitigate the impacts of the Lofts Pond impoundment through the installation of fish and eel passage.

Silver Lake (Parsonage Creek)

HUNTINGTON



Town of Huntington
Priority restoration sites: ***Stony Hollow Run*** and ***Cold Spring Creek***

See full interactive map at www.seatuck.org

1) Stony Hollow Run – Stony Hollow Run drains the Twin Ponds system in Centerport, which is located within the Town of Huntington's Betty Allen Twin Ponds Nature Park. A fish ladder was installed on the outflow of the eastern pond in 2011. While river herring have been documented in the stream below the pond, use of the fish ladder has not been confirmed. Dense phragmites and rocky obstructions make the shallow stream difficult for river herring to navigate.

Recommendation: The stream should be cleared and the main channel deepened in certain sections to improve access for migratory fish.

2) Cold Spring Creek – Cold Spring Creek flows south into Cold Spring Harbor, running along the eastern edge of the Cold Spring Harbor Fish Hatchery. The dam forming St. John's Pond near the creek's mouth is a major obstacle that prevents fish from gaining access to the tributary. A second impoundment exists further upstream.

Recommendation: 1) Evaluate the feasibility of installing fish and eel passages at both dams, as the impoundments could provide significant spawning habitat for river herring. 2) The parcel owned by New York State located on the east side of the stream (SCTM# 0400-081.00-01.00-031.000) should be given permanent preservation status.

ISLIP

Town of Islip
Priority restoration sites: ***Connetquot River, Champlins Creek, Orowoc Creek*** and ***Brightwaters Canal/Creek***

See full interactive map at www.seatuck.org

1) Connetquot River – The Connetquot is a renowned Long Island tributary, with a celebrated history as a brook trout fishery. Nearly the entire freshwater portion of the river, including two branches off the main stem (Rattlesnake Brook and West Brook), exists within Connetquot River State Park. Unfortunately, most of this protected habitat is inaccessible to migratory fish, including sea-run brook trout. The potential for expanding migratory fish populations on the Connetquot is considerable, but only if populations of stocked trout are managed at levels that don't limit recruitment.

Recommendation: 1) Assess potential for fish passage at the park's Main Pond, as well as at barriers on the side branches. 2) Manage stocking program to ensure it is compatible with efforts to restore populations of native migratory fish.

2) Champlins Creek – Champlins Creek runs from north of the Southern State Parkway, through the Town of Islip's Brookwood Hall Estate and empties into the Great South Bay along the Seatuck National Wildlife Refuge. It is impounded first by two private dams (Lower and Upper Wingenhappauge Lakes) and again at Brookwood Hall's Knapps Lake.

Recommendations: 1) Work with landowners to mitigate the impact of the Wiggenhauppauge Lakes impoundments thorough dam removal and restoration, if feasible, or through the installation of fish and eel passage. 2) Mitigate the impacts of the Knapps Lake impoundment through dam removal and restoration, if feasible, or the installation of fish and eel passage.

3) Orowoc Creek – Orowoc Creek is a forked system that runs south from near the Southern State Parkway (where protected corridors exist on both branches) down through the Hamlet of Islip. Islip's High School and Middle School are located between the branches near where it empties into the Great South Bay. River herring have been confirmed in the creek's tidal section.

Recommendations: 1) Mitigate the impact of the Orowoc Pond impoundment (west branch) thorough dam removal and restoration, if feasible, or through the installation of fish and eel passage. 2) Mitigate the impact of the Pardees Pond impoundment (east branch) thorough dam removal and restoration, if feasible, or through the installation of fish and eel passage. 3) Target several privately held properties along the creek for public acquisition.

4) Brightwaters Canal/Creek – The tributary that flows into Brightwaters Canal is impounded to form a series of ponds known as Cascade Lakes, as well as Mirror Lake and Nosreka Lake. While river herring have not been documented in the river, the series of impoundments could provide suitable spawning habitat.

Recommendations: Mitigate the impact of the Cascade Pond impoundment through the installation of fish and eel passage.

NORTH HEMPSTEAD

Town of North Hempstead
Priority restoration sites: ***Udalls Mill Pond, Leeds Pond*** and ***Whitney Creek***

See full interactive map at www.seatuck.org

1) Udalls Mill Pond - This small tributary in Saddle Rock, which flows into Little Neck Bay, is impounded along its entire length by the Saddle Rock Gristmill to form Udalls Mill Pond. A fish ladder was installed at the dam in 2013, but its use by river herring or other migratory fish has not been confirmed.

Recommendations: 1) Seek to confirm the presence of river herring in the system and use of the existing fish pass; assess and make improvements to the structure if necessary. 2) Supplement the existing fish ladder by adding eel passage to the impoundment.

Saddle Rock Grist Mill, North Hempstead

2) Leeds Pond – This small tributary in Manhasset is impounded near its mouth at Manhasset Bay to form Leeds Pond. The 35-acre impoundment and small inflowing stream could provide spawning habitat for river herring, especially alewife.

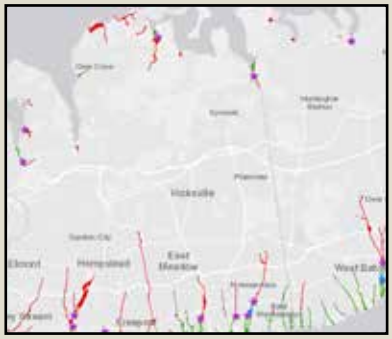
Recommendation: Assess the potential to mitigate the impact of the impoundment through the installation of fish and eel passage.

Leeds Pond (in North Hempstead) – photo by John Turner

3) Whitney Creek – This creek flows north through Whitney Lake and Manhasset Valley Park before emptying into Manhasset Bay. Its upper reaches, while running through an extended natural corridor, were hardened with concrete and significantly altered in places.

Recommendations: 1) Assess the potential to mitigate the impact of the impoundment through the installation of fish and eel passage. 2) Restore the stream channel and banks upstream from Whitney Lake to improve riverine habitat.

OYSTER BAY



Town of Oyster Bay
Priority restoration sites: ***Beaver Brook, Massapequa Creek*** and ***Seaford Creek***

See full interactive map at www.seatuck.org

1) Beaver Brook – Beaver Brook flows north off the moraine through the Charles T. Church Nature Preserve's Shu Swamp in Mill Neck before emptying into Mill Neck Creek. In 2017, fish passage was installed at Beaver Lake, an impoundment separated from the tidal Mill Neck Creek by a dam under the Robert de Graff Causeway.

Recommendations: 1) Continue to improve upstream habitat beyond Beaver Lake by ensuring migratory access through Shu Swamp and exploring the potential for fish passage at Lower Francis Pond and Upper Francis Pond. 2) Assess the potential for additional opportunities to protect open space in and around the brook.

2) Massapequa Creek – Large tributary that flows from South Farmingdale to the Great South Bay through a largely wooded

and protected corridor in Massapequa Preserve. Massapequa Lake, just north of Merrick Road, is an impoundment with two spillways. A fish ladder is currently in place in the western spillway, which provides passage for a small number of river herring. However, it appears a greater number of alewife arrive each spring at the base of the eastern outfall, where there is no access. Nassau County has funding tentatively allocated for a fish ladder at Massapequa Reservoir, the next upstream migration barrier.

Recommendations: 1) Install fish passage at Massapequa Lake's eastern spillway to enhance migratory access to the lake and the upper portions of the creek. 2) Continue plans to install fish passage at Massapequa Reservoir. 3) Install eel passage at all spillways to ensure high migration success rates for juvenile eels.

Massapequa Preserve

3) Seaford Creek – Seaford Creek, which divides the Towns of Oyster Bay and Hempstead, flows through the County-owned Tackapausha Preserve. A dam at the preserve's southernmost end (just north of Merrick Road) creates a small impoundment and prevents migratory access to the freshwater portion of the creek.

Recommendation: Assess the Tackapausha Preserve Pond dam to determine the feasibility of installing a fish and eel passage at this site, which would provide access to nearly a mile of protected habitat.

Tackapausha Preserve Pond

RIVERHEAD

Town of Riverhead
Priority restoration sites: ***Peconic River*** and ***Arrowhead Lake***

See full interactive map at www.seatuck.org

1) Peconic River – The Peconic River, the longest tributary on Long Island, runs west from its headwaters near Brookhaven National Laboratory to the Peconic Bay at Riverhead, draining large portions of the Pine Barrens Region. The 2009 construction of the "rock ramp" fishway at Grangabel Park opened migratory access to approximately one mile of the river's main stem to the base of Upper Mills Dam.

Recommendations: 1) Mitigate the impact of the impoundment at the Upper Mills Dam thorough dam removal and restoration. Fish and eel passage should be installed if removal of the dam is not feasible. Restoring the river at this point would provide access to an additional mile of habitat for migratory fish. 2) Modify the downstream USGS gauging station to accommodate migratory fish. 3) Target the privately owned properties along the north side of the river for public acquisition.

2) Arrowhead Lake – This short tributary drains the steep Baiting Hollow valley and runs north through an extensive salt marsh complex into Long Island Sound. It is impounded at the Boy Scout's Camp Baiting Hollow to form Arrowhead Lake. A small river herring run has been documented at the base of the dam.

Recommendation: Assess the dam at Arrowhead Lake for the feasibility of fish and eel passage, which would provide access to the 4-acre impoundment.

SHELTER ISLAND

Town of Shelter Island
Priority restoration sites: ***Sanctuary Pond*** and ***Fresh Pond***

See full interactive map at www.seatuck.org

1) Sanctuary Pond – This large freshwater complex lies within The Nature Conservancy's Mashomack Preserve.

Recommendation: With the permission and support of The Nature Conservancy assess the connectivity between the pond and Bass Creek to determine if it provides or has the potential to provide spawning habitat for river herring.

Mashomack Preserve, Shelter Island

2) Fresh Pond – Fresh Pond is a small pond in the south-central portion of Shelter Island.

Recommendation: Assess the connectivity between West Neck Harbor and Fresh Pond to determine if the pond provides or has the potential to provide spawning habitat for river herring.

SMITHTOWN

Town of Smithtown
Priority restoration sites: ***Nissequogue River, Sunken Meadow Creek*** and ***Fresh Pond***

See full interactive map at www.seatuck.org

1) Nissequogue River – The Nissequogue is the largest tributary on the North Shore. It flows north from Hauppauge through Blydenburgh County Park and Caleb Smith State Park to the Long Island Sound, just east of Sunken Meadow State Park. The primary barrier is the head-of-tide gristmill dam at Phillips Millpond. Access to upstream habitat is further blocked by additional barriers at Blydenburgh Lake and Millers Pond, as well as Caleb Smith's three-pond system (Winston Pond / Webster Pond / Willow Pond). A remnant run of river herring was confirmed in the Phillips Millpond spillway (White's Pool) in 2017. Fish passage is anticipated as part of a planned renovation of the gristmill dam.

White's Pool (Nissequogue River)

Blydenburgh Lake (Nissequogue River) – photo by Zach Yang

Recommendation: 1) Complete plans to restore connectivity at the Phillips Millpond gristmill dam. 2) Assess the feasibility of fish passage at additional upstream barriers, especially Blydenburgh Lake, which could provide important additional habitat for migratory fish.

2) Sunken Meadow Creek – Sunken Meadow Creek hosted an alewife run for many decades, with fish gaining occasional access through a pair of culverts to a freshwater impoundment. When Superstorm Sandy destroyed the dam in 2012, the (now partially tidal) creek was made fully accessible up to the dam impounding two small freshwater ponds immediately north of Route 25A.

Recommendation: Assess the feasibility of installing fish and eel passage at the upstream ponds.

3) Fresh Pond – This Fort Salonga creek drains into Long Island Sound from the steep valley that lies on the line between the Towns of Huntington and Smithtown. A small, private dam impounds Fresh Pond near the mouth of the creek at a site that was formerly quarried as part of a brick kiln facility. The dam is in significant disrepair and in need of attention. A small, intermittent run of river herring occurs at the Fresh Pond spillway; the fish reportedly gain access to the pond on spring tides and high water storm events.

Recommendation: Conduct a bathymetric survey and analysis of the pond to determine the potential impacts of the dam's failure or removal. It is possible, given the site's quarrying history, that only minimal changes to the pond would occur. Failure/removal of the dam would provide migratory access to the remaining pond, as well as upstream habitat.

SOUTHAMPTON

Town of Southampton
Priority restoration sites: ***Alewife Creek*** and ***Little River***

See full interactive map at www.seatuck.org

1) Alewife Creek – Alewife Creek, which runs relatively unobstructed between Big Fresh Pond and North Sea Harbor, boasts Long Island's premier alewife migration. The size of the run has been estimated at near 100,000 fish. However, this impressive run could likely be improved by culvert modifications at both the Noyak Road and North Sea Road crossings. The culvert at Noyak Road is episodically passable, only allowing river herring to migrate upstream on or near high tides. The culvert at North Sea Road is perched and extremely shallow. Modifications made in 2014 improved the situation, but the culvert still presents a considerable migration barrier and results in high mortality from predators.

Alewife Creek (in Southampton) – photo by Enrico Nardone

Recommendations: 1) Replace the culverts at Noyak and North Sea Roads to allow fish unimpeded access to Big Fresh Pond. Open-bottom culverts that spanned beyond the width of the stream would facilitate not only the migration of river herring, but also the movement of river otters and other riverine species. 2) Prioritize parcels along the stream corridor for public acquisition to ensure protection of stream habitat and water quality.

2) Little River – The Little River, a branch of the Peconic River, supports one of the largest alewife runs on Long Island. The run has flourished since the installation of the Grangebel Park rock ramp and is currently estimated to number as many as 80,000 fish. Unfortunately, the migrating fish only have access to a quarter-mile of river before being blocked by Woodhull Dam. There is no access to the remainder of the river, which includes Sweezey Pond and the 64-acre kettle-hole-pond, Wildwood Lake. Design and funding is in place for river herring and eel passage at Woodhull Dam; construction is expected to commence in 2018.

Recommendation: Complete implementation of the connectivity project at Woodhull Dam, which would provide access to the significant upstream habitat and support the continued growth of the Little River alewife run. Additional upstream access improvements at the outflows from Sweezey Pond and Wildwood Lake should be assessed and implemented if necessary.

SOUTHOLD

Town of Southold
Priority restoration sites: ***Arshamomaque Pond***

See full interactive map at www.seatuck.org

1) Arshamomaque Pond – Arshamomaque Pond is connected to Shelter Island Sound through a narrow stream that drains into a tidal channel.

Recommendation: The connectivity between Arshamomaque Pond and Pipes Cove / Peconic Bay should be assessed to determine if the pond provides or has the potential to provide spawning habitat for river herring.

Arshamomaque Pond

Please visit the full interactive River Revival map at
www.seatuck.org or **https://tinyurl.com/seatuckrivermap**

SEATUCK
ENVIRONMENTAL ASSOCIATION

About Seatuck

Seatuck Environmenal Association is a non-profit, 501(c)(3) organization dedicated to the conservation of Long Island wildlife and the environment. The organization works to advance conservation policy across Long Island and conducts a diverse environmental education program, including the operation of two public nature centers and the first "forest preschool" on Long Island.

Peconic River Alewives – photo by Byron Young

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SEATUCK
ENVIRONMENTAL ASSOCIATION

For more information:

Seatuck Environmental Association
P.O. Box 31, Islip NY 11751
631-581-6908
staff@seatuck.org
www.seatuck.org

Prepared by:
Maureen Dunn, Enrico Nardone, John Turner and Byron Young

In partnership with:
Peconic Estuary Program (Sarah Schaefer and Elizabeth Hornstein) Long Island Sound Study (Victoria O'Neill)