Alewife Herring: An Anadromous Fish in the Bronx River

A silver flash in the water is soon followed by more flashes, and all of them are heading upstream. It's not salmon, but it is an anadromous fish, and they are heading upstream to spawn.

Fish that live part of their lives in marine or salt water environments and a part of their lives in freshwater environments are called Diadromous (Greek; Dia = across or between, dromous= to run or move). Diadromous fish will usually spend most of their time in one environment and then migrate to the other to release their eggs in an act known as spawning. In general, the young of a species can only survive in one environment or the other, marine or freshwater, necessitating that the eggs be deposited in the appropriate location. As of yet there is no clear answer as to why the migration between environments began, though it may have to do with population size, food availability and predation, or some combination of all of them. A large school of fish in a small pond or stream may have more difficulty finding sufficient food sources and would be easier targets for predators. Heading out into deeper waters may make survival more probable. The belief is that a given species probably began living only in the environment in which the spawning occurs.

Alewife Herring (Alosa pseudoharengus)) are an anadromous (Ana= up) fish that are native to the American North East. Anadromous fish live much of their adult lives in marine, (salt water) and must swim upriver in order to spawn in fresh water . catadromous (Cata = down) fish, including the American eel (http://www.fws.gov/northeast/AmEel/facts.html) that we find in the Bronx River, live their adult lives in freshwater or estuaries and must swim downriver in order to spawn. In the case of the eels, they swim to the Saragossa Sea in the Atlantic Ocean to meet up with all of the American Eels in the world for their annual spawning festival.

Figure 1 Alewife Herring (Anadromous) photo: Tony Archino

Figure 2 American eel (catadromous)

The anatomy of diadromous fish is exactly the same as those of fish that are specifically fresh water or marine fish, however most fish are incapable of making the adjustment necessary to live in both environments. The reason that most cannot move between the two environments actually comes down to a question that many of us have asked; "Do fish drink water?" The answer is that some do and some don't. Marine fish are always drinking water and special cells in their gills called chloride excretory cells filter out the salt. Due to the dissolved salt content of marine waters, the fish need a constant supply of water since they are constantly excreting water through their skin. Osmosis, the diffusion of water across a semi permeable membrane, occurs due to the salt water surrounding the fish, being about four times more saline, drawing out the water from inside the fish in search of equilibrium. The loss of water through this process means that the fish is constantly drinking water and the kidneys excrete very little water but it has a high salt concentration. In a freshwater environment, the fish's bodily liquids more closely match that of the surrounding water and osmosis does not occur. Fresh water fish retain more water so they do not drink as much as do their salt water counterparts, but the gills take up small amounts of needed salt from the water and the kidneys work hard to remove excess water from the fish.

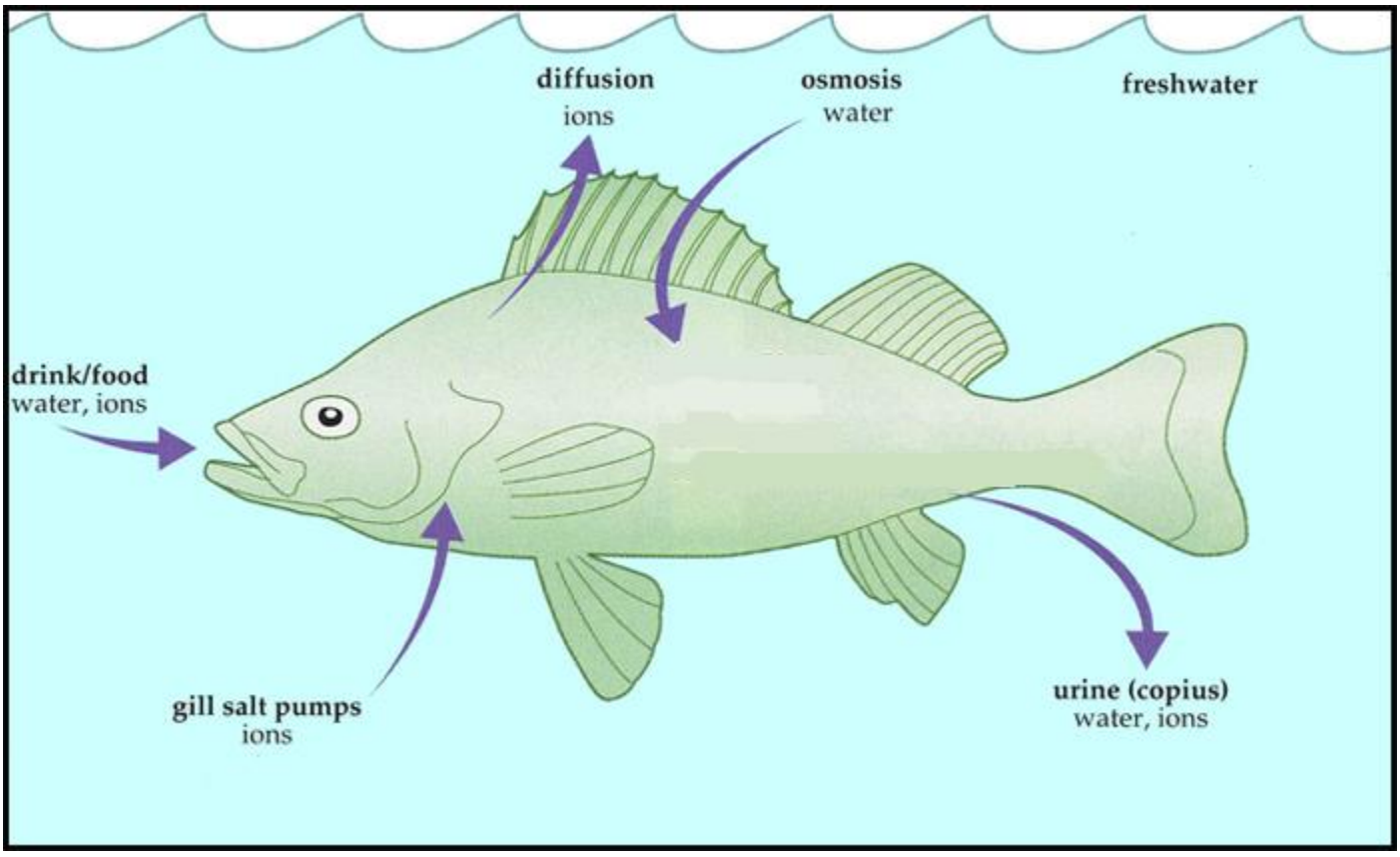


Figure 3 Freshwater (To be replaced by Penny drawing)

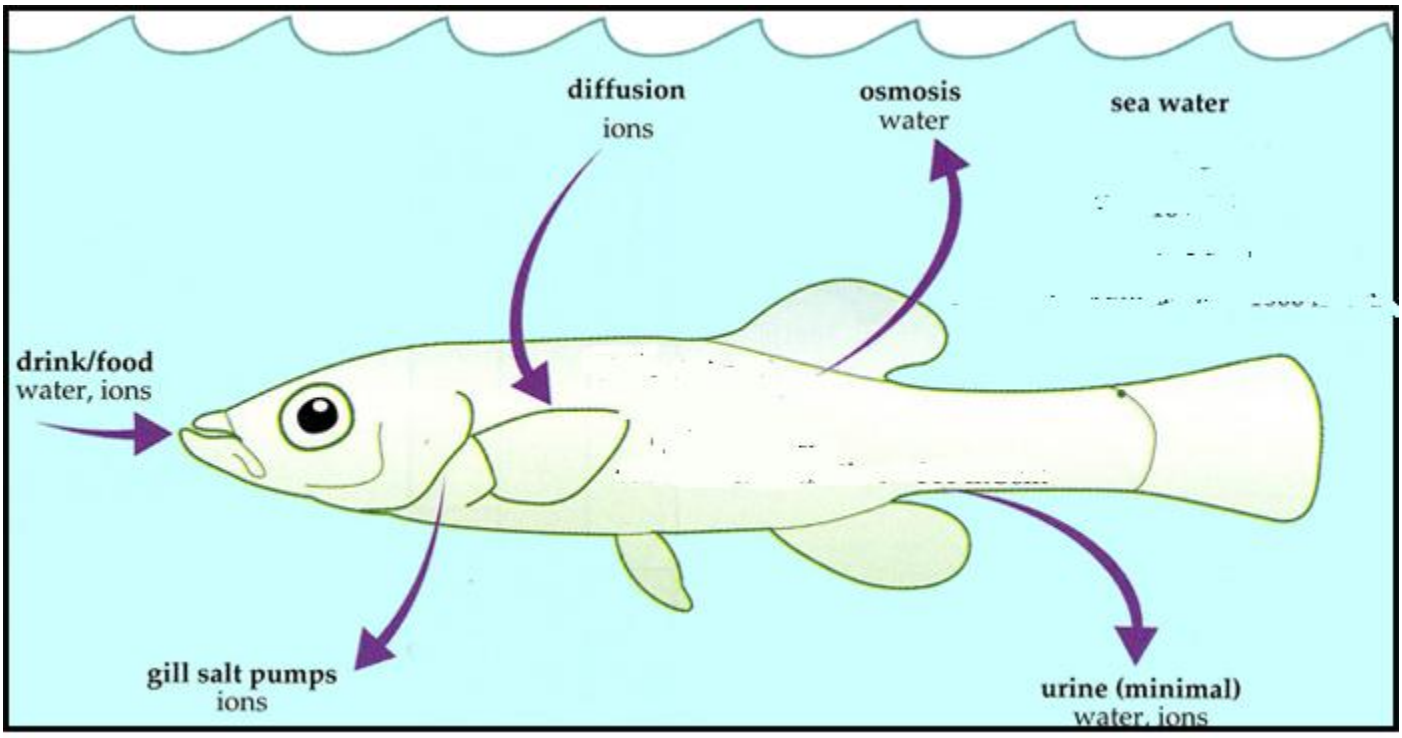


Figure 4 Saltwater species (To be replaced by Penny drawing)

Diadromous fish, when they are born, are perfectly adapted to the environment into which they hatch or quickly begin migrating towards a more suitable one. As adults, however, they are either able to regulate their systems during migration so that they change their habits depending on the concentration of dissolved salt in the water or, as in the case of some salmon species, begin to die when they enter the new environment and continue on a suicide run in order to fulfill their destiny to offer the opportunity for a new generation of salmon to be spawned before they themselves expire.

Alewife herring were, at one time, possibly an abundant food source in the Bronx River. If what is true for other rivers in the North East is true for the Bronx River, alewife would have been depended upon by native peoples, as well as by other predators in the area. Unfortunately construction of mills and dams as early as 1680 cutoff all possible access to spawning grounds upstream and a lack of data prior to the construction of the dam makes it impossible for us to know if the alewife used the river as a spawning ground. What is known is that the construction of the first dam at the top of the estuary ended any possibility of anadromous migration. In 2006, an alewife reintroduction program was begun and for two years alewife fry were released into the Bronx River inside the Bronx Zoo, one half mile north of the lowest existing dam on the river in River Park. Alewife reach spawning maturity in three to four years so the plan was (is) to have the dam retrofitted with a fish ladder: a sort of ramp that allows the fish to fight their way over the dam. There was no reintroduction in 2008 or 2009 due to worries over fish stock contamination of viral hematoma syndrome (VHS, http://www.dec.ny.gov/animals/25328.html). In 2009, 7 alewife herring, believed to belong to the population that had been released into the river in 2006, were caught in a specially designed net in the Bronx River, just north of 180th street. The return of what could be the first alewife in the river in over 300 years is seen by many as yet another symbol of the continued rehabilitation of the Bronx River. These magnificent seven, most likely males since the male of

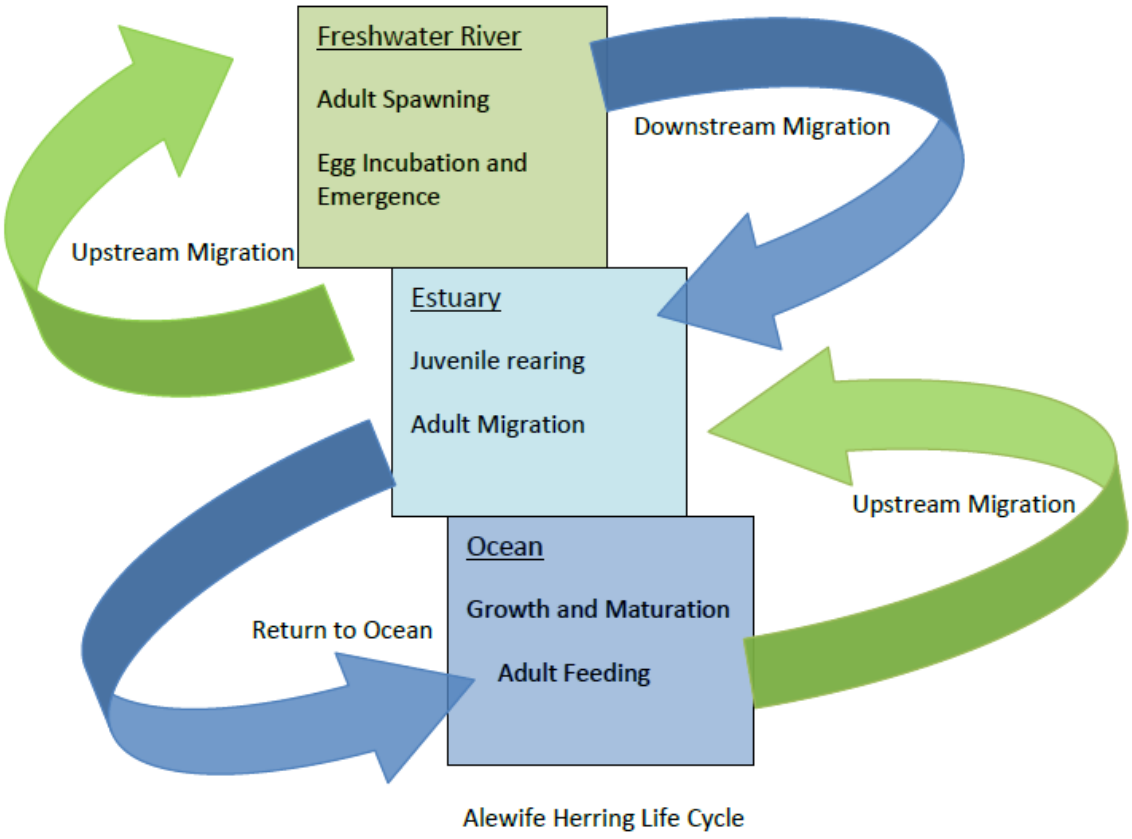
the species matures in three years while the female needs a minimum of four, are expected to be back again in 2010 along with a larger number of their earlier re introduced bretheren.

Alewife information:

Every May and June, adult alewives, guided by their sense of smell, migrate upstream from the ocean to rivers, streams, ponds and lakes to spawn. Spawning occurs in ponds and lakes or the quiet backwaters of rivers and streams where there is minimal flow. Following the scent of fresh water, the Alewife swimming against the current, rarely jumping like their more famous cousin the Salmon, but able to navigate white water rapids when necessary. Some males return to freshwater when they are three years old as they mature faster, but females usually return when they are four or five years old. Spawning usually commences when water temperatures are 8.9-12.2 Celsius, often in shallow slow moving water, even as shallow as 15 centimeters (6 inches). Spawning generally will not occur if water is above 24 Celsius.

One migrating female alewife can produce somewhere between 60,000 to 100,000 eggs in one spawning season which she broadcasts in a random fashion and are demersal, meaning they sink close to the bottom. This may be another reason the alewife return to freshwater to spawn. In the denser salt water the eggs would be more likely to float and, hence, in more danger of predation. Even in freshwater, only a few eggs survive to the juvenile stage, and sometimes only as few as three juveniles survive to adulthood. The tens of thousands of eggs that do not reach maturity are a valuable source of nutrients for other organisms in the ecosystem.

Although some adults die after spawning, the majority of adults make their way back to the ocean shortly after spawning and many return the following spring again. Alewife sampling has found members of the ocean going species as old as nine years of age which would mean the possibility of participating in five spawning seasons. During their downstream migration, adult alewives feed primarily on zooplankton. Once hatched, juvenile alewives remain in freshwater lakes and ponds where they also feed on zooplankton. Juvenile alewives grow anywhere between one to six inches, depending on the productivity of the lake. From mid-July through October, juveniles migrate downstream to the ocean where they grow to adulthood.



Alewife Herring Life Cycle

Activity:

Alewife come home: The return of an anadromous fish to the Bronx River.

Summary: Students learn about the amazing reproductive cycle of the Alewife Herring. While learning about this cycle, students form expert groups that will compare fish biology, river data and maps to decide upon a good area for spawning in the Bronx River.

Students will be able to: define diadromy, specifically, anadromy in particular that of the Alewife Herring (Lifecycles and reproductive cycles.), read maps, sort data on water quality.

Students work towards deciding where the alewife should spawn.

Materials: map of the Bronx River from Soundview to the Bronx Zoo or (Google earth, Live search), data sets for WQ (from Soundview, Hunts Point, Starlight Park, Drew Gardens and Bronx zoo and Burke Bridge)

Students in groups of 4-5.

Procedure:

1) Pass out maps and information sheets or web quest guides for Alewife herring project. Each member receives a specific packet to look into based on their specific information and then will share their findings with the group(maybe expert groups should be formed to study a subject; ex. All cartographers find coordinates, all fish biologists read about alewife life cycle, etc.).
    a. Cartographer(s): maps and coordinates of sites: Soundview, Hunts Point, Starlight Park, Drew Gardens, Bronx Zoo, Burke Bridge. Mark sites on map.
    b. Fish Biologist: description of anadromous fish, life cycle of alewife, optimum conditions chart.
    c. Ecologist: CSO's, Estuaries, tides and river issues
    d. Hydrologist: WQ data sets for sites over specific times. DO, Temp, salinity only (if necessary, a short explanation of what each parameter means.)
2) Experts share information for 15 minutes in expert groups
3) Experts return to core groups to share information. Sharing information in order, round robin, the experts must insure that the others understand the information.
4) As a group, the team must decide where on the Bronx River would be the optimum area for spawning of the alewife herring and be able to explain why they feel they have chosen the best place.
5) The finished product will be a chart paper poster made with four colors (one pen per team mate, one color each). The poster must in some way explain why they have chosen a specific place (places?) The design is the decision of the group but it must in some way include: words, symbols, and drawings(at least one of each)
6) Groups present findings.

Information that is not offered or provided is that of the dams on the Bronx River. As the following lesson will be about dams, dam removal and fish ladders, such information may be discovered only by the students themselves.

<u>Definitions</u>:

- Concentration: the amount of stuff dissolved in solution. (Seawater has a higher salt *concentration* than fresh water).
- Diffusion: the dispersal of matter within an environment such that it becomes equally concentrated throughout the environment.
- Hypertonic: a solution containing a greater amount of dissolved stuff than a creature or object in the solution.
- Hypotonic: a solution containing a lesser amount of dissolved stuff than a creature or object in the solution.
- Isotonic: a solution containing an equal amount of dissolved stuff than a creature or object in the solution.
- Osmoregulation: the process of regulating the amount of salt and other dissolved substances to control the loss or gain of water from osmosis.
- Osmosis: the diffusion of water across a semi-permeable membrane.
- Salinity: the relative amount of salt dissolved in water. (Seawater has a higher *salinity* than freshwater).
- Semi-permeable membrane: a membrane that permits the free passage of water but prevents the passage of a dissolved substance like salt.

Expert Group role cards: All experts will research and learn with their respective experts, (i.e.ecologists with ecologists) and must be able to share what they have learned with the other members of their team.

- Cartographer: As cartographer, you will need to map the Bronx River and the locations that are provided. You may means of discovering your information that you have at hand and some possibilities are offered at the bottom of this profile. Your map must be large enough that your group will be able to use it in their presentation, but the details that you provide are your decision. Your map must show: The Bronx River in the Bronx, connecting bodies of water, the monitoring sites that are listed, and any river geography that might be important. Your teammates may offer some opinions on this matter.
  Cartography Resources:
  Introductory information http://math.rice.edu/~lanius/pres/map/
  http://www.edgate.com/lewisandclark/cartography.html
  Historical Maps
  http://www.davidrumsey.com/luna/servlet/groups/search?firstName=&lastName=&searchText=Bronx&userSearchText=&search=Search&includeLocked=on

- Fish Biologist: As a fish biologist you will need to learn about the alewife herring and all of the terms that are associated with the species. A minimum amount of information that you must be able to share is: description of anadromous fish, life cycle of alewife, optimum spawning conditions including type of water (fresh or salt), temperature and depth .
  Fish Biology Resources:
  What is a Fish Biologist? http://calfish.ucdavis.edu/Careers_in_Fish_Biology/
  Herring of NY http://www.dec.ny.gov/animals/7043.html
- River Ecologist: Ecologists look into the big picture of how everything in the world has an effect on everything else in the world. As a river ecologist you are dedicated to mainataining he health and biodiversity of the riverine environment and find solutions to any problems that exist. What are the issues that affect the Bronx River and the life that it supports? Be sure to investigate what issue may cause problems for Alewife Herring migration , including natural and man-mad causes. CSO's, Estuaries, tides and other river issues.
  River ecology resources: What is a river ecologist? http://www.ehow.com/about_4781577_role-stream-ecologist.html
  Stream Ecology information http://chamisa.freeshell.org/ecology.htm
  Estuaries and salt marshes http://www.nearctica.com/ecology/habitats/estuary.htm
- Hydrologist: Alewife Herring live in water so it will be important to learn about what that environment is like for the fish. You will need to research how Dissolved Oxygen, Temperature and Salinity can change on a river, what can affect them and where on the river these parameters might be different. WQ data sets for sites over specific times are available. Be sure to define the following terms: Dissolved oxygen, temperature, marine, fresh water, brackish, salinity, estuary, salt wedge and tide.

Appendix A

Resources:

1.
Hughes, Andrew; O'Reilly, Clare. (2008) .Monitoring Alewife Runs in the South Shore Estuary Reserve. http://www.estuary.cog.ny.us/council-priorities/living-resources/alewife_survey/Alewife%202008.pdf

2.
Stang, Douglas; Stegemann, Eileen C. (1993). The Herring Of New York. Department of Conservation; The Conservationist magazine.
http://www.dec.ny.gov/animals/7043.html

3.
Oceans Alive. (2006, February) Running On: Conservation of Migratory Fishes on Long Island, An Alewives Tale. Environmental Defense Fund.
http://www.edf.org/documents/4450_ConservingMigratoryFishLI.pdf

4.
Crimmens, Teresa; Larson, Marit. (2006, March). Herring Return To The Bronx River. New York City Department of Parks and Recreation's Daily Plant.
http://www.nycgovparks.org/sub_newsroom/daily_plants/daily_plant_main.php?id=19818

5.
Wildlife Conservation Society. (2006). Bronx River Diary Expedition 1-6 and Final Expedition.
http://www.wcs.org/353624/bronxriver7wcs
6.
http://www.estuary.cog.ny.us/council-priorities/living-resources/alewife_survey/alewife_survey.htm

Case Study
7.
Maine Dept. of Marine Resources. (2004). All about Maine Alewife. US fish and wildlife service northeast region.
http://www.fws.gov/northeast/gulfofmaine/downloads/fact_sheets/alewife%20fact%20sheet.pdf

Video on Alewife
8.
Teachers' Domain. (2003, September). Scent of an Alewife. Online video.
http://www.teachersdomain.org/resource/tdc02.sci.life.reg.alewife/

Ipswich River
http://www.ipswichriver.org/projects/science.htm

9. Freshwater vs saltwater fish

http://www.ca.uky.edu/wkrec/VertebrateFishEvolution.PDF

Alewife information

http://fwie.fw.vt.edu/WWW/macsis/lists/M010037.htm

http://www.gma.org/undersea_landscapes/alewives/index.html

Fish anatomy lesson:

http://www.statefishart.com/lesson.pdf

Osmosis activities:

http://www.usoe.k12.ut.us/CURR/science/sciber00/7th/cells/sciber/osmosis1.htm

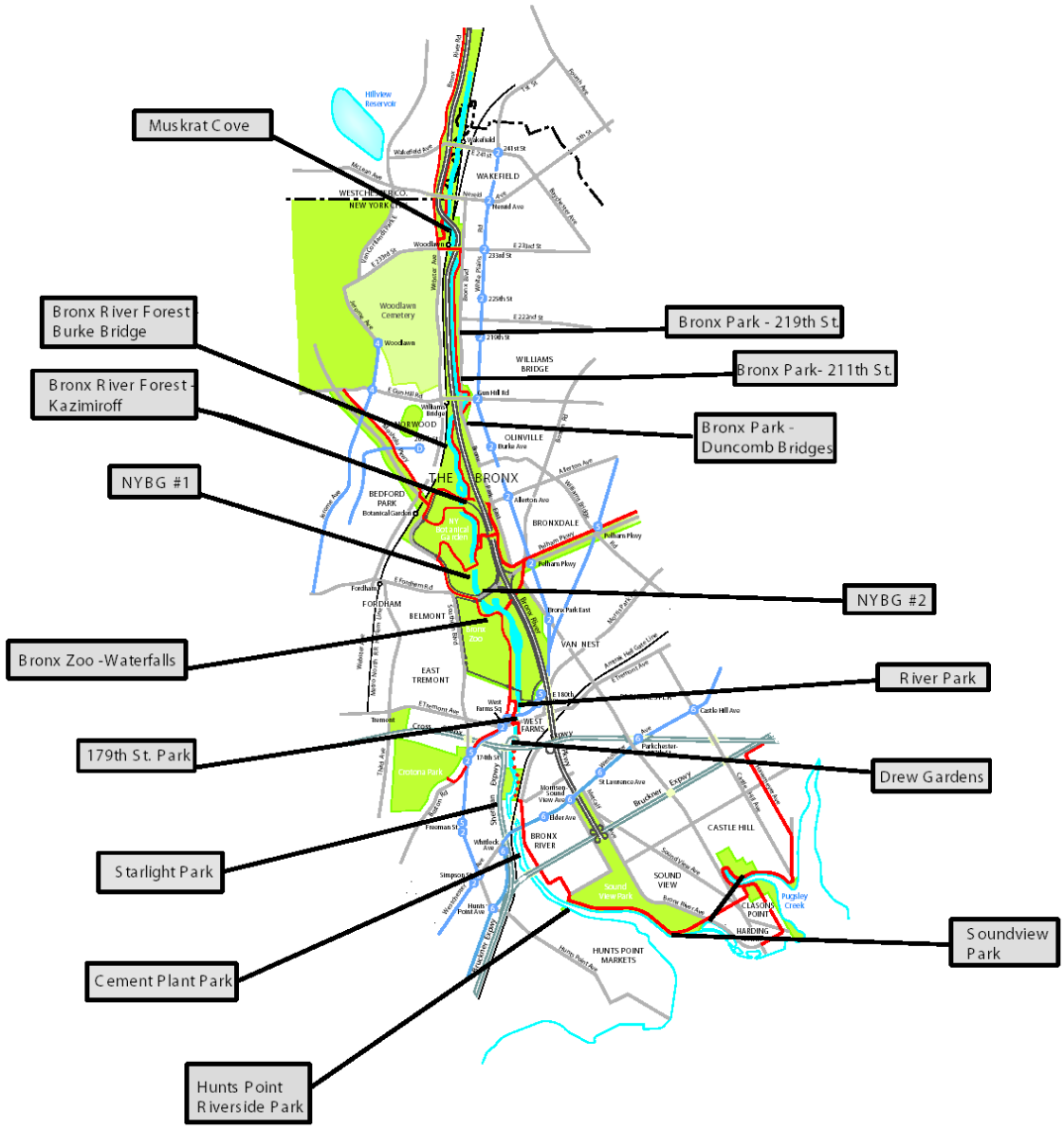
http://marinediscovery.arizona.edu/lessonsS01/blennies/2.html

Bronx River Wetlands:

http://www.nycgovparks.org/sub_about/parks_divisions/nrg/bronx_river_epa/aquatic_life/table_aquatic.html

Appendix B

Bronx River Stewards Monitoring Sites



As adopted by the Bronx River Education Team: March 2002

Appendix C

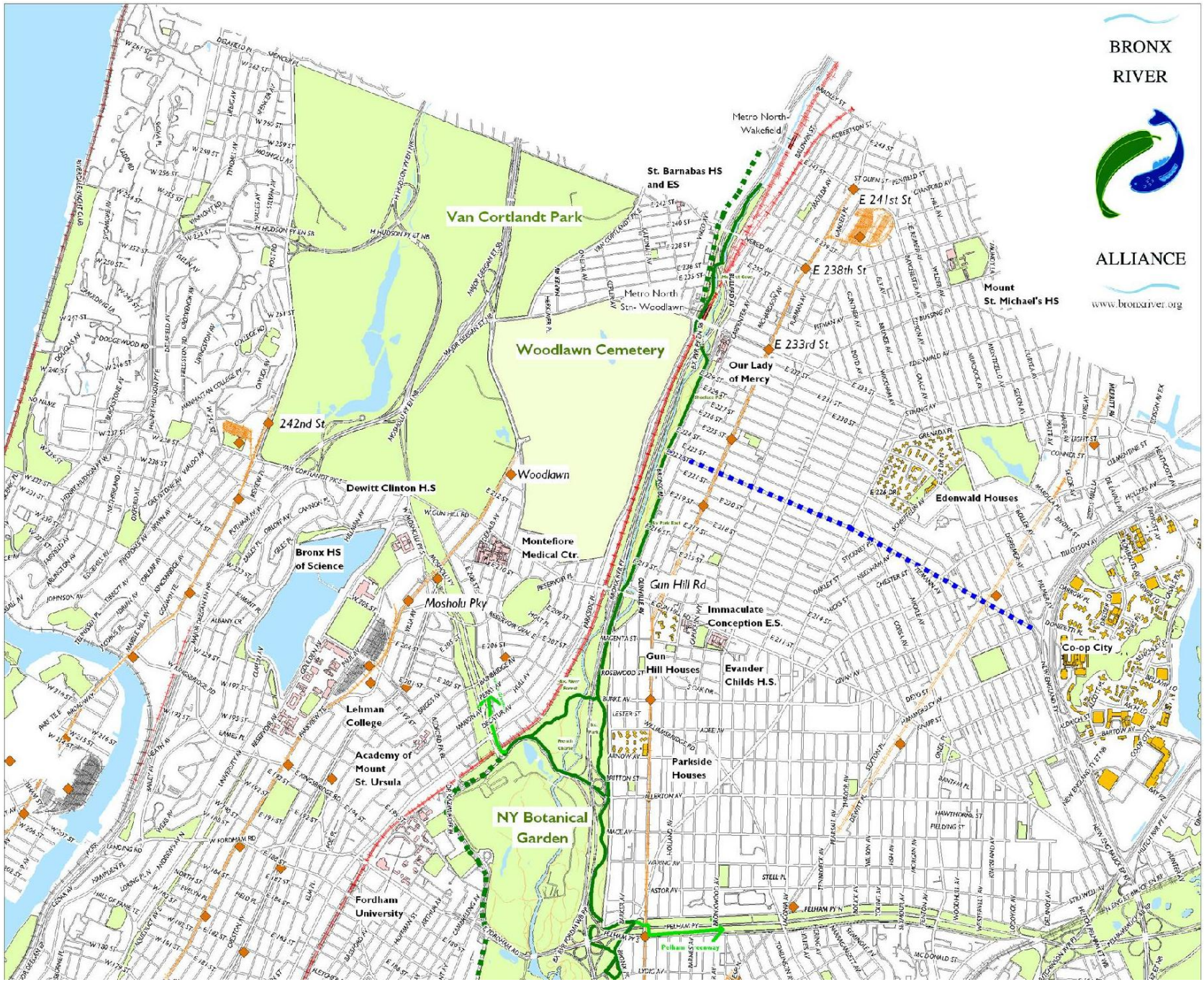
BxRS Monitoring Site Names and Locations amd Water Quality Averages

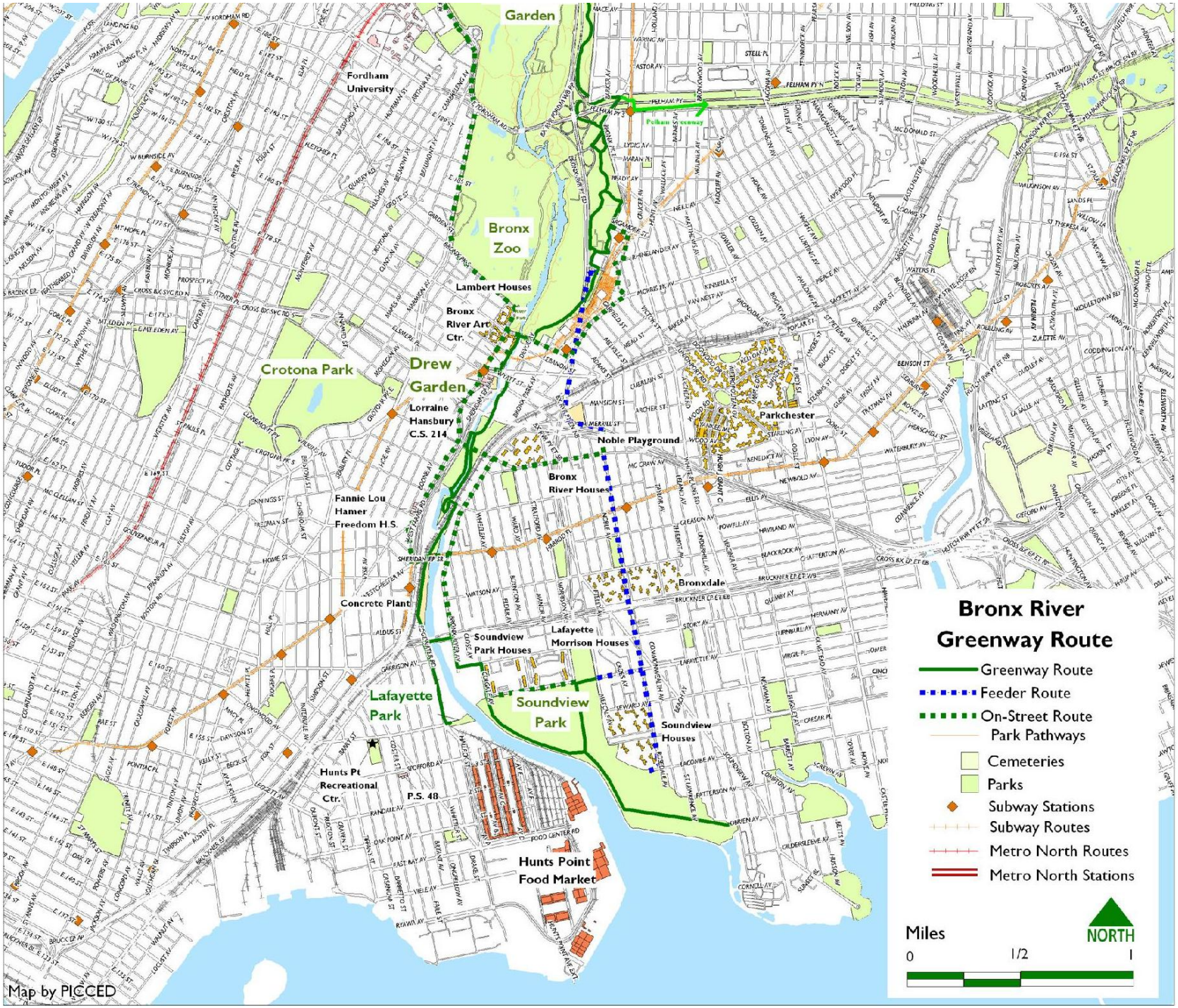
Location	**GPS** degrees/min	**Average W.Q Data**	**Average water depth**	**Average water velocity**
Muskrat Cove, 233rd Street	40°54'0.03"N 73°51'38.03"W	Spring Water Temp. 15º C D.O 9 ppm Salinity 0 ppt	18”	
Shoelace Park, 219th Street	40 53.066' N 073 52.037' W	Spring Water Temp. 15º C D.O 9 ppm Salinity 0 ppt	15”	
Stairs at intersection of Bronx Park East and Duncomb Ave.	40 52.578' N 073 52.210' W	Spring Water Temp. 14º C D.O 9 ppm Salinity 0 ppt	48”	
Bronx River Forest, Burke Avenue	40 52.301' N 073 52.367' W	Spring Water Temp. 12º C D.O 9 ppm Salinity 0 ppt	16”	
NYBG-South	40 51.536' N 073 52.592' W	Spring Water Temp. 13º C D.O 9 ppm Salinity 0 ppt	16”	
Bronx Zoo	40°51'17.18"N 073°52'34.98" W	Spring Water Temp. 11º C D.O 10 ppm Salinity 0 ppt	12”	
River Park, 180th Street	40 50.583' N 073 52.614' W	Spring Water Temp. 10º C D.O 9 ppm Salinity 2 ppt	14”	
Drew Gardens, Tremont Avenue	40 50.3382' N 73 52.7364' W	Spring Water Temp. 12º C D.O 8 ppm Salinity 6 ppt	36”	
Starlight Park, Edgewater Rd.	40°49'57.49"N	Spring Water Temp. 11º C D.O 6.5 ppm	8 feet	

(south of Westchester Ave)	73°52'58.51"W	Salinity 9 ppt		
Concrete Plant Park, Edgewater Rd. (north of Westchester Ave.)	40 49.508' N 073 53.102' W	Spring Water Temp. 12º C D.O 8 ppm Salinity 11 ppt	14 feet	
Hunts Point Riverside Park, Lafayette Ave. and Edgewater Rd.	40°49'4.57"N 73°52'53.05"W	Spring Water Temp. 10º C D.O 9 ppm Salinity 18 ppt	14 feet	

Appendix D

Printable Map of Bronx River in the Bronx. This map provides a larger map to be used for reference. It should be printed on letter size paper in landscape orientation and then joined together.


BRONX
RIVER
ALLIANCE
www.bronxriver.org
Van Cortlandt Park
Woodlawn Cemetery
242nd St
Woodlawn
Dewitt Clinton H.S
Bronx HS of Science
Montefiore Medical Ctr.
Mosholu Pky
Gun Hill Rd
Lehman College
Academy of Mount St. Ursula
NY Botanical Garden
Fordham University
Pelham Parkway
Metro North-Wakefield
Metro North Stn- Woodlawn
St. Barnabas HS and ES
E 241st St
E 238th St
E 233rd St
Mount St. Michael's HS
Our Lady of Mercy
Edenwald Houses
Immaculate Conception E.S.
Gun Hill Houses
Evander Childs H.S.
Parkside Houses
Co-op City


Garden
Fordham University
Bronx Zoo
Lambert Houses
Bronx River Art Ctr.
Crotona Park
Drew Garden
Lorraine Hansbury C.S. 214
Fannie Lou Hamer Freedom H.S.
Concrete Plant
Lafayette Park
Hunts Pt Recreational Ctr.
P.S. 48
Hunts Point Food Market
Soundview Park Houses
Soundview Park
Lafayette Morrison Houses
Soundview Houses
Bronx River Houses
Noble Playground
Parkchester
Bronxdale
Pelham Parkway
Bronx River Greenway Route
Greenway Route
Feeder Route
On-Street Route
Park Pathways
Cemeteries
Parks
Subway Stations
Subway Routes
Metro North Routes
Metro North Stations
Miles
0
1/2
1
NORTH
Map by PICCED