FISH AS BIOINDICATORS

WHAT IS THE RELATIONSHIP BETWEEN AN AQUATIC "ECOSYSTEM" AND A FISH "COMMUNITY"?

An aquatic ecosystem is made up of the interactions between biota and their physical and chemical surroundings (e.g., physical habitat, nutrients, oxygen, temperature) in a specific place. A fish community is one part of the ecosystem, including only fish and their interactions with each other. The physical and chemical surroundings usually determine the character of the fish community and can vary between places and change over time (e.g., due to seasons or human influences). Fish communities are likely to reflect those environmental differences. Common ways to group fish are described in Text Box 1.

TEXT BOX 1: HOW DO ECOLOGISTS REFER TO GROUPS OF FISH?

Ecologists frequently group fish into broad categories based on the behavior of the fish, their preferred environment, or human use. A single fish species may belong to several of the following groups:

BY TEMPERATURE PREFERENCE:

- Cold water (e.g., trout, salmon, whitefish)
- Cool water (e.g., walleye, muskellunge)
- Warm water (e.g., carp, bluegill, largemouth bass)

BY MOVEMENT PATTERN:

- Resident (e.g., brook trout, minnows)
- Transient (e.g., large predatory fish)
- Migratory (e.g., salmon, eel)
  - Diadromous – fish that spend part of their lives in freshwater and the other part in saltwater
  - Anadromous – fish that spawn in freshwater and live most of their life in saltwater (e.g., salmon)
  - Catadromous - fish that spawn in saltwater and live most of their life in freshwater (e.g., eel)

BY LOCATION WITHIN THE ECOSYSTEM OR TYPE OF ECOSYSTEM:

- Lotic – flowing water
- Lentic – still water
- Benthic – bottom-dwelling
- Littoral – near shore
- Pelagic – open water

BY THE FOOD THEY EAT:

- Herbivore – aquatic vegetation
- Planktivore – free-floating plankton (usually zooplankton)
- Benthivore – benthic macroinvertebrates (e.g., insect larvae, mussels, or worms), periphyton (small attached algae and microbes)
- Piscivore – fish
- Omnivore – plant and animal

WHAT IS THE RELATIONSHIP BETWEEN AN AQUATIC "ECOSYSTEM" AND A FISH "COMMUNITY"?

Ecosystem or fish community boundaries are arbitrary, but they are usually defined by natural patterns in environmental features. For example, lakes or ponds are commonly identified as distinct ecosystems. Watershed divides are frequently used as boundaries between lotic (i.e., stream or riverine) ecosystems. Boundaries within natural rivers and creeks can be more difficult to define because the character of the system changes, sometimes gradually, along its length (Fig. 1). However, obstructions to water or fish movement sometimes provide clear boundaries between fish communities. These include natural barriers such as waterfalls, and man-made barriers like dams or extensive reaches of degraded habitat.

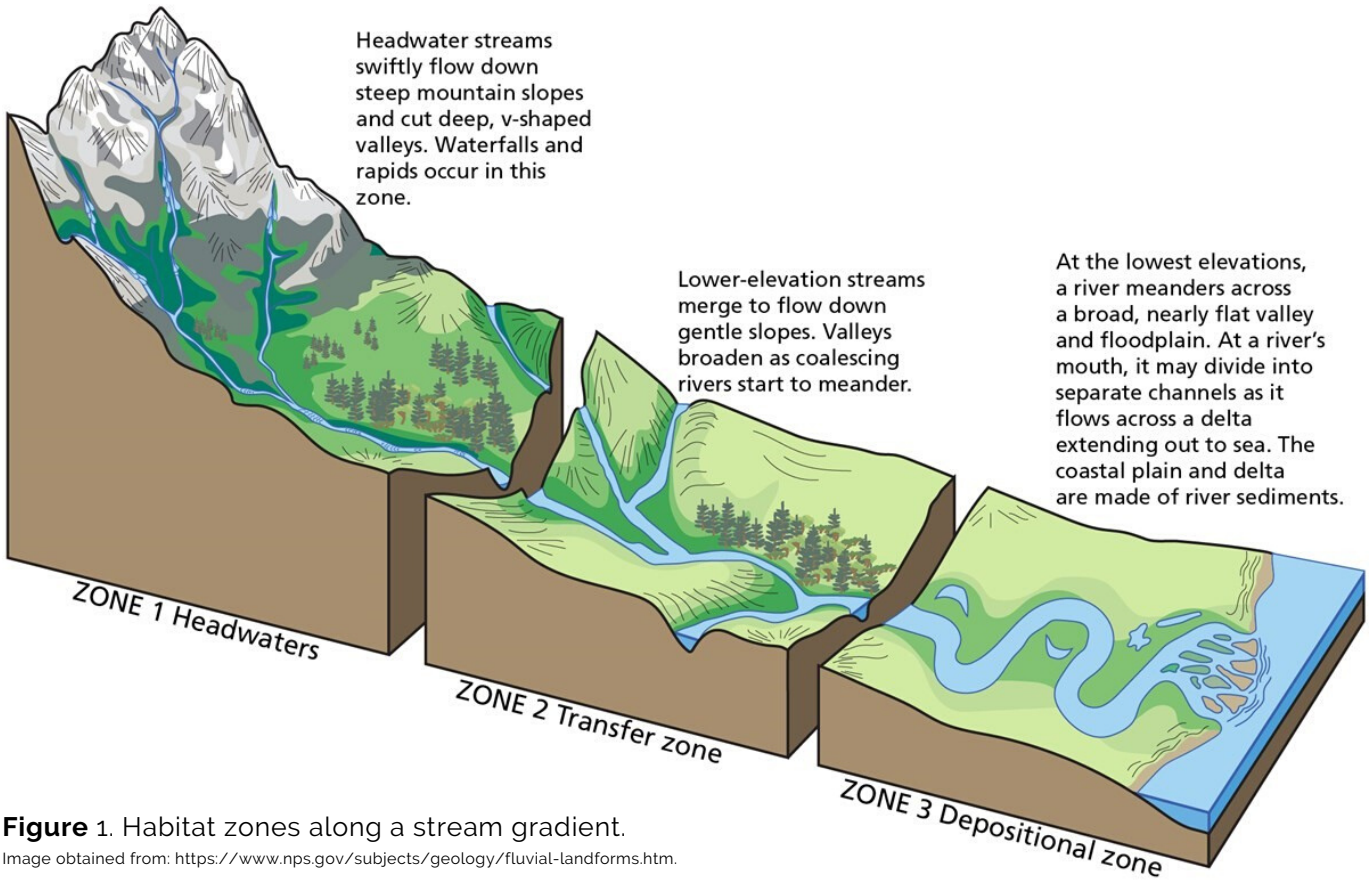

Figure 1. Habitat zones along a stream gradient.
Image obtained from: https://www.nps.gov/subjects/geology/fluvial-landforms.htm.

WHAT ARE FISH COMMUNITIES LIKE IN UNDISTURBED STREAMS?

Fish communities vary between headwaters and the mouth of a creek. In undisturbed streams, fish communities near headwaters are typically comprised of a few cold-water species, gradually transitioning to cool or warm water communities at the mouth, with the greatest diversity in between. This transition in species composition reflects changes in topographic, aquatic and riparian habitats, water quality, and food types along the length of a stream. Migratory and transient species may use parts of the creek seasonally for feeding, reproduction, or refuge, temporarily increasing diversity.

HOW ARE FISH COMMUNITIES STUDIED IN STREAMS?

Fish surveys can be used to investigate species, number, size, sex, reproductive status, and health of fish using many different field techniques. A common sampling technique for fish surveys in wadeable streams is backpack electroshocking (Fig. 2). Various types of nets can be used in deeper waters. Repeated sampling in an area enclosed with nets can be used to calculate the total number of fish at a location. Fish density (number / area) is the total abundance divided by the estimated stream area. During a particular fish survey, species composition at that time is affected by a number of environmental and circumstantial factors. The aquatic environment in Poesten Kill changes along its length, transitioning from a small, pond-fed stream in a largely undeveloped landscape to a wide, fast-moving stream containing several large waterfalls in a highly urbanized area of the watershed. Due to Poesten Kill's connection to the Hudson River estuary, as well as seasonal changes in stream condition, the fish community can change throughout the year. Multiple samples conducted at intervals along a creek and its tributaries, and at multiple times, can give an overall picture of local fish communities and their spatial relationships to natural and man-made conditions.

Figure 2. Fish sampling with the use of a backpack electrofisher in Poesten Kill, 2017. Photo credit: OEI.

THE ROLE OF FISH IN AQUATIC MONITORING PROGRAMS

Most water quality designations in the United States pertain to fish assemblages and fishing restrictions. In New York State, assigned designations such as “swimming/fishing”, “fishing”, “trout”, and “trout spawning” are used to describe water quality and stream health. Fish is a common biotic assemblage that is incorporated into biological assessments of streams because (Barbour et al., 1999):

(1) Fish are long-lived and mobile; therefore, they are good indicators of temporal changes in habitat condition.

(2) Fish assemblages typically include species that occupy different trophic levels. Trophic structure is reflective of overall stream quality.

(3) Fish are of recreational and commercial value to humans.

(4) Fish are relatively easy to collect and identify to species

(5) Environmental requirements, life history, and distribution of fish are well known, and such data is usually easily obtainable.

LITERATURE CITED

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols For Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C.