# Aquatic Ecology

**INTRODUCTION**


**Aquatic Ecology Field Station**

Aquatics or aquatic ecology is the study of animals and plants in freshwater environments. In addition to the many common aquatic species in this Western New York region, a student of aquatics learns about watersheds, wetlands and the hydrologic cycle. Essential to understanding and appreciating the field of aquatics is a basic knowledge of the physical and chemical properties of water.

Water is arguably the most valuable substance on the planet, and is the common name applied to the liquid state of the hydrogen oxygen compound H2O. It covers 70% of the surface of the Earth forming swamps, lakes, rivers, and oceans. Pure water has a blue tint, which may be detected only in layers of considerable depth. It has no taste or odor. Water molecules are strongly attracted to one another through their two hydrogen atoms. At the surface, this attraction produces a tight film over the water (surface tension). A number of organisms live both on the upper and lower sides of this film.

Density of water is greatest at 39.2° Fahrenheit (4° Celsius). It becomes less as water warms and, more important, as it cools to freezing at 32° Fahrenheit (0° Celsius), and becomes ice. Ice is a poor heat conductor. Therefore, ice sheets on ponds, lakes and rivers trap heat in the water below. For this reason, only very shallow water bodies never freeze solid.

Water is the only substance that occurs at ordinary temperatures in all three states of matter: solid, liquid, and gas. In its solid state, water is ice, and can be found as glaciers, snow, hail, and frost and ice crystals in clouds. It occurs in the liquid state as water droplets in rain clouds, and on vegetation as dew. Under the influence of gravity, water may accumulate in the openings of hard rock beneath the surface of the earth. This groundwater sustains wells, springs and some streams. As a gas, or water vapor, it occurs as fog, steam, clouds, and humidity.

The transparency of water permits enough light to penetrate for plants to carry on photosynthesis and animals to thrive. The depths to which light can penetrate decrease as water contains more suspended materials and becomes turbid (or less clear). Less light means fewer plants can grow, thus attracting less wildlife.

Our dependence upon water and competition for it have imperiled and will continue to threaten aquatic environments and the organisms living in them. Good water quality is essential for aquatic life as well as for the human species. Recently, the historical emphasis on political entities, such as counties, towns, villages and cities, has shifted to watersheds. It has been said that one-third of the world¹s population will experience a water shortage crisis in 2025. Wars in the future may well be fought for water rather than for oil! Source for text on water properties:

*Reference: NYC Envirothon Resource Packet, Central New York Regional Envirothon Study Guide*

# Table of Contents

## AQUATIC ECOLOGY - LEARNING OBJECTIVES

**For successful completion of the aquatics section, contestants should be able to:**

- Know the processes and phases for each part of the water cycle and understand the water cycle's role in soil erosion, groundwater recharge, and climatic influences.
- Understand the concept and components of a watershed and be able to identify stream orders and watershed boundaries. Know the features of a healthy watershed and an unhealthy watershed.
- Know how to interpret water and biological quality tests and understand why aquatic organisms and water quality is affected by the physical, chemical and biological conditions of the water and how it impacts aquatic environments.
- Understand the dependence of all organisms on one another and how energy and matter flow within an aquatic ecosystem.
- Understand the concept of carrying capacity for a given aquatic ecosystem, and be able to discuss how water usage may affect the ability of the system to sustain different needs.
- Identify common, rare, threatened and endangered aquatic species as well as aquatic invasive species.
- Identify aquatic and wetland environments based on their physical, chemical and biological characteristics.
- Know characteristics of different types of aquifers, and understand historical trends and threats to groundwater quantity and quality.
- Understand the benefits and ecological functions and values of riparian zones, wetlands and open water systems and be able to identify the associated zone areas.
- Be familiar with both NYS and federal water protection laws and the agencies that enforce those laws. Understand the requirements for required permits.
- Understand concepts and practices to manage non-point source pollution from agricultural, forest and land under development.
- Be familiar with general terminology and definitions pertaining to the subject area.

## I. Abiotic Factors

A. Water Cycle
B. Watershed Features

1. Stream Order
2. Stream Health Factors
3. Identify Boundaries

C. Water Conditions

1. Physical
2. Chemical
3. Biological

## II. Biotic Factors

A. Energy Flow
B. Carrying Capacity
C. Identify Aquatic Species (Plants, Fish, Amphibians, Micro and Macro Invertebrates)

1. Common
    a. Basic Physiology
    b. Lifecycles
    c. Habitat

2. Rare, Threatened, Endangered
3. Invasive
4. Water Quality indicators

## III. Aquatic Environments

A. Wetlands

1. Definition
2. Characteristics
3.Functions /Importance /Values

B. Riparian Zones
C. Aquifers and Groundwater
D. Ponds and Lakes

1. Temperature Zones
2. Vegetation

## IV. Water Protection and Conservation

A. Water Quality and Pollution

1. Groundwater
2. Surface Water

B. Types of Pollution

1. Point Source
2. Nonpoint Source
3. Thermal
4. Control methods

C. Management and Legislation

1. Laws
2. Agencies

**1. A lake ecosystem is termed "phosphorous limited" if:**

a. adding nitrogen to the lake causes increased phytoplankton growth

b. adding phosphorus to the lake causes increased phytoplankton growth

c. adding nitrogen to the lake causes decreased phytoplankton growth

d. adding phosphorus to the lake causes decreased hytoplankton growth

e. adding phosphorus to the lake causes no change in phytoplankton growth

**2. Pacific salmon (Onchorhyncus spp.) are an example of the "anadromy" life history because they do which of the following:**

a. fish spend most of their lives in freshwater and then migrate to the sea for breeding

b. fish spawn in freshwater but juveniles drift back to the ocean where adults spend most of their lives

c. adult female fish die immediately after spawning

d. adults can metamorphose from male to female under high density pressures

e. none of the above

**3. Which of the following would NOT be considered a benthic macroinvertebrate organism?**

a. Diatom

b. Decapod

c. Gastropod

d. Ephemeroptera

e. Bivalvia

**4. The water in jar "A" was collected from the surface of a mesotrophic system; the water in jar "B" was collected from the surface of a eutrophic system. What physical parameter should show the greatest difference between these two water samples?**

a. Temperature b. Dissolved oxygen concentration
c. Turbulence d. Turbidity e. Salinity

**5. Identify the creature making this call by listening to the tape.**

a. Wood frog

b. Pickerel frog

c. Spring peeper

d. Green frog

**6. If a New York state stream contains a wild trout population then a permit is required to construct a road crossing it. Which of the following agencies would issue the needed permit?**

a. United States Fish and Wildlife Service

b. Soil and Water Conservation District

c. New York State Department of Environmental Conservation

d. United States Environmental Protection Agency

e. New York State Department of Transportation

**7. Because they produce so much plant biomass and invertebrate life, estuaries and their coastal marshes serve as important nursery areas for the young of many game (recreational) and commercial fish and shellfish. Which of the following fish species is dependent upon coastal wetlands?**

a. Brown trout

b. Atlantic chad

c. Northern pike

d. Flounder

**8. One of the main functions of a healthy watershed is the temporarily storage and transportation of water from the land surface to the water body. Over time, streams develop into defined drainage networks. Which of the following is not a recognized drainage pattern?**

a. Parallel b. Spiral
c. Angular d. Dendritic

**I. Abiotic Factors**

Water Science Basics, Watershed, Stream Classisfication

**II. Biotic Factors**

Primers for Aquatic Plants, Order, Order & Classification, Pond Stream, Eurasian Watermilfoil

**III. Aquatic Environments**

Threats to Wetlands, Wetland Types, US EPA Wetlands, Wetland Functions, Benefits of Wetland for Amphibians & Reptiles, Lacustine, Palustine, Ranks Glossary, Riverine, Terrestrial System, Aquifers, Groundwater, Mgt. Fish Ponds In PA

**IV. Water Protection and Conservation**

Urban Runoff Fact Sheet, Managing NPS from Agriculture, Managing NPS from Households, Clean Water Act, Wetland Regulation Authority

**Aquatic Ecology**

Aquatic Plants, Vegetation & Algae, Controlling Aquatic Vegetation, Identification, Use & Benefits of Aquatic Plants

**Communities of NYS**
Introduction, System Key

**Ponds , Marcoinvertebrates**
Aquatic Ecology, Caddis, Macro Key, Macro Invertebrates (1), Macro Invertebrates (3) Pond Habitat

**Non Point Source Pollution**

After The Storm, Buffer Fact Sheet

**Wetlands**
Economic Benefits of Wetlands Overview

**Links**

- North America Native Fishes Association
- NatureNorth.com
  USGS Nonindigenous Aquatic Species
- NatureSongs.com
  Cortland Herpetology Connection
- LEFT for Aquatic and Invasive Plants
- NYS DEC Facts About the Waters of New York State
- NYS DEC Key to Aquatic Macroinvertebrates
- NYS DEC Saving Water Makes Good Sense
- NYS DEC Getting the Most (Out) Of Your Aquatic Plants
- NYS DEC Color Brochures and Posters of Wildlife in New York State as first seen in the Conservationist magazine

**A**

**Acid rain:** rain containing pollutants that give it a pH of less than 7.0.

**Algae:** photosynthetic organisms with a one-celled or simple multi-cellular body plan.

**Aqueous:** containing or composed largely of water.

**Aquifer:** a land, gravel or rock formation capable of storing or conveying water below the surface of the land.

**B**

**Bacteria:** unicellular microorganisms of the class Schizomycetes existing as free living organisms or parasites.

**Benthos:** bottom dwelling or substrate-oriented organisms.

**Best Management Practices:** a practice or combination of practices that provide an effective, practical means of preventing or reducing pollution from non-point sources.

**Bioaccumulate:** the practice of concentrating a particular substance over time.

**Biomonitoring:** the use of organisms to assess or monitor environmental conditions.

**Biochemical Oxygen Demand (BOD):** a measure of the quantity of oxygen used by microorganisms in the aerobic oxidation of organic matter.

**Brook:** a small stream Buffer: a vegetated area of grass, shrubs or trees designed to capture and filter runoff from adjoining land uses.

**C**

**Channelization:** the practice of straightening a water course or stream to remove meanders and make the water flow faster. Sometimes concrete is used to line the sides and bottom.

**Cobble stone:** 2-10 inch size stones where stream life can be found.

**Coliform Bacteria:** a group of bacteria found in cold and warm blooded animal intestines commonly used as indicators of pathogens.

**Cultural Eutrophication:** process whereby human activity increases the amount of nutrients entering surface waters.

**Culvert:** a closed passageway (such as a pipe)under roadways and embankments which drains surface water.

**D**

**Decomposition:** the separating or decaying of organic or chemical matter.

**Dendritic:** a pattern of stream drainage that resembles the pattern of a tree.

**Density of water:** Is greatest at 4°(39.2°F).

**Dilute and disperse:** the practice of discharging a substance into a large body of water that will carry the substance away from its source and reduce its concentration.

**Discharge:** the flow of surface water in a stream or canal or the outflow of groundwater from a flowing artesian well, ditch or spring.

**Discharge pipe:** a pipe used to carry wastewater from a factory or other facility into a receiving stream or lake.

**Dissolved oxygen:** oxygen dissolved in water which is readily available to plants and animals.

**Drainage basin:** a large watershed usually referring to the combination of several watersheds.

**E**

**Ecology:** the science of the relationships between organisms and their environments.

**Ecosystem:** an ecological community together with its physical environment, usually considered as a unit.

**Ephemeral Stream:** a stream that flows only during wet periods or rainstorms.

**Epilimnion:** topmost layer of water in a lake.

**Estuary:** an arm of the sea that extends inland to meet the mouth of a river, usually characterized by tidal changes and rich diversity of aquatic life.

**Eutrophication:** a process in which organic matter accumulates in a body of water until eventually it fills in and becomes dry land.

**F**

**Fecal coliform:** that part of the coliform group of bacteria originating in the intestinal tract of warm blooded animals.

**Floodplain:** a low area of land, surrounding streams or rivers, which holds the overflow of water during a flood.

**Freshwater:** water that is not saline or brackish.

**G**

**Groundwater:** water beneath the earth's surface between saturated soil and rock.

**H**

**Habitat:** the area or environment in which an organism lives.

**Hardness:** a characteristic of water caused by the presence of various salts, calcium, magnesium and iron.

**Headwaters:** the uppermost reaches of a river or stream.

**Hydric soils:** soils found in saturated, anaerobic environments usually characterized by gray or mottled appearance, found in wetlands.

**Hydrologic cycle:** the series of pathways the earth's water may take on its journey from the sea to the atmosphere to the land and ultimately back to the sea.

**Hydrologic unit:** all land and water within a drainage area.

**Hypolimnion:** lower layer of water in a lake. Infiltration: the downward entry of water into the soil.

**I**

**Instar:** the individual insect between two molting events or an organism between egg hatching and the first larval molt.

**Intermittent stream:** a stream which has an interrupted flow or does not flow continuously.

**L**

**Larvae:** the plural of larva, the first major mobile life stage of an insect or first development following egg hatching.

**Lentic:** standing water as in a lake.

**Limiting factor:** something that determines the presence, survival and success of an organism.

**Limnology:** the study of inland water: ponds, lakes and streams.

**Littoral:** region of shallow water where light reaches the bottom. Lotic: running water as in a river.

**M**

**Macroinvertebrates:** an animal without a backbone visible to the naked eye or larger than 0.5

**Meander:** the circuitous winding or sinuosity of a stream, used to refer to a bend in the river.

Monitoring: to watch and care for a stream on a regular basis.

**N**

**Nitrate:** an important nutrient for building protein in plants and animals.

**Nonpoint source pollution (NPS):** pollution that originates from many diffuse sources and usually is not regulated, such as runoff from streets that carries with it oil, feces and sediment.

**O**

**Oligotrophic:** a body of fresh water that contains few nutrients and few organisms.

**P**

**Part per million (ppm):** the quantity of one substance contained in one million units of another substance. Equivalent to milligram per liter(mg/l).

**Perennial stream:** a stream which flows continually.

**pH:** a symbol used to indicate how acidic or basic a solution is.

**Phosphorus:** an important nutrient for life, especially plants and algae.

**Plankton:** collective word for microscopic organisms that drift around in the upper level of a body of water.

**Point source pollution:** Pollution that is discharged through a pipe or other conduit and is usually a regulated discharge.

**Pollutant:** any substance or mixture of substances that defile or contaminate the soil, water or atmosphere.

**Pond:** a quiet body of water so shallow that rooted plants usually grow completely across it.

**Profoudal:** region of water below photosynthetic light penetration.

**R**

**Riffle:** a hallow section of a stream where water bubbles over rocks, often found at the bend in a river.

**Riparian:** relating to the banks of a stream or river.

**River:** a body of running water of considerable volume usually moving over the earth's surface in a channel or bed.

**Run:** the straight section in a river between riffles, also refers to fish migration.

**Runoff:** water, including rain and snow, which is not absorbed into the ground: instead it flows across the land and eventually runs into streams and rivers. Runoff can pick up pollutants from the air and land, carrying them into the stream.

**S**

**Salt water:** water that is saline.

**Secchi disk:** a simple device for measuring turbidity.

**Sediment:** soil, sand, and materials washed from land into waterways.

**Settling ponds:** ponds constructed or used to hold storm water and other runoff where heavy materials can settle and the water can become clear before being discharged.

**Stream:** a body of running water moving over the earth's surface in a channel or bed.

**Stream order:** system used to number streams and their tributaries with first order as the headwater stream. When joined by another first order stream the union of two streams becomes a second order stream and so on.

**Streambank:** the side of a stream.

**Subwatershed:** a small watershed that is part of a larger watershed such as the watershed of a tributary stream.

**Surface water:** Water that flows over or is found on the earth's surface.

**T**

**Thermocline** (metalimnion): intermediate) layer of water in a lake.

**Total solids**: a term used to describe all the matter suspended or dissolved in water.

**Tributary:** a stream or river that flows into another larger stream or river.

**Turbidity:** a measure of water cloudiness caused by suspended solids.

**W**

**Waterfowl:** birds that depend on water for habitat i.e. ducks.

**Watershed:** an area of land that drains into a particular river or body of water usually divided by topography.

**Watertable:** the upper level of groundwater.

**Waterway:** a natural or man-made place for water to run through (such as rive, stream, creek, or channel)

**Wetland:** an area of land that is saturated at least part of the year by water, usually found in depressions, low-lying areas or along floodplains or coastal areas.

*Source: New York State Envirothon Web Site*

# What do Aquatic Ecologists Do?

Water nourishes life. It is the single most important resource on the earth, and without it humans could not survive. Aquatic Ecologists study the earth's water systems; they monitor, research and analyze the relationship of aquatic organisms to one another and to their watery habitat. Aquatic Ecologists also observe microscopic life, chemical reactions, human impact, geologic activity and native as well as nonnative species within a specific aquatic environment. Through these observations they hope to garner an understanding of how aquatic ecosystems interact as a whole. They use the information gained from monitoring programs to determine future conservation and management strategies for aquatic ecosystems.

To become an Aquatic Ecologist one must first attend a four year bachelor's degree program at an accredited university. Graduates with majors in Environmental Science are the most prevalent in the field of Aquatic Ecology, but Aquatic Ecologists can also come from a varied scientific background including chemistry, geology, biology, climatology, statistics and even economics. In today's economy, postgraduate work in ecology or science is becoming a requirement for work in Aquatic Ecology research.

Aquatic Ecologists work many hours out of doors gathering data and just as many hours in the lab or behind a computer analyzing that field data. They often work with mathematical models analyzing and interpreting human actions and their effects on aquatic ecosystems. An Aquatic Ecologist must have strong verbal and writing skills in order to accomplish intensive research and present their findings in simple, concise and well-written oral reports and journal articles.

An Aquatic Ecologist may work with the government, a non-profit, or even in the corporate sector. They often work for government agencies such as the US EPA, US Fish and Wildlife Service, state environmental agencies, or local Soil and Water Districts.

Aquatic Ecologists can also become teachers, professors or researchers for private companies. A recent graduate can expect to make between $30,000 and $40,000 per year, or more depending on experience and the extent of their education.

*Source: NYC Envirothon Resource Packet*