Habitat - Temperature, Oxygen and Turbidity

Compiled by **George J. Babey**[1][2]

Objectives
Participating young people and adults will:
1. **Observe impacts of non-living factors on fish**
2. **Recognize the adaptations of local fish species to temperature, oxygen concentration and turbidity**
3. **Explore factors that cause changes in temperature, dissolved oxygen and turbidity in aquatic systems**
4. **Have fun while learning**

Youth Development Objectives
Participating young people will:
1. **Enhance critical thinking and deductive reasoning skills**
2. **Apply theoretical knowledge to actual situations**
3. **Form hypotheses**
4. **Enhance observation skills**
5. **Work together in teams and discuss observations**

Roles for Teen and Junior Leaders
Lead demonstrations or group discussions
Assist participants having questions or difficulties with techniques
Set up and take down teaching sites

Best Time: anytime, but this should be considered an intermediate level activity

Best Location: anywhere, table space is preferred

Time Required: 1 hour

Equipment/Materials
paper towel
paper plate
pond water source
gallon jars or small aquaria
tropical fish food
clean water
gravel
aquatic plants or plastic plants
soil
goldfish
thermometer
Secchi disk
fish pictures or flash cards

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1 Connecticut Department of Environmental Protection, Fisheries Division, 79 Elm St, Hartford, CT 06106-5127

2 Adapted from Bob Schmidt, Sport Fishing and Aquatic Resources Handbook

Relate personal experiences to make learning concrete

Potential Parental Involvement
See "Roles for Teen and Junior Leaders" above
Arrange for or provide teaching locations
Arrange for or provide teaching equipment and materials
Arrange for or provide transportation
Arrange for or provide refreshments

Evaluation Suggestions
Observe discovery process among youth during activities
Observe interactions within working groups
Observe level of inquiry and application of knowledge
Observe application to fishing techniques

Safety Considerations
Pond water may contain either infectious micro-organisms or tiny parasites. Normal hygiene, like washing hands before eating and avoiding ingesting pond water should be encouraged, particularly in areas with *Giardia* or similar organisms. No toxic materials are used in these exercises, but a shop apron may help protect clothing where soil and water are being used. For younger kids, using clear plastic jars rather than glass containers may reduce risk of injury and breakage.

References
Sport Fishing and Aquatic Resources Handbook*,* Bob Schmidt, 1991, Kendall/Hunt Publishing, Dubuque, IA pp. 56-60.

Lesson Outline:

Presentation	**Application**
I. Why are non-living factors important? A. Basic to angling success 1. Critical to locating fish 2. Important to fish activity 3. Influence on angling strategies	**NOTE** that before catching fish, the angler must know how to find them.
B. Physical elements related to these factors 1. Depth, shape and orientation 2. Gradient and inflows 3. Weather and climate 4. Latitude and elevation	**NOTE** that physical characteristics of the body or water may have strong influences on these factors.
II. Adaptations of fishes to their environment A. Adapted to specific environments and conditions	**USE** leading questions to help participants **CONCLUDE** that various fish species have differing preferences in the factors being considered.
1. Turbidity 2. Oxygen concentration 3. Water temperature 4. Factors often interact	**NOTE** that these factors are often interrelated. For example, higher temperatures generally produce lower oxygen concentrations and high turbidity tends to increase water temperature.

B. Turbidity - suspended solids in water
1. Silt or other soil particles
a. Sources of turbidity from soil
1) Bank erosion
2) Construction
3) Poor farming practices
4) Poor forestry practices
5) Floods, ice scouring
b. Impacts of siltation
1) Gill damage
2) Smothering eggs or young
3) Covering spawning areas
4) Reducing cover or changing types
5) Reducing diversity of prey species
6) Reducing productivity
7) Reducing feeding success
2. Suspended algae or plankton
a. Sign of high productivity
1) Good primary production
2) Good fish growth
b. Excessive blooms damaging
1) Loss of submerged vegetation
2) Potential for fish kills
a) Oxygen depletion at night
b) Oxygen depletion in deep water

If nearby sites are available, consider using a Secchi disk to **DEMONSTRATE** turbidity.

Have participants **SPECULATE** on sources of suspended soil in lakes or streams, allowing all potential sources. Be careful to **KEEP** human activities in perspective.

Lead youth to **BRAINSTORM** some ways that siltation and suspended soil can damage fish or their habitat.

NOTE that living things causing turbidity may indicate a fertile or eutrophic site with excellent growth and production.

NOTE that both summer fish kills or lack of oxygen in deep waters can result from excessive blooms of plankton.

C. Oxygen concentrations
1. Source of oxygen in the water
a. Diffusion from the air
b. Mixing through surface turbulence
2. Oxygen production by photosynthesis by aquatic plants and phytoplankton
3. Factors reducing oxygen levels

Lead participants to **DISCUSS** ways that oxygen concentrations in the water can increase. **NOTE** the major sources may differ with the type of water body involved.

POUR water from one container into another. **ASK** participants what they observed. **NOTE** that the bubbles are the result of air being mixed with the water by surface turbulence.

Have participants **OBSERVE** living water plants (like *Elodea*) in bright sunlight. **NOTE** the tiny bubbles on the leaves are primarily oxygen produced during photosynthesis by the plant. **EXTEND** the concept to include oxygen produced by phytoplankton.

Ask participants to **BRAINSTORM** ways that oxygen can be removed from the water. **NOTE** that all living things consume oxygen as they respire. **ASK** how the

a. Respiration of aquatic organisms
b. Increased water temperature
c. Decomposition of organic materials
1) Detritus
2) Decaying animals
3) Sewage or other organic effluent

4. Critical factor in fish survival

D. Water temperature
1. Fish as “cold-blooded” animals
a. Body temperature near ambient
b. Some large species above water temperature

2. Temperature preferences
a. Cold water fishes
b. Cool water fishes
c. Warm water fishes
d. Tropical fishes

3. Impacts on fish distribution
a. Influence on fish distribution
1) Seeking preferred temperatures
2) Vertical movement in deep water
3) Use of cover or shade

b. Influence on oxygen concentrations
1) Temperature and oxygen
2) Turbulence and oxygen
c. Influence on activity and vigor
1) Peak activity and growth near preferred or optimum temperatures
2) Less active somewhat above

process of decomposing organic materials could affect oxygen levels. Lead them to **SPECULATE** on some sources of decomposing organic materials, including detritus, animal remains, sewage or other organic effluents.

Help participants **GENERALIZE** about types of fishes and their oxygen needs and preferences. **USE** their habitats as a cue to their oxygen requirements.

ASK participants whether fishes are “cold-blooded” or “warm-blooded” animals. Although some fishes can maintain a body temperature above that of the water in which they are swimming, fishes are poikilothermic or “cold-blooded” animals.

Have participants **PLACE** pictures of fishes into groups by their temperature preferences. **USE** a table of preferred temperatures as a reference after the fishes have been placed. **NOTE** that each fish species is adapted to a range of temperatures and that it is most efficient at or near its preferred temperature.

ASK participants what would happen if our body temperatures went up to 110°F or down to 80°F. Lead them to **CONCLUDE** that we would die under those conditions. **EXTEND** that notion to fishes, noting that most fishes must live in water that stays within a certain range of temperatures. If desired, **EXPLORE** the distributions of some selected fishes. **NOTE** that, where possible, fishes will seek out areas with water temperatures or oxygen concentrations in their preferred range.

NOTE that oxygen concentration drops with increasing temperature and increases with turbulence.

ASK participants how they feel when the weather is very hot and muggy or extremely cold. **NOTE** that fishes tend to be most active and grow best near their preferred temperatures and less so as the temperatures move away from their optima. Some fishes become very inactive when temperatures vary greatly from their optima, and death may result if the temperatures change too quickly or exceed their tolerance levels. **CONSIDER** using examples specific to your area.

and
below preferred temperatures
3) Inactive well above or well below
preferred temperatures
4) Death may result at extremes
a) Temperatures beyond tolerance
b) Changes too rapid

III. Influence of living factors
A. Overhead cover and shade
1. Influence on water temperatures
a. Reduced solar radiation
b. Cover reduces heat loss to atmosphere
c. Slower warming and cooling
2. Influence on runoff
a. Retards runoff
b. Increases infiltration into soil
c. Reduces siltation

3. Food source in upland streams
a. Detritus-based communities
b. Land productivity for aquatic animals
1) Food falling into streams
2) Detritus supporting invertebrate life
4. Importance of protecting riparian zones
B. Wetlands
1. Where land and water intermingle
a. Seasonal wetlands
b. Tidal wetlands
c. Permanent wetlands
2. Food production for aquatic systems
a. Rich in nutrients
b. Capture and consume nutrients
c. Rich "soup" for juvenile animals
1) Invertebrates
2) Fishes - spawning and nursery areas

NOTE that overhead cover and streamside or shoreline vegetation shade shallow waters, slowing heat exchange by sunlight. **ASK** if the overhead cover would act as a "blanket" when temperatures fall at night (*yes*).

Lead participants to **SPECULATE** about the role of ground cover and trees in reducing runoff, increasing water storage in the ground and reducing erosion. **NOTE** that all of these factors have a positive influence on aquatic habitats.

If these types of resources are available near you, ask participants to **REFLECT** on the presence of leaves and other dead land plants in the water. **NOTE** that these waters are often dependent upon land inputs to support the web of life in them.

NOTE that wetlands filter, store and clean water on its way into streams, lakes and seas. **EMPHASIZE** that the contribution to water quality, water storage and animal productivity is tremendous by all sorts of wetlands.

NOTE that many fishes and invertebrates use wetlands as either spawning or nursery areas for their young. **CHALLENGE** participants to develop a list of wetland creatures important to the angler directly or indirectly.

DISCUSS the role of salt marshes and shallow bays as rich feeding grounds for many species of fish. **NOTE** that some species are found inshore only seasonally when temperatures and feeding conditions support them. **USE** local examples if possible.

Lead participants to **CONCLUDE** that the coastal waters change more quickly than deep waters because of sunlight penetration and absorption of sun energy by the sediments. **USE** local examples of seasonal migration

3. Capture sediments and purify water
4. Hold and gradually release water

IV. Marine environments
A. Salt marshes and shallow bays
1. Nursery areas and rich feeding grounds
2. Warmer than deep waters
3. Primarily "inshore" species
B. Coastal waters
1. Shallower waters
a. Warm and cool more readily
b. Better light penetration
c. Seasonal migrations to preferred temperatures common
2. Richer food supplies
a. Floating or swimming prey
b. Bottom dwelling prey

C. Deep waters
1. More stable conditions
a. Generally cold water
b. Little or no light penetration
c. Large bodies of nearly uniform water
1) Temperature
2) Salinity
3) Density
2. Rich in nutrients
a. Low primary productivity
b. Nutrient "rain" from upper levels
c. "Detritus" based communities
D. Upwellings and currents
1. Bringing deep waters to the surface
2. Highly productive areas
a. Rich in nutrients
b. Cold and oxygen enriched at surface
c. Sunlight for plankton growth
E. Hypersaline and brackish waters
1. Salt tolerance differs
2. Fishes seeking water within

into and out of coastal waters if possible.

ASK why shallower areas may have richer food supplies. **NOTE** that both pelagic (free-swimming) and benthic (bottom dwelling) foods are available in these relatively shallow waters.

LEAD the group in discussing the relative stability of deep waters and the conditions that might be found in them. **CONSIDER** temperature, light, sources of food, sources of oxygen and other factors that the young people may identify.

EMPHASIZE the fact that light is essential for plant and phytoplankton production.

If possible, have participants **IDENTIFY** productive fishing grounds (e.g. the Grand Banks or the waters off Peru and Ecuador) where deep, cold waters are pushed to the surface by the action of currents. **ASK** why these waters are so productive when they reach the surface [*rich in nutrients, exposed to sunlight, and rich in oxygen*].

NOTE that the concentration of salts in the water also influences the types of fishes that may be located there.

tolerance
range
a. Euryhaline fish - wide
tolerance range
b. Stenohaline fish - narrow
tolerance
range

V. Conclusions
A. Non-living factors influence fish
distribution and abundance
B. Understanding non-living factors
aids in
fishing success

Summary Activities

1. How muddy is muddy?

Have participants extract water samples from several ponds or streams in your area. Thoroughly mix each sample (e.g. by shaking it). Extract smaller samples (about 1/4 cup) from each one for small groups of young people. Have them pour each sample on an individual white paper plate or bowl. Next have them spread a piece of absorbent paper toweling over the plate to soak up the water. When the toweling is saturated, remove it carefully from the plate. The remnant materials represent the sediment or soil particles that were suspended in the water. Note that some of the sediment may have been picked up on the towel. Encourage the groups to compare their results with the samples and discuss reasons for any differences they may observe within and between samples.

2. Polluting a pond

Consider demonstrating the effects of various pollutants and nutrients on pond water. This can be accomplished by adding fertilizer (nutrient), fish food (nutrient and organic matter), vinegar (acid), hypochlorite bleach (toxic material), salt (toxic material), or similar materials to the water. Have the participants observe the water daily for several days (usually a week is adequate). Encourage them to record their observations carefully, noting smell, water clarity, growth of algae or plankton, and any other factors they feel are important. Encourage them to compare their findings and to analyze the reasons for their observations. What would happen to other living things, like fish under the conditions tested?

3. Temperature effects on oxygen concentration

Provide participants with two clear jars. Fill each jar nearly to the top with non-chlorinated water. Place one jar in the sun or otherwise heat it until its temperature has risen approximately 5°F. Maintain the other jar of water at room temperature. Place a goldfish in the room temperature jar and observe the goldfish. Count the number of times it opens and closes it operculum (gill cover) in 30 seconds, recording that number once a minute until you have at least five observations. Net the goldfish and place it in the jar of warmer water. Allow two minutes for it to settle down, and repeat the counting process. If the goldfish shows signs of distress (losing its orientation, turning belly up) stop the experiment and remove the fish to fresh water. If it gulps air from the surface of the water, record that as well. In which jar was the rate higher? What may have caused the observed difference? Which body of water had a higher oxygen concentration? Could there be any other explanations for the observed differences? [Increased metabolism could be a factor. This could be checked by observing the actions of the fish or by running the experiment until the fish began to gulp air.]

4. Turbulence effects on oxygen concentration
Provide the participants with three clear jars. Fill two of the jars nearly to the top, keeping both jars at room temperature. Place a goldfish in one of the jars. Wait for it to settle down (one or two minutes should be adequate) and observe the rate of its respiratory movements until at least five readings have been taken. Just prior to moving the fish to another jar, pour the water back and forth between the other two jars or shake one of the jars vigorously. Move the fish to the jar with the shaken water, and repeat the process. Did the turbulence cause an increase in oxygen concentration? How could you tell?

5. How Silt Destroys Water Quality
Build a small aquarium in a jar, with gravel and plants. Add some stones or other larger material if you wish. Place a small amount of soil in a small jar of water, shake thoroughly, and pour the Amuddy@ water into the aquarium. Allow the soil to settle, recording the conditions periodically. Repeat the process several times, noting the changes in the aquarium. Discuss the impact of sedimentation on the substrate and the plants in the aquarium. How would those changes affect animals adapted to living in the gravel or rocks? How would the sediment impact fishes that used gravel as a spawning bed? What are some things you can do to reduce the amount of sediment going into water courses in your area?

Lesson Narrative

Introduction
To catch fish an angler must first locate them. Non-living factors are important, because fish orient to them, they influence fish activity, and they have an impact on the type of fishing strategy or techniques that will be effective. Factors like temperature, oxygen concentration, and turbidity can influence the types of fish present, their activity and their location in the water. Each fish species is adapted to an array of conditions. When those conditions are ideal, they thrive. When they are marginal, the fish may survive, but show poor growth or vigor. When they are beyond the range that the fish can tolerate, it must move or die.

Many physical elements are related to these critical non-living factors. The depth, shape, orientation and gradient in a body of water can influence all of these factors. The amount and timing of inflows and the nature of the watersheds is also influential. Both climate and weather have a strong influence on the fish species and populations present. Lakes with 80°F water may hold warm water fishes like largemouth bass, but species like brook trout cannot survive temperatures that high. They are more comfortable in 60°F mountain springs where a largemouth would be hard pressed to survive. Latitude and elevation, with their influence on local climate and weather, also contribute to these physical factors.

Turbidity

Turbidity is a measure of suspended solids in the water, usually measured by the amount of light penetration. A major factor contributing to turbidity is the amount of silt or other soil particles suspended in the water. Water borne soil can come from back erosion, activities that disturb the bottom sediments (like currents, winds or tides), construction activities, poor farming or forestry practices, surface mining, floods, ice scouring or similar actions.

The impacts of sediments are many. While suspended in the water, soil particles can clog or damage gill membranes in fish or other animals or reduce feeding success by sight-hunting predators. As the sediment drops out of suspension, it can smother eggs or young animals, bury spawning sites, eliminate cover (like rocks or rubble), bury aquatic vegetation, kill or eliminate habitat for prey species, cloud the water enough to reduce productivity by algae and plankton, or cover detritus with a layer of soil, making it unavailable as forage for detritivores. The result is a reduction in diversity of species present.

Another source of turbidity may be found in ponds or lakes. Suspended algae or plankton may cloud the water. This turbidity may be taken as a sign of high productivity or a eutrophic condition. Generally rich aquatic environments are somewhat turbid, while those with lower levels of productivity are clear. These more productive waters may show higher growth rates for fishes that can tolerate the conditions. Excessive blooms can be damaging, however. They can result in the loss of submerged vegetation by simply starving them for light. Fish kills are possible as deeper waters are deprived of oxygen or oxygen tensions drop during the night. Reduced oxygen levels in deeper waters of large lakes can result in the loss of species that require the deep waters for survival during hot weather.

Oxygen Concentration

Oxygen is just as important to fish and other aquatic organisms as it is to land animals and plants. Since oxygen is not very soluble in water, the amount in water under the best of conditions is much less than that found tin the air. Without adequate oxygen supplies, fish cannot survive. Further, some fishes require highly oxygenated water, while others can survive in water with very low oxygen tensions. Carp require much less oxygen for survival than do trout or salmon. On the other hand, they do require some dissolved oxygen; while some other fishes can survive by gulping air from the surface and using their air bladder or a labyrinth organ as a simple lung.

Oxygen in the water comes from many sources. Much of the dissolved oxygen simply diffuses into the water from the surface. Much more of it enters the water as a result of turbulence. Wind mixing, wave action, turbulent flow over rapids or waterfalls tends to oxygenate the water. At times, particularly around waterfalls, the water can become super-saturated with oxygen (and other gases). Still more oxygen enters the water as the result of photosynthesis by aquatic plants, algae and phytoplankton. As the plant splits water molecules to produce simple sugars, oxygen is released as a by-product. Oxygen is much more soluble in cold water than it is in warm water, so oxygen concentrations in cold water are usually much higher than they are in warm water under similar conditions.

Many other factors reduce the amount of oxygen in the water. All living things respire, consuming oxygen as they use energy to survive. As metabolic rates rise with temperature (within limits), the rate of oxygen consumption increases. Decaying plants or animals use oxygen from the water as they go through physical decomposition; and decomposers use oxygen, too. Many kinds of pollutants reduce oxygen supplies in the water as well. Some chemicals trap oxygen or consume it as they react. Others may result in consumption of oxygen as they are broken down by bacteria or other decomposers. Sewage contains nutrients that serve as fertilizers. They cause algae blooms that can cause severe oxygen depletion when the plants die and begin to decompose. Under those conditions, fish kills can take place. Often these are summer fish kills. Thermal pollution, the addition of excess heat too the water through industrial use, also reduces the amount of oxygen water can hold.

Oxygen levels are not necessarily the same throughout a body of water. Water below the thermocline may become oxygen depleted if excessive "rain" of dead plants and animals takes place. Wind mixing near the surface may result in high oxygen levels, at least temporarily. Fish will seek out areas with adequate oxygen for their needs, perhaps moving long distances to find suitable conditions.

Water Temperature

Although some large fishes maintain a body temperature higher than that of the surrounding water, fish are considered poikilothermic or "cold-blooded" animals -- animals whose body temperature approximates the temperature around them. Large sharks, tuna or similar species may produce enough heat by muscle contractions to keep their temperature a few degrees above the water, but they are the exception. Most fishes are small enough that their temperature and that of the water are very close.

Most fishes are adapted to a range of body temperatures. The enzymes that govern biochemical reactions work most efficiently at or near those temperatures, and their actions are greatly reduces if the temperatures are either lowered or raised appreciably from that optimum. Thus at temperatures well above or below the optimum, the bodily functions of the fish may become sluggish or the fish may die. Humans have a temperature that varies around an average of about 98.6EF, but individual humans may have temperatures slightly higher or lower than that average. Conditions may result in the temperature rising slightly or dropping slightly without serious implications. Severe changes, say on the order of 10-15EF can result in death as the enzymes become denatured or fail to function adequately to maintain life. Fish experience the same situation, but often are tolerant of wider variations in temperature.

In general, fishes may be divided into several groups based upon their temperature preferences. Cold water fishes, like trout, whitefish and grayling, are adapted to relatively cold waters. These fishes can tolerate very cold water, but they cannot adapt to water much over 70°F. They prefer water temperatures well below their lethal upper limits. Cool water fish (e.g. pickerel, northern pike, yellow perch, walleye) are most active at moderate temperatures, but they can tolerate higher upper limits than can cold water fishes. Warm water fishes (e.g. bluegill, largemouth bass) are adapted to withstand higher water temperatures, growing and reproducing better as temperatures increase. Tropical fishes may thrive at still higher temperatures. Some are even adapted to very low oxygen tensions, being able to gulp air at the surface to supply their oxygen needs.

Clearly, the temperature preferences and adaptations of each fish species can have an influence on their geographic distribution. It also has a strong influence on their distribution in a body of water where variation in water temperature or related factors (like oxygen levels) are possible. For example, consider a deep lake with a mixed fish population. If the surface waters were about 80°F, one might expect to find bass and bluegills or other sunfishes in the warmer shallow waters. Yellow perch might be slightly deeper. Cold water fishes like lake trout would be found in the deeper waters in or below the thermocline, layers of water where temperatures change very quickly with depth. If the thermocline is down 20 feet on one side of the lake and 65 feet on the opposite shore (usually because of a seiche or other currents), an angler seeking these cold water fish would need to adjust his or her techniques to the depth at which the fish were locating their preferred temperatures. For pelagic fishes, leaving areas of preferred temperature to pursue prey species with slightly different preferences is common. Sometimes fish even can be found in areas where their temperature tolerances are exceeded if other conditions, like high oxygen levels mitigate (make better) the effects of the high temperature.

Some fishes have narrow ranges of temperature tolerance or preference. Others are very adaptable to temperature changes. Most fishes, however, must make those changes gradually. [Remember, water has a high specific heat and generally changes temperature quite slowly.] Thermal shock can take place when water temperatures change too rapidly to allow the fish to adjust. In some areas, e.g. the Laguna Madre of Texas, major fish kills can take place when warm water adapted fishes are caught in very shallow water during winter freezes. Wind and shallow water combine to change water temperatures so quickly that the fish are shocked or killed. The same thing can happen if water warms too rapidly for cold adapted fishes.

The angler who understands the temperature preferences of fishes and the temperature structure of the body of water being fished will usually be able to locate fish successfully. He or she will also know how to keep baitfish from dying because of thermal shock.

Water Quality

Water quality is a complex set of parameters. Water chemistry, oxygen and other dissolved gases, and temperature all interact. If the water quality is good, more species of fish and larger populations of fish can be supported than if the water quality is poor. High quality water will have a high concentration of oxygen. It will have a pH (a measure of acidity -- technically the negative log of the hydrogen ion concentration) close to the neutral range -- slightly acid to slightly basic. It will be relatively free form suspended solids, except for algae and plankton; and it will be moderate in temperature during the hottest part of the year. Low quality water may be low in oxygen or even anoxic (no oxygen). It may be highly acidic or highly basic, creating conditions in which fish cannot survive, or it may contain high sediment loads or heavy concentrations of pollutants. Thermal pollution may reduce of the quality of other waters. Some apparently beautiful lakes are completely devoid of fish because the water quality is inadequate for nearly all aquatic life. Some productive lakes or ponds are devoid of fish live because water quality drops below tolerance levels at some time of the year. In many others, the array and abundance of fishes is limited by water quality considerations.

The impacts of water quality on fishes differs with the species and its tolerance. Some fish can live in extremely low quality water. Carp and gar, for example, can survive in water that is very warm, low in oxygen, and high in turbidity. Trout cannot. They require relatively clean, cold water with high levels of oxygen. In general, fish are more active, consume more oxygen and feed more often when the waters are at or near optimum levels of water quality.

The foraging habits of fishes differ and may result in differences in their reactions to water quality changes. Pelagic species, those that roam the entire water column or "free-swimmers", may move to areas of higher quality if local changes take place. Species like white bass, ciscoes, salmon, tuna, bluefish or dolphin are examples of fishes of this type. Benthic fishes, those that live on or near the bottom and forage their for prey, may find conditions so unfavorable that they are forced to abandon their preferred habitat. Some years back, the deeper levels of Lake Erie's Eastern Basin were nearly devoid of fish in the summer because of low oxygen levels. Eliminating phosphates from detergents and reducing the organic wastes added to the lake have restored this fishery.

One must understand that water quality must be within the tolerance limits of the fishes at all times. Even a brief pulse of intolerable water conditions can completely eliminate fish populations. Some lakes, ponds and streams in some regions of the continent are devoid of fish life, even though their waters are within tolerance limits for all but a few weeks of the year. Pulses of acidified rain or snowmelt cause tolerance levels to be exceeded for those short periods. If conditions are sufficiently stressful to kill fish during that period, those bodies of water are devoid of life for the entire year.

Influence of Living Factors

Riparian Zones

Living things also contribute to these water quality measures. Overhead cover or shade reduces solar radiation striking the water during the day and reduces heat loss to the atmosphere at night. This combination of effects dampens changes in water temperature. In addition, vegetation has a strong influence on runoff, softening the impact of rain on the soil, increasing infiltration, and spreading runoff over a longer period of time. This reduces sediment loads.

Riparian (along water courses) vegetation also provides a food source for aquatic systems. Insects and other prey living on the land often fall into the water, providing food for fish or other aquatic organisms. Detritus (decaying organic materials, like leaves and twigs) forms the base of the food web in many streams. Decomposers feeding on the detritus provide food for first order predators and eventually support the fishes in those streams.

Maintaining healthy riparian zones is important both to water quality and to productivity of streams and rivers. These buffer strips between the land and the water are extremely valuable to many plants and animals, not only in the drier parts of the country, but throughout the continent.

Wetlands

Wetlands also provide vital service in maintaining water quality and productivity. These areas where land and water overlap come in many forms. Some are tidal, being dry or inundated as tides ebb and flow. Some are seasonal, storing water only during the wetter portions of the year and releasing it into the ground or watercourses during drier periods. Still others are permanent B bogs, fens, marshes and swamps that remain wet nearly all the time. Although the conditions in bogs and fens may be too acidic to be highly productive, swamps and marshes are extremely productive. Rich in nutrients and detritus, they feature a nutrient "soup" that nourishes many invertebrates and juvenile fishes. Often they serve as vital spawning and nursery areas for both sport and commercial species. They also capture nutrients and sediments, slowly releasing higher quality water to the watercourses they feed.

Marine Environments

Salt Marshes and Shallow Bays

Like other marshes, salt marshes are profoundly productive nursery areas and feeding grounds for some kinds of fishes. Shallow bays, particularly those with patches of vegetation, are similarly valuable nursery and feeding grounds. Usually quicker to warm and cool than deeper waters, these shallow areas are rich in invertebrates and other prey species, making them very attractive to predatory fishes and plankton feeders as well. While many larval or juvenile fishes of pelagic species may be found in these habitats, many of the fishes found in these environments are "inshore" species that occupy these warm, rich waters seasonally.

Coastal Waters

Coastal waters, those areas near shore, are seldom as clear as the open ocean. Relatively shallow water permits wave action to stir up lots of sediment. The structure of the bottom will determine how mobile and persistent these sediments are. Like shallow bays, coastal waters tend to warm and cool more quickly than the open ocean. When the water is clear, light is able to penetrate to the bottom. This permits plants to grow at greater depths, providing an oxygen source, a foundation for aquatic food chains and some cover for marine life. Seasonal migrations timed to preferred water temperatures and movements of forage species are common. These waters share the salinity of the open ocean for the most part, and they provide both bottom and mid-water prey species and an assortment of predators adapted to those foraging areas. In general, the variety of life forms is greater in coastal waters than that found in the colder waters of the open oceans.

Deep Waters

The deep waters of the oceans provide stable conditions for the fishes living there. The deeper layers of water are generally cool to cold, but within the major bodies of ocean water the conditions are somewhat uniform with respect to temperature, salinity, and density. Little or no light penetrates to the bottom, but the overlying layers of water produce a relatively constant "rain" of organic material which supports a diverse array of animal life from scavengers to predators adapted to swallow prey nearly the size of the predator itself.

The nutrient "rain" into the deeper waters of oceans generates a nutrient-rich, cold body of water that can support abundant life when currents and upwellings bring the water to shallower levels. Areas like the Stillwagon Banks or the Grand Banks owe their phenomenal fishing (at least historically) to this phenomenon. Similar situations occur in deep lakes. These conditions are often the result of currents encountering geologic formations or areas having different densities.

Hypersaline and Brackish Waters

Where saltwater and freshwater meet, gradients in salt concentration can be found. When salt concentration is too high to call the water fresh but less than that of open oceans, the water is brackish B a mixture of salt and fresh. These conditions are ideal for many types of coastal fishes and invertebrates. Organisms that can tolerate a wide range of salt concentrations are known as euryhaline organisms. Those that are able to tolerate only a narrow range of salt concentrations are known as stenohaline organisms. Some fishes, like salmon, eels or striped bass, are able to tolerate a complete range of salt concentrations from salt to fresh (and possibly back again). Others are restricted to a relatively narrow range of salt concentrations. Pupfishes, for example, are able to survive in the Red River between Oklahoma and Texas because the water is salty enough to prevent some predatory freshwater fishes from thriving in their habitat. As with other factors, fish tend to seek salt concentrations that are within their tolerance range.

Conclusions - Seasons and Movement
Non-living factors have a profound effect on the distribution and abundance of both fish and the foods that nourish them. Understanding those non-living factors can be critical in fishing success. Fish react to the changing water conditions -- temperature, oxygen concentration, turbidity, salt concentration, and more. Some of those changes are seasonal. Water temperature impacts fish metabolism as well as the availability of oxygen. If the near-surface waters become cold enough, fish will go to deeper water to seek refuge in the cold, but nearly constant temperatures found there. They may move either vertically or long distances to locate temperatures and other conditions that are optimal for them. Bluefish found in Florida during the winter, for example, may be found feeding along the Maine coast during the summer, heading back southward larger and heavier. Winter flounders may disappear in late spring as summer flounders move inshore to feed during the summer. Tuna found off Mexico in the winter may be off the coast of Canada during the summer. These seasonal patterns are part of the interaction between the fishes and their physical environment.

Anglers who use this type of information and the patterns that it shows become better anglers. Spending some time learning the physical preferences and tolerance limits of the fish being sought is worth the investment if one wishes to be a successful angler or student of the fish.

Exhibit or Sharing Suggestions
1. Prepare an exhibit based on one of the summary activities, showing the results of the experiments. Interpret the results using posters, other physical objects and discussion at an appropriate event or activity.

2. Prepare an exhibit, demonstration, or illustrated talk about non-living factors and their influence on fishes. Discuss the impacts of changes in the factor chosen from either a fishery science or angling point of view.

3. Study the habitat preferentia of a selected fish in your area. Present your findings to your 4-H Sportfishing group or to another interested group of people.

4. Study a local watercourse over the seasons, recording your observations and taking photographs to document your studies. Determine any sources of pollution, siltation or other factors that could be detrimental to fish in it. Present recommendations to your club or to another group on means of reducing the impact of those factors on the body of water.

Community Service and "Giving Back" Activities

1. Help install silt fencing or hay bales at local construction sites where erosion could carry soil into water courses.

2. Obtain permission to stencil storm drains with signs helping people know where anything that gets into the storm runoff will end up, e.g. “Caution drains directly into Long Island Sound” or “Please be Careful - Gulf of Mexico Watershed”

3. Choose a site to stabilize a stream bank by planting willows or similar action. Be sure to consult your local Extension office, conservation officer or fisheries biologist for assistance, technical advice and any required permits.

4. Prepare a photo story or presentation that can be shared with others concerning water quality issues in the local area. Share that story with your peers, adults, service organizations or conservation groups.

5. Join a wetlands development or enhancement group or join a water watchers organization. See what you can do in cooperation with your state conservation agency or other agencies in monitoring water quality.

6. Exercise personal environmental responsibility by:
   a. Re-seeding bare spots in your lawn
   b. Mulching flower or vegetable beds
   c. Being careful about damaging stream banks with bikes, motor vehicles or foot traffic
   d. Avoiding damage to streamside vegetation

Extensions or Ways of Learning More

1. Talk to a civil engineer or environmental engineer about erosion control practices on construction sites or about construction of water control devices.

2. Visit a waste water plant or sewage treatment plant to see how the wastes are handled and about the quality of water released to streams or lakes.

3. Visit a power plant and see how waste heat is handled. Ask about impacts on water quality and the measures taken to reduce impacts on fish and other aquatic life.

4. Visit a fisheries biologist and discuss some of the challenges to fish management in waters of interest to you. Ask what you could do to improve conditions for fish.

5. Visit local mills, processing plants or other industries to see how water is handled and what is done to treat the water before it is released.

6. Study an issue that interests you. Spend time in the library and in the field if possible. Consult knowledgeable people and develop a “white paper” on the topic or issue. Share what you have learned in a suitable group.