2020 National Conservation Foundation - Envirothon

Aquatics Study Guide

Louisiana Department of Environmental Quality
Office of Environmental Assessment
Water Planning and Assessment Division
Nonpoint Source Pollution Unit

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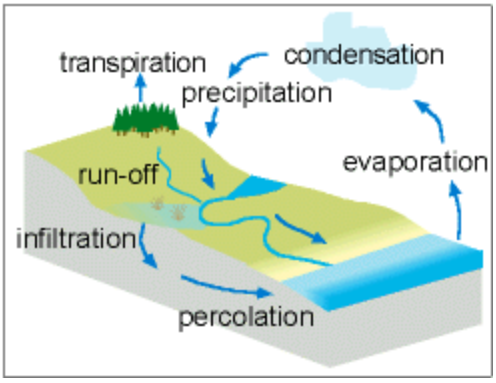
1. The Hydrologic Cycle

Water moves through the environment in a pattern commonly understood as the hydrologic cycle. However, this cycle has many side branches that can redirect the water, temporarily hold it in one of several places, or even lock it up for centuries.



https://pmm.nasa.gov/education/videos/water-cycle-animation

1.1 Water Quantity and Availability for Drinking

About 71 % of the earth's surface is covered with water. There is an estimated 332 million cubic miles of water on earth. But of that huge amount, some 97% is unfit to drink because it is too salty. This salty water can be desalinated, but the process is expensive and only currently used in extremely arid (and wealthy) regions of the world.

Of this remaining water, about 80% is frozen at the poles and not readily available for consumption. Out of the remaining portion, about 99.5% is too far underground to be of use, is trapped in soil, or is too polluted to be drinkable. Another way to look at it is that only 0.003% of all the water in the world is potable (drinkable) water.

In south Louisiana many people get their drinking water from surface water bodies including the Mississippi River. While these are generally adequate sources of water, they run into additional problems with contamination. As a result, surface water supplies of water have to be carefully treated to remove sediments, bacteria, and chemicals that may cause human health or aesthetic problems.

The **quantity** of water in a surface water source is affected by precipitation levels in its associated watershed. A watershed is the land area where water from precipitation accumulates and then drains to a specific water body, such as a stream, river, or lake. This water can also seep into an aquifer. When excess precipitation occurs in the watershed it cannot be absorbed into the soil. The excess precipitation runs off into the surface water source, thereby replenishing the water supply. When precipitation levels are low, as during droughts, the surface water levels may drop, reducing the amount of water available to everyone, including those who use it for drinking water.

The **quality** of surface water is affected by activities in the watershed. Surface water can become contaminated from a variety of sources, including point and nonpoint sources. Point source pollution is pollution from a definite source. An example of a point source is a leaking above ground chemical storage tank. Nonpoint source pollution is pollution from diffuse sources that are difficult to measure directly. Nonpoint source pollution is the result of sediments, nutrients, bacteria, heavy metals, pesticides, oil, and other pollutants running off from various features on the surface of the ground like streets, parking lots, lawns, farms, logging areas, construction sites, parks and camps. As water runs off the ground it flows into surface water bodies during and after precipitation. More information on drinking water can be found at:

http://esa21.kennesaw.edu/modules/water/drink-water-trt/drink-water-trt-hist-epa.pdf.

2. Aquifers

Louisiana receives an average of 62 inches of rain each year. Precipitation (rain, sleet, snow, or hail) flows into surface water such as lakes, streams, marshes, and rivers, or it seeps into underground storage areas called aquifers. Aquifers are underground formations of sand and gravel that contain water, known as groundwater. Approximately two-thirds of Louisiana residents get their drinking water from groundwater, while one-third of Louisiana residents get their drinking water from surface water sources. To use surface water as drinking water, water is pumped out of a lake, stream, or river through a water intake. A water intake is a pipe that is submerged into a surface water source and connected to a treatment plant. The water is pumped from the surface water source to the treatment plant where it is treated to make it safe to drink. It is then sent through distribution pipes to the community.

The water that flows through aquifers contains very little bacteria and is naturally filtered by passing through underground sand layers. Because the water in aquifers is naturally filtered, it requires very little treatment and is typically an excellent source of clean drinking water. To use ground water as drinking water, wells are drilled into the aquifer and the water is pumped out of the ground and into treatment and distribution systems. Aquifers are refilled or "recharged" by precipitation seeping into the ground from the land above. The land may be covered with soil and trees or with marshes and swamps, which absorb and store water that later slowly drains into aquifers. It may take hundreds of years for water to enter the recharge areas and flow through the aquifers.

When precipitation levels are low, as during droughts, the water level in an aquifer may drop, reducing the amount of water available to everyone, including those who use it for drinking water. Less water may also reach the aquifer if parking lots, highways and other development replace the natural land surface in recharge areas. There isn't much you can do to ensure adequate precipitation for recharging aquifers. However developers can utilize technologies that minimize impervious areas, allowing more water to reach the aquifers through the recharge areas.

We use common household products that contain components that could also potentially affect the quality of our drinking water sources. These products include: gasoline, antifreeze, paint, paint thinner, drain cleaners, motor oil, and pesticides. When these household chemicals are used or disposed of improperly, they could enter and contaminate a water body.

It is much easier to prevent contamination than to clean it up. To help prevent contamination of your water source, use cleaning products that will not harm the environment, follow directions for proper use and disposal of pesticides and other harmful products, and recycle used oil. Taking these steps will help ensure your community has a clean supply of drinking water for everyone. More information on groundwater in Louisiana can be found at:

http://pubs.usgs.gov/circ/circ1139/

3. Uses of Water

Fresh water is used for public drinking water supply, domestic use, irrigation, livestock, aquaculture, industrial, mining, and thermoelectric power generation. In fact, so many people are using Louisiana's groundwater that the aquifers are literally beginning to run out of water in some parts of the state. We have not reached a crisis yet but if Louisiana does not begin to manage its water resources more carefully we could be in big trouble. It is important to conserve our drinkable water and prevent polluting it.

http://www.waterencyclopedia.com/Tw-Z/Uses-of-Water.html

4. Watersheds

Streams and rivers form watersheds which carry water from high points on the land to lower areas. A watershed is the area of land where all of the water that is under it or drains off of it goes into the same place. Watersheds come in all shapes and sizes, and can cross city, state, and national borders.

As small streams gather together they former larger and larger rivers until they ultimately become a large river. Deltas often form where rivers empty into the Gulf of Mexico. When rain falls on the land it generally behaves in predictable patterns. Some of the water soaks into the ground, some runs off slowly through natural streams, and some may run off quickly across roads. These usually consist of exposed soil, grassy areas, fields and pastures. Pervious surfaces allow rainwater to move more slowly through the system, while allowing some of the water to soak in. This actually works to reduce flooding in many areas. Impervious surfaces on the other hand include roads, parking lots, and rooftops. These surfaces cause rainwater to rapidly fill area streams often causing flooding because none of the water is able to soak in. In addition, the water simply moves faster and is often funneled off of roads or parking lots directly into area ditches and streams. While the area where the rain falls may not flood, downstream areas often have significant flooding as more and more water backs up because there is no place for all the water to go. More information on runoff can be found at:

https://www.usgs.gov/special-topic/water-science-school/science/runoff-surface-and-overland-water-runoff?qt-science_center_objects=0#qt-science_center_objects

It is important to know how to do a watershed delineation on a topographic map:

http://www.nrcs.usda.gov/wps/portal/nrcs/detail/nh/technical/?cid=nrcs144p2_015680

5. Wetlands

Wetlands, as you can imagine, are wet lands. They can be forested with giant cypress and tupelo gum or full of grass and sedges. Some can be dry much of the year but fill with water during rainy seasons. Other wetlands are always full of water. In order to be considered a wetland the area only has to be flooded periodically in order to support the specialized plants and animals that normally reside in wetlands.

Many of Louisiana's natural and man-made lakes are surrounded by wetlands because the land is so low and saturated with water. The Atchafalaya Basin in south central Louisiana is one of the largest wetlands in the United States. It consists of a maze of interconnected bayous, lakes and small rivers, all fed at one time by the overflow of the Atchafalaya River. Now the Atchafalaya River is closely hemmed in by flood control levees. These levees cut the river off from the forested wetlands it once nourished. The Atchafalaya River is actually a distributary of the Red and Mississippi Rivers, flowing from the confluence of these two rivers near Simmesport, Louisiana. More information on wetlands can be found at:

http://www.epa.gov/owow/wetlands/
http://www.nature.com/scitable/knowledge/library/ecology-of-wetland-ecosystems-water-substrate-and-17059765

Vernal pools are a small form of wetland that only hold water for short periods of time. But in that short period many animals like frogs, toads, salamanders, and insects can rapidly locate the pool, breed, hatch, and grow into adults before once again dispersing into the surrounding areas when the pool dries up.

Smaller streams and bayous often form estuaries where they meet the ocean or Gulf of Mexico. An estuary is an area where fresh and salt water mix forming a rich gumbo of plant and animal life.

Estuaries and coastal wetlands are vital to Louisiana but we are losing our wetlands at a rapid rate. This loss is caused by a number of factors that have occurred over many decades. The first and perhaps greatest cause of wetland loss in Louisiana is the leveeing of the Mississippi River following the Great Flood of 1927. These levees, while protecting life and property, starved the coast of vital nutrients and sediments necessary for its creation and regrowth. Added to this is the digging of hundreds of oil field access and navigation canals which led to increased infiltration of saltwater into freshwater marshes. This introduction of saltwater killed the freshwater vegetation in many areas and led to increased shoreline erosion from boat traffic. More information on estuaries can be found at:

http://www.estuaries.org/?id=10

In order to fully understand wetland systems, it is important to know and understand the common native plants associated with wetlands. Some of the most important wetland plants for wildlife and coastal protection are listed in Table 1 (page 8).

6. Riparian Zones

Riparian refers to all habitats within a stream corridor or valley, particularly the shrubs and trees on the stream bank. While riparian zones provide important plant and animal habitats, riparian zones are also an effective way to keep pollution out of water bodies. As with the study of wetlands, it is important to know and understand common riparian plants in order to appreciate the role they play along streams. Frequently riparian and wetland plants are the same, especially in low-lying areas of Louisiana. Examples include bald cypress, red maple, black willow, water oak, buttonbush, tupelo gum, and palmetto among many others.

http://extension.usu.edu/waterquality/htm/watershedinformation/riparian

Table 1: Common wetland plants of Louisiana.

Common Name	Scientific Name	Common Name	Scientific Name
duckweed	*Lemna minor*	cutgrass	*Zizaniopsis miliacea*
pondweed	*Potamogeton pusillus* (also other species)	cattail	*Typha latifolia; T. angustifolia; T. domingensis*
widgeon grass	*Ruppia maritime*	Rouseau cane	*Phragmites communis*
waxmyrtle	*Morella certifera*	duck potato	*Sagittaria platyphylla*
coontail	*Ceratophyllum demersum*	bulltongue	*Sagittaria lancifolia*
lotus	*Nelumbo lutea*	smartweed/knotweed	*Polygonum aviculare*
bulrush/three-square	*Scirpus californicus; S. maritimus; S. olneyi*	millet	*Echinochloa walteri*
panicum	*Panicum dichotomiflorum; P. hemitomom; P. repens; P. virgatum*	wiregrass/marsh grass	*Spartina patens*
palmetto	*Serenoa repens*	mangrove	*Avicennia germinans*
Baccharis	*Baccharis halimifolia*	bald cypress	*Taxodium distichum*
tupelo gum	*Nyssa aquatica*	black willow	*Salix nigra*
milfoil	*Myriophyllum myriophyllum*	red maple	*Acer rubrum*
fragrant flatsedge	*Cyperus odoratus* (also other species)	buttonbush	*Cephalanthus occidentalis*
fanwort	*Cabomba caroliniana*	dwarf spike-rush	*Eleocharus parvula* (also other species)
wild celery	*Vallisneria americana*		

Descriptions of these and other wetland plant species can be found at:

http://www.herbarium.lsu.edu/home.html
http://www.rnr.lsu.edu/plantid/listwetland.htm
Common Vascular Plants of Louisiana Marshes by R.H. Chabreck and R.E. Condrey

7. Aquatic Ecosystems

Healthy aquatic ecosystems are those where human disturbances have not impaired the natural functioning (e.g., nutrient cycling) nor altered the structure (e.g., species composition) of the system. An unhealthy aquatic ecosystem is one where the natural state is out of balance.

These disturbances can be physical (e.g., injection of abnormally hot water into a stream, dredging, installation of dams and weirs), chemical (e.g., introduction of toxic waste at concentrations harmful to the organisms), or biological (e.g., introduction and propagation of non-native animal or plant species).

Symptoms of poor ecosystem health include the following:

- The loss of species.
- The accelerated proliferation of organisms. One example is algae blooms caused by an excess of phosphorous and nitrogen compounds in the water. This condition is called "eutrophication".
- Increased incidences of tumors or deformities in animals.
- A change in chemical properties. Perhaps one of the most significant has been a reduction of pH in water in some parts of the world caused by acid rain.
- The presence of certain organisms that indicate unsanitary conditions. Coliform bacteria, for example, are a sign that the system may contain organisms that cause a variety of human diseases.

8. Aquatic Organisms

The macroinvertebrates living in a water body can be used to determine if the stream or lake is healthy enough to support a good aquatic community. Macroinvertebrates are organisms that are large enough to see with the naked eye (macro) and do not contain a vertebral column (invertebrate). Most macroinvertebrates used for this process are the aquatic larval stages of flies. Other macroinvertebrates that can be used include crayfish, clams, snails, leaches, and worms. Different types of macroinvertebrates have different tolerances toward water pollution. More information on these organisms can be found at:

https://extension.usu.edu/waterquality/learnaboutsurfacewater/propertiesofwater/aquaticmacros

9. Water Properties

Water is unique in that it is the only natural substance that is found in all three states - liquid, solid, and gas - at the temperatures normally found on Earth. Earth's water is constantly interacting, changing, and moving. Water is called the "universal solvent" because it dissolves more substances than any other liquid. This means that wherever water goes, it takes along chemicals, minerals, nutrients, and pollution.

https://chem.libretexts.org/Core/Physical_and_Theoretical_Chemistry/Physical_Properties_of_Matter/States_of_Matter/Properties_of_Liquids/Unusual_Properties_of_Water

10. Assessing Water Quality

Natural, unpolluted water contains many substances such as minerals and bacteria. Some of these are essential for good health, but in large quantities, they can be harmful to human health and to aquatic organisms. In order to protect human and aquatic life, the Louisiana Department of Environmental Quality (LDEQ) establishes water quality standards. Water quality standards consist of values for various substances in water in order to protect or maintain designated uses such as swimming and fishing. The designated uses of Louisiana's waters include:

- Swimming
- Boating
- Fish and wildlife propagation
- Drinking water supply
- Oyster harvesting
- Agriculture
- Outstanding natural resources (Scenic Rivers)

We measure water quality in terms of its chemical, physical, and biological characteristics. If these do not meet the water quality standards the water is considered polluted. Described below are some of the characteristics we measure.

10.1 Dissolved Oxygen

Oxygen enters water from the atmosphere and is released by plants that grow in the water. Fish and other organisms that live in water need dissolved oxygen to survive and reproduce. If dissolved oxygen levels drop to very low levels, aquatic organisms become unable to reproduce and can die. Dissolved oxygen levels normally range between 3 and 12 mg/L or parts per million (PPM) (same measurement, different ways of saying it). The typical criterion or standard for dissolved oxygen in Louisiana is 5 mg/L; however, in many cases the standards have been reduced to 2 – 3 mg/L due to natural conditions.

Some of the factors that affect the amount of dissolved oxygen in water include:

- Temperature (warmer water contains less oxygen)
- Velocity (rapidly flowing water absorbs more oxygen)
- Turbulence (higher turbulence = higher oxygen content)
- Plants in the water (photosynthesis releases oxygen)
- Decaying materials in the water (decomposition of dead algae, leaf matter, and wastes uses up oxygen)
- Shading of a stream (affects temperature and photosynthesis, thus oxygen level)
- Depth (deeper water = lower oxygen content)

10.2 Temperature

All aquatic organisms require certain temperatures for health and reproduction. If the temperature of the water falls below or rises above the ideal range, organisms may become stressed and unable to reproduce. In very warm temperatures, fish may become more vulnerable to disease and other pollutants. In addition, other aquatic organisms upon which they feed may become less plentiful during extreme temperature changes.

In Louisiana waters, temperature ranges between 32 degrees Fahrenheit in the winter and 90 degrees Fahrenheit in the summer. The maximum temperature allowed by Louisiana water quality standards is between 30 and 35 degrees Celsius.

10.3 pH

pH is an indicator of whether water or a solution is acidic or basic. pH is a measure of hydrogen ion activity in water, and can range from 0 to 14, with normal measurements ranging from 6 to 9 standard units. A pH below 7 is acidic, and a pH above 7 is basic.

As with temperature and dissolved oxygen, aquatic organisms have specific requirements with regard to pH. pH can play a role in determining the size and makeup of the aquatic community. In general, low pH waters have fewer species and smaller populations of aquatic organisms. pH also affects other chemical processes that occur in water. For instance, in low pH waters, metals become toxic to aquatic organisms. Although not common in Louisiana, coal and other mines can cause acid mine drainage. In Louisiana the criteria or standard for pH typically ranges from 6.0 – 8.5.

10.4 Nutrients

The nutrients commonly found in water are nitrogen and phosphorus. These are the same nutrients found in plant fertilizers, and algae and aquatic plants also utilize these nutrients. High nutrient concentrations in surface waters can cause excessive algae and grass production, which in turn can cause unwanted conditions in a water body. Excessive algal growth produces the pea soup color in lakes and ponds. In addition, when these algae die and begin decomposing in the water, a sudden decrease in dissolved oxygen levels can occur, causing fish kills.

The sources of nitrogen in water include the air, sewage, animal wastes, artificial fertilizers, and plant and animal matter. Sources of phosphorous are sewage, animal wastes, artificial fertilizers, and soil that washes into the water. The concentration of inorganic nitrogen in relatively unpolluted streams in Louisiana ranges from 0.03 to 0.18 parts per million, and in polluted streams it can be as high as 0.50 parts per million. The concentration of phosphorous in unpolluted Louisiana streams ranges from .05 to .10 parts per million, and in polluted streams phosphorus can be as high as 1.0 part per million. Louisiana has not yet established numerical water quality standards for nutrients.

10.5 Turbidity

Turbidity refers to the cloudiness of water and is a measure of the amount of light that penetrates the sample of water. The cloudier the water, the more substances there are suspended in the water. High turbidity can inhibit photosynthesis in aquatic plants and makes the water look dirty. In addition, high amounts of suspended particles in water can be harmful to fish and other aquatic organisms.

In Louisiana water, turbidity varies widely, but in the least polluted streams and in lakes turbidity ranges from below 10 Nephelometric turbidity units (NTU) to 25 NTU. In the Mississippi River, the average turbidity is near 50 NTU but can go as high as 150 NTU. The criterion for turbidity in scenic streams and lakes of Louisiana is 25 NTU, while the criterion for the Mississippi and Atchafalaya Rivers is 150 NTU.

10.6 Bacteria

Bacteria occur naturally throughout our environment; some are beneficial, and some can cause disease in humans and animals. We measure bacteria in water to determine if there may be disease-causing organisms present in the water. We test for a group of bacteria called fecal coliforms, which are bacteria found in the intestines of warm-blooded animals. If fecal coliforms are found in the water in large numbers, then it is likely that other organisms which can cause illness are present as well. The water quality standard used most often for swimming is 400 colony forming units (CFU) per 100 milliliters of water (equivalent to about one glassful).

Bacteria in the water do not affect the quality of fish, nor do they make the fish unsuitable for human consumption. However, shellfish taken from polluted waters should not be eaten raw.

10.7 Metals

Metals measured in water include arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc. These metals are natural elements of the earth, but they also enter surface waters from man's activities. In elevated concentrations, these metals can be harmful to fish and other aquatic organisms. These metals can also accumulate in fish in polluted waters and cause health problems in humans that eat those fish.

10.8 Equipment

LDEQ primarily uses water quality sampling and field or laboratory analysis to determine the quality of Louisiana waters. This testing is done with a variety of sampling equipment including electronic water meters, water sampling devices, sediment sampling devices, flow meters, and other more specialized equipment. (All equipment pictures were taken from the Rickly Hydrological Company online catalog.

http://rickly.com/

Electronic sampling devices are widely used to measure parameters such as dissolved oxygen, pH, salinity, conductivity, and temperature. There are several companies that make different versions but they all work in the same basic fashion. These devices work by lowering an electronic probe or group of probes into the water. The probes are attached to a small box-like device that allows the user to read the results for the various parameters. These devices must be carefully maintained and calibrated in order to ensure accurate measurements are obtained.

YSI electronic water meter

Hydrolab electronic water meter

Water sampling devices usually consist of bucket or tube-like devices used to obtain water from either the surface or deeper underwater. However, it is important to make sure the bucket or tube device is not made of or contaminated with chemicals that may result in false detections of chemicals in the water. Laboratory analysis has become so accurate, with detection levels in the very low parts per million, parts per billion, even parts per trillion and parts per quadrillion, that proper sampling techniques are more important than ever.

Kemmerer water grab sample bottle

Van Dorn horizontal water grab sample bottle

Sediment sampling devices consist of various implements designed to grab sediment from the bottom of a water body. Some consist of long poles with a "clamshell" device on the end that closes and grabs the sediment. Others are weighted clamshells that are lowered into the water on ropes. Once the clamshell hits bottom, tugging on the rope causes the device to close and grab the sediment. Sediment samples are then sent to laboratories to determine if harmful chemicals are present in sufficient concentrations to cause harm to fish, macroinvertebrates, or humans.

Ekman bottom grab samplers

Ponar bottom grab sampler

Van Veen bottom grab sampler

Flow or current meters are used to measure the speed of water flowing in a stream. This measurement along with measurements of the stream width and depth profile can be used to estimate not only the speed of the water but also the quantity of water moving past a given point on a stream. Flow measurements are usually given in cubic feet per second or CFS, and are known as a stream's "discharge". A sluggish bayou may have a discharge of 0.1 or even 0 CFS if there has been no rain in recent days. By contrast, the Mississippi River's discharge ranges from about 200,000 CFS to 1,000,000 CFS. Discharge or CFS is important when estimating the quantity of various chemicals found in the water. This in turn is used by LDEQ to determine the amount of different pollutants that can be safely released into the water without harming aquatic life or humans. This determination is done using a mathematical model known as a Total Maximum Daily Load or TMDL. TMDLs are used to develop water discharge permits and to make recommendations regarding the prevention of nonpoint source water pollution. Taken together, these actions are designed to protect and improve the uses of water bodies in Louisiana.

Pygmy flow meter

Wading rod flow meter **Columbus weight mounted flow meter**

11. Protection and Management of Water Quality

Water quality management in Louisiana is a team effort. There are hundreds of scientists and engineers that work together to ensure Louisiana has clean water for all its varied uses - both now and in the future. Many of these people work with the Louisiana Department of Environmental Quality (LDEQ), which has primary responsibility for water quality in the state. However, others are with the Louisiana Department of Natural Resources, the Louisiana Department of Health and Hospitals, the Louisiana Department of Agriculture and Forestry, and the Louisiana Department of Transportation and Development. Still others work for the various universities in Louisiana, conducting research on how best to protect and improve Louisiana's water resources. There are also many engineers and scientists who work for municipalities, industry and consulting firms. Their jobs are to work with the various State and Federal agencies in ensuring that discharges from these facilities will not harm water quality in Louisiana.

11.1 Water Quality Standards and Assessment

The section on water quality provided an overview of the various aspects of water that are important. The standards or criteria described in that section are determined by the LDEQ and written into State regulations in what is known as the Louisiana Environmental Regulatory Code (ERC). Louisiana's ERC regulations for water can be found in 09. Part IX Water Quality at:

http://www1.deq.louisiana.gov/portal/Portals/0/planning/regs/title33/33v01.pdf

The same group that determines these criteria is also responsible for conducting assessments or tests to determine if these criteria are being met. Another group within LDEQ samples the water in approximately 130 locations around the state every month. In most cases the water is tested for about 20 different parameters or chemicals found in the water. Each of these parameters and locations has their own criteria that are used to

determine if the water is meeting its designated uses, which were outlined above. More information on water quality standards, monitoring and assessment can be found in the Draft 2018 Water Quality Integrated Report found at:

https://www.deq.louisiana.gov/page/water-quality

Part III of this document provides an overview of Louisiana's water quality assessment process.

11.2 Point Source Discharges

Point source discharges are releases of wastewater from an identified location. Wastewater may originate from large industrial or petrochemical facilities. It may also be discharged from large municipal sewage treatment plants or small neighborhood or business wastewater facilities. In each case the discharger must have a permit from the LDEQ to ensure that the discharge will not harm or impair the water quality of the water body receiving the discharge. LDEQ administers and reviews the Louisiana Surface Water Quality Standards found in the Louisiana Environmental Regulatory Code, Title 33 Louisiana Administrative Code, Part IX, Chapter 11. LDEQ is also charged with the responsibility of maintaining and enhancing the waters of the State through the permit process. Permitting regulations and implementation plans establish procedures to effectively incorporate the water quality standards into wastewater discharge permits. Although all applications for permits to discharge wastewaters are considered on a case-by-case basis, LDEQ believes that a consistent approach to application reviews is important. Draft water quality permits are reviewed by the facility requesting the permit and subject to a public review period to ensure citizens in the area have a chance to comment on the facility. This public review period is a chance for local citizens to get involved with the permitting process, and thereby have some impact on what happens in their area.

https://www.epa.gov/npdes-permits/louisiana-npdes-permits

11.3 Nonpoint Source Pollution

In addition to point sources of water pollution, a larger source of pollution is what's known as nonpoint source (NPS) pollution. NPS pollution comes from many different sources but the common feature is that it results from the runoff of rainwater from the land. What the land is used for determines the possible pollutants the water picks up as it moves into streams and lakes. Agricultural land frequently causes high levels of pesticides, fertilizers, and soil or sediment to be picked up by stormwater. When these pollutants get into streams or lakes they can cause problems for fish, other organisms, or people who use those water bodies. Runoff from urban areas like roads and parking lots often have high levels of oil, gasoline, metals, and other chemicals from the cars and truck using them. Runoff from suburban lawns and agricultural areas often contains pesticides, fertilizers, and sediments. Taken together, NPS pollution now accounts for over half of the water pollution in

Louisiana and the nation. More information on NPS, the different sources and forms of NPS pollution, and ways to prevent it can be found at:

https://www.epa.gov/nps

11.4 Threats to Water Quality in Louisiana

As most people realize, there are numerous threats to water quality in Louisiana and the nation. Fortunately, things are not nearly as bad as people frequently believe. Since 1972, the Federal Clean Water Act (CWA) has worked to protect and improve water quality in the United States. The CWA initially focused on cleaning up discharges of pollutants to water bodies by requiring industry of all sizes, cities, and towns to reduce or eliminate the amount of harmful chemicals in their wastewater. Yes, cities and towns contribute significant amounts of water pollution through their sewage treatment facilities. Largely as a result of the CWA, water quality in the United States is much better than it was 30 years ago. But there is still much work to be done. Nonpoint source pollution, which was described earlier, is now the largest single source of water pollution in the United States. This is largely because nonpoint source water pollution can occur anywhere and anytime it rains.

http://www.epa.gov/lawsregs/laws/cwa.html

Mercury contamination of fish is currently a big issue in Louisiana and the nation. This contamination results from a number of sources, but the largest single anthropogenic (man-made) source is coal-fired power plants. Coal contains low levels of elemental mercury. When coal is burned the mercury is released into the atmosphere where it travels in the air until falling out in rain or dust. Once this mercury reaches a water body it may be methylated, which changes the form of mercury into one that can be accumulated by animals in their bodies. As larger animals eat smaller ones the mercury builds up in their bodies in a process known as bioaccumulation. As a result, fish such as largemouth bass, bowfin (choupique), king mackerel, and other predatory fish can develop somewhat hazardous concentrations of mercury in their flesh. These concentrations are generally not high enough to cause harm to humans. However, pregnant women and small children are more at risk because mercury can permanently affect developing brains. Therefore, these populations must be more careful regarding the fish they eat and in what quantities. Likewise, commercial and recreational fishers who consume unusually large quantities of fish should review Louisiana's fish consumption advisories to ensure they are not eating too many fish that may be contaminated with mercury or other chemicals. LDEQ is working with the Louisiana Department of Health and Hospitals and other State agencies to identify areas at risk due to mercury contamination of fish. The agencies then notify the public as to what fish are of concern and at what quantities they may be safely consumed. It is important when considering Louisiana's fish consumption advisories due to mercury to read the details, because in many cases the average person can safely eat as much fish as they want. More information on mercury in fish can be found at:

The two most significant forms of water pollution in Louisiana are low dissolved oxygen and sewage. Just like land animals, fish require oxygen to survive but they get their oxygen from the water through gills. Low dissolved oxygen is caused when things such as fertilizer, sewage, or plants are present in the water in excessive quantities. Once in the water these things act just like fertilizer on a lawn or field, causing algae and other plants to grow rapidly. Two things can then happen. One, these plants can actually begin using oxygen in the water as they go through the process of respiration. Most people know about plants using carbon dioxide and giving off oxygen. But what most people don't know is that plants also take in oxygen, especially at night, as part of their normal respiratory process. If there is too much algae growing in a water body it can actually cause oxygen levels to drop too low for the fish and macroinvertebrates living there. The second problem with excess plant and algae growth occurs after it dies and sinks to the bottom. When the algae die it decays as bacteria begin to eat it. This causes more and more bacteria to grow. Just like all animals, bacteria require oxygen to survive so if there are too many bacteria they can remove much of the oxygen from the water. This again makes it difficult for the fish to survive.

Sometimes the source of this low dissolved oxygen is simply nature in Louisiana. Swamps and marshes are naturally high in nutrients causing high levels of plant and algae growth. But this is not the problem because the animals living in Louisiana's waters are generally adapted to relatively low dissolved oxygen. What can potentially harm Louisiana's water bodies is when humans dump too many nutrients in the water. Nutrients can come from a variety of sources, but the most frequent sources are farmer's fields, sewage treatment plants, home lawns, and other heavily fertilized areas. LDEQ works with all of these groups, either through regulations or through education to try and reduce the level of nutrients being released to Louisiana's waters. More information on dissolved oxygen in water can be found at:

http://www.state.ky.us/nrepc/water/wcpdo.htm
http://www.lenntech.com/why_the_oxygen_dissolved_is_important.htm

When reading through these links be sure to remember that 5.0 mg/L of oxygen is the norm for many other parts of the United States, and even parts of Louisiana. However, many of Louisiana's aquatic environments do just fine with natural concentrations of 4.0, 3.0, even 2.0 mg/L of oxygen, because the fish and macroinvertebrates here have adapted to survive and even thrive in this area.

The second most significant form of water pollution in Louisiana is sewage. In addition to causing dissolved oxygen problems as described above, sewage can cause health problems for humans swimming in the water. Sewage frequently contains high levels of what are known as fecal coliforms. These bacteria are naturally found in the intestines of warm blooded animals, where they contribute to the digestion of food. Since they are found in animal intestines they naturally end up in the waste product of those animals. While fecal coliforms are not normally harmful by themselves, the presence of fecal coliforms may indicate the possible presence of harmful bacteria, viruses, and parasites that may be

coming along for the ride. It is these harmful organisms that can cause illnesses should someone accidentally swallow contaminated water while swimming.

Fortunately, sewage treatment plants in Louisiana are regulated by LDEQ under the terms of the CWA, which was discussed earlier. Unfortunately, many cities and towns cannot afford to properly build or maintain their sewage treatment plants in order to adequately treat the sewage before it is released to area streams. Also of concern are the thousands of homes and camps located in Louisiana that use septic tanks or nothing at all before releasing their waste to the environment. In many parts of the State people feel it is okay to simply run a pipe to the nearest ditch or stream. Decades ago, when there were not as many people as there are now, this may have been acceptable. However, today there are so many people living along Louisiana's streams and lakes that many of them have become contaminated with sewage. Money often lies at the heart of the problem with both municipal sewage treatment systems and septic tanks. Everyone wants clean water for swimming and drinking but nobody wants to pay for it! More information on municipal sewage treatment and septic tanks can be found at:

http://home.howstuffworks.com/sewer.htm

A less recognized form of water quality impairment comes from invasive aquatic species. These are organisms, frequently plants but also mussels, mammals, and fishes that have been accidentally or deliberately introduced to Louisiana's environment. Water hyacinth, salvinia, hydrilla, zebra mussels, and nutria are all aquatic invasive species that are now causing extensive damage to Louisiana's water bodies and aquatic ecosystems. Invasive species generally grow at such a rapid pace that they tend to choke out native plants and animals that should be living in or around the water. In the case of nutria, they can quickly destroy marshes and trees or burrow into levees causing failures of these important structures. The State of Louisiana has developed an Aquatic Invasive Species Council to try and deal with this problem. The Council is composed of representatives of a number of State and Federal Agencies, along with industry and citizen groups who are charged with coming up with a strategy to address this problem. While many of these harmful species are here to stay, the Council is working to prevent more species from entering Louisiana, while trying to reduce the impact of the existing species. More information on aquatic invasive species, including photos of the most common plant and animal invasives in Louisiana, can be found at:

http://is.cbr.tulane.edu/
http://www.anstaskforce.gov/

Questions regarding the Aquatics Station for the 2020 Louisiana Envirothon competition may be addressed to Greg Waldron – Gregory.Waldron@la.gov