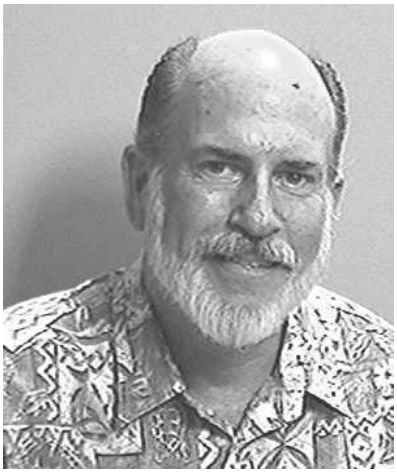

Bill Halstead

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Bill retired at the grade of Master Sergeant from the United States Air Force after twenty years of service. He earned his associate's degree in Biological Science from St. Petersburg Jr. College in 1981 and received his Bachelor of Science degree in Marine Biology from Eckerd College in 1984.

Currently he directs the FWC Fisheries Stock Enhancement Program and manages the Port Manatee saltwater hatchery located in Manatee county Florida. He works closely with Mote Marine Laboratory and the University of South Florida using his experience as a marine biologist and aquaculturalist to help assess and design marine stock enhancement programs. He also oversees the culturing of saltwater game fish and bivalves while helping to design and implement new hatchery construction.

Unit II Fisheries Management

On the cutting edge…..
The Florida Fish and Wildlife Conservation Commission (FWC) is responsible for one of the premier stock enhancement research facilities in the southeastern United States. At this saltwater facility, one project focuses on increasing the red drum stock in Tampa Bay. Through the use of cutting edge technology, researchers are rearing hatchery animals from wild brood stock and releasing them into the environment. Scientists use four unique tagging systems to determine the optimum release place and size for these fish. Project Tampa Bay is a partnership between FWC and Mote Marine Laboratory.

Stock Enhancements and Hatcheries

Lesson Objectives: Students will be able to do the following:
- Identify the components of a fish hatchery
- Describe the breeding process for red drum
- Recognize four types of fish tags

Key concepts: habitat, rate of mortality, aquaculture, hatchery

Stock Enhancement

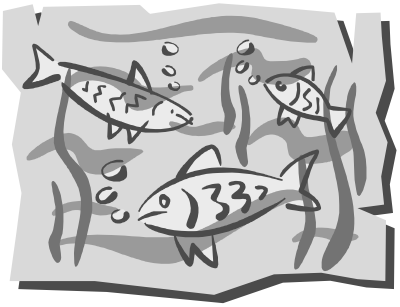
The populations of commercial and recreational fish species in our waters is rapidly decreasing due to increased fishing pressure and habitat destruction. As our human population grows, more people are using the waters for boating, swimming, and fishing. These activities present special problems for fish and their **habitat**. Technology has allowed the development of better fishing equipment including better ways of finding fish, graphite rods, super strong fishing line, and a wide variety of artificial baits and lures. These advances make fishing a more efficient enterprise.

Habitat destruction from humans and natural processes has also created additional concern. As litter and toxins are introduced into the near shore **estuarine** nursery areas, many juvenile fish succumb to changes in water quality. Delicate sea grasses cannot withstand the strong winds associated with storms or the destruction caused by speeding boats and other recreational vehicles. In the past, most fish stocks have been able to sustain themselves through enforcement of fishing regulations and habitat management. Today the **rate of mortality** exceeds the

natural possible birth rate potential for some stocks with these traditional methods alone. Researchers have had to look for additional ways to increase fish populations so recreational and commercial fishermen can continue to catch fish. **Aquaculture** is one of the fish enhancement programs used by scientists.

Aquaculture

Aquaculture is the growing of fish, shellfish, or aquatic plants to supplement the natural supply for recreational, commercial and scientific purposes. The **hatchery** is the farm where this cultivation takes place. At the hatchery a variety of natural or artificial areas may be used to contain the stock. These include ponds, tanks, pools, or cages hung in natural waters. In recent years, advances in aquaculture have allowed the rearing of freshwater and saltwater species through an entire life cycle.



Most fish hatcheries include a breeding area and a rearing area. Some also require an area to treat their wastewater. In the breeding area, tanks are prepared for the brood stock. The water quality is monitored to insure the appropriate environment. Scientists check the temperature, **salinity** (in the case of saltwater fish), oxygen levels, and **pH** to be sure they are maintained at the correct levels. This area also contains the brood rooms in which the environmental cues that begin the spawning process can be manipulated. These cues usually include water temperature, day length, water quality, and cycles of the moon. These tanks include egg-gathering containers from which the young are moved to **incubators**.

When the juveniles reach the appropriate size they are released into larger outside ponds or other grow-out containers or areas. This rearing area is monitored to be sure that the temperature, salinity (in the case of saltwater fish), and ammonia levels are appropriate for the fish. **Ammonia** tends to build up in the ponds because the fish excrete it. Adequate amounts of food must also be added to the ponds. The juvenile fish usually feed on **plankton**. The larger fish can be fed different types of formulated food called chow. When the fish reach the desired length, weight, or age they are released. Some fish are raised to be used as food and others are released as **fingerlings** or **fry** to replenish stocks in natural waters.

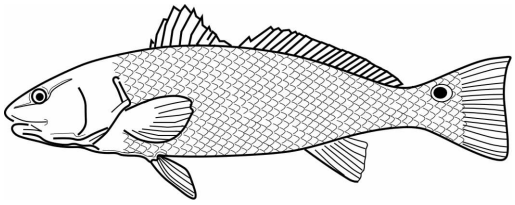
When fish are released into the environment for scientific purposes, researchers need to follow the fish. To do this, they have created several

types of tags that can be placed on the fish for specific purposes. All tags contain some type of code that identifies the fish. A common type of tag is an anchor tag or dart tag that is inserted into the fish with only the streamer showing. This tag is visible when the fish is caught. Much smaller coded wire tags about 3 **millimeters** in length, are mechanically placed in the cheek of fish. DNA tagging is used to identify fish by checking one loop in the entire DNA strand. Researches check the DNA from a particular fish by cutting a small piece from the dorsal fin and testing it in the laboratory. Sonic tags are much larger bullet shaped devices that are surgically implanted in the fish. These are generally inserted in adult fish to follow their migratory patterns. Sonic tags are very expensive (approximately $250 each) and they are found by using a hydrophone under the water's surface.

Wastewater treatment is an important aspect of all hatcheries. The water released from the pond areas needs to meet DEP (Department of Environmental Protection) guidelines before it can be returned to the environment. This ensures that the water does not contain a high level of nutrients and is not carrying any diseases to the natural waters.

Red Drum Rearing at the Florida Saltwater Fish Hatchery

Red drum are being raised at the Florida saltwater fish hatchery to be released back into Tampa Bay to increase the number of fish available to recreational fishermen. Adult drum are captured in the wild and brought to the hatchery where they are placed in tanks adjusted to the correct temperature, pH, salinity, and oxygen levels. Once the fish are



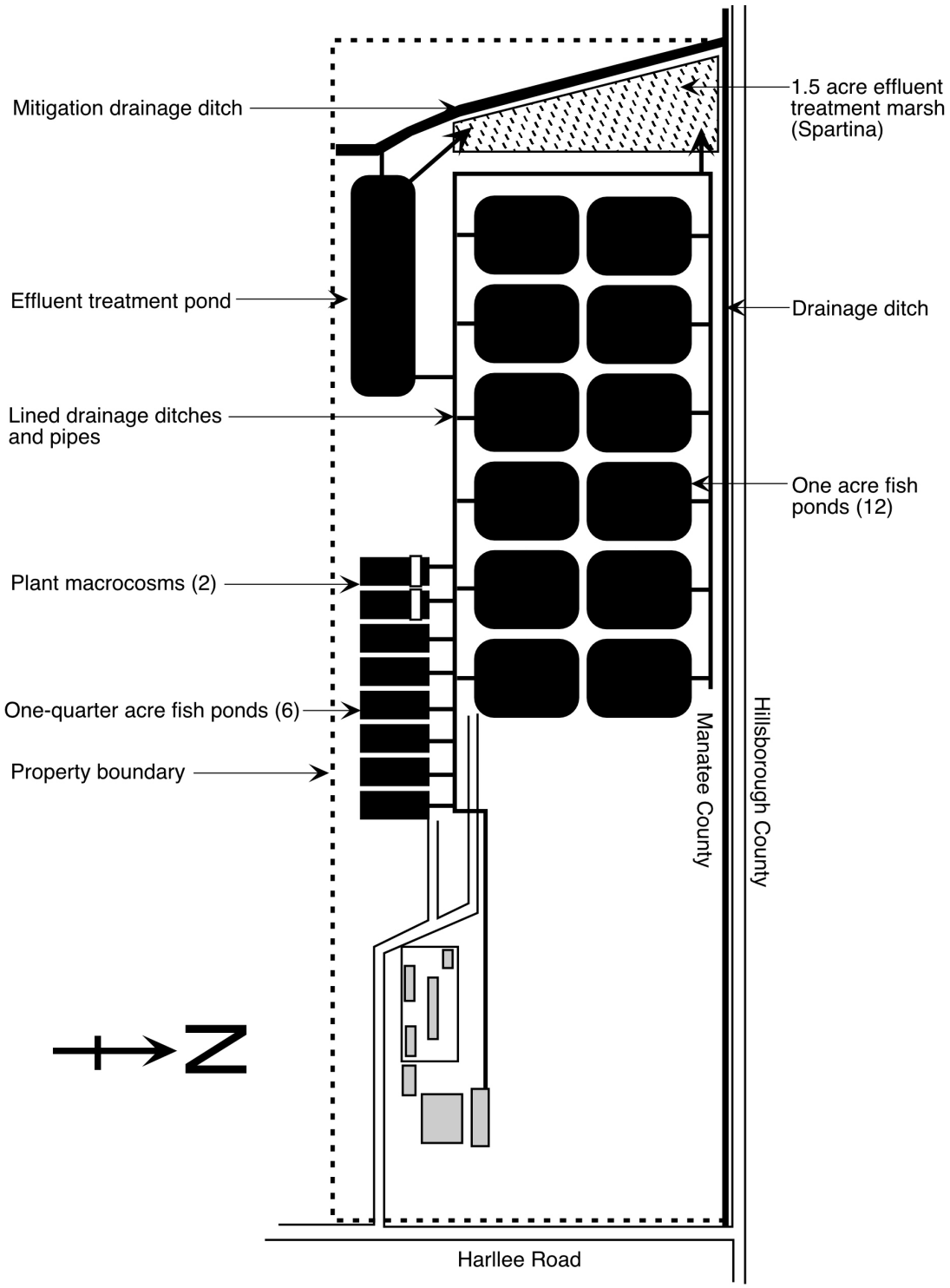
acclimated they are placed in brooding tanks. Here the day length and temperature of the water is altered which stimulates the **pituitary** to release hormones. After a lengthy mating ritual in which the male drums loudly and chases the female, the female **spawns** just after sundown. The male swims over the eggs and fertilizes them. The eggs contain oil that makes them rise to the top of the water. The eggs then float in the artificial current and are swept into a collection tube that dumps into a holding bin. The eggs are separated from the water and measured in liter containers. One million red drum eggs will fill a one-liter container. Next the eggs are incubated and hatch into larvae with a yolk sack, which they use as food for three days. At this time the fish

are ready to leave the brood area and move to the rearing area.

The one-acre ponds constructed of earth and lined with polyvinyl have been prepared. They are filled with water directly from the bay. The pipe used to fill the ponds contains a filter so that undesired elements do not enter the ponds. They have been checked for the correct temperature, salinity, pH, and ammonia content. The aerators have been running to ensure adequate oxygen. The fish are placed in the ponds containing plankton. The plankton will be used as food by the young fish. The ponds are covered with bird netting to keep cormorants from eating the small fry. When the fish are six weeks old, they are moved to another pond. They continue to be moved as they grow. Some fish are kept until they are six months old. The fish are then tagged, taken in special tanks to the release site, and drained into the water.

The ponds are then prepared for the next crop. The **effluent** water is drained into an **aerated** pond and treated for two days. It is then pumped into an artificial wetland area that acts as a filter to remove any remaining pollutants. The ponds are also periodically cleaned to remove any **sediment** that has built up.

The design of this wastewater treatment facility has advantages, because a natural habitat has been reclaimed and the grasses grown on fish waste are then used in habitat restoration projects throughout the bay area.



Stock Enhancement Research Facility (SERF)
at Port Manatee, Florida
Diagram courtesy of the Florida Fish and Wildlife Conservation Commission.

Activity: Fish Hatchery Model

Fish hatcheries are places where fish are raised in artificial enclosures for food, research, or recreational stock enhancement. There are several problems to overcome when running and designing a fish hatchery. Of course researchers must find cost effective ways to produce fish or the hatchery could not exist.

Objective: Students will be able to design and construct a model of a fish hatchery.

Materials:
- Drawing and writing materials
- Art supplies such as colored pencils, markers, construction paper, etc.
- Building materials for various parts of the hatchery. Students can bring in items or use recyclables. Items can include boxes to represent buildings, plastic containers for ponds, carpet, material, plastic mesh, straws, sticks, etc. to represent other items including habitat.
- Fish hatchery graphic from the teacher packet

Procedure:
1. Discuss fish hatcheries and their importance. (Use materials from the teacher information guide.)
2. Hand out the fish hatchery diagram from the teacher information guide.
3. Discuss the important features of all hatcheries. Include information pertaining to the types of enclosures that can be used for the fish including pools, ponds, cages in water, tanks, etc.
4. Make a list of features to be included in the student models such as the fish containers (ponds), the effluent treatment plant (wastewater treatment), the acclimation tanks, the brood rooms, and incubators.
5. Distribute building materials to the students.
6. Provide students with information that they are to include.
7. Have students construct a model of a hatchery. (This can be done individually or in small groups.)
8. Have students describe their fish hatchery and its component parts.

Possible Extensions:
1. Discuss with students the type of information they would need to present to a local funding agency to continue their hatchery research. Develop a list of questions they would need to be able to answer.
2. Have students do additional research and make presentations discussing an aspect of their hatchery in depth. For instance, have students discuss what happens to the wastewater in their hatchery after it is treated, and how this would impact the environment.

Activity: Fish Hatchery Math

Fish hatcheries are designed to be cost effective alternatives for providing fish for a variety of reasons. One way hatcheries are used is to grow fish to enhance recreational stocks when the numbers in the wild are too low to recover adequate populations. To find out if researchers can do this for a low cost, they need to figure out a budget using basic math principles.

Objective: Students will be able to use basic math skills to solve real world math problems.

Math Problem Information

This fish hatchery has 3 one-acre ponds.

- A one-acre pond holds 100,000 fish.
- Six -week old fish cost 10 cents a piece to raise.
- Twelve-week old fish cost 25 cents a piece to raise.
- Six-month old fish cost 75 cents a piece to raise.
- New bird netting costs $14,000 per pond.
- Replacement bird netting costs $9000 per pond.

Problems:

1. There are three one-acre ponds at this hatchery. Each pond is filled to capacity. Two of the ponds contain six-week old fish and one pond contains six-month old fish. How much did it cost the hatchery to raise these fish to this point?

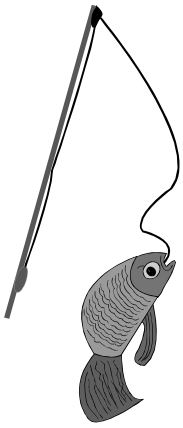
2. When the fish in these three ponds were released, some of them died. 25,000 of the six-week old fish died. 5000 of the six-month old fish died. How much did this loss cost the hatchery?

3. Cormorants began to eat the six-week old fish. Before the researchers could scare them away, they had eaten 25,000 of the fish. How much did this cost the hatchery?

4. Hatchery personnel decided to install bird netting to keep the cormorants from eating the fish. They put up two new bird nets and one replacement bird net. How much did it cost to put up the bird netting?

Challenge Problem:
During the second season, all three ponds contained twelve-week old fish. The cormorants chewed holes in the bird netting and ate 25% of all of the fish in one day. The hatchery personnel had to buy replacement nets for the ponds. How much did the fish loss and bird netting cost the hatchery?

Student Information: Fishing for the Future



Fishing is a popular sport among people of all ages. As more people set out on weekends to boat and fish, fewer fish are available. As more people move into coastal areas, they bring with them pollution that can destroy fish **habitat**. Sometimes there are not enough fish left in the wild to reproduce. Also **predators** eat many of the spawn so few of the **offspring** survive. These two factors have caused scientists to look to new ways of increasing fish populations. They want future generations to be able to enjoy what we have today and have had in the past.

One way to restock fish is to use **aquaculture** or fish farming. Scientists raise fish in **hatchery** ponds, then release them back into the environment. Most of the fish in the ponds survive because they are kept safe from their predators and always have enough food to eat. Tags are used to track the fish once they are released. When tagged fish are caught, researchers can gather information about the fish. They can tell how many fish are surviving, how fast they are growing, and where they live. They can also tell if pollution is affecting the fish or their habitat.

We can help by fishing responsibly. Follow the fishing regulations and only take what is needed. Report tagged fish to the appropriate agency. Keep our fishing areas clean by not leaving litter or pollution in our waterways. Protect fish habitat from recreational vehicles.

Fisheries Management Vocabulary

Acclimate-adjust to a new environment

Aerate-to add oxygen to

Ammonia-a colorless, pungent gas composed of nitrogen and hydrogen from animal waste

Aquaculture-cultivating fish, shellfish, or plants under controlled conditions

Effluent-discharged wastewater

Estuarine-pertaining to a place where freshwater and saltwater meet

Fingerling-young or small fish

Fry-fish hatchlings

Habitat-the area or environment in which an organism normally lives or occurs

Hatchery-the place where fish are produced from eggs

Incubator-apparatus that control environmental conditions so young will grow

Millimeter-a metric unit of measurement, 25.4 millimeters equal one inch

Offspring-young

Pituitary-an endocrine gland whose secretions control the other endocrine glands and influence growth, metabolism, and maturation

pH-a measure that indicates the relative acidity or alkalinity of a substance. pH ranges from 1 (most acidic) to 14 (most basic), where a pH of 7 is neutral

Plankton-small or microscopic plants and animals that float in water

Predator-an organism that lives by hunting and eating other organisms

Rate of Mortality-number of deaths in a given time period

Salinity-term used to describe the amount of salt in a liquid

Sediment-material that settles to the bottom of a liquid

Spawns-the laying of eggs by aquatic animals

Fisheries Management References

"Aquaculture." Encyclopedia Britannica. Online. 15 Sept. 2000.

"Commercial Fishing." Encyclopedia Britannica. Online. 15 Sept. 2000.

Florida. Fish and Wildlife Conservation Commission Marine Research Institute Ecosystem Assessment and Restoration. Fisheries Stock Enhancement. Florida Fish and Wildlife Conservation Commission Marine Research Institute. 27 Jan. 2000.

Florida. Fish and Wildlife Conservation Commission, Marine Research Institute. Sea Stats. "Red Drum Marine Musicians." Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute. 100 Eighth Ave. SE, St. Petersburg, FL 33701-5095. Apr. 2000.

Florida. Dept. of Natural Resources Div. of Marine Resources Florida Marine Research Institute. Sea –Stats. "Red Drum/Redfish." Florida Dept. of Natural Resources Div. Of Marine Resources Florida Marine Research Institute. 100 Eighth Ave. SE, St. Petersburg, FL 33701. No. 15. 18 Sept. 2000.

Florida. Fish and Wildlife Conservation Commission. Stocking Florida Redfish in Tampa Bay. Florida Fish and Wildlife Conservation Commission.

Halstead, W. G. Personal interview. 13 Sept. 2000.