III. Restoration and Commercial Applications

SCIENCE
Strand
- processes that shape the earth
- processes of life
- how living things interact with their environment
- the nature of science

Standards
- understands the need for protection of the natural systems on Earth
- describes patterns of structure and function in living things
- understands the competitive, interdependent, cyclic nature of living things in the environment
- understands that science, technology, and society are interwoven and interdependent

SOCIAL STUDIES
Strand
- people, places, and environments (Geography)

Standards
- understands the world in spatial terms
- understands the interactions of people and the physical environment

LANGUAGE ARTS
Strand
- writing
- listening, viewing, and speaking
- language

Standards
- writes to communicate ideas and information effectively
- uses listening strategies effectively
- uses speaking strategies effectively
- understands the power of language

Aquaculture can be defined as the raising of aquatic organisms under controlled or semi-controlled conditions. It is similar to farming, only underwater!

Americans spend billions of dollars importing marine foods from around the world. We imported 80 million pounds of Bay Scallops from China last year. These scallops were started from 26 bay scallops originally taken from the United States and raised using our aquaculture techniques! Just over thirty years ago we could go right out to Tampa Bay and collect them ourselves. Now we pay to import them from China! How did this happen?

Scallops are catastrophic spawners, that is, when one scallop spawns they all follow and you have one massive spawning. This occurs because fertilization occurs in the water column, In order for eggs and sperm to meet they have to be present at the same time. However, if conditions are not ideal when the first scallop spawns and triggers spawning in the rest of the population, the results may be disastrous.

The major factor determining the occurrence of the spawning event seems to be a change in temperature. Unfortunately, even though the temperature may be correct, something else may be wrong. For instance, the tide may be going out, not in. The entire spawn from that population may be lost. However, there are usually other

populations around to reseed the lost population, and all is not lost. Unfortunately, if the area is over-fished or there is a high mortality due to pollution there may not be sufficient stock to jump-start the population. The natural year to year fluctuation in larval survival carries with it a greater cost in Florida than it does in some of the colder climes because the life span of the bay scallop in Florida is only about one year. If the spawn is lost, the population is lost. These factors along with a possible loss of habitat may have brought about the demise of the bay scallop in Tampa Bay.

This brings us to 1998 on Florida west coast. For example, Tampa Bay and other areas now have adequate water quality. The bay scallop would stand a good chance of surviving here now. However, there are no populations nearby to spawn and reseed the area. We now have the power, using aquaculture, to restore the bay scallop in Tampa Bay and in other areas along the Florida west coast.

TECHNIQUES OF PLANTING FOR RESTORATION

We start the restoration process by collecting scallops from wild populations. Spawning is induced by bringing about the correct temperature change (Fournier and Marsot, 1985). The fertilized eggs are then placed in a 100-L Nalgene container at a density of 700 eggs/cm^3. A mixture of antibiotics may then be added. However, this brings with it the problem of tissue residues, toxic effects on the larvae and possibly bacterial resistance. Other avenues of pathogen avoidance such as water treatment and probiotics are being studied at USF. The water is replaced every two days. When the larvae reach the **veliger stage** they are sieved through a 150 micron screen and retained on a 20 micron screen. The weakest swimmers are usually discarded and the remainder is kept in a tank where they are fed with phytoplankton. The phytoplankton are also raised at the aquaculture facility. They also must be treated with antibiotics so as not to introduce a pathogen into the scallop culture. Currently, the hatchery at USF is using two species of phytoplankton, which the scientists grow until the cultures reach the correct density hopefully at the same time the scallops are at the correct life stage. They are fed twice a day. The optimal way to feed the larval scallops would be to feed them a mixed culture of phytoplankton continuously. The mixed culture ensures they are getting all of the nutrients that they require. A continuous feeding is better because that is how a scallop feeds, continuously. It is a filter feeder and it constantly filters the water for its food. The scientists at the University of South Florida and Florida DEP are currently working on the development of a cost efficient method for a continuous

feeding with a mixed phytoplankton culture.

TRANSPORTATION OF JUVENILES

When the scallops reach the pediveliger stage after about 8 days, which is indicated by the presence of a foot and a bottom seeking behavior, the diet is reduced and the species mixture is changed. The scientists then utilize either astro-turf or strips of black plastic (to mimic sea grasses) for the larvae to settle upon. The settled spat are kept like this for about one month. They are now visible to the naked eye and can be gently brushed off of their plastic seagrass home into very fine mesh nylon bags. Each of these mesh bags hold about 25 to 50 thousand spat! The mesh bags can now be transferred to various nursery sites. There, they can be hung over seawalls or off docks. The scallops grow for another 2 months to a size of about 6-8 mm shell height.

CAGE CULTURE FOR RESTORATION

At this time they can move into their scallop condos! These condos are actually specially designed cages for the scallops to live in. They can be hung from a raft (hanging culture) or they can sit on the sea floor, (bottom culture). The cages prevent predators from munching on the scallops, yet they allow the scallops to filter their food from the water column. Care must be taken in deciding where to place the cages because suitable food organisms must be present and the current regime must be correct. There must be adequate protection from storms, and of course the salinity, temperature and water depth must also be just right! Frequent cleaning of both the nylon mesh bags and the cages is important. If barnacles, oysters and algae foul these devices heavy mortality may occur. This is probably because the scallops need a constant flow of water from which to filter their food.

ASSESSMENT

If money is to be spent annually on the restoration of the bay scallop then it has to be proven that in fact the restoration efforts are effective. Therefore a baseline population count must first be made before any areas are restocked. The best way in which to carry this out is by choosing sites that will be restocked and making initial scallop counts in this area and later comparing this with counts made after the restocking has occurred. Transects (rope lines) are deployed and scuba divers swim along the transects and count the number of scallops that they see. They usually count 20 different transects at each sites. The data should then be analyzed using appropriate statistical methods.

The proportion of enhanced versus wild stock may also be assessed using genetic means. The initial population can be measured genetically. The scientists then isolate, find a unique genetic tag in the hatchery scallops. This genetic tag may be later surveyed for using non-invasive techniques so as not to deplete the restocked population.

HOW INDUSTRIAL AQUACULTURE DIFFERS FROM RESTORATION

The intent of the restoration project is to utilize stock enhancement to assist in re-establishment of the wild scallop population. In contrast the intent of an industrial aquaculture project is to raise scallops strictly for commercial purposes. That is, to keep them captive until they reach their maximum size 60-70m and then harvest them for human consumption. The restoration project will also bring money to the Florida west coast. Tourists used to flock to known bay scallop harvesting areas providing revenue for area hotels, dive shops, fishing guides and restaurants. The industrial aquaculture projects will also have an economic impact provide jobs/steady income for the unemployed Florida fisherman on the west coast.

5. MARKETING

The bay scallop only lives about one year, therefore it has a short production cycle. Also, once it is in the nursery and grow-out stages, food is supplied by the natural phytoplankton population. Therefore, most of the cost is incurred by spawning, incubation, larval rearing and harvesting the adductor muscle. The meat yields from cultured scallops are usually 10-15% higher than those of comparably sized, wild scallops. There is already a market for the bay scallop, the success of the Chinese bay scallop producers can attest to that. However, the cost of labor is much lower in China than it is in the United States The question is can the costs of raising them locally offset the price of shipping them into U.S.?

Scallop Aquaculture

Discussion Questions

1. Name two ways in which a scallop moves? (larve move with water currents and adults have jet propulsion by rapidly opening and closing its valves)

2. How can you determine the top side of a scallop? (Note growth of algae and fouling organisims on top side)

3. What part of a scallop do Americans eat? (Only muscle, Europeans eat whole animal)

4. What does a scallop eat? (plankton)

5. What eats a scallop? (Starfish, carnivorous snails, stingrays and some fish)

6. How can you tell a male from a female? (they are both male and female)

7. What Phylum is a scallop in? (Mollusca)

8. How long does a Bay Scallop live? (two years)

9. Where does a scallop live? (seagrass beds)

10. Do scallops have a future in Florida? (discuss habitat and development)

Activities

1. Label the parts of a scallop. (see teacher/student worksheet inset)

2. Scallop Cook Off- each student should look for different scallop recipes that they find in various cook books or on the internet. Compare different uses for scallops.

3. Have the students do a research project on scallops. Some ideas are:

- the effects of pollution on the scallop population

- the effects of phytoplankton blooms on the scallop population

aquaculture

life cycle