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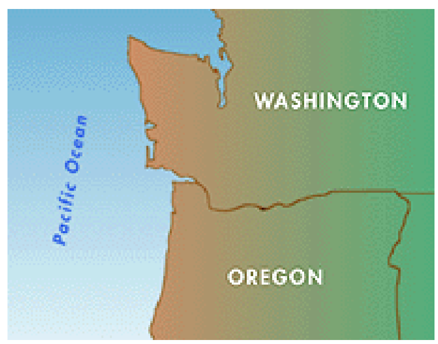
In This Issue:

Oysters on the Other Coast: Progressive Development



Don Webster
Eastern Shore Area Agent

There is a well-worn path between the Chesapeake Bay and the Pacific Northwest, which winds from the banks of our estuary, now denuded of oysters, to the hatcheries and planting grounds of Washington and Oregon. Many people have traveled the same trail. While we have all seen the same sights -- a flourishing oyster industry out there -- some have returned with far different interpretations of what they saw.

Bay watermen have come back claiming that we cannot have similar results here. "Their tides are bigger than ours. Different oyster, too. Won't work," some exclaim. Resource managers have made the trip and likewise have said, "we are too dissimilar. Environment's different. Laws are different. Won't work." While recognizing the differences between our two regions, I've always felt that we need to look at the similarities and adapt the best of theirs to our conditions. The key lesson from West Coast oystermen is that industry can adapt and grow in the of face adversity. It is a lesson that desperately needs to be learned here in the Chesapeake if we are to remain in the oyster business.

I recently had the chance to travel that path again at the annual meeting of the World Aquaculture Society which was held in Seattle. With Maryland Sea Grant Specialists Don Meritt and Jackie Takacs, I visited commercial shellfish producers before the conference. It was, as always, an educational trip.

The shellfish industry on the West Coast is made up of both large and small producers. While they primarily raise the Japanese oyster Crassostrea gigas, other shellfish are either under cultivation or in development. Because of cold water temperatures, oysters on the West Coast take about as long as ours to reach market size. Their industry, like ours, largely produces shucked, raw products. Also, like ours, their industry primarily produces shellfish through bottom culture techniques. A West Coast benefit, however, is the wide tidal range which minimizes fouling and simplifies harvesting. Also, they get to see their crop during ebb tide. Aside from those benefits, their main advantage is progressive thinking, with a production oriented outlook on the industry and its future.

Conversations with West Coast producers are always interesting. Rather than try to discourage others from trying to increase production, they want the industry to expand, feeling that more products offer increased opportunity for market expansion around the world. In fact, it is not at all unusual to find members of the Pacific Coast Oysters Growers Association exhibiting their products in foreign seafood shows, courting new business.

That outlook may be one of the key differences between the regions: harvesters in the Chesapeake area frequently voice the opinion that production needs to be kept down in order to keep prices up. The difference is significant. One group believes that you need to constrict supply while the other believes that you need to stimulate demand. As one west grower put it, "When an industry ceases to grow, it begins to die. Static production is not the way to success."

We visited the Taylor United and Coast Oyster Company hatcheries, both of which are located in Quilcene, Washington. They are impressive, with the state-of-the-art production methods and equipment. They produce billions of shellfish larvae annually which are set and grown at various locations. At the Coast hatchery, a mountain of bagged oyster shell was waiting to be set. Shells are bagged at their shucking plant, then strapped into bundles and transported to the hatchery by trailer. Material handling is done by a truck mounted cranes.

From Quilcene, we went to Nahcotta where we once again visited Lee and Fritz Wiegardt. The Wiegardt operation includes hatchery, setting, nursery, growout, harvest, and shucking operations in one area of Willapa Bay. Their company is impressive. Many of our visitors to the West Coast have been to Willapa Bay, and Lee has always shown them his production facilities with the pride that they merit. On this visit we saw his expanded setting tanks and new shell washer and bagger.

Oyster producers on the West Coast understand that their livelihood depends on clean water. Many of them have joined with local environmental groups to ensure that the watersheds their businesses are built on are kept healthy. A publication by the Willapa Alliance about the estuary includes a section on the importance of the oyster industry, a mutual recognition that the industry is an inherently clean business that has environmental benefits for the estuary and its citizens.

The West Coast oyster industry was once faced with the death of its native species. Prducers had the choice of changing the way they did business or going out of business. They chose to change. When faced with other problems over the years, industry leaders have made progressive adaptations; they now have most of the grounds in the region in successful production.

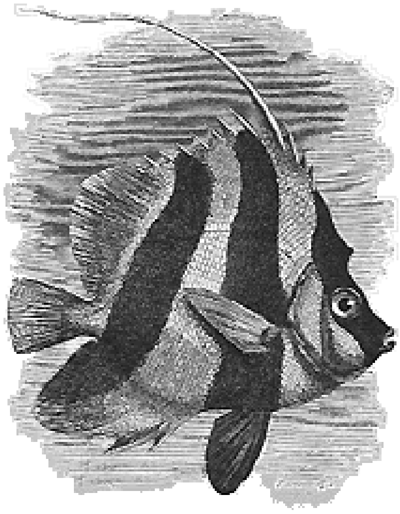
There are many small businesses in the West Coast shellfish industry. I have always been impressed with those that seem to be to be the types that Maryland watermen could develop. One that we always stop at while traveling the Washington coast integrates a few setting tanks and grow-out grounds with a small shucking house and retail store. It is the type of business that could be developed in the Bay region -- even in the face of diseases such as MSX and Dermo -- if laws and attitudes were changed to allow private production in areas where it would be successful. Doing so would allow us to bring the talents and practicality of Maryland watermen to ensure the continuation of the oyster industry without the constant need for government support that keeps alive old methods of production. It is these mthods which have actually helped to bring the industry to its current state.

top

Marine Ornamentals

Reginal M. Harrell
Finfish and Biotechnology Specialist

Marine ornamentals are not as innocuous as the name might imply. Fish and shellfish ornamentals -- used mainly in aquarium tanks -- are big business. Although it is difficult to obtain reliable dollar values, a 1992 estimate put the wholesale value of trade at greater than $400 million in the U.S. with a retail value at some $7 billion globally. While this is good news for the ornamental industry, it can also be



problematic for the ecosystems that provide these species.

The reason is that a majority of marine ornamentals are taken from the wild. Much of the collection pressure focuses on coral reefs in developing nations where harvesting practices are often destructive. Harvesting often involves the use of poisons (e.g., cyanide) or explosives, and such practices can result in high mortalities to the catch and by-catch alike -- they may also damage reef superstructures as well as other members of the reef community. The economic implications alone are of concern since many reef organisms are sources of important compounds such as biomedical materials and pharmaceuticals.

Maryland Sea Grant has been instrumental in coordinating support for an initiative in the conservation and culture of marine ornamental fishes and invertebrates. The objectives are two-fold -- to ease harvest pressure on natural stocks of reef organisms and to develop the economic potential of the marine ornamental industry. This initiative was the focus of a recent meeting at the World Aquaculture Society in Seattle, Washington, that brought together representatives from the National Sea Grant Office, the USDA Agricultural Research Service, Sea Grant Directors from across the county, the Cooperative Extension Service, the New England and National Aquariums, private institutions, the USDA Northeast Regional Aquaculture Center, and the National Coastal Resources Research Institute.

Attendees agreed that the potential of aquaculture expansion and the issue of habitat and species conservation were significant enough for a steering committee to develop a plan of action. The 14-person steering committee, represented by institution and governmental scientists, private industry representatives, and the two public aquariums identified four immediate goals:

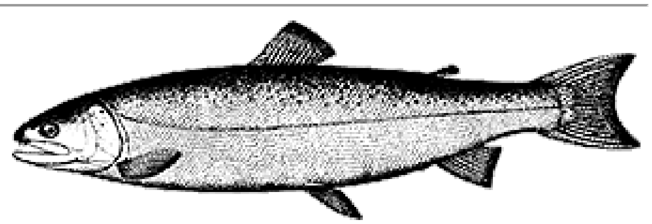
- Raise the awareness of the importance of the industry and the challenges and/or opportunities for the development of a renewable resource through culture and the husbandry activities.
- Assemble data and information on the environmental impacts of the industry as it is now practiced.
- Identify the areas where new information is needed and where education and development of Best Management Practices could enhance sustainability.
- Develop a network of those active in marine ornamental issues, current partnerships among industry users, scientists and conservation.

Since some of this work is already underway by different agencies or non-governmental organizations, the first step will be to work with these different groups to identify critical areas of need that are not being addressed.

The plan of action calls for (1) writing a brief outline for further developing a national Sea Grant initiative; (2) convening a steering committee meeting in the fall in conjunction with the Florida Aquaculture Association to interact with the Florida ornamental industry; and (3) develop formal "marine tropical ornamental interest groups such as the Marine Aquarium Fish Council and the Ornamental Fish International Groups, and the American Association of Zoos and Aquaria.

top

Trout and Aquaculture



Douglas W. Lipton
Marine Economic Specialist

In 1997, Maryland's Department of Natural Resources plans to release approximately 400,000 hatchery reared trout into the State's rivers and streams (Baltimore Sun, March 13, 1997). A recent report, Trout Fishing in the U.S. (U.S. Fish and Wildlife Service Report 91-5, December, 1996) documents the extent of trout fishing that occurs throughout the United States.

In Maryland, 22% of the freshwater anglers fish for trout, as compared to 30% for the nation as a whole. However, a larger percentage of the total freshwater fishing days are spent fishing for trout (24%) as compared to the United States average (19%). Thus, the smaller number of trout fishermen in Maryland spent a lot more days at their pursuit than in many other states. In fact, at an average of 12 days per year per trout fisherman, Maryland is just behind Pennsylvania (12.7 days per fisherman) as having the highest average trout angling days per fisherman in the United States.

In terms of demographics of trout anglers, they tend to be younger than the overall U.S. population distribution. Seventy-one percent of trout anglers fall in the age range of 16-44 years, while the U.S. population for that age range is only 58%. This is surprising given that older age groups tend to have more leisure time to pursue recreational activities. Trout anglers are predominately male (77%) and well-educated, with 9% more having some college compared to the population as a whole. Trout anglers are also more likely to be in the higher income brackets than the U.S. population in general, with 13% greater representation in the income brackets greater than $30,000.

The 400,000 fish released by the State translates into an average daily catch of only 0.4 fish per day. This catch though supplemented by wild trout populations indicates a continuing need for enhanced trout populations to satisfy the needs of an avid trout-angling state such as Maryland.

top

Water Quality Issues in Aquaculture: Alkalinity

Dan Terlizzi, Water Quality Specialist

This is the third installment of a series on water quality issues that aquaculturists need to be concerned with.

The first, on ammonia, appeared in the Summer 1996 issue; the second, on nitrite, appeared in the Winter 1997 issue.

Introduction

Alkalinity is the alkali concentration of water, its acid-neutralizing capacity. Chemically, alkalinity is measured as the sum of the negatively charged, or anionic, components in water and is most often expressed as parts per million (ppm) calcium carbonate.

Though expressed as ppm calcium carbonate, alkalinity is the sum of all anions, primarily carbonate, bicarbonate, hydroxide and, to a lesser extent, borate, phosphate and silicate. Alkalinity is sometimes confused with water hardness, which is a measure of the calcium and magnesium content of the water. Generally, waters of high alkalinity will have high hardness, which reflects the limestone (calcium or magnesium carbonate) origins.

In aquaculture systems, alkalinity functions as a buffer: this means that it prevents fluctuations in pH. Although fluctuations in pH may not be directly harmful, they can influence the toxicity of some aquatic chemicals such as ammonia, or the availability of others, like phosphorus, resulting in increased fertility and production. The primary alkalinity components of aquatic systems, carbonate and bicarbonate, stabilize pH near 8 which is beneficial for most aquatic plants and animals.

The importance of the buffering action of carbonates in a pond is shown graphically in Figure 1, which compares pH with time of day for low and high alkalinity bodies of water. In the low alkalinity pond, the pH shifts 5 or more units during the course of the day while the high alkalinity pond only changes by about 1 pH unit. These fluctuations in pH are a result of daily cycles of photosynthesis and respiration. Photosynthesis during the day increased pH, while respiration of both and animals during the night decreased the pH.

Alkalinity can range from less than 50 ppm in fresh water and ponds and streams to several hundred ppm in seawater. Freshwater springs and streams originating in limestone (calcium carbonate) formations also have high alkalinity and are well known for their high fertility and abundant plant and animal population. This high productivity emphasizes the importance of the principal function of alkalinity, namely, to regulate pH or act as a buffer. Adequate alkalinity of source water is a significant factor in siting aquaculture facilities.

Toxicity

Alkalinity can influence the toxicity of other aquatic chemicals through its buffering action. For example, increases in alkalinity may be recommended in ponds with high ammonia levels and dense algae growth (high photosynthetic potential) where pH is likely to rise about 8. Stabilizing pH at about 8 will decrease the formation of the toxic un-ionized form of ammonia (see article on "Ammonia" in Maryland Aquafarmer, Summer 1996).

Treatment

To increase alkalinity, you will need to add lime to your water. Methods are available for calculating the lime requirement and treatment rates for ponds that take into consideration these chemical characteristics of soil and water (see "Liming Aquaculture and Farm Ponds," R. Harrell and A. Bandel in the University of Maryland Sea Grant Pond Management Workbook Series). Alkalinity testing is convenient and provides good information concerning the need for lime. Agricultural limestone is the most common treatment for low alkalinity. The more you know about your soil time and lime requirements, the better you will be able to manage alkalinity.

Testing

Field measurements of alkalinity are easy to perform using an analytical procedure called titration. Alkalinity is determined by neutralizing all of the anions (negative charges) in a water sample to a specific pH with acid (positive charges). The pH where the titration stops determines which components of alkalinity have been neutralized. The "endpoints" can be determined using a pH meter; however, in field testing, it is more convenient to use an indicator or dye which changes color at a specific pH, which signals the end of the titration.

Total Alkalinity indicator, a mixture of bromcresol green and methyl red is routinely used in alkalinity titrations in aquaculture. Total alkalinity indicator measure virtually all of the alkalinity present, including hydroxyl, carbonate and bicarbonate. This is illustrated in Figure 2, which shows percentages of the different components of carbonate alkalinity as it varies with pH. The shaded portion of the graph indicates the small portion of alkalinity which is not determined by Total Alkalinity indicator as titrated from pH 11 to the endpoint, pH 4.6.

Calculating Lime Requirements

Although excessive liming of a pond is not likely to be a problem, calculating the lime requirement from alkalinity determination is a quick, accurate and economical approach. Application of 4.5 lb. of lime per acre foot of water will increase alkalinity 1 ppm. Assume you have a one-acre pond with an average depth of 6 feet and an alkalinity of 20 ppm. To stabilize pH you may want to raise the alkalinity to 50 ppm, an increase of 30 ppm. Therefore,

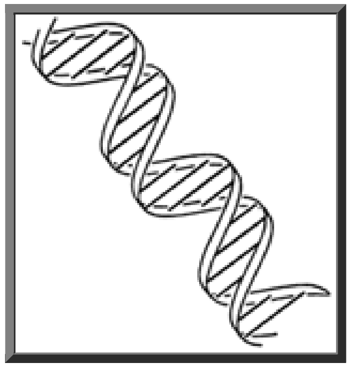
30 ppm x 4.5 lb lime x 6 acre-feet = 1,350 lbs. of lime.

In some cases lime treatments are prescribed at 1 ton per surface acre when alkalinity has been determined to be low through chemical testing or observation. For long-term alkalinity management, learn about your type of soil and the lime requirements to maintain a given alkalinity. Knowledge of soil types and lime requirements is advised.

top

Aquaculture and Biotechnology: Expanding the Connection

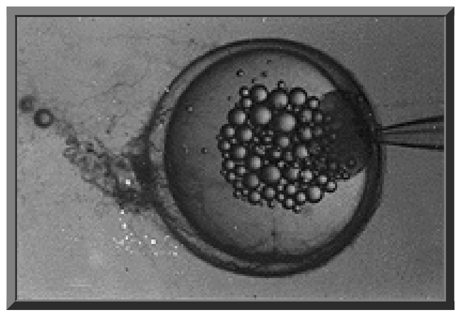
Reginal M. Harrell
Finfish and Biotechnology Specialist



Introduction

Aquaculture is the art and science of controlled rearing of aquatic organisms. Biotechnology is the industrial production of goods through the manipulation of biological organisms, systems, or processes. What is the relation between the two?

Aquaculture requires wide ranging knowledge in a number of disciplines. In civil and biological engineering, for example, for optimizing systems design and environmental conditions, such as those found in the biofiltration processes of recirculating systems. In chemistry as it relates to managing water quality since water quality influences biological production and economic potential when trying to balance maximum carrying capacity with the limits of the system. In physiology, whether for spawning fish and minimizing stress, or in trying to maximize growth from a metabolic perspective.



Aquaculture requires a knowledge of diseases, their identification, causes, etiology, prevention, and treatment. Of nutrition, which is essential for developing daily feeding requirements -- whether in a closed or open pond system, whether fish are fed on artificially developed diets or depend on natural production. Of animal husbandry principles, for daily care to ensure proper development. Of genetic principles, which are important when considering selective breeding programs, maximizing trait performance, undertaking hybridization efforts, or genetically manipulating stocks in areas such as sex reversals and production of triploids. Of business, namely economics, marketing, and financial management.

Biotechnology is already playing a role in many of these disciplines of aquaculture. Historically, hatchery operators depended on capturing sexually mature adults from the wild during their natural spawning season and artificially inducing spawning with the use of ovulatory hormones (i.e., chorionic gonadotropin or pituitary extracts), or by macerating gonadal tissue for release into waters holding other gravid adults, as is the practice with shellfish. However, as we confine animals to systems where they are not exposed to natural photothermal cycles or feed them less than nutritionally complete diets or submit them to chronic stress through handling and crowding, we interrupt the natural processes and cues that cause gonadal maturation and progression toward spawning -- advances in molecular biology are enabling us to develop techniques (i.e., hormonal treatment protocols) for overcoming interruptions in natural cycles that can result from artificial environments and diets. Through the use of maturational hormone strategies, we can now control the conditioned spawning of many economically valuable fish, for instance, Atlantic salmon, striped bass, flounder, sea bream and sea bass, and even ornamental fishes such as marine tropicals.

At a recent workshop sponsored by Maryland Sea Grant and held at the University of Maryland Center of Marine Biotechnology at the Christopher Columbus Center in Baltimore, scientists and private industry representatives discussed the relative merits and potential that biotechnology offers to the aquaculture industry. Here is a brief overview of some of the topics that were covered.

Biotechnology and Detection of Disease

New molecular probes are making it possible to detect pathogens more effectively than conventional laboratory tests, a capability that should eventually give aquaculturists the ability to better protect stocks against widespread outbreaks of disease. These capabilities are also improving our understanding of the mechanisms and pathways whereby diseases can infect a host organism. One concern, however, is that such new technologies can be too sensitive when they are used for determining whether cultured stocks are safe for food consumption. To take one example, scientists can detect antibodies developed against specific pathogens or even minute amounts of a pathogen's DNA. When disease is present at levels where the organism is infectious, such technology benefits both the industry and public health; however, detection of an antibody or DNA fragment of a pathogen in fish or shellfish does not necessarily mean either is clinically diseased. It could mean that sometime in the past that fish or shellfish had been exposed to the particular pathogen and either antibodies were developed as a response, or parts of the pathogen still exist because its DNA is detected. A potential problem in trying to use such data can center on not distinguishing exactly what the information means, from both a hatchery and natural resource perspective. Clinically and etiologically, the presence of antibodies for DNA may be significant, or they may not.

Biotechnology and Nutrition

Biotechnology will have increasingly important role with regard to nutrition, particularly as they relate to the cost of feed. For example, biotechnology companies are now able to produce highly unsaturated fatty acids from algae that can be used to supplement artificial diets, diets which now largely depend on fish oils collected from wild-capture fisheries. Because wild fisheries fluctuate considerably the price of those oils are not stable and fluctuate as well. As alternative natural sources of oils become more widespread, they will impact feed costs, a major factor in the rearing of fish and larval shellfish.

Biotechnology and Biofouling/Bioremediation

Biotechnology is now examining new ways to reduce biofouling of open water cages and net pens and that can aid in a host of bioremedial situations. Biofouling can be costly, both in its impact on water quality and in the intensive labor that is required to remove fouling organisms. With the development of biofilms now underway that can prevent or limit attachment of fouling organisms, there may soon be a commercial means to significantly reduce the costs for replacing and/or cleaning nets.

Microbes have been employed in recent years for detoxifying compounds such as PCBs. New advances in microbial bioremediation also hold promise as a possible means for using engineered microbes to mitigate effluent and nutrient problems that the industry faces with uneaten food and fish wastes.

The Future

Marine biotechnology is already enlarging our concept of new growth possibilities for aquaculture -- from producing pharmaceuticals and food additives to developing medicinal compounds. Many wild organisms (these include plants as well) from which compounds are taken have the potential of being reared under aquaculture conditions. In developing new products from cultured species, aquaculture can relieve harvesting pressure on wild resources and play a major role in conservation. Just as culturists have relied upon other forms of technology to improve production and profitability, biotechnology has the potential for further opening opportunities for the aquaculture industry.

top