UNC Sea Grant

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COASTWATCH

Photos by Laurel Horton

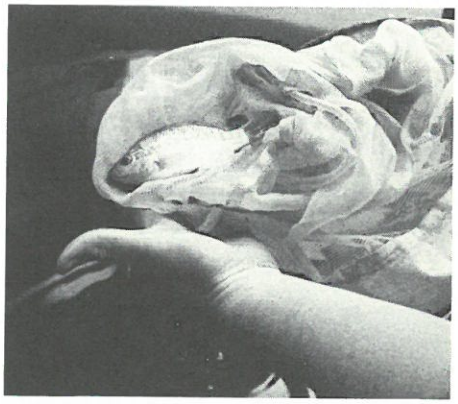
Joyce Moore and her daughters—Megan, 5, and Adrienne, 7—in their greenhouse. The fish tank and filtering system are in the background

Aquaculture

Webster's says the word means "the regulation and cultivation of water plants and animals for human use or consumption." In some foreign countries, aquaculture has for years supplied much of the edible protein. And in this country, the great potential of fish-farming is beginning to attract the energies of scientists and business people alike. From Hawaii's prawn ponds to North Carolina's trout farms, aquaculture is on the rise.

But while some are steering fish farms toward large-scale food production, others are finding ways to lead aquaculture out of the lab and into the backyard. The experts agree on their advice to beginners: start small. Even an aquarium or two can teach some fundamentals.

This month, Coastwatch *takes a look at small-scale aquaculture, and what it takes to try it.*



A young tilapia in the dip net

Farming fish in your own backyard—the basics

Backyard aquaculture can be as simple as stocking a farm pond with catfish, bream and bass for harvest with a hook and line. Or, with time and money to invest, fish can be raised in backyard pools or greenhouses, using the methods of intensive culture.

Backyard aquaculture is a fledgling enterprise in the United States. Private research companies like the Rodale Research Institute, the New Alchemy Institute and the Foundation for Self-Sufficiency are sponsoring small-scale aquaculture research and making inroads into reducing its costs. At UNC Sea Grant's Aquaculture Demonstration Project in Aurora, scientists are studying small-scale and commercial aquaculture, using eels, yellow perch, tilapia, rainbow trout and other species.

On a large-scale, commercial basis, two fishes, trout and catfish, are proving to be excellent culture species. Both are grown commercially in North Carolina. North Carolina's cold-water mountain streams make an excellent habitat for trout. Already 35 commercial, full-time trout farms are operating in this state, making it the second largest trout-farming state behind Idaho. There are 50 catch-out ponds where the public pays to fish for trout.

"I think North Carolina has the greatest potential for (trout) growth," says Charles Johnson, fishery training specialist for Haywood Technical College. "We have the benefit in that we have a better growing season because we have very little weather when the fish don't grow." Trout grow best in waters between 38°F and 70°F, the normal range of water temperatures in the North Carolina mountains, Johnson says.

Johnny Foster of the Aquaculture Demonstration Project says that it appears rainbow fingerlings can be raised in North Carolina's coastal waters during the winter. Foster has tested this idea by growing rainbow trout in cages in South Creek at the Aurora laboratory. The trout have prospered and have adapted well to brackish water, Foster says.

While trout farming is a growing enterprise in western North Carolina, a few commercial catfish farms are operating in the eastern part of the state. Catfish grow best in warm waters. In Mississippi, the catfish-farming capital of the world, almost 25,000 acres of ponds were in production in 1979. Throughout the United States, 76,680,000 pounds of cultured catfish valued at $53,572,000 were sold in 1980.

Photo by Neil Caudle

A tilapia raised at Sea Grant's Aquaculture Demonstration Project

At Lake Waccamaw, Robert Bey and Neil Allen are into catfish farming in a big way. Last year they sold over 8,000 pounds of farm-raised catfish, mainly to Raleigh restaurants. This year Bey says he's putting 40,000 fingerlings in eight raceways in hopes of harvesting 3000 pounds of catfish per raceway.

After studying fish and wildlife management at Wayne Community College in Goldsboro, Bey took off for the Delta—Mississippi, Alabama and Florida—to see how they raised catfish. He used some of the methods that he saw there and combined them with some ideas of his own to build Buck Trail Aqua Farm on the shores of Lake Waccamaw.

Besides catfish, Bey raises tilapia, which eat the excess vegetation growing in his raceways. He is also experimenting with large Asian prawn, and he has started a catfish hatchery that he hopes will keep his raceways stocked.

But Bey says that beginners planning any commercial aquaculture enterprise on a large scale should spend several years raising fish on a small scale. "There are a lot of things you need to learn before you start putting big money into it," he says.

One of the easiest ways to set up a small-scale aquaculture project is to use a farm pond or water source already on your property, says Ron Hodson, director of Sea Grant's Aquaculture Demonstration Project. "There are a substantial number of farm ponds that go unused every year that could be used to raise fish for food or recreation," he says.

"There are a lot of things you need to know before you start putting big money into it"

—Robert Bey

A well-built and properly managed recreational pond can yield from 100 pounds to 300 pounds of fish for each acre of water surface. In piedmont and eastern North Carolina where waters are warm you can stock ponds with largemouth bass, bream and catfish. Ponds 5,000 feet above sea level in western North Carolina are usually cold enough to grow trout.

A pond should be stocked with the right kinds and numbers of fish for the

size of pond you have and the level of management you plan to follow. A pond that receives run-off containing herbicides or pesticides should not be used to raise fish, Foster says. Soil Conservation Services (SCS) agents in your county can help you decide how many and what kind of fish to stock in your pond.

Under a low-management system you can stock your pond with fish, fertilize the pond to encourage aquatic plant growth (which attracts worms, insect larvae and other aquatic animals for the fish to eat) and harvest by hook and line or by seine. If you want to follow a more structured management system, perhaps for a small commercial harvest, you will probably want to feed the fish a commercial fish feed.

Or perhaps you want to try cage culture. Steve Van Gorder of the Rodale Research Center says cage culture is one of the easiest methods of growing fish. At their Pennsylvania research location Van Gorder says tilapia, a hardy African food fish, and catfish have been raised in pond cages. Researchers stocked a 3x3x4-ft. cage with 250 to 500 catfish. Van Gorder says at least 250 catfish must be put in each cage to prevent territorial fighting. The team fed the fish a floating feed, which doesn't escape the cage, and they periodically cleaned the cage of algae and debris accumulations to allow a good flow of water. When the fish were ready to harvest the cage was simply pulled from the pond. Van Gorder says a pond will support the same number of catfish caged as it will without cages.

"We believe more people would eat fish if they grew their own, and it would be a better-quality fish"
—Steve Van Gorder

For people with no pond, there is another alternative—pool or greenhouse culture. Van Gorder says 100 pounds of fish or more can easily be raised in one season in a backyard pool. A backyard or greenhouse pool is a closed system, which means there is no natural exchange of water from a creek or river. Under a closed system the same water is constantly being recirculated and cleaned.

Van Gorder says that using the Rodale method for backyard aquaculture, a person can set up a pool-culture system for between $500 and $550, not including labor, and that the system will pay for itself within five years. The costs run like this: a 12-ft. pool, three feet deep with a vinyl liner—$150; a clarifier (built from two 55-gallon drums and fabric mesh)—$50; a biological filter—$130; aerator (only needed if raising over 100 pounds of fish)—$60; a hose and connector—$10; two pumps—$60. Besides the set-up costs, feed runs $45 a year, electricity $25 a year and fingerlings $30 a

Continued on next page

Photo by Pat Seip, Rodale Press

Experimental fish tanks set futuristic mood at Rodale's Pennsylvania research site

year per 100. To extend the growing season for warm-water species, a plastic dome can be built for $40.

How does the system work? The fingerlings are placed in the pool and fed a commercial feed. The biological filter and clarifier are used to remove the large amounts of wastes fish produce under the intensive feeding schedule. The clarifier removes the solid wastes, while the biological filter changes the ammonia in the water, which is toxic to fish, to nitrite then nitrate. The nitrate is food for the algae in the pool.

Van Gorder suggests stocking a backyard pool with tilapia. Tilapia are hardy fish, tolerant of a wide range of water conditions. They grow quickly in warm water. And, they taste good. "They're almost boneless," says Van Gorder. "They have a mild flavor, not fishy. The meat is very white, not mushy. To me it tastes better than trout."

Water quality can make a big difference in the fish you produce. "You should test the water that you have to make sure there's nothing in it toxic to fish, or to people who eat fish," says Van Gorder. The North Carolina Department of Agriculture's Agronomic Division will test water for its nutrient levels. Send a small plastic container half filled with water to the Agronomic Division, Plant Analysis Center, Blue Ridge Road, Raleigh, N.C. 27611.

Temperature is one very important aspect of water quality. Tilapia, for instance, grow faster when water temperatures are above 70°F. All species have an optimum water temperature at which they grow best and have the greatest resistance to disease or parasitism. "There is a range of tolerance above and below this temperature within which the fish will survive, but with increasingly reduced growth the farther the temperature is from the optimum," writes Van Gorder. "For a fish-culture situation to be economically feasible, the feed conversion and growing season must be maximized to reduce feed costs and obtain a harvestable-sized crop as quickly as possible."

One way to lengthen the growing season in the fall and raise water temperatures earlier in the spring is to insulate the pool with plastic. Using an inexpensive ¾-inch PVC frame draped with six millimeter plastic to cover the pool, the backyard aquaculturist can collect solar energy and store it more easily. Plastic-draped pools also keep water temperatures more constant.

Photo by Neil Caudle

Sea Grant's Johnny Foster with pool and biological filter

Another method for extending the growing season is to raise fish in a greenhouse. Under this efficient method, the fish pool acts as a heat sink, keeping waters warm for the fish and storing solar energy for slow release into the greenhouse at night or on cloudy days. The nutrient-rich pond water can also be used to fertilize plants growing in the greenhouse.

To test other aspects of water quality, many aquaculturists use a water-quality test kit. Test for levels of dissolved oxygen, nitrate, ammonia and pH. The tests should be made daily. Running the test and feeding the fish take about 20 minutes daily, Van Gorder says.

Backyard aquaculture, like gardening, is a means of self-reliant food production, Van Gorder says. "We (Rodale Research Center) don't ad-

vocate backyard aquaculture as a money-making venture. We don't sell equipment, only ideas. We'll tell you how to build and maintain an aquaculture system as inexpensively as we know how, using readily available materials. And we're always looking for ways to make backyard, small-scale aquaculture easier and less expensive. We believe fish is a good source of protein that people don't eat enough of. We believe more people would eat fish if they grew their own, and it would be a better-quality, fresher fish."

While Van Gorder maintains you can raise fish for less than what it costs in the grocery store, other scientists are not so optimistic about the balance of costs and benefits in backyard aquaculture. They stress that small-scale projects should be approached strictly as a hobby, and they warn of get-rich-quick schemes that make aquaculture seem too simple or more lucrative than it is.

To beginners, their advice is often, "Start small, and don't expect to get a lot without some effort."

—Kathy Hart

For more information

If you'd like to know more about small-scale aquaculture, the following list of organizations and publications could help you get started.

Organizations

Rodale Research Center (Publications available)
RFD 1
Kutztown, PA 19530

The New Alchemy Institute (Publications available)
P. O. Box 432
Woods Hole, MA 02543

The Ark Project
Institute of Man and Resources
Souris, Prince Edward Island
Canada, COA 2BO

Cate Farm (Publications available)
Goddard College
Plainfield, VT 05667

Foundation for Self-Sufficiency Inc. (Publications available)
35 Maple Avenue
Catonsville, MD 21228

NCSU Aquaculture Demonstration Project
Rt. 2, Box 305
Aurora, NC 27806

Old Dominion University
Dept. of Oceanography
Norfolk, VA 23508

Soil Conservation Service (Publications available)
One in each county

Publications

Backyard Fish Farming and Small Scale Aquaculture, Keeton Fisheries Consultants, Inc., 2809 Dean Drive, Ft. Collins, CO 80521

Fish Farming in Your Solar Greenhouse, William Head and Jon Splane. Amity Foundation, P.O. Box 7066, Eugene, OR 97401.

Fish Farming Handbook: Food, Bait, Tropicals and Goldfish, E. Evan Brown and John B. Gratzek. AVI Publishing Company, Inc., Westport, CT.

Principles of Warmwater Aquaculture, Robert R. Stickney. John Wiley and Sons, Inc., New York, 1979. ($22.50)

Raising Fresh Fish in Your Home Waters, Brenda Bortz, Jack Ruttle, Marc Podems and *Getting Food From Water: A Guide to Backyard Aquaculture*, Gene Logsdon. Rodale Press, Emmaus, PA 18049.

Small-Scale Fish Culture Systems, Steven Van Gorder. Rodale Research Report 80-12. Rodale Research Center, RFD 1, Kutztown, PA 19530.

Small-Scale Culture of Fish in Cages, Douglas Strange and Steven Van Gorder. Rodale Research Report 80-17. All available from: Rodale Research Center, RFD 1, Kutztown, PA 19530.

Techniques for Small-Scale Spawning and Rearing of Channel Catfish, Douglas J. Strange. Rodale Research Report 80-16. Rodale Research Center, RFD 1, Kutztown, PA 19530.

Newsletters

Network, Steven Van Gorder and Douglas Strange (editors), Rodale Research Inc., 33 East Minor Street, Emmaus, PA 18049. $15 per year.

Magazines

"Aquaculture Magazine" (Includes annual buyers guide listing goods, supplies, and services). Published bimonthly, $14 per year. Subscription Dept., P.O. Box 2451, Little Rock, AR 72203.

"Aquaculture Digest." Published monthly, $24.00 per year. 9434 Kearny Mesa Road, San Diego, CA 92126.

"Progressive Fish Culturist." Published Quarterly, $7.50 per year. Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

"Farm Pond Harvest." Published quarterly, $4.00 per year. P.O. Box AA, Momence, IL 60954.

"Fish Farming International." Published quarterly, $25.00 per year. Arthur J. Heighway Publications, Ltd., Heighway House, 87 Blackfriars Road, London, SE1 8HB.

Family's aquaculture experiment passes taste test

Not everything that grows in the Moores' greenhouse is green. Just past the salad greens and vegetable seedlings is a 550-gallon tank. And inside swims a crop with gills, fins and an appetite for algae.

There's a bit of the pioneer in Joyce and Allen Moore. Aquaculture, for them, has been part experiment and part adventure. They've had a few setbacks—cold water, periods when the fish wouldn't grow, a clog-prone clarifier—but lately things are looking up. And this spring, their experiment passed its stiffest test when the Moores sat down to their first plates of homegrown tilapia.

"They were pan-size, with good texture and few bones," Joyce says. "The meat itself was very good. They tasted faintly of algae around the gut cavity, but we should be able to eliminate that problem by reducing the algae population and by holding the fish in fresh water for a day or so before we clean them."

The Moores' 8- by 20-ft. greenhouse, finished in 1980, adjoins the south side of the house they built themselves high in the mountains of Jackson County, N. C. Allen, who teaches biology at Western Carolina University in Cullowhee, supplies some scientific knowhow to their homesteading. Joyce, a weaver, is home enough to keep an eye on things and to make sure their garden, greenhouse, orchard and livestock stay productive. The Moores feel that food is best and safest when it is fresh and homegrown. And that's one reason they've turned to aquaculture.

"We're definitely interested in food production," Joyce says. "And aquaculture is an efficient way of producing good protein."

Allen says that fish-farming and greenhouses are natural companions. Efficient solar greenhouses, he explains, use some kind of massive material to absorb excess solar energy. This heat sink can radiate warmth into the greenhouse as things cool off at night. And water is one of the best materials for storing heat.

"We needed five hundred gallons of heat storage in our solar greenhouse," Allen says, "so we thought, why not raise some fish in that water?"

Simpler said than done. First came reading and questioning that led them through piles of books and numerous interviews. A workshop at Haywood Technical Institute last year put them in touch with aquaculturists around the country.

They learned a lot about the biological problems they faced, but found information sketchy on the newfangled idea of raising fish in home greenhouses. Much of their system's design is original and its components are mostly homemade, though they did get some professional help shaping the fiberglass fish tank.

"There's really nothing in the books that duplicates our system," Joyce says.

Photo by Laurel Horton

The Moores' greenhouse looks south over mountains

She designed the biological filter for the system herself, using a length of perforated drain pipe, partly filled with gravel, to aerate and detoxify the water. In the Moores' design, water drawn from the bottom of the fish tank is pumped into a clarifier, a plastic tank packed with a filtering medium to catch sludge. Cleared of most solids, the water is piped over the biological filter, where bacteria in the gravel do the rest.

"As far as we can tell, the water quality is good," Joyce says. "The best news was the lack of crud on the bottom of the tank when we drained it recently (to patch a leak). I think we can easily increase the quantity of fish without over-extending the system's carrying capacity."

The Moores stocked 50 tilapia fingerlings last spring. The largest have been eaten, and Joyce says they are thinking of adding catfish to cohabit with the tilapia. They hope the catfish will grow better during cool weather. The tilapia, which grow fastest when water temperatures are around 80° F, stopped growing altogether when temperatures in the tank dropped to 42° F last winter. The fish tank didn't hold quite as much heat as the Moores had hoped it would.

"We actually did have to heat the water some this winter, when the temperature outside at night went down to minus six or minus seven," Joyce says.

The problem could be solved by installing a heater, but the Moores are trying to keep things simple, low-cost and energy-efficient.

"You could easily have a net loss of energy if you used a heater all winter," Joyce says. She's hoping they can adjust things in the greenhouse and make better use of free sunshine.

Other problems with the system will have simpler solutions, the Moores believe. The Moores have concluded that the polyester fabric they had used in the clarifier was too closely woven. Acting on the advice of Johnny Foster, one of Sea Grant's aquaculture experts, they have recently installed bird netting in the clarifier. Now they're planning ways to reduce algae which have grown faster than the tilapia can eat them. (The tilapia have also been fed a commercial trout feed.)

Setbacks aside, the Moores say they're enjoying their experiment with aquaculture. "It's something like managing a little ecosystem," Allen says, "You can see how all these things fit together."

Their two daughters have had the benefit of a living lesson in biology, right at home. "It's just such a fun environment to watch," Joyce says. "Children love watching things grow."

The Moores recommend acquaculture as a hobby. And, while a background in science is useful, they say novices who study and design their systems carefully can be successful.

"We could have been a little more scientific about things," Joyce says. "Most of the time we've spent has been on developing the system, and we've spent virtually no time on it otherwise."

"Their advice to beginners is simple: "Learn as much as you can before you get started," Joyce says, and Allen agrees. "You should put it all down on paper first," he adds. "Plan everything."

—*Neil Caudle*

Photo by Laurel Horton

Joyce Moore checking tilapia

Clam gardening: an old idea with new potential

Like most types of aquaculture, clam farming began in the Orient. The Japanese have been raising clams for hundreds of years. Today, however, the relative importance and sophistication of clam aquaculture in the United States surpasses most other countries.

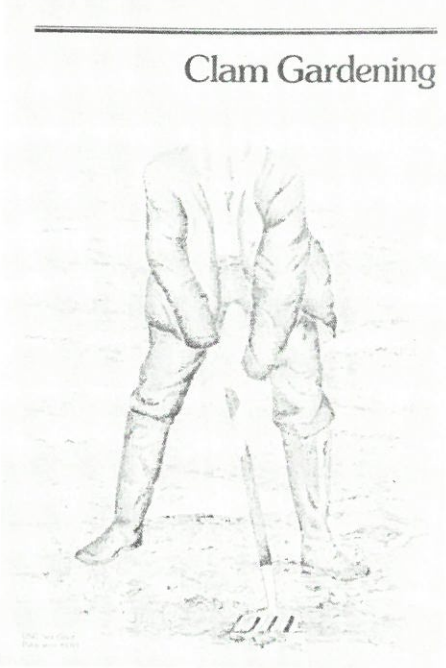
Most of this culture has been practiced in New England and Long Island, where it usually takes three to seven years to grow a marketable clam. But warmer waters and a longer growing season in North Carolina enable seed clams to reach market size in as little as two years. For this reason, commercial clam aquaculture has attracted interest in the southeastern states.

The hard clam (*Mercenaria mercenaria*), sometimes called the "quahog" lives along the East Coast of the United States. Increasing prices and decreasing harvest from natural clam beds have stimulated an interest in clam aquaculture in the coastal states, including North Carolina. Several relatively small-scale projects have been started to investigate the feasibility of clam farming in our waters.

UNC Sea Grant has helped people interested in clam gardening since 1973. In addition to providing information and conducting trial seedplantings along the coast, methods for excluding predators have also been developed.

To meet the demand for information specifically on North Carolina clam aquaculture, Sea Grant has published *Clam Gardening*. Written by Johnny Foster of the NCSU Aquaculture Demonstration Project, this publication offers specific information on obtaining and raising seed clams, leases and permits, location requirements and management of the garden. The appendix lists additional references and material suppliers.

If you are interested in clam aquaculture and would like a copy of this free publication, write Sea Grant, Box 5001, Raleigh, N.C. 27650-5001. Ask for publication UNC-SG-81-03.



Sea Grant's Clam Gardening

Put a bit of the coast in your home aquarium

You don't have to leave the coast behind after your vacation is over. You can keep living, breathing and multiplying sea creatures right in your home in a brackish or marine aquarium. And, you can learn something about aquaculture at the same time.

Brackish-water aquarium

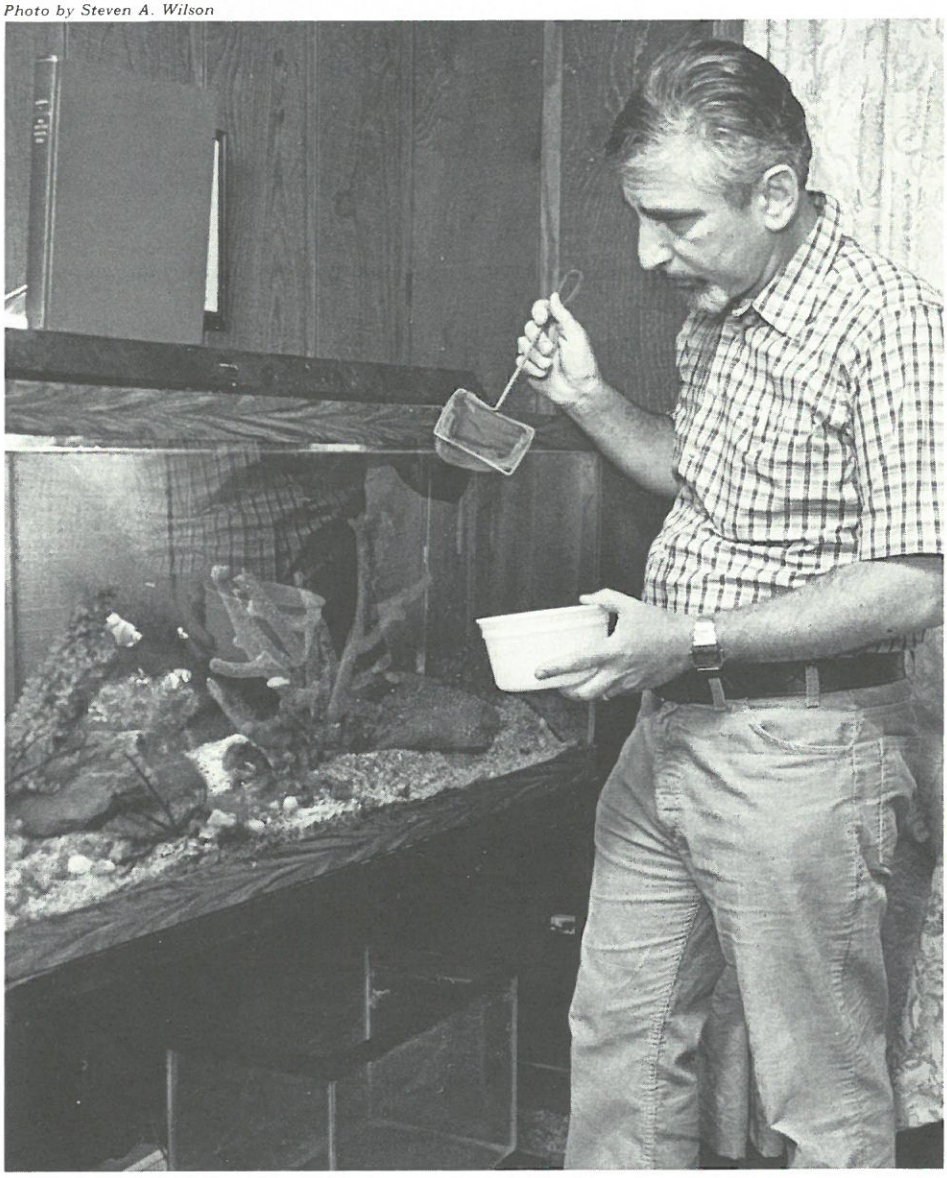
A brackish-water aquarium set-up imitates the ecology typically found in North Carolina's sounds and estuaries. The river-diluted sea water in this area has a low salinity, and is suitable for a variety of fishes and invertebrates, both freshwater and marine. To duplicate this environment, you will need the following equipment:

- Aquarium tank—all-glass tanks of at least 20 gallons are preferred. Larger tanks provide more space for inhabitants and more stability for the system. A cover for the tank is optional but handy, because it prevents animals from jumping out of the aquarium. Pick a sturdy stand or table for the tank (a 20-gallon aquarium will weigh approximately 170 lbs. when filled) away from direct light, and protect the aquarium from extreme heat or cold. Some light is necessary to promote the growth of algae, but too much will cause excessive growth.
- Filter—an outside power filter attached to the side of the tank is sufficient. Filtration and circulation remove particulates from the water and help maintain adequate dissolved oxygen levels.
- Bottom material—a thin layer of sand and gravel mixed with crushed shell, no more than one-half inch deep. A small amount of garden soil (one cup to two square feet of bottom surface) is good for certain fishes and invertebrates.
- Decorations—non-metallic rocks, bricks and sections of PVC pipe used sparingly are good for territory markers, hiding places and spawning surfaces. Clean seashells are also attractive, but use very few because they can collect decaying materials which affect the pH of the water.
- Water—can be collected from sounds and tidal creeks or mixed up from diluted sea-salt mix. Brackish water has about one-half to one-fourth the amount of salt ocean water has, so multiply by two or four the amount of fresh water needed for every pound of sea salt mix (salinity levels are not very critical in the brackish system.) If using chlorinated tap water, let it age, or set it out in buckets, for a week to get rid of chlorine and other chemicals.

When you are ready to stock your brackish-water aquarium, the rule of thumb is one inch of inhabitants per gallon of water. Sea creatures can either be collected on a field trip to the coast or purchased from tropical fish shops, bait shops or scientific supply houses. Species that do well in this type of aquarium are marsh mummichogs, sheepshead minnows, striped killifish, sailfin mollies, mosquitofish, mullet, eels, freshwater flounder (or hogchoker), grass shrimp, hermit crabs, starfish and sea cucumbers. If collecting species from estuarine areas, be conservation-minded—don't take more than you can use.

Most inhabitants in the brackish-water aquarium should be fed once or twice a day. There are three food categories: live foods, such as brine shrimp or small nematodes; dried foods, which are prepared and sold commercially, and fresh foods, such as chopped earthworms. Avoid leaving excess food in the aquarium, as it will

Photo by Steven A. Wilson



Bob Goldstein working at one of his aquaria

decay and deplete the oxygen.

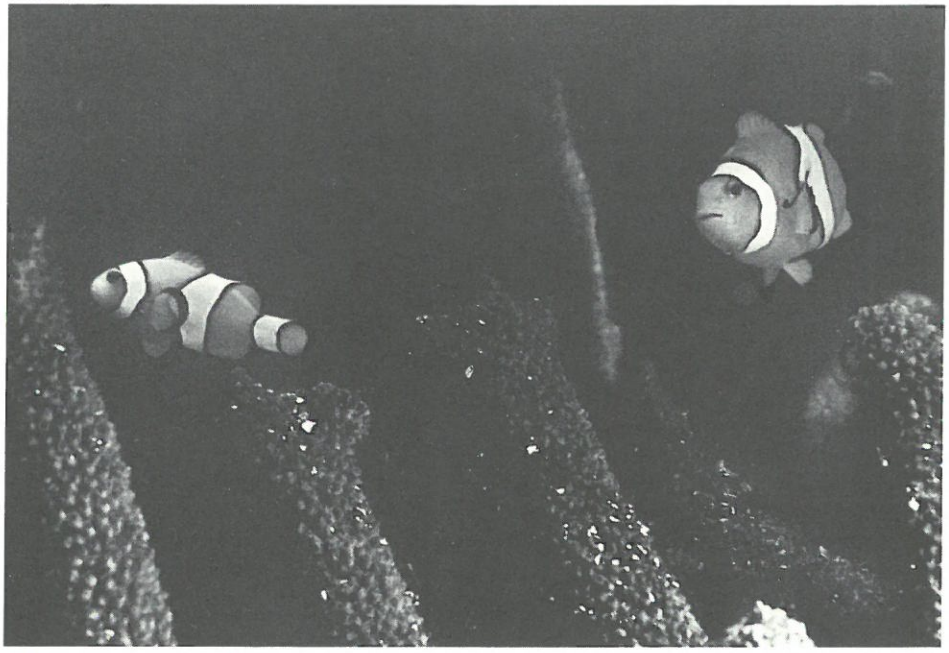
Maintenance is minimal for the brackish aquarium. Once the tank has been completely filled with water, creatures and decorations, mark the water level. Any water lost to evaporation can be replaced with aged tap water. At least once a month, replace a quarter of the water with more brackish water, either collected or mixed up. This addition of water improves the water quality by dilution in addition to stabilizing the pH and replacing any trace elements used up by the inhabitants.

Marine aquarium

Most of the inhabitants of a marine system are sensitive to changes in salinity and water quality, so these variables must be monitored. The following equipment is necessary to set up a marine aquarium:

- Aquarium—choose at least a 20-gallon or 50-gallon, all-glass tank with no metal parts at all. A cover, with or without a light, will reduce the amount of water lost to evaporation and prevent salt water from splashing onto furniture, floors and electrical cords or outlets. Position the tank on a very sturdy stand or table away from direct drafts and sunlight. The chosen spot should also be a permanent one because the tank won't be portable once filled; sea water weighs approximately eight and a half pounds per gallon.
- Filter—an under-gravel filter inside and/or a pump-circulating filter attached to the outside of the tank are necessary. The under-gravel filter is important because it removes organic waste material, and the pump circulates water. The more circulation you have the better.
- Bottom material—use enough calcareous gravel for a layer two to three inches thick on the bottom. Crushed oyster shell, which is available at most feed stores, is excellent. Gravel must not be small enough to fall through openings in the filter. Rinse well before using to remove dust and debris.
- Decorations—clean seashells, corals, non-porous rocks and artificial plants are suitable for the marine aquarium, if used sparingly. If using seashells, check often for decaying material that may get trapped in openings. Do not use any metal objects or objects with any metal on them because metal in salt water is usually toxic to the inhabitants.
- Water—you can use natural sea water or artificial sea salt mix. You need sea water as pure as possible, so collect it when the tide is coming in to lessen your chances of getting contaminants. Filter all natural water through a funnel with dacron floss. Then store in containers with covers, undisturbed, for at least two weeks. This process will kill most microorganisms and algae. Aerate the water before you use it. If using an artificial sea-salt mix, mix according to package directions with aged tap water.
- Hydrometer—an inexpensive instrument that can be used to measure salinity, it is available at most tropical fish shops and biological supply houses. Salinity levels must remain fairly constant in the marine aquarium. A level of 30-35 parts per thousand is recommended.

Photo by Steven A. Wilson



Clown anemonefish do well in saltwater tanks

Before stocking the marine aquarium, you need to culture the filter to bring bacteria into the system. These bacteria will use the waste given off by the inhabitants. If not removed, this waste could be poisonous. The easiest culture method is to obtain a cup of gravel from a healthy marine aquarium and spread this gravel over the gravel in your aquarium.

The tank is now ready for several hardy species, such as small blue crabs, hermit crabs or sea bass, which will provide waste material for the filter. In about three weeks, you can add other species that have either been collected or purchased. Several species suitable for a brackish-water aquarium, such as mummichogs, killifish, eels and starfish, are also excellent choices for the marine tank. Rock bass, toadfish and small flounders are easy marine species to collect, and bivalves live reasonably well for a short time. Consider purchasing some of the exotic marine tropical species, such as the angelfish, butterfly fish and anemonefish, which exhibit brilliant colors. Avoid seaweeds, algae and some sponges as they don't survive and easily foul the tank.

"You have to maintain the system very carefully and check it frequently"

—Bob Goldstein

Marine aquarium creatures should be fed twice a day, with all uneaten food removed to prevent decay. Live foods, such as brine shrimp or whole earthworms, and prepared dried foods are excellent. If you get ambitious and want to "grow" you own foods, check the references for information on rais-

Continued on next page

ing brine shrimp.

Regular maintenance is essential with a marine aquarium. After the tank is completely filled, mark the water level to check evaporation. Salts do not evaporate with the water, so remember to replace any water lost to evaporation with aged fresh water. The salinity level should be checked with the hydrometer every week if the aquarium is full of fish and less frequently if it is less crowded. Once a month, change one-quarter of the water and replace with aged natural sea water or freshly mixed artificial sea water (made with aged fresh water) of the same salinity and temperature as the tank water. Clean filters regularly, according to the package directions.

It is important to maintain your marine aquarium. Bob Goldstein, an aquarist and environmental consultant, says "A marine system is a closed system with no natural changing of water. The water is deteriorating steadily due to evaporation and the addition of wastes, so you have to maintain the system very carefully and check it frequently."

This information should get you started in setting up a brackish-water or marine aquarium system. If you would like to try breeding or growing your own food, check the references listed below.

For additional reading

Aquarium Systems, edited by A. H. Hawkins. 1981. Academic Press, New York, NY.

Caroline Marine Aquaria, Carolina Biological Supply Company, Burlington, NC 27215. (Booklet can be ordered for $1.00. Also, request free pamphlets on marine aquaria.)

Exotic Aquarium Fishes, William T. Innes, L.H.D. 1979. Metaframe Corporation, Elmwood Park, NJ.

Fish Farming Handbook: Food, Bait, Tropicals and Goldfish, E. Evan Brown and John B. Gratzek. 1980. AVI Publishing Co., Inc., Westport, CO.

How to Set Up a Saltwater Aquarium, Project CAPE, Box 640, Manteo, NC 27954. (Booklet can be ordered for $1.00.)

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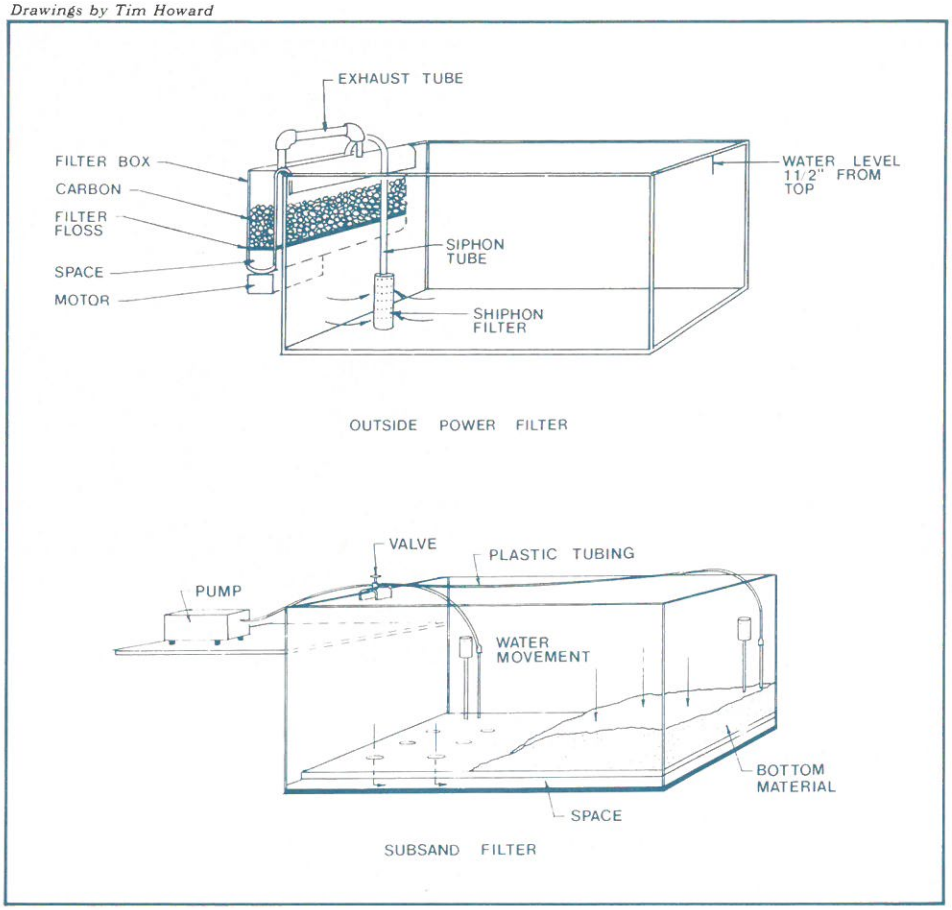
Drawings by Tim Howard



The outside power filter (above) and the subsand filter (below) remove particles and help maintain water quality

Coastwatch is a free newsletter. If you'd like to be added to the mailing list, fill out this form and send it to Sea Grant, Box 5001, Raleigh, N.C. 27650.

Name _____

Address _____

City•State•Zip Code _____

To help us specialize our services, please answer these questions.

I am in the following line of work:

__Boatbuilding/Repair	__Marine operator
__City/County government	__Marine recreation
__Commercial fishing	__Mass media
__Educator	__Seafood processing/marketing
__Farming	__State government
__Homemaker	__University professor/researcher
__Lawyer	__Other _____

Coastal property owner __yes __no Boat owner __yes __no

THE BACK PAGE

"The Back Page" is an update on Sea Grant activities—on research, marine education and advisory services. It's also a good place to find out about meetings and workshops, and new publications. For more information on any of the projects described, contact the Sea Grant office in Raleigh (919/737-2454).

Part of the Roanoke River basin, the Camassia Slopes in Northampton County, harbors more than two dozen species of wildflowers designated as endangered, uncommon or rare in North Carolina. The most noteworthy wildflower, *Camassia scilloides*, or wild hyacinth, for which the area is named, is an endangered "disjunct" because it is usually found only west of the Appalachian Mountains.

At home in Midwestern river valleys and prairies, the Camassia grows thickly in the Roanoke River basin, one of only two known occurrences in North Carolina. Biologists believe the flower's presence there can be attributed to the area's unusual soil. The soil, which is highly basic, is much like the soil found in Midwestern river basins and very unlike the acidic soils found elsewhere in the Roanoke River basin. Because of the different soil, the slopes harbor such other endangered, uncommon and rare plant species as the James' sedge, the eastern wahoo, the sessile trillium, the wild blue phlox, the purple larkspur and the three-bird orchid.

The Camassia Slopes have been donated by the Union Camp Corporation, a forest-products company, to The Nature Conservancy, a non-profit conservation organization, for preservation. The preservation of the slopes is part of a joint, long-range effort by the state and The Nature Conservancy, through its state chapter, to protect the Roanoke River basin, a refuge for many rare species.

Jim Murray, director of Sea Grant's Marine Advisory Services, has announced an opening for a marine advisory agent. Working from a Manteo location, the agent will be responsible for developing an extension education program for 10 counties in northeastern North Carolina. Candidates must have a knowledge of commercial fishing gear and gear technology. A bachelor's degree in marine or fisheries science and/or experience in commercial fisheries is preferred.

Applicants should contact Dr. William H. Queen, director, Institute for Coastal and Marine Resources, East Carolina University, Greenville, N. C. 27834, or call (919) 757-6779. Applications must be received by June 11. East Carolina University is an Affirmative Action/Equal Opportunity Employer.

A man pops the top of his favorite beverage as he leans back in his boat waiting for a fish to tickle his line. He tosses the pop-top overboard.

A small fish, attracted to the light-reflective top as it drifts downward, attempts to swim through the top. The ring won't slide over the fish's fins. The fish is now encircled with a pop-top that may mean its death.

Littering coastal water can be more than just unattractive; it can kill and maim wildlife. Three kinds of litter are particularly dangerous to wildlife: plastic six-pack rings, pop-tops from aluminum cans and monofilament fishing line.

Plastic rings and monofilament line can easily become wrapped around the heads, necks and feet of waterfowl and aquatic birds, disturbing their flight, swimming and feeding abilities, often with fatal results.

Fish that become entangled in litter may also die because the litter interferes with feeding, restricts swimming, damages skin and scales, or inhibits growth.

What can you do to prevent these problems? Don't throw your trash into the water. Keep a litter container with a lid on board and use it. When at the beach, pier or marina, use trash containers provided there, or take your trash with you and discard it at home. If you see litter floating on the water, help the birds and fish. Pick it up.

About 100 Florida builders, architects, engineers and officials recently got some advice from North Carolina on how to build safer coastal buildings. The occasion was a workshop held March 25-26 in Pensacola Beach. The workshop was sponsored by the Federal Emergency Management Agency.

Spencer Rogers, Sea Grant's coastal engineer, spoke to the group about natural hazzards during hurricanes and floods. He discussed the effects of the storm surge, winds, waves and erosion, and offered some guidelines on how to select coastal building sites.

Closer to home, the topic was erosion when Rogers spoke to a group of 30 property-owners at a public hearing conducted April 10 by the Topsail Beach town council. Rogers explained how and why beachfront and estuarine erosion occur, and discussed the advantages and disadvantages of several erosion-control techniques.

Shipwrecks off North Carolina's coast, like artificial reefs, attract and shelter underwater life. They also attract divers. But few regions can offer such a wealth of shipwrecks, and divers from across the country have been trying to get reefs built in waters near them.

Jim Murray, director of UNC Sea Grant's Marine Advisory Services, spoke to many of those divers recently,

Continued on next page

when he addressed the 12th Our World Underwater conference, held May 1-2 in Chicago. Murray, a diver himself, told the crowd of 400 about advances in artificial-reef technology, and suggested ways diving clubs could get new reefs started. He was part of a panel of experts that included representatives from Sea Grant programs in several states.

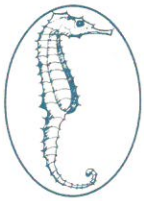
Groups interested in Murray's presentation, which includes a program of slides, should contact him at Sea Grant, 105 1911 Building, NCSU, Raleigh, N. C. 27650, or call (919) 737-2454.

Where can you find information on field trips, films, government resources and aquaria, all under one cover? In the new Sea Grant publication, *Connections: Guide to Marine Resources, Living Marine Systems and Coastal Field Trips.*

Connections is the new, revised appendix to the North Carolina Marine Education Manuals, which are published by Sea Grant to help educators put marine education into their lessons. Written by Lundie Spence, Sea Grant's marine education specialist, and Jaynee Medlicott of the 4-H Marine Awareness Program, the 94-page illustrated guide has sections on field trips, resources and references and aquarium systems for the classroom or school.

Single copies of *Connections* are available to North Carolina educators free of charge. For out-of-state requests, there is a charge of $2.00. Write UNC Sea Grant, P. O. Box 5001, Raleigh, N. C. 27650-5001. When ordering *Connections*, please request publication number UNC-SG-82-1-F.

Seafood was on both the menu and the agenda when the Southeastern District Extension Homemakers met April 1 in Carteret County. Over 800 extension homemakers from a 17-county area heard Frank Thomas, NCSU extension seafood specialist, discuss how to buy and preserve fresh seafood. Joyce Taylor, Sea Grant's seafood technician at the NCSU Seafood Laboratory, showed several new ways to prepare seafood and had samples of bouillabaisse, clam bake, deviled crab with flaked fish, and fish flakes and macaroni salad on hand for tasting and testing.



Surf fishing, trawling and tasting unusual seafoods are just a few of the activities planned for a workshop for teenagers this summer. Sponsored by the 4-H Marine Awareness Program, the workshop will concentrate on marine resources and will include field trips and programs with the Division of Marine Fisheries, NCSU Seafood Lab and N. C. Marine Resources Center at Bogue Banks.

The summer workshop will be held August 8-13 at Mitchell 4-H Camp in Swansboro. Registration is open to high school juniors and seniors and to graduating seniors who have not entered college. The fee for the week-long workshop is $125, with a $50 deposit due upon registration. The deadline for registration is July 1.

For more information on the workshop and registration, contact Jaynee Medlicott, State 4-H Office, 202 Ricks Hall, North Carolina State University, Raleigh, N.C. 27650 (919) 737-3243. Or call the 4-H agent at your local county extension office.

B. J. Copeland, UNC Sea Grant director, has awarded Mary Beth Dail, a prospective graduate student at the University of North Carolina at Wilmington (UNC-W), a UNC Sea Grant Graduate Fellowship to begin her masters thesis study in marine biology in the fall. Dail, who will complete her undergraduate studies at UNC-W this spring, plans to study the chemical differences and changes in the shell of a crab during its molting period.

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