

COASTWATCH

Photo by Doug Yoder



Technician Tom Blevins squeezes ripe eggs from a female striped bass

Aquaculture

Shrimp, catfish and mussels—they're often harvested from the wild, but they have cultured counterparts. Fish farmers, or aquaculturists, nurture these species from egg or larvae much like the farmer raises a crop from seed.

The aquaculturist tends pools and ponds just as a farmer tends fields and livestock. Daily, the fish are fed and the oxygen content of the water monitored. When the fish reach optimum size, they are harvested.

Why go to all the trouble? In some cases, natural stocks are dwindling. Worldwide, most species are fished to maximum levels. The bottom line: There's too much demand and not enough supply.

Aquaculture alleviates some of these problems. It provides a consistent quality and steady supply of these species.

Already North Carolina has a flourishing aquaculture industry. In 1984, this state was the second largest producer of rainbow trout in the nation.

But Sea Grant researchers think there is an even more promising culture candidate. The striped bass hybrid offers culturists a hardy, fast-growing culture species.

This month, *Coastwatch* examines the culture of striped bass hybrids.

Fish of a different breed

For years, scientists manipulated the genetics of plants—corn, tomatoes, cucumbers—to develop hybrids. This manipulation allowed farmers to get more and better food to the American table faster.

Now UNC Sea Grant scientists are applying genetic manipulation to fish. The striped bass. Howard Kerby and Mel Huish, zoologists at N.C. State University, are crossing striped bass with white bass or white perch to develop a hybrid.

Today this type of genetic manipulation is loftily called biotechnology. But its aim is more down-to-earth—to produce hardier, faster growing hybrids that can be raised commercially in culture conditions.

Kerby and Huish chose to work with the striped bass because of its declining natural stocks. Commercial and recreational fishermen have long sought the striped bass for its highly prized meat. But as stocks declined, the fish became harder to find. To save the fishery, resource managers in states along the East Coast have begun limiting commercial catches. (Such a regulation was being considered by the N.C. Marine Fisheries Commission when *Coastwatch* went to press.)

A substitute was needed to fill the commercial demand for the striped bass and to remove pressure on the unstable natural population. The hybrid answers both these needs, offering culturists an opportunity to produce a high quality, high-priced fish.

But Kerby and Huish's work goes beyond just crossing striped bass with white perch and white bass. They are genetically manipulating the fish to improve the production potential of the hybrid and to develop a domesticated hybrid brood stock. The development of a brood stock would alleviate the need to collect scarce wild fish and would streamline the production of hybrids for culturists.

At a recent striped bass workshop sponsored by UNC Sea Grant, Kerby put his genetic knowledge on display. Female striped bass taken from the wild during the spawning season were

injected with hormones to induce ovulation. Twelve hours after the fish were injected, Kerby began sampling the eggs to predict when they would ripen. Upon ripening, the eggs were manually squeezed from the females. Likewise, sperm were squeezed from white bass males.

Kerby produced gynogenetic diploid and triploid hybrids. What does this mean, you ask? Well, it's all in the chromosomes.

A diploid is any fish with a normal number of chromosomes. Like humans, most fish have 48 chromosomes.

To produce gynogenetic diploids—essentially clones—Kerby irradiates the sperm from the male fish to destroy its chromosomes. After the sperm fertilizes the females' eggs, the eggs are heat- or cold-shocked or chemically treated to retain an extra set of chromosomes the female usually ejects. The fish still ends up with 48 chromosomes, but they are all contributed by the female, making the fish a virtual clone of its mother.

Using this process, Kerby can cross striped bass with white bass or white perch to produce hybrids, then clone

Photo by Doug Yoder



Howard Kerby tests the water for dissolved oxygen

the biggest and best hybrid offspring. Unlike many hybrids, this cross is capable of reproducing. The cloning also would alleviate the need for acquiring or maintaining two different parental stocks.

To make triploids, Kerby does not alter the white bass sperm, which allows the male to contribute 24 chromosomes. But after fertilization, the striped bass eggs are again heat-shocked to retain the extra set of chromosomes. Therefore triploids have 72 chromosomes and are, in theory, sterile.

This sterile hybrid has several advantages, Kerby says. If the hybrids are accidentally or purposely set free in the wild, they would not crossbreed with natural stocks to alter their genetics. "Some scientists speculate that the sterile hybrids grow faster because none of their energy is channeled into reproduction," Kerby says.

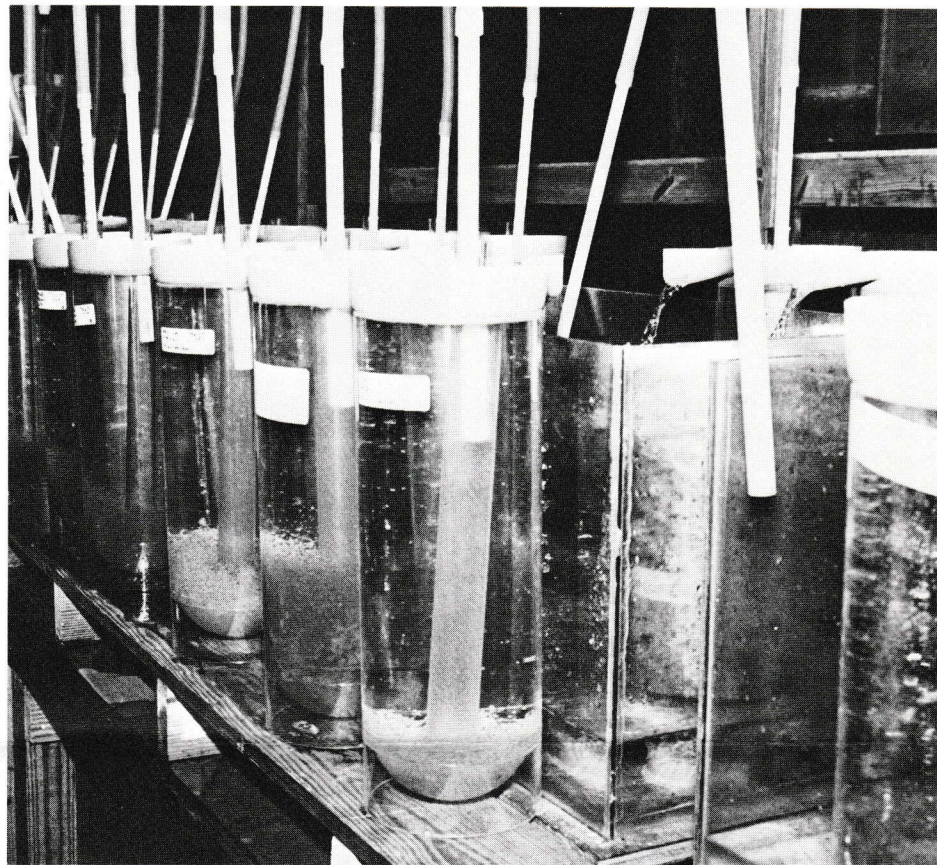
Next year, Kerby will work toward creating tetraploids, or hybrids equipped with 96 chromosomes. If these fish are not sterile, the tetraploids could be crossed with diploids to produce triploids naturally. "Creating a brood stock of tetraploids would be an easier, more practical way to produce triploids," Kerby says.

All of this genetic manipulation is naught if the hybrids don't thrive and grow under culture conditions. But in the case of the striped bass hybrids, grow-out is not a problem. Kerby stocked the fish in earthen ponds, in freshwater flow-through circular pools and in floating cages placed in brackish estuarine waters. In all cases, Kerby was able to produce marketable fish (1½ pounds) in 14 to 18 months, and the survival rate for hybrids stocked as fingerlings exceeded 70 percent.

At the experiment's completion, the researchers harvested 5,291 pounds of fish per acre from the ponds and 60 kilograms per square meter from the cages. The pond harvest of hybrids compares favorably with catfish culture. For the lower-valued catfish, 4,900 pounds of fish per acre is considered commercially viable.

To boost growth even more, Margie

Photo by Doug Yoder



Eggs incubate in hatchery at Aurora lab

Gallagher, a UNC Sea Grant researcher at East Carolina University, is working with the protein/energy ratios in fish feed. "In fish, the requirement for protein is complicated by the fact that dietary protein can and is used as an energy source," Gallagher says. "Therefore in studies of protein requirements of fish, it is necessary to look not only at the effect of protein levels on growth and metabolism, but also the effects of protein/energy levels on these processes."

Gallagher's research with elvers, or baby eels, showed that diets too high in energy restrict the fish's feeding to the level where the elvers don't meet their protein requirements. But if the energy level is too low, protein will be wasted for use as energy instead of being used for growth. These findings confirm earlier research on other species: fish eat to meet energy needs rather than their protein needs.

Focusing on striped bass hybrids, Gallagher is looking for that optimum ratio of energy to protein needed to spur growth. The proper ratio will not only result in larger, faster-growing hybrids, but it also will lead to a better and more cost-effective feed for the hybrid.

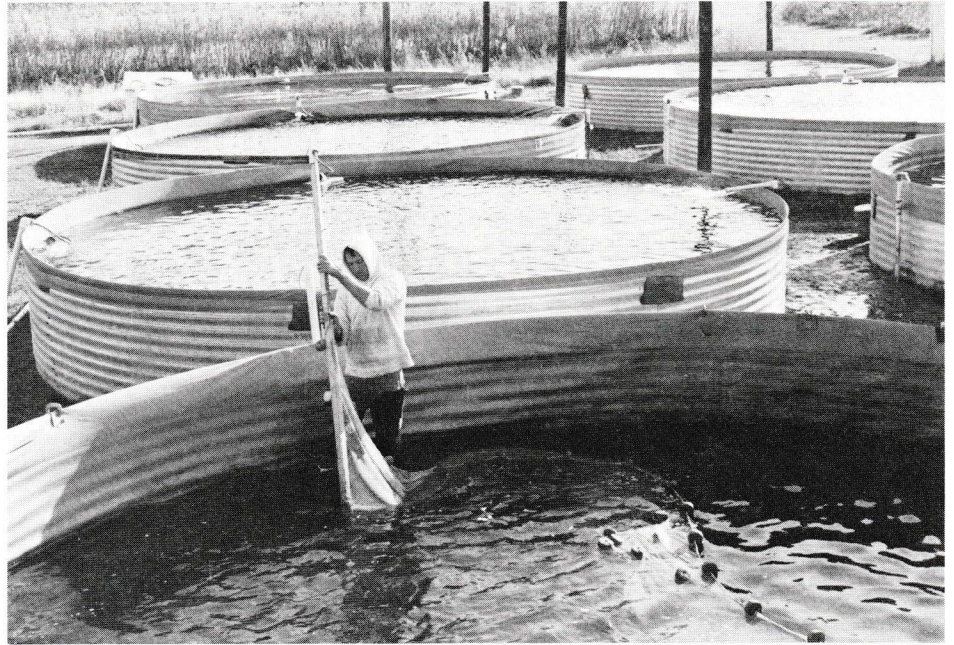
As in other forms of aquaculture, feed costs are a major part of the total cost of production. Because striped bass hybrids require a high protein diet and protein is the most expensive ingredient in their feed, it's very important to maximize its return.

As Sea Grant scientists work out the genetics and feed requirements of striped bass hybrids, many believe the fish is ready to leave the laboratory. The striped bass is no longer a potential aquaculture candidate, scientists say, but one on the verge of commercial success.

—Kathy Hart

Fish Farming

Photo by Howard Kerby



** Chris Okano fished for striped bass for eight years until he finally went broke, he says. Instead of giving up on fishing altogether, Okano has decided to try another angle—raising striped bass hybrids in a culture operation.

** B.E. Singleton Jr.'s 40-acre pond near Washington, N.C., may serve a dual purpose. He uses it to pump sand for his concrete business, and he'll try to raise striped bass hybrids in its waters.

** In Columbus County, the Wacamaw-Siouan Development Association has constructed 12 quarter-acre ponds for raising channel catfish and striped bass hybrids. Executive Director Gloria Patrick says the association will use the ponds to show local farmers how they may be able to supplement their incomes.

So far, aquaculture is only a fledgling industry in coastal North Carolina. But it's people like Okano, Singleton and Patrick who may push the industry from the fledgling stage into viability.

At a recent Sea Grant workshop, 20 participants joined a team of researchers and advisory personnel to find out more about the potential for the industry here—particularly for the striped bass hybrid.

Ron Hodson, UNC Sea Grant

associate director, offers three reasons why hybrid culture looks promising: "It grows faster, is more disease resistant and harder than either of the parent species. It has potential because of the market for striped bass that is already available. And in North Carolina we have the water and the climate for this particular species."

But even with such positive outlooks, Randy Rouse, marine advisory agent at Sea Grant's aquaculture facility in Aurora, cautions potential aquaculturists to investigate the market before investing time and money in an operation. "Set up ahead of time where you're going to sell your product and how much you're going to sell it for," says Rouse. If you determine that there is a demand for hybrids, you're ready to proceed.

Your water supply may be the most important consideration, since its quality has a lot to do with the fish's overall health.

Surface water, ground water or brackish estuarine water will do. Next, evaluate the water. You'll need a hardness of at least 50 parts per million and a pH between 6.5 and 8.5. Check for toxins, particularly in surface waters from a farm. Runoff from chemically treated fields could degrade the water quality.

The next step is to obtain a fish propagation permit from the N.C.

Wildlife Resources Commission. (All fish culture operations require permits.) Fishery biologist Bill Smith says the commission will consider the species you want to raise and the potential effect on nearby natural watercourses. If you divert water from a stream or river, you must return water to that watercourse. And, the commission wants to be sure none of the cultured fish can escape into the natural watercourse and possibly inbreed with natural stocks.

Now, you're ready to decide what sort of operation you want. Do you want to set up your own hatchery and raise fish to the fingerling size? Or do you want to buy fingerlings and raise food fish?

If you're going to sell the fingerlings as "trained-to-feed," you'll need pools where you can teach them to eat a pelleted food. Trained-to-feed fingerlings command a higher price, says Rouse.

You may opt to sell your excess fingerlings, retaining enough to raise as food fish. In that case, you'll need 1- to 5-acre ponds constructed for seining and draining. A large farm pond with a sufficient source of water would suffice. If the pond is too deep for seining, you may be able to float net pens and keep the fish contained.

To get maximum production from the ponds, you'll need an aeration system to maintain the oxygen levels in the water. And you should invest in an oxygen-monitoring kit.

The fish will have to be fed two to three times a day, either manually or with an automatic feeder. The feed for the fish is perhaps the greatest expense you'll encounter—as much as 40 to 50 percent of your costs. Depending on the feed conversion rates, it may take as much as 25,000 pounds of food to yield 10,000 pounds of fish. At 20 to 25 cents a pound, the feed costs could add up to \$6,250. All factors considered, Hodson estimates hybrids can be raised for about \$1 per pound and may bring from \$1.50 to \$2.50 depending on where you market them.

It takes about two growing seasons to produce marketable 1- to 1½-pound fish. By seining his pond, an aquaculturist could begin selectively harvesting toward the end of the second season. When the remaining fish reached the desired size, he could

Photo by Doug Yoder



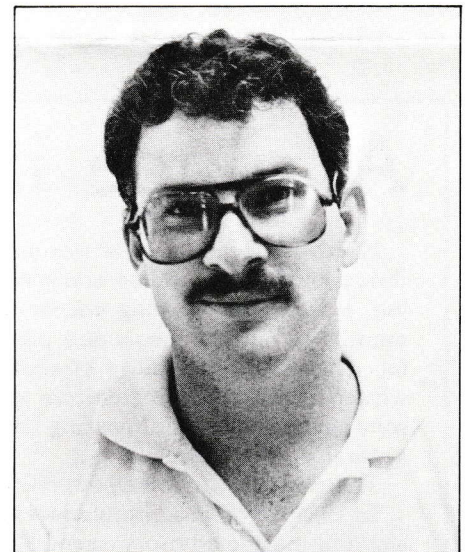
Workshop participants heat-shock fertilized eggs

harvest by draining his pond.

Your job is not completed when you harvest the crop. Gary Van Housen, Sea Grant's seafood marketing specialist, has some advice for potential aquaculturists. "A lot of aquaculture operations have either ignored marketing or not given it the consideration it deserves. If you have the knowledge of raising fish, put at least some time into researching the market for your fish."

Van Housen believes there is a potentially strong market for hybrids. He points to a 1981 National Marine Fisheries Service survey that indicates people in the mid-Atlantic region consume more fresh fish than people in other areas of the country. Add to that the popularity of striped bass in these same states, and the hybrid looks like a winning product.

Now define your market even more. Will it be home consumers, retail fish markets or restaurants? Van Housen points to the results of the same survey. It found that of the 29 percent of fish that is eaten fresh, only 8 percent was actually eaten at home. Twenty-one percent was consumed in restaurants. That might indicate that you would want to look at the



Randy Rouse

restaurant trade rather than selling to retail fish markets who in turn will sell to home consumers.

When should you put your product on the market? Van Housen advises aquaculturists to consider seasonal price fluctuations. As a general rule, when landings of striped bass are highest, the price will be low. Van Housen says farmers should look at

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Striped bass x white bass hybrid, top; striped bass, below

price fluctuations and harvest their ponds when striped bass are not as plentiful. Look for trends, he says, not day-to-day fluctuations.

Control over time of harvest also will allow you to choose where in the distribution channel you want to en-

ter. Generally, fishermen sell to packing houses, which sell to wholesalers, who can either sell to restaurants or retailers or to another wholesaler. At each step, the price of the fish goes up because of the profit margin of each of the participants.

But the fish farmer has more flexibility. He can enter the distribution channel further on and get more money for his product.

Another advantage is that the farmer has control over the size of fish he harvests. This can be crucial since there are definite preferences for sizes within the mid-Atlantic states. New York and New Jersey consumers, for example, prefer larger fish, from 2 to as much as 30 pounds. In North Carolina and Virginia markets, consumers prefer smaller 1- to 4-pound fish. If larger fish demand a higher price per pound, weigh that against the cost of holding the fish until they reach the larger size.

To promote your product, research and analyze the market to determine which segment you want to sell to. Then, go to that segment and emphasize the advantages of a hybrid. For example, suppose you want to sell to restaurants. Tell the restaurateur that you can control the size of the product, when he can get it and what form it will be in.

For more information about aquaculture, contact Hodson at 919/737-2454 or Rouse at 919/322-4054.

—Nancy Davis

A place in the sun

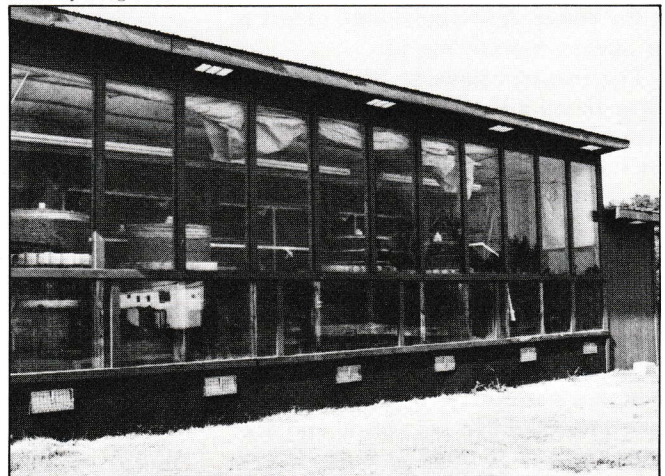
North Carolina has numerous sites where aquatic farms could locate and several species suitable for culturing. But with a growing season of only seven to eight months in outdoor pools and ponds, aquaculturists are faced with the possibility of shutting down during the winter months. Moving culture operations inside is one solution but the cost of heating large volumes of water is generally prohibitive.

The solution? A solar-powered greenhouse.

In 1984, UNC Sea Grant Associate Director Ron Hodson and marine advisory agent Randy Rouse tested the feasibility of raising fish year-round. They constructed a passive solar greenhouse that would store the heat it collected during the day. Water serves as the main heat sink, and a recirculating system maintains water quality and reduces heat loss.

In January, Mother Nature put the greenhouse through its toughest test so far. Temperatures outside Sea Grant's Aquaculture Center in Aurora plunged below zero. But in tanks inside the greenhouse, striped bass hybrids swam in 70-degree water temperatures. Even when the weather was harsh on plants and animals outdoors, fish inside fared well.

Photo by Doug Yoder



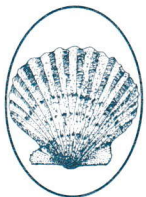
Sea Grant's passive solar greenhouse

Hodson estimates the greenhouse cost \$5,000 to build and \$5,000 to equip as a culture facility for larvae and fingerlings.

If you'd like to take a look at the greenhouse, contact Rouse at 919/322-4054.

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, workshops and new publications. For more information on any of the projects described, contact the Sea Grant offices in Raleigh (919/737-2454). For copies of publications, write UNC Sea Grant, NCSU, Box 8605, Raleigh, N.C. 27695-8605.



What fish is most like the soybean? For UNC Sea Grant researcher Tyre Lanier, the answer is menhaden. In fact, Lanier thinks the similarities are so strong that he nicknamed the fatty, oily fish "the soybean of the sea."

At the turn of the century, he explains, soybean research resulted in edible oils and protein concentrates. Now, one or both of those ingredients can be found in almost every domestically manufactured food product.

In a recent Sea Grant publication, *Menhaden: Soybean of the Sea*, Lanier predicts a similar outcome for the currently underutilized menhaden. Although the menhaden fishery is the nation's largest in terms of volume, its value per pound ranks well below other species. The reasons are simple: the menhaden has always been an industrial fish. Until now, it has been used for fertilizer and for chicken feed, but it's never made it to the dinner table.

Lanier's research brings menhaden one step closer to our menus. In his 24-page booklet, Lanier describes his research aimed at using menhaden to make surimi—a minced fish product developed by the Japanese. By water washing the mince, they end up with a protein concentrate suitable for use in restructured seafood products such as shrimp, scallops and crab legs. The natural counterparts of these foods are high in demand and in price. But the

restructured product is low in cost and high in food value.

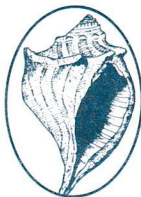
For a copy of Lanier's booklet, write UNC Sea Grant, Box 8605, North Carolina State University, Raleigh, N.C. 27695-8605. Ask for publication UNC-SG-85-02. The cost is \$3.

Drinking and driving don't mix—on the road or on the water. The sun, sea and suds can be a deadly combination for boaters. More than half of the boating fatalities that occur each year are alcohol-related.

Accidents can happen in any kind of vessel if boaters are intoxicated. Alcohol dulls the senses, impairs balance and doubles reaction time. Overexposure to the sun, wind, motion and glare can have a similar effect. Together, the two decrease a boater's ability to safely observe and react to conditions on the water.

This summer, be aware of these dangers. Don't drink and drive. Watch your speed, and stay alert.

For more tips on boating safety, write or call the local office of the Coast Guard Auxiliary, the U.S. Power Squadron or the Red Cross.



Catch some excitement this summer at the 1985 Marine Environment Workshop in Swansboro. July 22 to 26, youngsters ages 14 to 18 can take a ride on a trawler, snorkel in the ocean or study aquariums. These activities and others will teach participants about marine resources, ecology, marine problems and marine-related careers.

Set at Mitchell 4-H Camp on Queens Creek, instructors will use surrounding marine resources to conduct field investigations in marsh and beach habitats. The program is sponsored by the North Carolina 4-H organizations and UNC Sea Grant. Attendance is not limited to 4-H members.

Cost for the workshop is \$125. The fee includes meals, lodging, insurance, equipment fees and field trips. Participants must arrange their own trans-

portation to the camp, but names and addresses of others attending can be furnished for those who would like to arrange a carpool.

For an application, see your county 4-H agent or write Roland Flory at the N.C. 4-H Camping Office, Box 7606, N.C. State University, Raleigh, N.C. 27695-7606. Or call, 919/737-3242.



Sea Grant's winning style was recently recognized by the Society for Technical Communications in their annual publications competition. Three Sea Grant publications received awards this year.

"North Carolina Seafood," a colorful poster showing the seasonality of 23 kinds of fish and shellfish, won an award of excellence in the regional competition sponsored by the Carolina Chapter of the STC. From there, the poster went to the International Technical Art competition where it won an award of achievement. Joyce Taylor, Sea Grant's seafood agent at the N.C. State University Seafood Laboratory in Morehead City, created the concept for the poster. Graphic designer Ginny Petty illustrated the poster.

In the STC's regional technical publications competition, "Coastwatch" received an award of merit. The newsletter is edited by Kathy Hart; Nancy Davis and Sarah Friday are staff writers.

"Opening a Bed and Breakfast," a brochure providing guidelines for homeowners who are considering opening such an establishment, won an achievement award. It was written by Rich Novak, a Sea Grant regional marine specialist, and edited by Kathy Hart.

Mark your calendar for the Crystal Coast Saltwater Sportfishing Show August 10 and 11 in Morehead City. Anglers can take a day off from the water and see the latest in recreational

Continued on next page

boats, tackle, motors, trailers and other fishing equipment. In addition, seminars and workshops related to recreational fishing will be offered on topics such as bait-rigging, surf fishing and flounder fishing.

This free, public event will be held at the National Guard Armory off U.S. 70. It is sponsored by the Crystal Coast Charter Boat Association, the Carteret County Sportfishing Association and UNC Sea Grant. Some of the seminars will require pre-registration. Times for the show are: Saturday, 11 a.m. to 9 p.m., and Sunday, 11 a.m. to 5 p.m.

For more information, call Sea Grant marine advisory agent Bob Hines at 919/247-4007.

The N.C. Marine Resources Centers have a summer program for you. Seafood programs, film series, sea-shore workshops, field trips and special programs for children . . . just to name a few.

Located at Roanoke Island, Bogue Banks and Fort Fisher, the facilities house public aquaria, exhibits,

laboratories and more. UNC Sea Grant Marine Advisory Service offices also are located at the centers.

For a calendar of the summer's events, contact the centers at: Roanoke Island, Box 967, Manteo, N.C. 27954; Bogue Banks, Atlantic Beach, N.C. 28512; and Fort Fisher, P. O. Box 130, Kure Beach, N.C. 28449.



There're more fish in the sea to catch than flounder, snapper and red drum. Other species normally shunned like triggerfish, skate and shark can be good

targets, too.

That's the message behind a new Sea Grant slide/tape show on underutilized fish. The 21-minute show discusses the findings of a National Marine Fisheries Service study of underutilized recreational species in Southeastern waters. Its purpose is to dispel common misconceptions about 20 underutilized species.

The program also gives tips on

fishing for underutilized species, and tells how to prepare them.

Anthropologists Jeff Johnson and David Griffith of East Carolina University, and Jim Murray, Sea Grant's Marine Advisory Service director, conducted the study. Their slide/tape show is available for loan to sportfishing clubs. Upon request, Murray will show the slides and tell club members about the project.

For more information about the show, write Murray at UNC Sea Grant, Box 8605, N.C. State University, Raleigh, N.C. 27695-8605. Or call 919/737-2454.

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