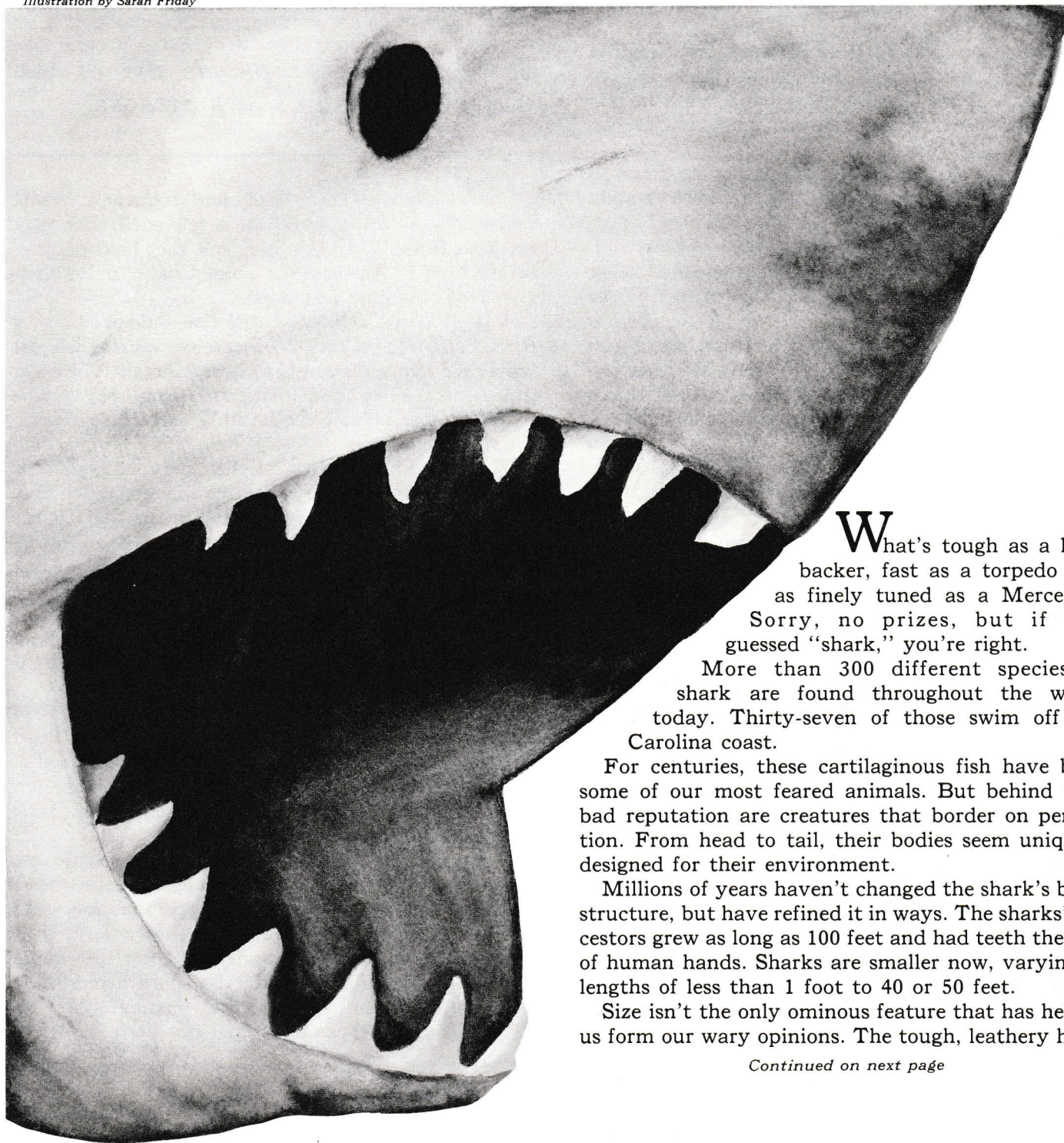


COAST WATCH

Illustration by Sarah Friday



What's tough as a line-backer, fast as a torpedo and as finely tuned as a Mercedes? Sorry, no prizes, but if you guessed "shark," you're right.

More than 300 different species of shark are found throughout the world today. Thirty-seven of those swim off the Carolina coast.

For centuries, these cartilaginous fish have been some of our most feared animals. But behind that bad reputation are creatures that border on perfection. From head to tail, their bodies seem uniquely designed for their environment.

Millions of years haven't changed the shark's basic structure, but have refined it in ways. The sharks' ancestors grew as long as 100 feet and had teeth the size of human hands. Sharks are smaller now, varying in lengths of less than 1 foot to 40 or 50 feet.

Size isn't the only ominous feature that has helped us form our wary opinions. The tough, leathery hide;

Continued on next page

a perpetual frown; and that mouthful of sharp, pointy teeth have haunted more than one nightmare. But, it all adds up to a vertebrate proficient in achieving its sole objective—survival.

One means of protection for the shark is its thick, rough skin. It's rough because it has denticles, or microscopic teeth, embedded in it. These unusual structures are actually prototypes of the teeth found in the shark's mouth, says Steve Ross of the N.C. Division of Marine Fisheries in Morehead City.

Whether a shark is escaping or pursuing, its streamlined body, dorsal tail and assorted fins maneuver it quickly through the water. As with most fish, the fins move water across gill slits on the sides of the shark's head, keeping a constant flow of oxygen going into its body.

For buoyancy, fish have an internal swim bladder that changes amounts of air and gas according to movements. Sharks, on the other hand, don't have a swim bladder and must maintain buoyancy in two other ways, says Ross.

Sharks have a giant liver that is full of oil. Since oil is lighter than water, the liver acts "kind of like a life preserver," Ross says.

Secondly, he says, most sharks constantly swim. "As they move through the water, there's a lifting force much like an airplane. The flow of water over the body lifts them up."

Because sharks must move all the time, there's no sleep for most species. They don't really require sleep anyway, says Lundie Spence, UNC Sea Grant's education specialist. The shark's brain is so small, it doesn't need resting.

High on the list of priorities for the shark is eating. To do so, it is equipped with "mechanisms" that help it locate food and with a set of teeth that would scare off any dentist.

Those mechanisms, or sensory organs, are very

well-developed, says Ross. Sharks have an acute ability to detect low-frequency vibrations such as those set off by a struggling fish. They also can smell objects long distances away with nostrils located underneath their head. This combination allows sharks to quickly home in on their prey.

For years, it was believed that the glassy eyes of a shark could only see blurry, mottled shapes. But research shows that sharks can discern color and fairly definite shapes—a handy feature around mealtime.

Carnivorous sharks tear into their dinner with up to 1,000 sharp, white teeth. Ross says each species has a set number it can replace indefinitely. A few have no teeth at all.

Each year, more people die of bee stings than from shark attacks.

Sharks lose their teeth easily and frequently. White sharks, for example, may lose a few each time they eat, says Ross. When that happens, they have another tooth, or even a whole set, folded back under their jaw, ready for the next meal.

A shark's diet depends on its size and species, says Ross. Some eat fish, while others, like the dogfish, eat crabs. We know of a few that eat mammals. The great white eats seals and penguins, Ross says. The toothless species, like the basking and whale sharks, eat plankton.

Their digestive system, as their nervous system, is relatively primitive. Neither have changed much over the years. Another primitive facet of the shark is the high concentration of salts and minerals found in its blood, says Spence. The shark urea stores a large quantity of salt in the shark's body, which prevents it from dehydrating quickly.

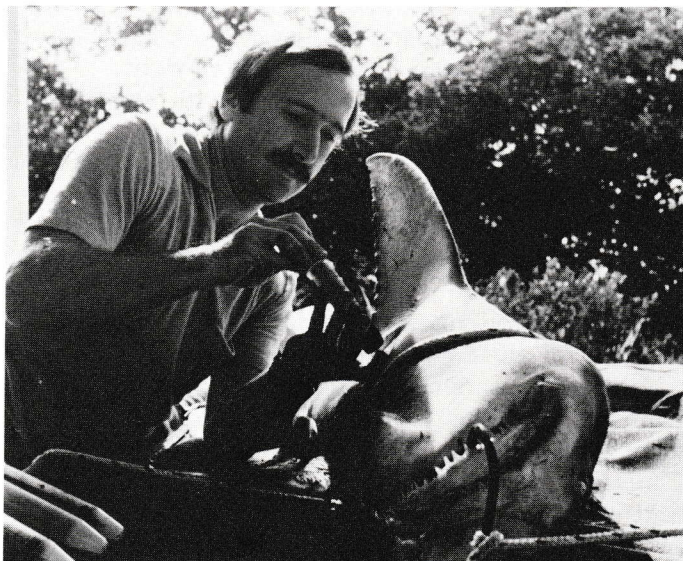
With all this finely-tuned survival equipment, sharks can live 20 or 30 years. Their most vulnerable stage in life, however, is the first.

Sharks reproduce in three ways that vary with the species. Some females lay eggs on the ocean floor. Others produce eggs surrounded with a yolk sac that provides nutrients to the embryo as it develops. And some form eggs that attach to the womb and derive nutrients from it.

The majority of sharks are born by the second and third methods, which produce young, or pups, in the womb. With the third type of reproduction, says Spence, usually only the first-developed embryo lives because it eats the others that later enter the womb.

From conception to death, the shark attempts to satisfy its voracious appetite. But fortunately for us, its affinities are toward fish and not flesh.

—Sarah Friday



Scientist Carl Luer continues to study the anatomy of sharks.

The name of the catch is shark

There aren't many folks who'd like to see the toothy jaws of a shark snapping in their faces. But that's exactly what Lloyd Davidson of Morehead City wants. He's one of a rare breed of commercial fishermen who stalk North Carolina's waters for shark.

For two to three days at a time, Davidson rigs up his boat, throws out his lines, and reels in some of the most dangerous, but delicious, fish that lurk the deep.

During the winter months, he and two crewmen go offshore 30 to 40 miles where tiger and sandbar sharks are plentiful.

In the summer, when sharks move to warmer nearshore waters, shark fishermen follow close behind. And anglers are more likely to catch them off piers than. Silky, dusky, black-tip, spinner, bull, sandbar and tiger sharks are a few of the species caught.

Other types snagged off North Carolina include the blue, dogfish, white, mako and thresher sharks, says Lundie Spence, UNC Sea Grant's education specialist.

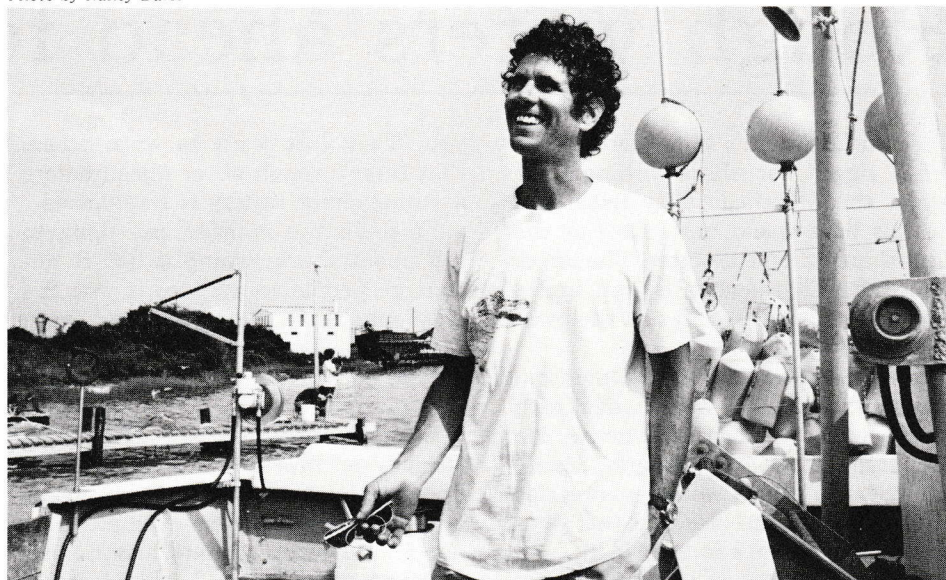
Jim Bahen, the UNC Sea Grant marine advisory agent at Ft. Fisher, says, "Anytime you go fishing in the ocean . . . there's always the chance you'll catch a shark," no matter what you're fishing for.

Davidson got hooked into commercial shark fishing last year when he and the owners of a Morehead City fish market thought there was a demand for the meat in Northern markets.

The first step was to rig his 41-foot boat. This is the minimum length that should be used, says Davidson, because you need room for longlining and for the proper facilities to prepare the shark once onboard. Davidson figures that it costs between \$5,000 and \$10,000 to rig a boat for shark fishing.

For Davidson and his crew, each outing operates more like a hunt than a fishing trip. Instead of fishing poles, they use miles of cable and nylon line attached to two huge, hydraulic reels that will pull in their catch. Hooks are spaced 30 to 50 feet apart on each line. For bait, almost any fresh fish will do, says Davidson, and if it's bloody—that's even better. When the hooks are

Photo by Nancy Davis



Lloyd Davidson on the Alligator

ready, the "chum," or bait, is dropped into the water and the waiting begins.

On a good day Davidson catches 15 to 20 sharks. Hooking them is the easy part, though. One by one, the sharks must be killed.

The methods are primitive, and all are dangerous for the fisherman. To kill sharks, fishermen club them, drag them by the tail until they suffocate, shoot them in the head or tie them around the gills.

When the shark is dead, it is hauled over the stern, gutted, then bled by cutting off the tail, fins and head. Shark blood contains high concentrations of urea that can convert to ammonia and taint the flesh if not drained promptly. The tough skin of the shark can be removed now or after freezing. The remaining carcass, or meat, is thrown into a tall vat of ice as the next shark is pulled aboard.

In all that time of working at what Davidson calls "a fairly grizzly operation," he still has 10 fingers and 10 toes. And he doesn't have any scars or "Jaws" stories.

But, Thomas Blevins does. A sport fisherman and a UNC Sea Grant research technician, Blevins came face-to-face with a female spinner that wasn't willing to give up. She thrashed, extended her jaws, jumped at the boat lights and bit at the rope. With only his brother to help him, and

a rod and reel to pull her in, Blevins finally succeeded in landing the shark.

This kind of excitement is what keeps Blevins searching for shark. He usually goes out in his 19-foot boat with his brother and another crew member. He uses a large rod and a reel with 400 to 700 yards of 80-pound braided dacron line, an amount he advises other shark fishermen to use.

Like Davidson, Blevins chums for shark. Blevins can usually guess the size of the shark by how fast it takes the bait. Smaller sharks rush up to the bait, grab it and run, he says. But when the big ones are around, his reel clicks slowly and continuously, like a bomb about to explode.

Most fishermen are not as fond of reeling in a shark as Davidson and Blevins. In fact, sharks are a nuisance to many anglers because they tear off bait and scare away other fish, says Bahen. Some fishermen shoot or club the fish and leave them on the beach. Bahen says he'd rather see anglers cut the shark loose and let it go.

Recreational fishermen just don't want to take the time or trouble to clean the sharks they catch, he says. But Bahen thinks that with a little more education about cleaning techniques and about the shark's tasty meat, more anglers will be inviting sharks to dinner.

—Sarah Friday

Marketing shark

Rough waters ahead for fishery

Lloyd Davidson's 41-foot *Alligator* is rigged for shark fishing. But lately, the Morehead City fisherman and his boat spend more time at the dock than out on the water. The prices his catch brings—when he can find a buyer—aren't enough to pay the costs of fishing.

It's a familiar story for Davidson. About a year ago he made a deal with the owners of a local fish house. He would rig his boat for shark fishing, and the fish house would market his catch. They had an idea that there was a demand for shark in the North, and they were willing to take a risk to get a jump on that market.

But now, with their venture in its second year, the experimenters say they may have jumped too soon. They're not ready to pull out, mind

you. They just want to warn others that there's rough water ahead before a strong shark fishery is established.

"I think the number one thing to say about shark fishing is not to encourage people to get into it yet. It's only marginally feasible now," says Davidson. The problem is, "You've almost got to talk people into buying it."

Doug Brady, an owner of Ottis' Fish Market in Morehead City, markets Davidson's catch—a task he likens to begging. Brady gives an example: if he had 5,000 pounds of shark meat today, he estimates it would take him 24 hours on the telephone to sell it.

Brady managed to convince some buyers in the North and West to purchase Davidson's shark. But he adds that his target market defies

regional borders—he'll sell to "whoever will buy it."

"There is some demand," Brady says. "But if you catch a lot, that demand will cease. You can fill up the demand quickly."

Concentrating on domestic markets, Brady sells fresh shark, headed and gutted, in the carcass form. His buyers chunk and steak the meat for retailing.

Traditionally, there has been a foreign market for shark fins, used in the Orient as a main ingredient in shark-fin soup. But Brady says the fishermen handle the marketing of the fins.

At the start of the shark venture, Brady intended to develop a product out of shark meat. He tested various forms, including patties, steaks, fillets, fish cakes and fish sticks. Brady reports mixed results. He'd like to see food scientists evaluate shark meat for use in such products.

There are other hurdles. "We're in the wholesale fish business," says Brady. "We make our money on volume. But we can't get a consistent supply. We need tons of shark."

Davidson says his catches are inconsistent because his is the only boat fishing specifically for shark. On some days, he catches as much as 7,000 pounds of carcass. On other days, his hold is empty.

The N.C. Division of Marine Fisheries estimates that commercial fishermen landed 136,702 pounds of shark in 1983, at a value of \$280,399. As part of a marketing program for North Carolina seafoods, the division may evaluate the potential for a shark fishery, says Director Bob Mahood.

Virginia Slosser, a fishery marketing specialist with the National Marine Fisheries Service, completed a study in 1983 on shark marketing on the East Coast. She believes there is a potential for a fishery. But she adds that the question is when.

U.S. fisheries statistics estimate the 1983 commercial landings of un-

Photo by Scott Taylor



This surprise catch could have been marketed if properly handled

"I think the number one thing to say about shark fishing is not to encourage people to get into it yet. It's only marginally feasible now."

—Lloyd Davidson

classified sharks at 4,700,000 pounds. ("Unclassified" is a designation that excludes dogfish, because it has been previously marketed.)

In the southeast region, the value of the commercial catch has increased 50 percent in the last three years, says Slosser.

Slosser says the key to a successful shark fishery will be a strong domestic market; fishermen can't rely on foreign markets. But achieving a market will take a lot of education, beginning with the fisherman who must learn to handle shark properly and reaching to the consumer who must learn to accept an underutilized species, says Slosser.

Recently, Davidson took a break from shark fishing when the market

declined. He explains: "Fish prices in general went down and people usually use shark as a cheap alternative to higher-priced fish. And swordfishing picked up and a lot of shark is landed as a byproduct of that." That put more shark on the market when people could get other fish for reasonable prices.

For all their doubts about the viability of the shark fishery, Davidson and Brady admit the picture isn't all bleak. Brady says he has seen more people catching sharks on charter boats. Rather than killing them and tossing them overboard, they're handling them properly, taking them home and eating them.

If sport fishermen use the sharks they catch, it will indirectly benefit marketers like Brady. More folks will find out shark is good eating and will buy it.

Inland North Carolinians are being introduced to shark via the grocery store. Each week, a Raleigh store sells about 25 pounds of shark caught from North Carolina waters at a cost of \$2.99 to \$3.99 per pound.

Now, Davidson is among the few East Coast fishermen longlining specifically for shark. His boat may be tied at the dock, but he insists that when the price is right, he'll be ready. And other fishermen are sure to follow.

—Nancy Davis

Shark: a dish in good taste

Sharks may be terrors in the ocean, but that hasn't kept them from falling victim to human jaws. In England, folks sink their teeth into fish 'n' chips made with shark. And for centuries, Orientals have prized the fins for use in shark-fin soup.

But Americans seem more squeamish about what they eat. And until recently, most of us haven't seen fit to include this well-known predator in our diets. But now, more folks are gathering up the courage to bite into the feared fish.

And with good reason, says Joyce Taylor, UNC Sea Grant's marine advisory agent at the NCSU Seafood Laboratory in Morehead City. Shark is nutritious and economical, and its lean, white meat has a mild flavor and a firm texture. While the results aren't in yet, food nutritionists say shark is like all fish—high in protein, iron and niacin, and low in calories, fat and carbohydrates.

And there are no bones about a shark. That means the meat yield is higher for shark than for most other fish. Only 20 percent of a bony fish's weight is edible. But 42 percent of a shark is edible.

Taylor says shark meat tastes much like other fish. To prove her point, she did some experimenting. She cut some shark into inch-wide strips, and battered and fried the meat. Then she fed it to some willing participants, without telling them what they were eating. Most of her subjects identified the fried fish as croaker.

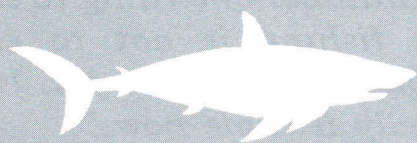
People like the taste of shark if it's been handled properly, says Taylor (see story, page 3). That means gutting and bleeding it as soon as it's out of the water, then icing it immediately. "If it's been poorly handled, it's not going to taste good and you're not ever going to buy it again," says Taylor.

If you're sold on the idea of trying shark, Taylor has some tips to ensure that you'll like that first bite. She recommends soaking shark, even if it's fresh. Soak the meat for at least an hour, preferably longer, in a solution of white vinegar and water ($\frac{1}{2}$ cup vinegar to 1 gallon of water); lemon juice and water ($\frac{3}{4}$ cup lemon juice to 1 gallon of water); or salt and water (1 cup of salt to 1 gallon of water). Taylor says any of these mixtures will help neutralize ammonia that may be left in the flesh of the shark. But she cautions that no amount of soaking will improve a shark that wasn't handled properly when it was caught.

Taylor buys shark in large chunks. Then she either cuts it into cubes, strips or fillets, depending on how she's going to cook it. For frying, cut the meat into 1-inch cubes or into strips about 3 inches long and 1 inch thick. Shark, like other fish, will flake when it's done.

If we've convinced you to give shark a taste, try the recipes on the next page. But don't let these limit you. Taylor says shark is great broiled, kebabled, baked, poached, barbecued, sauteed, or in soups and salads.

—Nancy Davis



Here's your chance to bite back

Shark Creole

1 pound shark fillets, cut into 1-inch chunks
1/3 cup vegetable oil
3 tablespoons flour
1 cup hot water
1/2 cup chopped green onions, with tops
1/4 cup chopped green pepper
1/2 cup chopped parsley
4 cloves chopped garlic
1 1/2 teaspoons salt
dash cayenne pepper
1/2 teaspoon thyme
bay leaf
lemon slice
1 10-ounce can tomato puree
cooked rice

Heat oil in large skillet and blend in flour over medium heat, stirring constantly until brown. Add water gradually and cook until thick and smooth. Add remaining ingredients except rice. Cover and simmer for 15 minutes. Remove bay leaf and serve over cooked rice. Serves 4-6.

Shark shish kebab

charcoal grill or hibachi
2 pound shark fillet cut into 1-inch cubes
12 cherry tomatoes
3 purple onions, quartered and separated
3 cans chunked pineapple, with juices
3 green peppers, cut in large pieces (blanched if desired)
fresh mushrooms
1/4 cup soy sauce
3 tablespoons lemon juice
1/2 cup oil

Cut fillets into 1-inch cubes. Soak for an hour in a salt, lemon juice or vinegar solution (see story). In the refrigerator, marinate shark cubes in soy sauce, lemon juice, oil and 1 cup of pineapple juice. Place shark cubes and vegetables on skewers and cook about 15 minutes, basting with the marinade. Serves 6.

Fish 'n' Chips

Batter

1 cup flour
1 egg yolk
4 tablespoons beer
1/4 teaspoon salt
5 tablespoons milk
5 tablespoons cold water
1 egg white

Pour flour into large bowl. Make a well in center and add egg yolk, beer and salt. Stir until well mixed. Combine milk and water and add half to batter. Stir until smooth. Add remainder, 1 tablespoon at a time, adding only enough to give right texture. For light texture, let batter rest at room temperature for at least 30 minutes. Beat egg white stiff. Fold into batter.

Chips

2 pounds baking potatoes
vegetable oil or shortening

Slice potatoes into 1/2-inch-wide and 1/2-inch-thick strips. Heat oil in deep-fryer to 375 F. Dry potatoes and fry until crisp and light brown. Transfer to lined pan to drain and place in 250 F oven to keep warm.

Fish

2 pounds fresh shark fillets

Cut dressed and skinned fish into 3- by 5-inch pieces. Wash in cold water and dry completely. Drop 2 or 3 pieces at a time into batter. When well coated, plunge into hot oil. Fry 4 to 5 minutes, or until golden brown.

To serve, heap fish pieces in the center of a large heated platter and arrange chips around them. Traditionally, fish and chips are served sprinkled with malt vinegar and salt. Serves 4.

(For more recipes or cooking tips, call Joyce Taylor, Sea Grant's seafood agent at the NCSU Seafood Laboratory in Morehead City, 919/726-7341.)



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.



When you get the itch to spend some time outdoors this summer, don't forget about mosquitoes. On North Carolina's coast, salt marsh mosquitoes are more numerous, more aggressive and can fly longer ranges than inland species. They'll also bite during the day, says Nolan Newton, head of the Vector Control Branch of the N.C. Division of Health Services.

Mosquito season varies each year according to the weather, but usually runs from April until October, says Charles Apperson, an extension entomologist at North Carolina State University. Heavy rains and high tides bring the potential for mosquitoes.

"Adult female mosquitoes lay their eggs in depressions in the salt marsh that are going to be flooded by rains or high tides," says Apperson. The eggs hatch when these sites are flooded. They quickly pass through several aquatic life stages before becoming adults.

Thousands of mosquitoes can hatch from such a brood, fly inland and disperse. In six or seven days, the female mosquito is mature enough to bite, says Apperson.

Mosquitoes bite us because they are attracted to our body heat and the moisture, vapor, carbon dioxide and sweat in our skin, says Apperson. Only the female bites because it needs to

collect the proteins from blood to produce eggs. When this is done, she flies to the breeding site to lay her eggs.

Apperson recommends using repellents to ward off these pesty insects. He also suggests that coastal property owners make sure they are not inviting mosquitoes into their homes. Repair screen doors and get rid of standing water in gutters, pots, tires and the like, he says.

If you want to bring your dog or cat along to the beach, use repellents on it, too, says Newton. Dogs should be given preventative heartworm medicine and, if possible, be placed in a mosquito-free shelter.



Dave Hill, a Sea Grant seafood technician at the NCSU Seafood Laboratory in Morehead City, spends his time at a drafting table, sketching seafood plants.

He makes line drawings of new plant layouts and expansions of old plants. Lately, Hill has noticed more of his sketches turning into reality.

For example, in 1982 and 1983, 21 companies asked the Seafood Lab for help. Hill supplied them with line drawings of crab plants, oyster shucking houses, freezer plants and retail markets. Of the 21, seven plants are completed and operating with an estimated new employment of 300 people. And, three more plants are under construction. When they are completed, about 130 more jobs will be open.

If you'd like to contact Hill or any of the Sea Grant staff at the Seafood Lab, write NCSU Seafood Laboratory, P.O. Drawer 1137, Morehead City, N.C. 28557, or call 919/726-7341.

The Effects of Salinity on the Potential of a Blue-Green Algal (Microcystis aeruginosa) Bloom in the Neuse River Estuary, N.C., by Hans W. Paerl, Patricia T. Bland, Jef-

frey H. Blackwell and N. Dean Bowles, all of the UNC Institute of Marine Sciences, examines the saltwater tolerance for the major bloom-forming nuisance species of blue-green algae in the Neuse River. The study also looks at the algae's ability to survive and proliferate in the marine environment.

For a copy of this working paper, write to UNC Sea Grant. Ask for UNC-SG-WP-84-1. The cost is \$1.25.

Mini-grant funds have been awarded to John Maiolo, an East Carolina University sociologist, to study the social and economic impacts resulting from growth in the North Carolina crab fishery.

This state ranks third on the Atlantic Coast in blue crab production. Pamlico Sound has yielded about 10 million pounds of crabs annually since 1970. And since 1978, North Carolina fishermen have landed record catches of blue crabs.

But the growth of the fishery hasn't been without its problems. Maiolo will analyze the conflicts among fishermen, the competition for space and the effects of changes in stock availability as a result of the growing fishery.



The waterway is crowded. Doves of swimmers ride the waves as big and little boats whiz by them. Who has the right to use this waterway? Everyone.

The laws concerning such rights on North Carolina's waterways are complicated. And the problems may be getting worse with increased coastal development, says Walter Clark, UNC Sea Grant's coastal law specialist.

These laws, or public trust rights, are "the rights that you have as a citizen of the state to use state property," says Clark. This property

Continued on next page

includes most of the navigable waters in the state. North Carolina's citizens have the right to use the water for recreational purposes such as boating, skiing and swimming or for commercial purposes such as shrimping or fishing.

Conflicts arise with public trust rights because more people want to exercise their rights on the waters, says Clark. For example, a commercial fisherman who has set a net in a waterway may be interfering with someone's boating or skiing.

If you are involved in such a conflict or would like to know more about public trust rights, write Clark at UNC Sea Grant, Box 8605, NCSU, Raleigh, N.C. 27695-8605. Or call 919/737-2454.



The future of marine and aquatic science may be in good hands, thanks to teachers who supervised students participating in the 1984 "World of Water" competition. The competition, sponsored by the National Marine Education Association, awards 20 students for science projects focusing on marine affairs. "World of Water" is designed to promote the career potential in marine and aquatic fields.

Lundie Spence, UNC Sea Grant's education specialist, and Dr. Jack Wheatley of the Division of Science Education at North Carolina State University, have received a grant from

the National Science Foundation to recognize these educators. Wheatley also will study the methods the teachers used to influence students' attitudes toward research projects.

As part of the recognition activities, the teachers will participate in the National Youth Conference on Marine and Aquatic Science in Washington, D.C., September 10 and 11. They also will attend Oceans '84, a major oceanographic conference also being held in the nation's capital.

Spence hopes that teachers attending these conferences will learn about new trends in marine science and take them back to their classrooms.

Soft shell crabbing can be profitable. But some soft shell crabbers have experienced high mortality rates among the crabs in their holding tanks, cutting down on their profits. Some researchers thought the crabs died because of microbial infections caused by improper handling or poor water quality in the holding tanks.

But Robert Sizemore, a biologist at the University of North Carolina at Wilmington, has some different ideas. Using UNC Sea Grant mini-grant funds, Sizemore will study "peeler" crabs. He thinks that crab mortality may be caused by a bacteria that exists in normal healthy crabs. But when the crabs are stressed under holding conditions, the bacteria may develop into acute infections that cause death.

If Sizemore's predictions prove correct, he may be able to develop techniques that will minimize crab mortality.

Jeff Johnson, an anthropologist at ECU's Institute for Coastal and Marine Resources, received a mini-grant to study the movement of commercial fishermen and vessels among Atlantic coastal states. Michael Orbach, also of ECU, will assist Johnson on the project.

Whether they're fishing for scallops, shrimp, bluefish or mackerel, North Carolina fishermen are sure to go where the catch is best. Johnson and Orbach will study the migratory patterns of fishermen along the Atlantic coast, the interdependence that migration creates among coastal states, and the implications for fishery management and policy.

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