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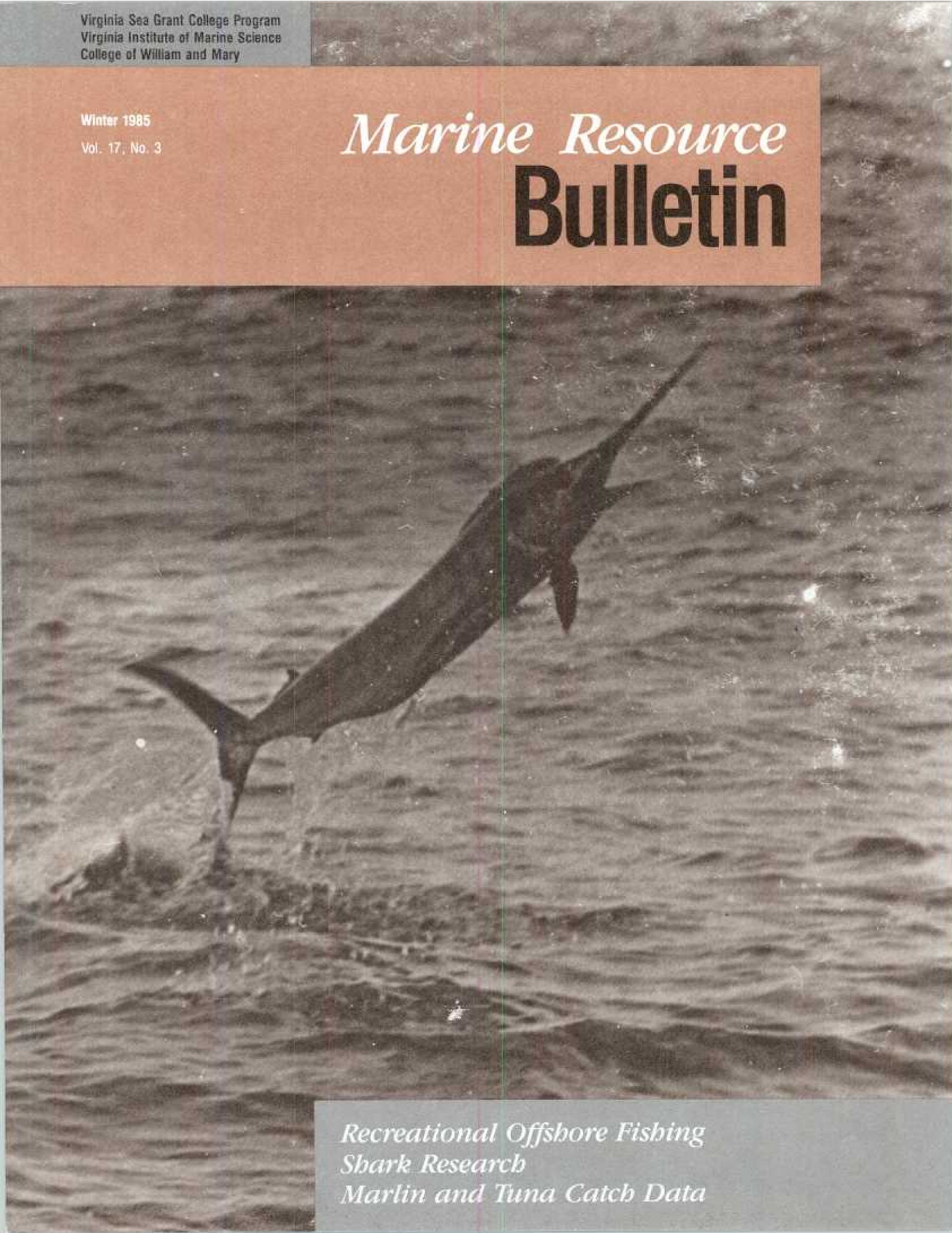


Recreational Offshore Fishing
Shark Research
Marlin and Tuna Catch Data

Virginia's Recreational Offshore Fishery: Catching Big Fish is Big Business

by Susan Schmidt

Susan Schmidt

C.K. Smith's 553¾-pound blue marlin won the Small Boat Marlin tournament in August 1985.

What draws some sportsmen 75 miles offshore? Out in the ocean you never know if you will hook a 20-pound tuna or a 1000-pound marlin. In the blue waters of the Gulf Stream, near drop-offs of submarine canyons or shoals on the otherwise-flat continental shelf, fishermen troll for pelagic, or open-ocean, gamefish. Their primary targets are bluefin and yellowfin tuna, white and blue marlin, dolphin, wahoo and sharks. It is a challenge to find these big fish, to hook one, to fight and land it.

Adventure writers like Ernest Hemingway popularized ocean gamefishing as an elite sport. As in *The Old Man and the Sea,* there is an aura of myth when a man matches his strength and wits with a marlin.

The first marlin and tuna were caught by rod and reel off California at the turn of the century. On the east coast in the 1920s, sportsmen started catching bluefin tuna from Cape Cod to Cape Hatteras, and tuna-fishing clubs formed in New Jersey. The first white marlin in the Mid-Atlantic were caught off Ocean City, Maryland, in the 1930s. Ocean City still calls itself the "white marlin capital of the world," although other ports like Virginia Beach's Rudee Inlet may challenge that claim.

In the mid-30s from Chincoteague and Wachapreague on Virginia's Eastern Shore, anglers found marlin less than 20 miles offshore. By the mid-50s sportfishing boats were venturing to Norfolk and Washington canyons. Today's anglers search for billfish at the 100-fathom curve (600 feet) along the edge of the continental shelf, which ranges from 60 to 90 miles offshore. From Rudee Inlet popular billfish and tuna hot spots are Norfolk Canyon, 70 miles east, and the Cigar, a seamount 65 miles southeast. Some fishing areas are named for their shapes: like the Fingers, the Boomerang, the Hot Dog, or the Horseshoe. Others are identified by their distance offshore, like 21-Mile and 26-Mile Hills, which are east of Wachapreague (see map).

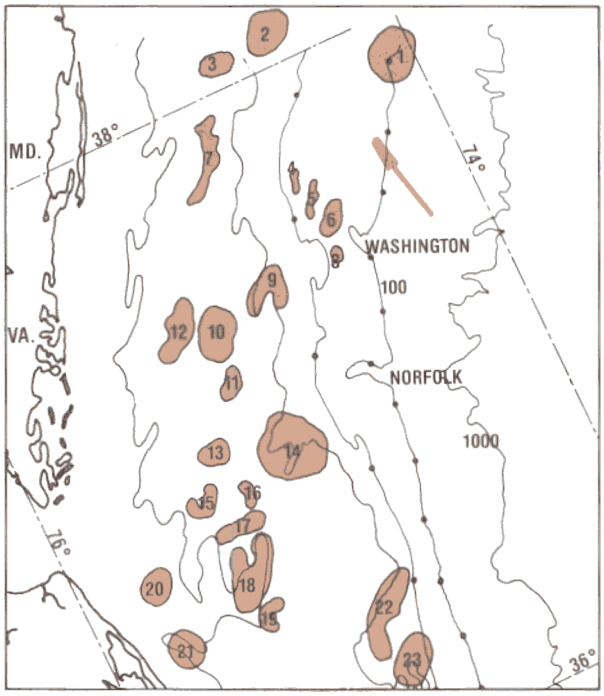
Seawitches, Green Machines, and Psycholead

Long runs to fishing grounds require seaworthy boats, electronic navigational equipment, and large fuel capacity. The method of catching tuna and marlin is high-speed trolling with rigged natural baits or artificial lures. Boats generally set five or more rods, with outrigger lines from the gunnels and flat lines off the transom. Popular bait rigs for fast-swimming pelagic gamefish have imaginative names like seawitches, green machines, ballyhoo, and psycholead.

Half the sport is expectation, being ready to hook and play a fish of unknown size. There is no telling when a marlin may crash the baits and take off, stripping yards of line off a reel. When the angler pulls the rod out of its holder, he sets the hook, and the fun and work begin. Depending on the size of the fish and the skill of the boat captain and angler, a contest may last several minutes or hours.

The thrill of bluewater angling lures many people to charter a boat for a day. Families travel long distances for a vacation of spectacular gamefishing, and coastal residents appreciate more frequent chances to fish offshore. For novices and occasional fishermen, charter boats offer the opportunity to catch big hard-fighting gamefish.

Virginia's offshore gamefish season reflects the periods when waters warm enough for each



Tuna and Billfish Grounds off the Virginia Coast

1. Poor Man's Canyon
2. The Fingers
3. Jackspot
4. First Lump
5. Second Lump
6. Rockpile
7. Lumps
8. 29 Fathom Lumps
9. 20 Fathom Fingers
10. 21 Mile Hill
11. Hambone (26 Mile Hill)
12. No Name
13. Triangle Wrecks
14. The Fingers
15. Fish Hook
16. Hot Dogs
17. SE Lumps
18. Horseshoe
19. Boomerang
20. V Buoy
21. 4A Buoy
22. Cigar
23. Honey Hole

species to move north. The big catches for offshore recreational fishermen are bluefin tuna in June and July and marlin, yellowfin tuna, dolphin, and wahoo from mid-July through October. In the summer some anglers specifically target sharks for their size and fighting strength. About 15 species of sharks in Virginia waters are caught by sportfishermen.

Besides these offshore pelagics, Virginia charter boats also work closer to shore for Boston mackerel in March and April, and bluefish and king mackerel from mid-May through October.

Many weekends during the summer, fishing tournaments draw participants to the challenge of catching the largest fish. As the season progresses, there are special competitions in large and small boats for bluefin and yellowfin tuna, blue and white marlin, and sharks. Unless they want to mount a trophy fish, many sportsmen voluntarily release billfish to conserve stocks and to allow anglers in the next tournament the chance to hook a trophy.

One popular tournament is the season-long Virginia Saltwater Fishing Tournament sponsored by the Commonwealth of Virginia to promote recreational fishing. The largest fishes in 22 species caught between May and November win trophies, and citation plaques are awarded for catches above established minimum weights. Cumulative records have been kept since 1958 (see Table 1).

Offshore sportfishing is big business in Virginia and offers economic boosts to the principal ports. In 1983 Virginia anglers fishing primarily for marlin and tuna spent over $7 million on boat maintenance and storage, tournament fees, bait, ice and fuel. Tournaments help bring tourist dollars to port communities, as non-resident fishermen and their families spend dollars on lodging, meals and entertainment. For example, the economic impact of the 1982 Virginia Beach Anglers Club Small Boat Marlin Tournament was approximately $35,000. To plan for the development of motels, marinas, boat ramps, and other facilities, port communities need to know the future trends of the sportfishing industry. To protect and manage future gamefish stocks, fishery managers must understand the distribution, abundance and harvest of pelagic species.

By sponsoring gamefish tagging programs for tuna, billfish, and shark, the National Marine Fisheries Service (NMFS) aims to provide information for better management. NMFS supplies tagging equipment and analyzes data; fishermen voluntarily tag and release their catch and sometimes recover tags. NMFS also helps fund surveys of recreational catches and monitors commercial catches of pelagic gamefish by U.S. and foreign fleets. Resulting data on migratory patterns, stock distribution, and exploitation rates are used for fishery management.

Management Options Addressed

In 1976 Congress created a "fisheries conservation zone" (FCZ) within 3 to 200 miles of the coast of the United States. Under the Magnuson Act (called the 200-mile limit law), the United States controls domestic and foreign commercial fishing, as well as domestic recreational fishing, through eight regional fishery management councils. With scientific assessments of economic, social and biological factors, these councils develop and implement

Virginia Marine Game Fish Records
Table 1

Species	C.W.†	Record Weight	Location	Year	Angler
Blue Marlin	250	1,093 lbs. 12 oz.	Norfolk Canyon	1978	Edward Alan Givens
White Marlin	50	131 lbs. 10 oz.	Off Va. Beach	1978	Rudolf D. van't Riet
Sailfish	30	68 lbs. 8 oz.	Off Va. Beach	1977	P.J. Murden
Shark (Tiger)	100	1,099 lbs. 12 oz.	Off Va. Beach	1981	John W. Thurston, Jr.
Bigeye Tuna	75	255 lbs. 8 oz.	Norfolk Canyon	1983	Pat Kelly
Bluefin Tuna	75	204 lbs.	Off Va. Beach	1977	W.J. Vance
Yellowfin Tuna	75	203 lbs. 12 oz.	Norfolk Canyon	1981	Bruce C. Gottwald, Jr.
Wahoo	30	97 lbs.	Off Va. Beach	1975	R.R. Matthias
Dolphin	20	62 lbs.	Off Va. Beach	1971	Sue Smith

† Citation Weight

Bill Abourjilie, *The Virginian Pilot*

Ed Givens (left) holds the Virginia record for his 1093¾-pound blue marlin caught in 1978 on Gannett *skippered by Mike Romeo (right).*

Robby and Clark Taylor of Norfolk land a yellowfin tuna at Rudee Inlet after the Small Boat Marlin tournament.

fishery management plans for recreational and commercial fisheries. Their goal is optimum yield, or the number of fish that provides the greatest national benefit in food production and recreational opportunity. Pelagic species like marlin come under the regulatory authority of fishery management councils, while highly migratory species like tuna come under international control.

In the western North Atlantic, U.S. commercial fishermen catch tuna, primarily in New England waters, by purse-seining, longlining, handlining and harpooning. Foreign commercial vessels also longline for tuna within the 200-mile FCZ. A typical longline may stretch 75 miles with 2000 hooks set as deep as 500 feet and is hauled every 24 hours. In 1985, 650 U.S. longliners have permits for incidental catch of bluefin tuna. Currently seven Japanese vessels have tuna-longlining permits, but on the average no more than two a month work off the U.S. east coast. Foreign vessels that longline for tuna within the FCZ are required to release all billfish and to keep accurate catch and effort records. A significant billfish mortality, estimated as 60 to 70 percent, has been confirmed by U.S. observers on foreign longline vessels.

Since 1969 the United States has belonged to the International Commission for the Conservation of Atlantic Tunas (ICCAT). ICCAT monitors the status of tuna species and sets harvest limits to protect or rebuild stocks. Three countries have harvest allowances for bluefin tuna in the Western Atlantic; the U.S. quota is roughly double that of Japan and Canada. After three years of quotas, ICCAT has just reported that stocks of smaller size bluefin tuna may be showing significant improvement.

Currently, fishery management councils on the eastern U.S. coast are jointly preparing a billfish management plan. Maximizing opportunity for recreational anglers is the primary objective in the working proposal. The councils are considering designating marlins, sailfish and spearfish as gamefish and setting minimum weights for possession. Recreational anglers would be able to keep any fish above the minimum size if caught by rod and reel; commercial vessels could keep only one billfish as bycatch per boat trip.

Under current regulations U.S. commercial fishermen may sell billfish only to licensed dealers, and these dealers submit bi-monthly catch reports

Courtesy of John W. Thurston, Jr.

to NMFS. The status of white and blue marlin stocks in the Western Atlantic is unknown, but NMFS estimates the catch reaches the optimum yield.

Pelagic Species Data Needed

There is insufficient catch and effort data for recreational fishing on pelagic species. In addition to distribution, abundance and composition of gamefish stocks, fishery managers need sound estimates of the total recreational catch to factor fishing mortality into their management calculations. Scientists at the Virginia Institute of Marine Science (VIMS) currently are studying gamefish popular with offshore recreational anglers in efforts to collect pelagic species data.

Catch and effort data for Virginia's recreational offshore pelagic fishery is being documented in a three-year Virginia Sea Grant Marine Advisory Services project. In another project partially funded by Sea Grant, VIMS fisheries biologists have been studying the life history of sharks. In related research of flow dynamics in water and in air, they are determining how shark scales can be copied to reduce airplane fuel demand.

More sportfishermen will continue to buy more boats and spend more time and money on fishing, but at the same time there may be fewer fish to catch. Recreational opportunity is balanced with harvest in fishery management plans; with accurate scientific information, fishery management councils will be better prepared to develop plans for the commercial and sportfishing industries. ≋

Susan Schmidt

An offshore fishing trip can yield big game. John W. Thurston, Jr. (r) and Bill Moffett proudly display their 1099-pound 12-ounce tiger shark, the largest shark ever caught in Virginia waters.

Billy Harvey, mate on Smith Ltd. *at Virginia Beach Fishing Center, unloads a wahoo.*

Pelagic Species, Fleet Data Support Sport Fishing Industry

To conserve stocks and to evaluate future trends of offshore pelagic species, fishery managers need information about the recreational anglers that frequent Virginia's port communities. In order to address the needs of the growing sportfishing industry, Sea Grant Marine Advisory Services at the Virginia Institute of Marine Science (VIMS) has conducted annual studies of recreational offshore fishing since 1983. Jon Lucy, marine recreation specialist, coordinates this research with Eleanor Bochenek, a graduate student in fisheries and marine resource management at VIMS.

In 1983 with funding from the Virginia Sea Grant College Program and the National Marine Fisheries Service (NMFS), Bochenek and Lucy participated in a Mid-Atlantic survey coordinated by the New Jersey Marine Fisheries Administration (NJMFA). Each week from June through October VIMS researchers used a random telephone survey to record the number of trips and to estimate catches of boat owners and captains fishing from Virginia ports for marlin and tuna. When researchers visited major ports on weekends to weigh and measure fish, they were able to increase their list of boats engaged in recreational offshore fishing. The season's catch and effort numbers were combined with economic data to estimate the magnitude of each state's fishing activity. Results of the five-state survey were published by the NJMFA is an 8-page bulletin titled "Survey of Recreational Tuna and Marlin Fishing in the Mid-Atlantic, 1983."

No NMFS funding was available in 1984 for a regional program, but VIMS continued research on the Virginia fishery by mailing out monthly catch logs to private boat owners and charter captains participating regularly in Virginia's marlin and tuna fishery. The Cape Henry Billfish Club also helped fund a VIMS catch and economic study of recreational fishing boats using Rudee Inlet. The Rudee Inlet study is scheduled for completion in January.

In 1985, with NMFS funding restored, VIMS was asked again to contribute to a regional study of the recreational pelagic fishery from Virginia to New England. Researchers doubled weekly phone calls to interview boat owners and captains, and port samplers continued to interview fishermen dockside.

Offshore fishermen are accustomed to seeing the team of VIMS port samplers on the dock. Researchers ask them what kind and how many fish they caught, where they fished, how long they trolled, the number of lines they fished, and what baits they used. The samplers also ask whether the fish were released and help measure and weigh fish, frequently cooperating with tournament officials.

In her doctoral dissertation Bochenek will compare the strategies the VIMS researchers used for sampling fishery catches. Using data from 1983-85, she will determine which of three methodologies — mail survey, telephone calls, or dockside interviews — provides the most statistically precise information. She will measure the size, catch and effort, and socio-economic value of Virginia's recreational pelagic fleet in 1983-85. She will also attempt to correlate the catch and effort data on yellowfin tuna, bluefin tuna and white marlin to sea surface temperatures and the positions of the Gulf Stream and warm-core eddies.

Data collected by fishery biologists from New York to Virginia in 1983 revealed that in the ocean off these five Mid-Atlantic states, sportfishermen caught roughly 74,000 pelagic gamefish, or about 3 million pounds. Yellowfin tuna dominated the total catch by weight, and albacore was the largest species by number. By total weight of fish caught, Virginians caught more yellowfin tuna than in New York, New Jersey, Delaware and Maryland, although yellowfin were evenly distributed throughout the

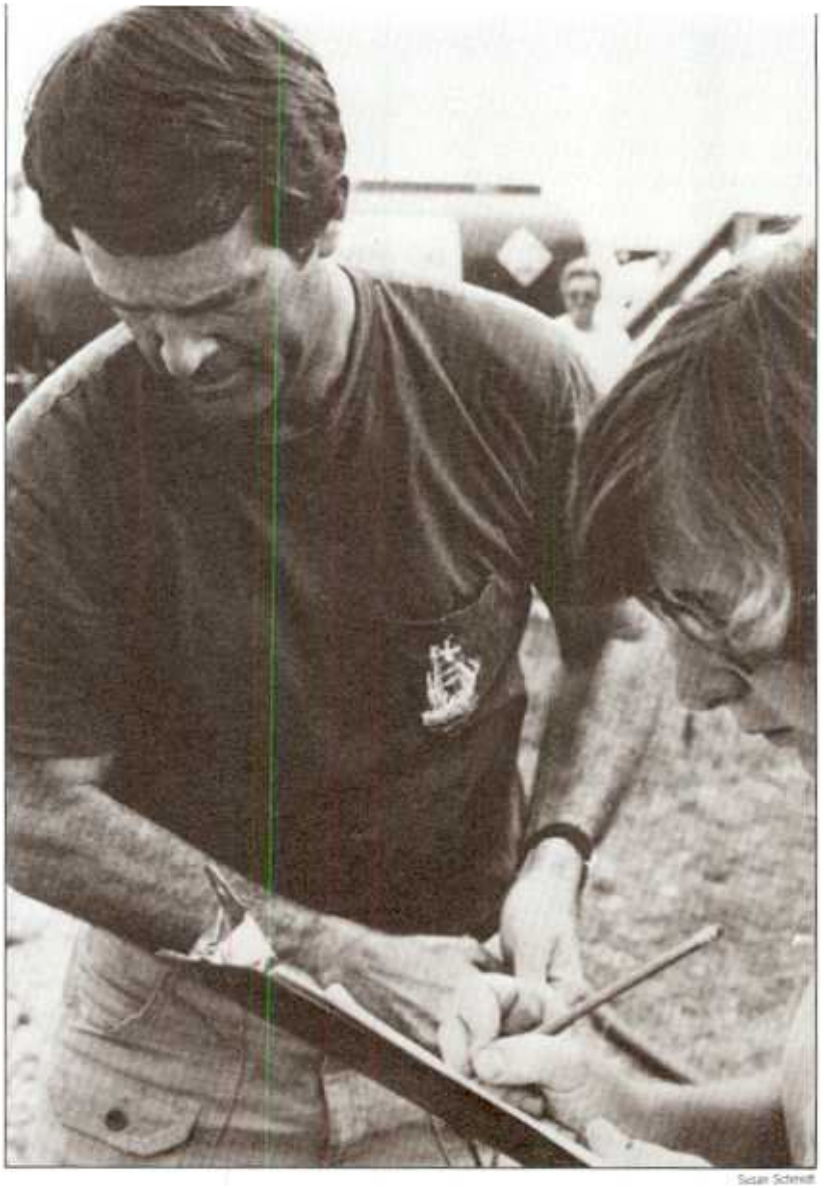
fishing grounds. Albacore and bigeye tuna were more abundant in the northern Mid-Atlantic off New Jersey and New York. Catches of white marlin, dolphin, and wahoo improved heading south and peaked in the Norfolk Canyon off Virginia.

The largest number of fish caught in Virginia was bluefin tuna (see Table 2). Virginia anglers catch young bluefin tuna in schools as they migrate along the Mid-Atlantic, mostly those between 14 and 135 pounds, but occasionally some over 135 pounds. Giant tunas over 310 pounds have yet to be caught off Virginia, although they are taken in recreational and commercial fisheries further north.

White marlin is the most numerous billfish in the Mid-Atlantic. In 1983 Virginia anglers caught more white marlin than in other states and had the highest rate, 82 percent, of releasing them alive. Blue marlin are much more rare, but Virginians caught the most blue marlin in the Mid-Atlantic, as well as the largest number of dolphin, wahoo and king mackerel.

Compared to anglers in other Mid-Atlantic states, Virginia sportfishermen enjoy a higher percentage of landing at least one gamefish per trip. They have more trips closer to shore, inside the 15-fathom depth curve, than other states. Of Virginia's fishing ports, Rudee Inlet had the most offshore trips; the next most popular ports in 1983 were Lynnhaven Inlet and Wachapreague.

Knowing participation trends and economic impacts of recreational fisheries helps states and their fishing ports in planning onshore fishing facilities. In 1983, 455 boats fished offshore for gamefish out of Virginia ports; of these 40 were charter vessels and 415 were private. The mean length of these boats was 30.4 feet, and the average cost was $66,356. Each boat carried rods, reels, line and lures worth an average of $3,871. In 1984, 666 boats fished for pelagic gamefish and estimates of their catch, effort and expenditures currently are being analyzed



Susan Schmidt

Jon Lucy and Eleanor Bochenek document fish catches at a tournament dock.

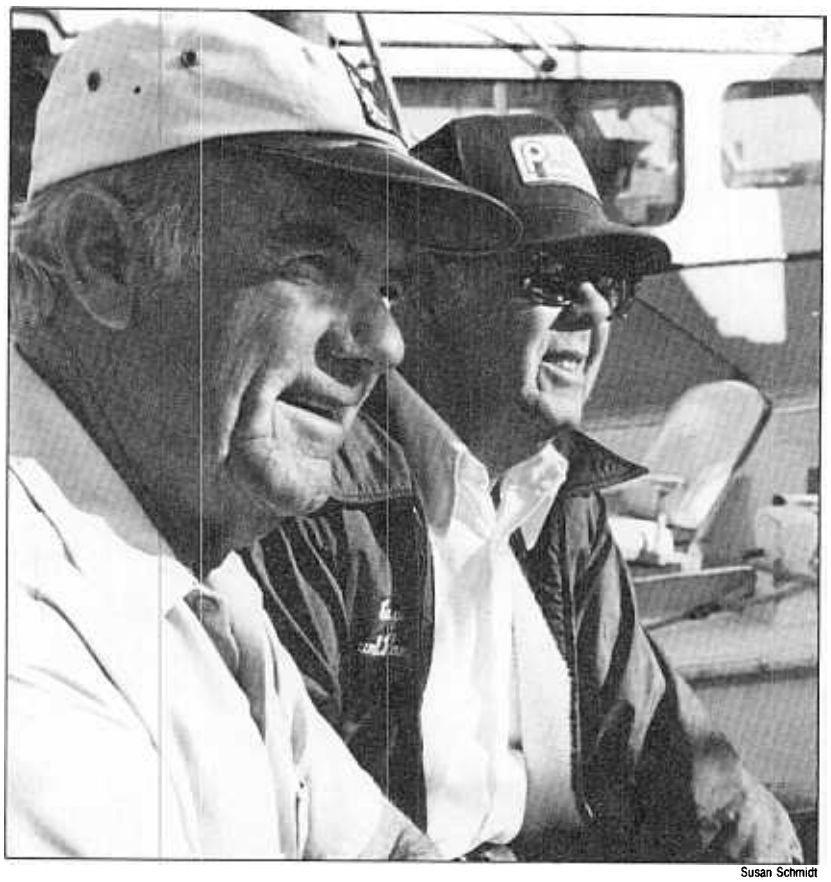
Estimated Recreational Catch of 1983 Offshore Pelagic Fish
Table 2

Species	VA	MD	Mid-Atlantic
Yellowfin	3,775	1,488	16,117
Bigeye	78	19	4,493
Albacore	48	420	20,451
Bluefin	4,904	5	12,801
White Marlin	1,839	693	5,131
Blue Marlin	123	15	276
Swordfish	*	6	92
Skipjack	781	139	3,571
Dolphin	3,236	751	6,567
Wahoo	919	109	1,200
King Mackerel	1,339	*	1,339
Mako	15	48	445
Blue Shark	*	*	208
Hammerhead	13	*	226
Other Sharks	*	25	1,082
Total	**17,070**	**3,718**	**73,999**

*too few to estimate

In 1983 the estimated annual fleet expenditures for the Virginia fleet was $7,416,000. This was divided among boat cost, storage, insurance, tackle, tournament fees, fuel, ice and bait. For an individual boat owner, the annual average cost of using a vessel for offshore fishing was $6,150; for maintenance – $3,929; for storage – $853, for insurance – $743; for tournament fees – $625. For each trip, a Virginia offshore angler spent an average of $167 on fuel and $35 for ice and bait.

Sportsmen are willing to spend a lot of time and money for the chance to catch marlin and tuna in the blue waters off Virginia's coast. Documenting the number of fish caught, the number of anglers, of boats, and boat trips and expenses, Lucy and Bochenek will assist NMFS and international management agencies such as ICCAT in their efforts to insure a healthy offshore recreational fishery. Furthermore, with this information, Virginia and its recreational port communities can better plan for maintenance and development of facilities for anglers.



Susan Schmidt

Brothers Ray (left) and Earl Parker have chartered out of Wachapreague since the 1930s.

Marlins make for exciting offshore fishing sport. This photo, also seen on cover, taken in the 1950's, is from the private collection of Captain Ray Parker of Wachapreague, Virginia.

Charter Captains Remember Days of More Fish

Offshore fishing, that occasional-to-frequent treat for residents and once-a-season highlight for tourists, is an everyday career for charter captains in Virginia's ports, Wachapreague and Rudee Inlet. There are good days and bad days when the sea is too rough or there are few fish. With a migrating natural resource like fish and with growing competition of more boats, there is no guarantee of a steady living. But charter captains would not trade their job for anything else.

"I like to be around people and I like to fish," said Captain Earl Parker of Wachapreague. "I've had lawyers and doctors tell me: 'I envy you; you're out here every day enjoying yourself.'"

Pride in learning the habits of fish and the secrets of the ocean keeps captains fishing. From their experience, each has opinions why fishing is good or bad. Most captains agree fishing is not improving; all have fine memories.

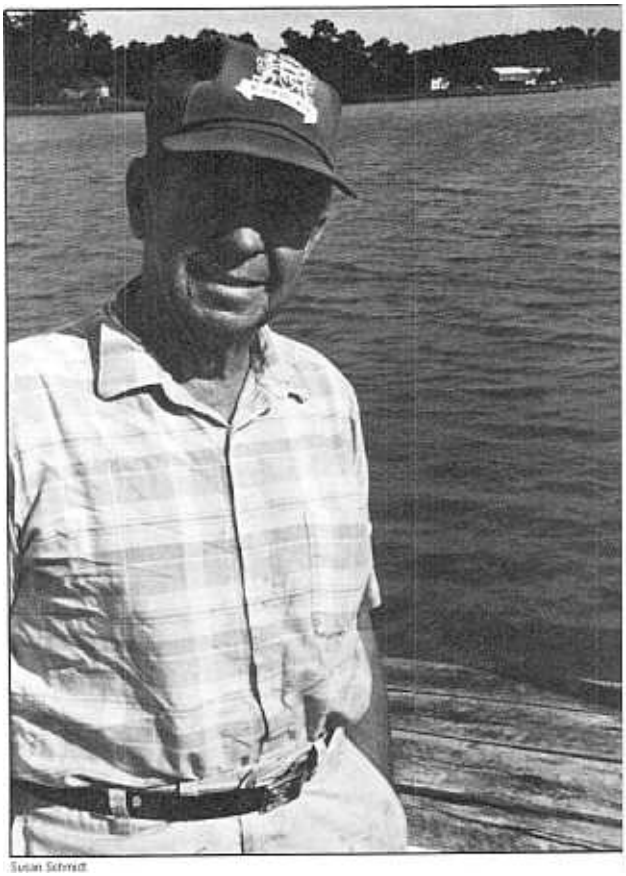
Chartering has been the life's work of brothers Earl, 67, on *Virnanjo,* and Ray Parker, 63, on *Sea Bird.* Like their father before them, they have chartered fishing parties out of Wachapreague since the 1930s.

Captain Earl is proud that he owned his own charter boat at 17 when he rebuilt a gun-club boat abandoned after a hurricane. He boasts that in the 40s he installed the first diesel engine and the first Loran on a charter boat.

"Why do I love fishing?" Captain Ray asked. "There's not a place on the face of the earth that has more wildlife than this Eastern Shore. On the way out through the marshes you get to see egrets, pelicans, railbirds swimming across the channel, mullets jumping. Out in the ocean we saw 50 leatherback sea turtles within one square mile at the end of August."

There's a lot of continuity. One of their father's customers, an 82-year-old lady from Pennsylvania, has been fishing with Captain Earl since 1936. Their customers return year after year. Since 1949 Ray has fished with four generations of a family from New Jersey — father, son, grandson and great-grandson.

Courtesy of Captain Ray Parker



Susan Schmidt

In this 1950's photo, Captain Ray Parker of Wachapreague holds up a white marlin he caught.

Captain Marshall Smith remembers 36-hour offshore fishing trips.

"When we started," Captain Earl said, "ten miles was as far as you had to go to find marlin. I once caught a marlin 5 miles from the beach."

"Some blame it on foreign long-liners, that marlin have moved farther off-shore," Captain Ray said. "I say currents have shifted in the ocean. Now we need to go to 100 fathoms to find Gulf Stream grass and debris that attract marlin. Another thing that's hurt us: there's less debris now that ships carry freight in containers instead of loose on deck."

Captain Marshall Smith, 65, on *Marsha Ann,* was one of the first 10 charter captains in Rudee Inlet in 1968. He started charter fishing in the Chesapeake Bay in 1945 and moved to offshore fishing in 1956. He would leave Back River in Hampton at 9 p.m. to get on the fishing ground at daybreak the next morning.

"When I started fishing offshore, I only had a compass, a 120-foot depth-sounding machine, and a direction finder to pick up Cape Henry to come home," Smith said. "Ten knots was good speed at the time. The Navy had a lighted buoy on the Cigar, a lump 60 miles southeast of Cape Henry. You had to get there before daybreak or you didn't find the buoy. When I could see the light flashing, I knew we'd catch big dolphin.

"One time on the first morning of a two-day trip we caught a 100-pound wahoo. The fish box was 8 feet long, so the fish had to be cut to be iced. During the day we talked to somebody else fishing. When we got to the dock the next evening, the newspaper people were waiting to see the record wahoo. When we put the wahoo on the dock less head and tail, a lot of faces dropped.

"On my first marlin trip out of Back River we caught five white marlin," Smith said. "In the late 1950s and 60s, it was nothing to raise 10 to 15 white marlin a day, catching from three to five. Just this past Labor Day weekend 60 boats from Rudee Inlet fished three days and caught about 13 white marlin.

"In one of the tournaments lately at Rudee Inlet a white marlin was caught with two hooks in its mouth, the third hook was left there. This marlin had probably been hooked at least 12 to 15 times.

"There's too many boats fishing now," Captain Smith said. "And with all the electronics, fish have no place to hide inside the 100-fathom curve."

At 28, Mike Romeo is captain of *Gannett* at the Virginia Beach Fishing Center. He started working on the dock there when he was 11 and for nine years has been a captain.

"Ten years ago I'd catch 50 bluefin a day. This year I've fished harder than I ever have," Romeo said, "and I'm just not catching anything. I've had 10 billfish all summer compared to 60 last year at this time.

"Granders, that's blue marlin over 1000 pounds, are hard to come by. I've seen three in my lifetime. One broke loose; one took all the line and we chased it for 23 miles. The record fish caught on my boat was a 1093-pound grander, caught the day before a tournament."

"It's not the fishing pressure, sports or commercial," he said. "The water's too warm. The fish won't come to the surface when it's 90 degrees. This year's slow; we had a great year last year; next year will be better."

Jack Musick

Jim Colvocoresses displays a shark caught on a VIMS research vessel.

Sportfishermen Aid Scientists in Shark Studies

For 10 years, partially under Virginia Sea Grant College Program funding, Virginia Institute of Marine Science (VIMS) fisheries biologists Dr. Jack Musick, Jim Colvocoresses and their students have been catching and examining sharks to learn about the ecology of "apex predators," that is, big fish at the top of the food chain.

Now, sportfishermen are teaming with the scientists to study sharks. Fishing for sharks is an exhilarating sport, and to assure a continuing supply of sharks, the Virginia Beach Sharkers club believes in conservation and research.

Sharkers Donate Sharks

Club members keep records of their catches, tag and release sharks, and donate fish for dissection to fisheries biologists at the Virginia Institute of Marine Science (VIMS). These scientists are studying sharks' life histories, distribution and abundance so agencies can better manage stocks and so fishermen can improve their catches.

At their annual tournament each July, the Virginia Beach Sharkers donate all fish brought in to VIMS. At the tournament dock in Rudee Inlet, Musick and his

Jack Musick

team help weigh-in the catch for the competition. Then the biologists measure and dissect sharks for their research. They remove vertebrae from aging sharks and collect the jaws of rarer species.

At another tournament the Virginia Beach Sharkers award a prize to the fisherman who has tagged and released the most sharks. The National Marine Fisheries Service (NMFS) follows shark migration by monitoring the age and location of the tagged sharks that are recaptured.

John W. Thurston, Jr., past president of the Virginia Beach Sharkers, holds the record for catching the largest shark in Virginia. In 1981 he caught a 1099-pound, 12-ounce tiger shark. That year a fisherman on Thurston's boat caught the only great white shark in Virginia waters. Virginia Sea Grant Marine Advisory Services plans to publish a manual by Thurston on shark-fishing strategies.

Fifteen Species Studied

Between 1973 and 1985 Musick and Colvocoresses have studied age, growth, reproduction, and feeding habits for 15 species of sharks in Virginia waters. Their longlining data have yielded frequency of occurrence by species, sex, habitat, size and season.

Sharks migrate south in the winter and return north when waters warm above 65 °F. Vast numbers of sharks congregate in the Gulf Stream near Oregon Inlet in North Carolina where surface water is still cooler than the Gulf Stream. By the end of June they move north to Norfolk Canyon. As summer progresses and surface waters warm on the continental shelf, the sharks spread out along the coast until the fall. In winter sharks take refuge again in large numbers along the west wall of the Gulf Stream. By October they are back at Hatteras.

In winter the spiny dogfish is almost the only shark in Virginia waters. In summer the most abundant species is the sandbar shark. The second most abundant species is the dusky shark.

Sandbar sharks grow slowly and have low reproductive potential. They mature sexually at about 16 years and then can have 10 pups a year or every other year for 10 to 20 years. Therefore, stocks must be carefully monitored to sustain a successful fishery. This long-term survey of sharks can help fishery managers understand shark life histories.

Female sandbar sharks have their pups in June in the lower Bay and in lagoons along the Eastern Shore. In an example of sharing resources, sandbars pup in lagoons, and dusky sharks in the shallow surf zone just offshore. Pups remain in estuarine nurseries until fall. Females move offshore to waters between 10 and 20 fathoms deep. Males stay offshore at depths greater than 20 fathoms.

Sharks are growing in popularity for both commercial and sportfishing. Foreign fishing vessels are restricted closer than 200 miles offshore, but U.S. commercial fishermen are catching sharks to meet the demand for sharks in Europe and Asia.

Trawling is the most efficient method of capturing small sharks. To catch large species of sharks, fishermen attach baited hooks to a longline at regular intervals. Gill nets can be set if populations of sharks are concentrated inshore.

Of 30 species of sharks that occur in Virginia waters, common species are bignose, blacktip, tiger, shortfin mako, lemon, and sand tiger. Although they are abundant, these sharks are not a significant threat in Virginia waters.

"There are only two documented, unprovoked shark attacks in Virginia," Musick said. "As an example, a 'provoked' attack may occur when a fisherman tangles with a struggling shark in the cockpit of a small boat. A real danger in shark fishing is from hooks on fishing lines."

At their annual tournament, the Virginia Beach Sharkers fishing club donates all sharks to VIMS scientists for their research.

Aerodynamic Scales, Hydrodynamic Fins

Sharks are fast swimmers, worthy of respect more than fear. Using skin samples collected at

Jack Musick weighs a dusky shark caught off Virginia's coast.

Tuna

Several species of tuna come to market fresh, frozen or canned. Light meat for the canning industry is yellowfin, skipjack or small bluefin. White meat is always albacore. Darker meats like bigeye or blackfin, although not marketed commercially, are savored where they are caught fresh.

For the best quality meat, when you land a tuna, make incisions above the tail, hang it to bleed and ice immediately. When filleting fresh tuna, cut out the bitter-tasting, dark meat along the median line.

Soaking darker-meat tuna in a salt "brine" solution leaches out blood. For best results, cook tuna one day, refrigerate overnight and serve hot or cold the next day. Tuna is large-flaked and moist. The amount of fat in tuna varies among species and seasons; do not overcook fish that is not fat. Tuna fillets freeze well for later use.

Giant bluefin are caught by Japanese longliners for the sashimi market. Sashimi is a generic Japanese term for raw fish, served in the United States at "sushi bars." Sushi are small balls of rice wrapped or topped with garnishes such as seaweed or raw fish. For sashimi, all fish must be prepared fresh and not frozen, and it takes skill to cut raw fish correctly. As a firm species, tuna is cubed to be served raw with a variety of sauces, like soy, vinegar or mustard. Raw bluefin has no fish flavor and resembles a slice of roast beef. Cooked it has a stronger, fishy taste.

Here's a recipe to prepare a tuna or other large fish. Because of the pickling effect of vinegar, escabeche has a shelf life of three weeks if refrigerated.

Escabeche

10 lbs. tuna cubes
4 cups olive oil
6 small onions
4 cups vinegar
2 tbsp. bay leaves
1 tbsp. black peppercorns
12 garlic cloves
1 tbsp. red peppers
1 tsp. cumin seeds
1 tsp. marjoram
3 cups salt

Wash small portions of tuna, drain and soak in 90 percent brine for an hour. Wipe dry. Sauté in olive oil with crushed garlic, 6 bay leaves and a few red peppers. Remove the fish when it is light brown and cool. Cook onions in oil until yellow. Add vinegar, whole black peppers, cumin seeds and marjoram and cook slowly for up to 30 minutes. Pack the cold fish and sauce in sterilized jars with the remaining red peppers and bay leaves. Close tightly. Escabeche is traditionally served with potatoes boiled in their skins with branches of oregano.

As the winter range of these gamefish is tropical, many recipes have a Mediterranean flavor of Spanish and Italian seasonings like olive oil, oregano, garlic, parsley and pepper.

Braised Tuna with Red Wine

2 lb. tuna steaks
2 tbsp. salt
3 tbsp. olive oil
3 tbsp. tomato puree
2 green Italian peppers
¼ cup chopped parsley
pepper
4 tsp. fines herbes
1 cup dry red wine
4 large scallions
butter
2 tsp. capers

Soak tuna steaks in a brine of 2 tablespoons of salt in 4 cups of water for an hour. Rinse tuna and pat dry. Cover the bottom of a flat baking dish with olive oil, chopped scallions, peppers, parsley, salt and pepper. Arrange tuna steaks in a single layer; sprinkle with pepper and fines herbes and pour wine around the steaks. Cover the dish with an oiled sheet of foil, perforated so steam can escape. Braise in a preheated 375°F oven for about 40 minutes. Puree the liquid and vegetables in a blender, then heat with tomato puree in a saucepan. Spoon puree over tuna on a serving platter and sprinkle with capers. Serve with rice or pasta and broiled fresh tomatoes coated with crumbs and Parmesan cheese. Serves 6.

For a free copy of the pamphlet *Making the Most of Your Catch... THE BLUEFIN TUNA,* write Sea Grant Communications, VIMS, Gloucester Point, VA 23062. ≋

sportfishing tournaments, Musick and his colleagues are analyzing the hydrodynamic aspects of shark scales. In a cooperative research program with engineers at the National Aeronautics and Space Administration (NASA), they are observing how the surface microstructure on scales overcomes drag in the water.

VIMS scientists measure the dimensions of microscopic ridges and valleys on each individual shark scale. They have compared the surface structures from 15 species to a theoretical model of drag reduction developed by NASA engineers. Then the engineers at NASA test their formulae in wind tunnels. Their tests have confirmed that grooved scales of some shark species reduce frictional drag 10 to 15 percent more than smooth scales would.

NASA has contracted the 3M Company to develop a grooved tape to attach to the fusilages of planes. This application is expected to save millions of dollars of fuel a year just on NASA airplanes. Another use for reducing friction may be on hulls of racing sailboats.

Apparently the angle at which sharks swim upward in water can be compared to the angle of ascent of airplanes taking off. In a second study with NASA, Musick and his colleagues are measuring the drag reduction caused by the scalloped edge of the trailing edges of fins of sharks, marlins and tunas. The first models tested in the NASA wind tunnel show that structural mechanisms like scalloped fins can reduce drag by 10 to 15 percent more than straight edges.

This teamwork among sportfishermen, VIMS scientists and NASA engineers can produce valuable information for recreational and commercial fishermen and better management of fish stocks. The new understanding of aerodynamic and hydrodynamic principles may lead to significant fuel economies in boats and aircraft. ≋

Satellites Help Fishermen Find Fish

Space-age technology is helping fishermen find fish. Images provided by satellite scanning sensors chart sea surface temperatures and Gulf Stream eddies that identify warmer water areas where pelagic gamefish school. With these satellite images, sophisticated marine electronics and faster boats, fishermen and fishing parties can enjoy more accurate navigation, better fish-finding capability and greater day-trip range.

Sea surface temperature affects the distribution and abundance of pelagic fishes like marlins, tunas and sharks; each species prefers a narrow range of temperatures (see Table 3). They move north as waters warm; some species summer off Virginia's coast and others pass through Virginia waters migrating further north.

Along the Atlantic coast of the United States fishermen catch pelagic gamefish in the warm, blue waters of the Gulf Stream. The Stream flows in a northeasterly direction at varying distances from shore. The waters of the Gulf Stream have warmer temperatures and different salinities than surrounding waters on the continental shelf. Tunas group together at frontal edges, or boundaries between water masses, where temperature changes occur over short distances. Satellite weather charts are available so that a fisherman can know the location of thermal gradients to locate concentrations of fish.

Satellite scanning sensors measure temperature by detecting infrared radiation emitted from the sea surface. Twice a day, polar-orbitting satellites pass over the western Atlantic Ocean at an altitude of 600 miles. Satellite sensors cannot see through thick cloud cover, so the scanning success rate is 75 percent in summer and 25 percent in winter.

Satellites also can detect warm- and cold-core eddies that break off from the Gulf Stream. Fishermen can use the location of eddies to find concentrations of pelagic gamefish. Warm rings usually form on the shoreward side of the Gulf Stream. They spin clockwise and move southwest 2 to 4.5 nautical miles a day until they are reabsorbed by the Gulf Stream near Cape Hatteras.

Cold rings, colder than surrounding water, are formed on the offshore edge of the Gulf Stream and spin counterclockwise in a haphazard path. Cold-core rings last three or four months, much longer than warm-core eddies.

Satellite charts of sea surface temperatures and Gulf Stream eddies are available by subscription. For $16, anyone can receive charts twice a week of the position of surface thermal fronts and isotherms (lines of equal temperature) plotted on a mercator grid of the Western North Atlantic. Oceanographic analysis charts showing Gulf Stream eddies are available for $65 a year. For both of these services, write NOAA/NESDIS/NCDC, Satellite Data Surface Div.; World Weather Bldg., Room 100; Washington, DC 20233.

Fishermen that have a thermal copier with a telephone modem can get a computer printout of temperature and eddy charts for the cost of a phone call. Between 8:30 a.m. and 1 p.m. from Monday to Friday, call NOAA weather at (301) 899-1139 for sea surface thermal analysis charts.

Also by telecopier, the Mid-Atlantic Marine Information Service at the University of Maryland can provide weather data including local Chesapeake Bay reports, inshore and offshore forecasts, sea surface gradients, tropical storm advisories, sea buoy data and notices to mariners. The number is (301) 454-8700.

Water Temperature Ranges for Saltwater Fish
Table 3

The table lists lower and upper water temperatures preferred by saltwater gamefish species caught off Virginia's coast. The range column lists temperature limits favorable for angling.

Species	Lower	Upper	Range
Albacore	59°F	67°F	62°-65°F
Amberjack	60°F	72°F	63°-67°F
Dolphin	69°F	80°F	73°-77°F
Marlin, Blue	69°F	88°F	75°-80°F
Marlin, White	62°F	84°F	66°-76°F
Sailfish	79°F	88°F	76°-81°F
Shark, Mako	60°F	78°F	65°-72°F
Tuna, Bigeye	55°F	68°F	60°-65°F
Tuna, Blackfin	70°F	82°F	72°-79°F
Tuna, Bluefin	50°F	82°F	61°-67°F
Tuna, Skipjack	63°F	86°F	68°-82°F
Tuna, Yellowfin	60°F	80°F	73°-77°F
Wahoo	68°F	85°F	72°-80°F

Reprinted courtesy of *Salt Water Sportsmen*

Now You See Them, Now You Don't

Marine Schoolhouse Series No. 25

by Mary Sparrow
Sea Grant Marine Educator

We know from ancient carvings, drawings, and fossils that fish were an important food resource to our ancestors. There is evidence already that fish, as a source of protein, will be increasingly important to our descendants. In addition to being used as food, fish and fish by-products are used for a number of commercial products. Fish oils, for example, are used in manufacturing medicines, cosmetics and paint. Non-food parts of fish are ground into fish meals to feed livestock and fertilize crops. Fish by-products are used in the process of making wine and beer, and also to make glue. Fish skins are used sometimes in the same way as leather.[1]

Recreational fishing is an important industry in itself. The sport catch in Virginia and Maryland is estimated at 35 million fish or more annually. Marinas, fishing guides, charter and head boats, boat and engine dealers, bait and tackle shops, and the fuel industry are primary examples of businesses that profit from recreational fishing activities.

Obviously, harvesting fish from the sea is important to our country's economy and to the world's food supply. Is it possible to over-exploit economically important species? Could entire species become extinct? How could such a thing happen? In 1883, a famous scientist said " . . . probably all the great sea fisheries are inexhaustible, that is to say nothing we do seriously affects the numbers of fish."[2] Of course in 1883, there was no 20th Century pollution, no motorized fishing vessels, no electronic fish-finding equipment, and there were fewer boats using less efficient methods to catch fish. We know today that our activities can affect the numbers of fish.

Because of their importance, fish stocks need to be conserved and managed for optimum harvest yields. Therefore, a new field of science is growing — fish management. Fishery management involves the study of fish biology and behavior, the factors influencing the survival and growth of fish stocks and the making of rules about how humans interact with these stocks. The goal is to maintain healthy stocks while allowing humans to meet their needs. The following game allows you to be a fishery manager. As you play you will learn what factors can influence fish stocks.

The game.[3]

You will need paper and pencil, calculators (optional) and dice — one per player, and a deck of "condition" cards. Copy one statement per condition card. The numbers in parentheses tell how many of each card to make.

Procedure.

1) Each player manages a stock of 100 fish to begin the game. This is the habitat's carrying capacity. 2) Each player adds or subtracts from his/her stock according to the statement read aloud from the condition card and the roll of his/her own die. Use paper and pencil to record the numbers you add and subtract from your starting 100 fish.

For example, your condition card reads "Your stock's habitat has suffered a decline in quality. Decrease your stock by the % = 5 x your roll." Every player rolls his/her own die and subtracts the appropriate % from the stock balance. Say one player rolls a 6. That player subtracts 30% (6 x 5) from his/her balance (if starting with 100, (100/1 x 30/100) = 30; 100 – 30 = 70 new balance). Another player may have rolled a 2. 2 x 5 = 10 (%), (100/1 x 10/100) = 10, 100 – 10 = 90 new balance. 3) The game is played for 30 minutes. Any player whose stock reaches less than 2 or more than 200 must drop out of the game. Read as many cards as possible in the 30 minutes, but make sure everyone has time to work his/her calculations. The player(s) that have a remaining stock between 2 and 200 are successful managers.

Some things to think about. Is fishery management necessary? Why or why not? What natural events may affect stocks? What types of human interactions can affect stock size? Are all human influences negative? What types of management activities were mentioned in the game? Can you think of any other possible options for controlling population sizes? Would those options usually result in a decrease or increase in stock size? What part of the game seemed unrealistic or unnatural (Clue: dice)? Why? What role does chance play in the natural fluctuations (changes) in a stock size? Does chance play a role in fishery stock management as it does in the game? Why or why not?

Condition Cards

Copy one statement per condition card. The numbers in parentheses tell how many of each card to make.

It appears to have been an excellent reproduction year. Increase your stock by the % = 5 x your roll. (5)

This has been an average reproduction year. Increase your stock by the % = 3 x your roll. (10)

Severe weather conditions have had a negative impact on stock survival. Decrease your stock by the % = 4 x your roll. (2)

Mild weather has lengthened fishing time this season. Decrease your stock by the % = 3 x your roll. (3)

The food resources for your stock have suffered a serious decline in your area. Decrease your stock by the % = 2 x your roll. (3)

Habitat improvement has increased your stock by the % = 3 x your roll. (2)

Your stock's habitat has suffered decline in quality. Decrease your stock by the % = 5 x your roll. (5)

Foreign fishermen are fishing in your area a lot. Decrease the number of your stock by the % = 5 x your roll. (2)

A quota has been set on the number of fish that can be harvested. Increase your stock by the % = your roll. (3)

Time (seasonal) and area restrictions have reduced the size of fish harvest. Increase your stock by the % = 5 x your roll. (5)

More effective harvesting gear has been approved by the regulatory agency. Decrease your stock by the % = your roll. (5)

Strong pressure by recreational fishermen has resulted in your stock area being closed to commercial fishing. Increase your stock by the % = 5 x your roll. (5)

A regulation requiring "catch and release" has had a positive impact on your stock size. Increase your stock the % = 2 x your roll. (1)

Improvements in catch and release methods have improved survival rates. Increase stock size by the % = your roll. (1)

U.S. management plan is created for your stock. Increase stock size by the % = 10 x your roll. (5)

Fishermen are getting more money per pound for fish caught, resulting in more intensive fishing. Decrease your stock by the % = 3 x your roll.

Definitions

carrying capacity — the greatest number of organisms (animal or plant) of a given species that can be supported by a given habitat, under given conditions.

catch and release — the capture of organisms and then their release without harm, if possible; some organisms will die from catch injuries or stress.

exploit — to use for profit.

extinction — the condition of having been removed from existence; vanished from our world.

habitat — place where an organism lives; has food, water, shelter and space to meet its needs.

harvesting — gathering of natural resources for people's use, such as in fishing or hunting.

manage — to control and change the harvesting of organisms and habitats to keep healthy stock and reasonable numbers of organisms for human use.

species — population of individuals more or less alike, able to mate and reproduce offspring that are able to reproduce.

stocks — groups of the same or similar species, usually born in the same general geographical area and kept together by biological, physical (water temperature, currents, etc.) and/or geological "barriers" (not necessarily visible barriers).

[1] Norman, J.R. 1975. A History of Fishes. Ernest Benn Limited, London, England pp. 408-409.
[2] Norman, p. 410.
[3] Game concept from Western Regional Environmental Education Council. 1983. Project Wild-Elementary Activity Guide. pp. 147-150.

The Marine Schoolhouse Series for grades K-12 is published by Sea Grant Marine Advisory Services, VIMS, Gloucester Point, VA 23062.

COMMUNICATIONS

Bay Education Resources Directory

A team of Bay educators has produced the *Chesapeake Bay Education Resources Directory,* compiled by Mary Sparrow, Sea Grant marine educator at VIMS.

The directory locates information sources, field guides, curriculum materials, audio-visual aids, computer software, field trips, special opportunities, organizations and publishers. The directory is designed to assist educators in integrating Chesapeake Bay education into most curricula.

Copies of *Chesapeake Bay Education Resources Directory* are available for $4.00 each from Sea Grant Communications, VIMS, Gloucester Point, VA 23062.

Marine Mammals Field Guide

Sea Grant Marine Advisory Services recently published *The Marine Mammals of Virginia,* by Robert A. Blaylock. The 34-page field guide has 15 illustrations that identify whales, dolphins, porpoises, seals and manatees.

Blaylock is the marine mammal stranding coordinator at the Virginia Institute of Marine Science (VIMS). According to Blaylock, the primary indication of marine mammals' presence in Virginia waters comes from strandings. All three orders of marine mammals — whales, dolphins, and porpoises; seals and sea lions; and manatees — have been found stranded on Virginia's shorelines. All marine mammals, even if not listed as endangered, are protected by federal law. Whether dead or alive, stranded marine mammals should be reported to VIMS at (804) 642-7000 or the National Marine Fisheries Service at (804) 723-4013.

Copies of *The Marine Mammals of Virginia* are available for $1.00 each from Sea Grant Communications, VIMS Gloucester Point, VA 23062.

Sportfishermen's Forum Set

The fourth annual Virginia Sportfishermen's Forum will be held Sat., Feb. 8, 1986, at the Virginia Beach Pavillion. The Forum will coincide with the first day of the Mid-Atlantic Boat and Sport Show, allowing anglers to attend both events. The Forum agenda will be available in January from Sea Grant Marine Advisory Services, VIMS, Gloucester Point, VA

Fish Havens Chart

Virginia Sea Grant Marine Advisory Services at VIMS is reissuing the chart, *Fish Havens off Cape Henry, Virginia.* Compiled in cooperation with the Virginia Marine Resources Commission's Artificial Reef Program, the 19" x 36" chart identifies reefs, wrecks and obstructions in an area from the mouth of the Chesapeake Bay south to False Cape and 30 miles offshore. Loran C coordinates are provided for artificial reefs and for certain wrecks well-known to fishermen and divers. Copies of the chart are available for $1.00 each from Sea Grant Communications, VIMS, Gloucester Point, VA 23062.

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