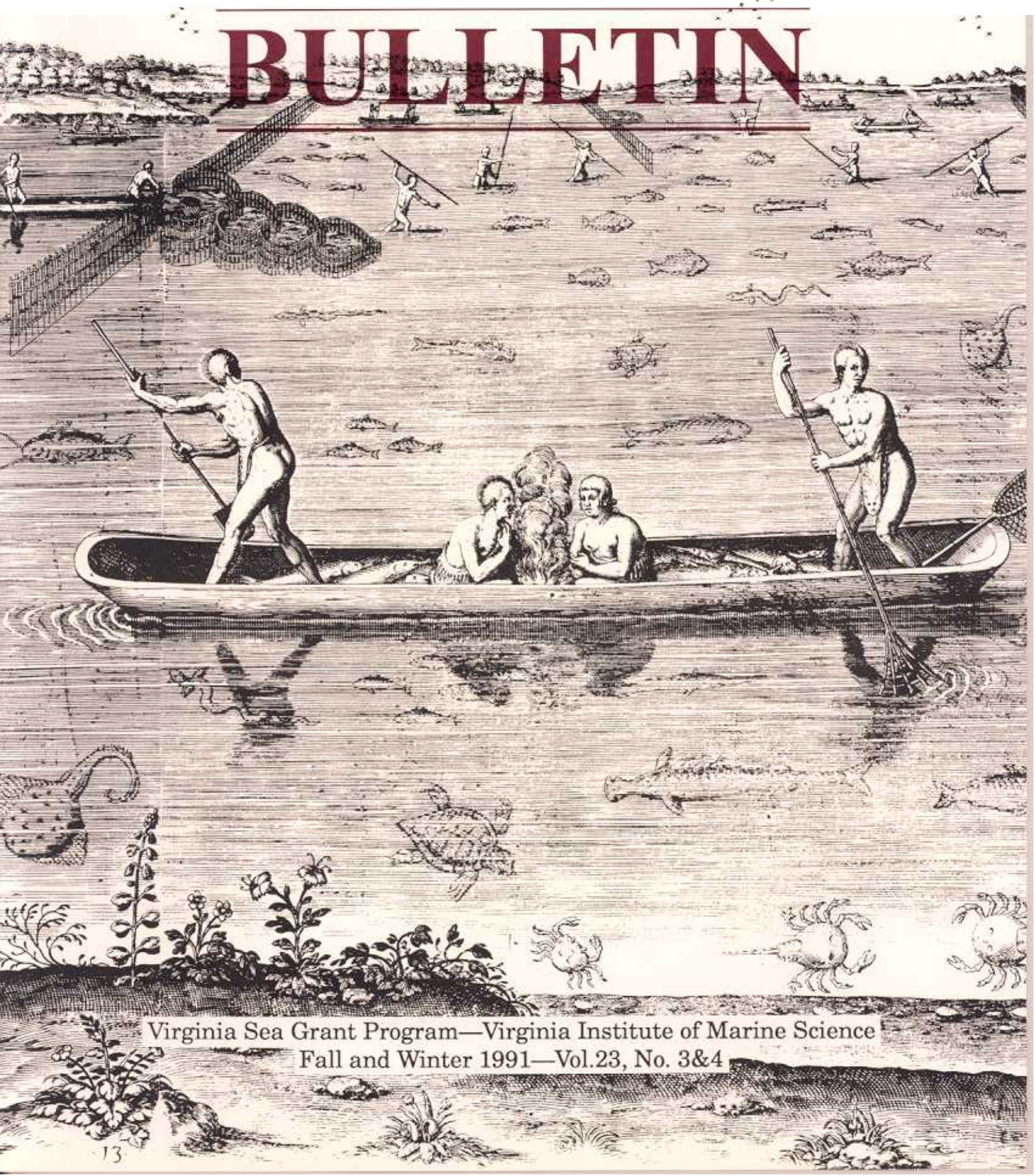
Virginia MARINE RESOURCE BULLETIN



Virginia Sea Grant Program—Virginia Institute of Marine Science
Fall and Winter 1991—Vol.23, No. 3&4

Virginia
MARINE RESOURCE
BULLETIN

DR. DENNIS L. TAYLOR
Dean and Director
Virginia Institute of Marine Science

DR. WILLIAM RICKARDS
Director
Virginia Sea Grant College Program

DR. WILLIAM D. DUPAUL
Director
Marine Advisory Program

Fall/Winter 1991 Vol. 23, No. 3&4

Contents

10 YEARS OF EXCELLENCE

Susan C. Waters, Editor, Writer and Designer
Janet G. Walker, Typography
Kay Stubblefield, Graphics

The Marine Resource BULLETIN is a quarterly publication of Marine Advisory Services of the Virginia Sea Grant College Program which is administered by the Virginia Graduate Marine Science Consortium with members at the College of William and Mary, Old Dominion University, University of Virginia and Virginia Polytechnic Institute and State University. Subscriptions are available without charge upon written request.

Sea Grant is a partnership of university, government and industry focusing on marine research, education and advisory service. Nationally, Sea Grant began in 1966 with passage of the Sea Grant Program and College Act.

The Great Migration

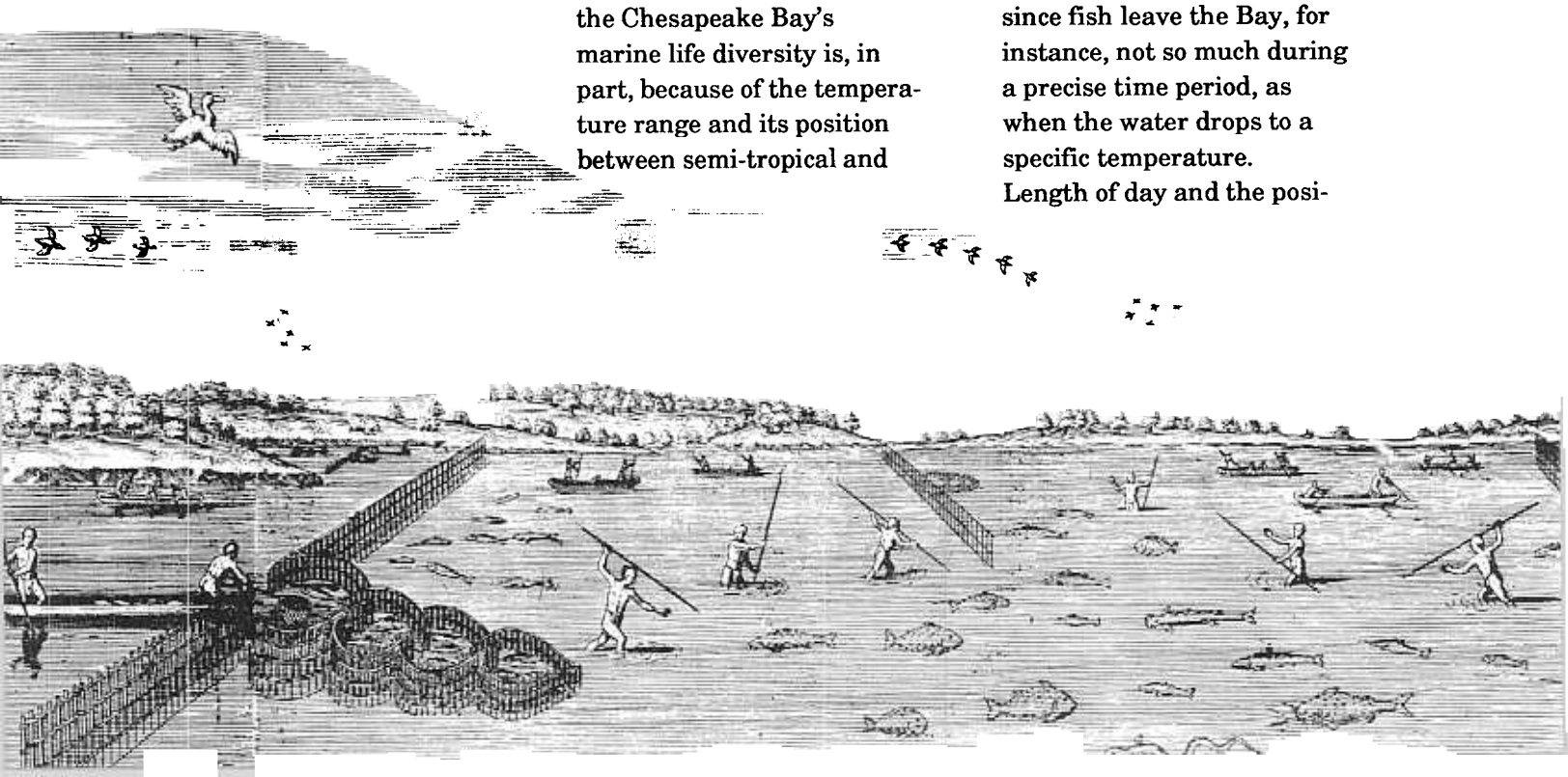
As terrestrial animals we readily witness the seasonal migration of birds, but few people know that even more of a fabulous, truly spectacular procession is taking place in coastal areas as marine animals move up and down the Atlantic coast and oftentimes into the Chesapeake Bay.

Virginia's offshore and Chesapeake Bay waters are wedged between two very different biogeographical areas, regions with different species of plants and animals. For this reason, Virginia is often the northern limit for semi-tropical fish and the southern boundary for cold-water species.

Among estuaries, the Chesapeake Bay is unique. Few parts of the world possess an estuary of this size and temperature range, from near freezing in winter to surface temperatures of 80°F in summer. The key to the Chesapeake Bay's marine life diversity is, in part, because of the temperature range and its position between semi-tropical and temperate waters. The Bay in any one year can be home to species from either zone.

Over 200 species of fish have been found in the Chesapeake Bay, some traveling from as far away as South America. Only a few species are permanent residents in the estuary; up to 80 percent of the fish present are temporarily utilizing the Bay for feeding, spawning and/or nursery grounds. During spring, summer and fall, fish are abundant. During the winter, the Bay is, relatively speaking, a fairly desolate place.

The migrational path up the Atlantic coast is a temperature, food and often reproductive-driven quest. While the mechanisms which spur migration have not been determined with all certitude, several factors are believed to be responsible. Temperature ranks high since fish leave the Bay, for instance, not so much during a precise time period, as when the water drops to a specific temperature. Length of day and the posi-



tion of the sun are also suspected prompts. The movement of a species could be attributed to one, or a combination of cues, or could even be determined by that all-important factor: food. When bay anchovies move out of the Chesapeake Bay, bluefish fall in fast behind, pursuing their food source.

The continental shelf, metaphorically speaking, could be likened to a 12-lane highway in parts, only to narrow down to a country lane around Hatteras, North Carolina.

During the journey up the coast, many species hug the Atlantic's continental shelf. The food sources they need are there, as is the optimum temperature range. Each species operates at optimum efficiency within a specific temperature range. Although a species could, for a short while, tolerate much colder or warmer temperatures, the fish would tend to seek out a certain temperature range.

The continental shelf, metaphorically speaking, could be likened to a 12-lane highway in parts, only to narrow down to a country lane around Hatteras, North Carolina. Because the shelf is so narrow around Hatteras, a great number of animals must traverse narrow straits, making environmental decisions about these areas of concern and importance.

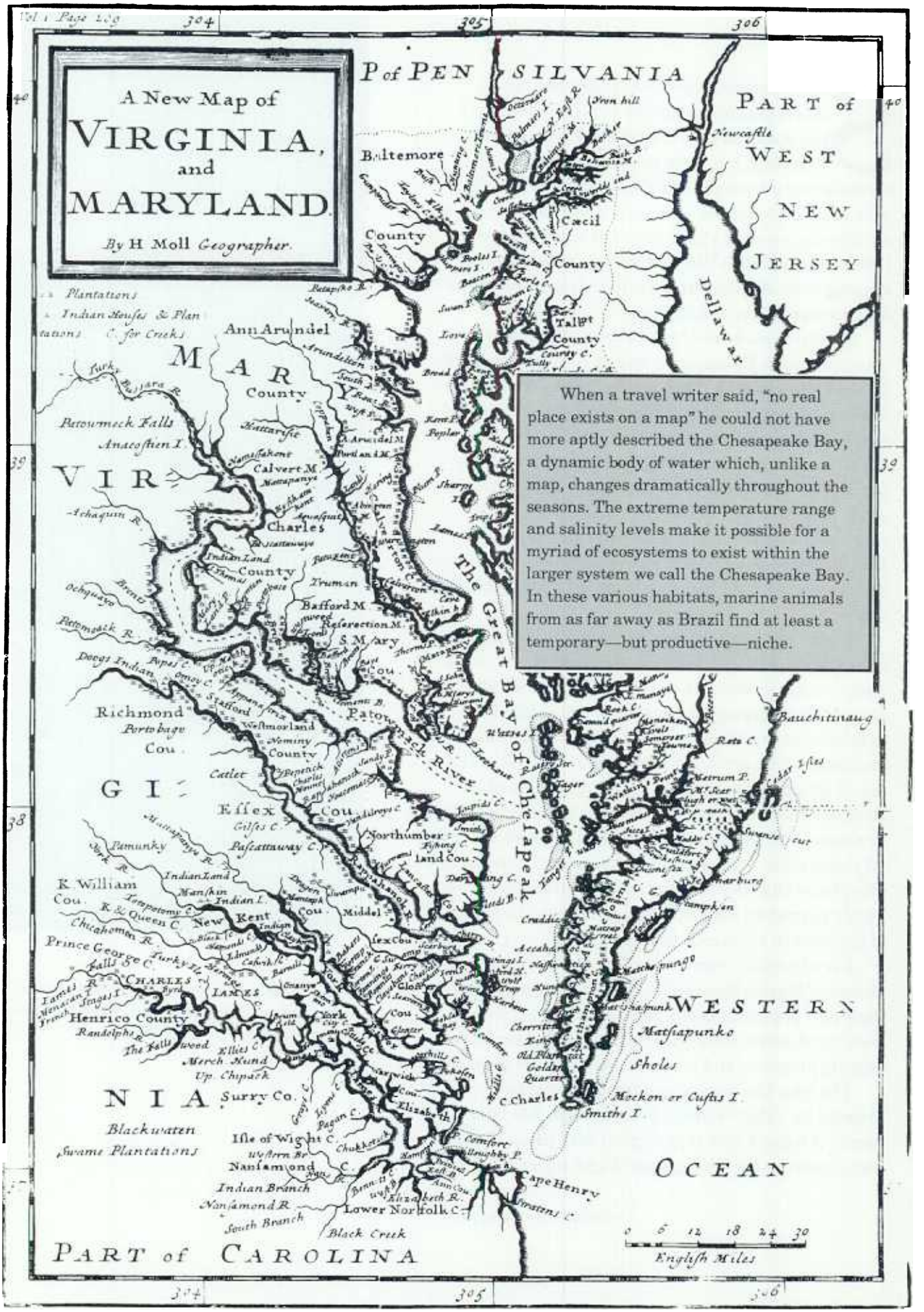
To detail every species found in Virginia's offshore waters or in the Chesapeake Bay is beyond the scope of a magazine and would, in fact, be a difficult book to write. Likewise, to detail all the research which in this case is applicable, is not possible. The intent in this issue of the *Marine Resource Bulletin* is to paint a portrait of the Chesapeake Bay and Virginia's offshore waters in broad strokes, hoping to foster an image of this area as a dynamic entity, of enormous ecological importance.

❖ ❖ ❖

A number of the articles included in this issue of the *Bulletin* indicate that many species are declining in abundance. This is not unique to the Chesapeake Bay. Rather, it is a worldwide trend, as increasing pressure is placed upon natural resources.

Over the past decade, reports of declining or threatened resources have multiplied. At times it was difficult for non-scientists to ascertain whether environmental doom was impending or if many of the reports could be dismissed as part of a "chicken little " syndrome—the environmental sky is falling.

Environmental viewpoints and prejudices aside, the role of the Virginia Institute of Marine Science and agencies like it has been to record the changes which have occurred, and to assist in assessing the stocks as accurately as possible. This sounds uncomplicated, infallible. However, maintaining continuous records has often become an uphill battle; in times of environmental apathy or during periods of fiscal austerity, the need to monitor marine life has not always been given priority. Credit should be given to the many scientists who have, year after year, managed to secure funding, under sometimes difficult circumstances. Without uninterrupted records natural fluctuations in a stock might be misleading. Conversely, a sudden downward trend might not be detected until too late.



When a travel writer said, "no real place exists on a map" he could not have more aptly described the Chesapeake Bay, a dynamic body of water which, unlike a map, changes dramatically throughout the seasons. The extreme temperature range and salinity levels make it possible for a myriad of ecosystems to exist within the larger system we call the Chesapeake Bay. In these various habitats, marine animals from as far away as Brazil find at least a temporary—but productive—niche.

Sharks, made larger than life by the movie *Jaws*, appear so capable of the challenges of the open sea that it might not occur to some that they, too, need protected areas for reproductive purposes. The Chesapeake Bay is one such area, occupied seasonally by a number of species, notably the sandbar shark (*Carcharhinus plumbeus*). Other sharks utilize Virginia waters, with the areas ranging from offshore, in the estuary itself, and even up into some of the tributaries.

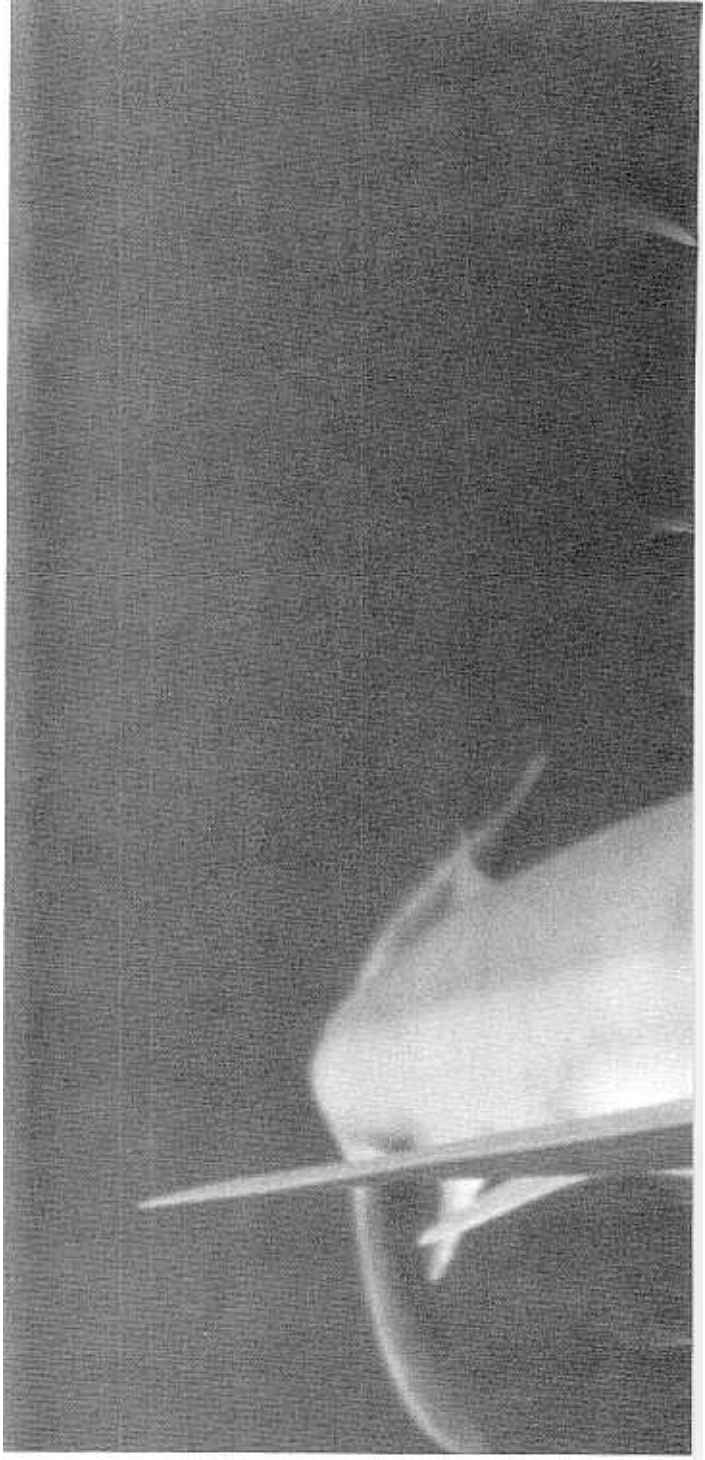
Sandbar sharks are by far the most pervasive, using the lower Chesapeake Bay as a nursery ground. The bays, inlets, and barrier island areas of the mid-Atlantic region, from the Chesapeake Bay to New Jersey, are a major nursery ground for this species. Juveniles occupy these areas during the summer for the first several years of life, moving offshore and south in winter and returning in the spring. The range of the sandbar shark is from New England to Brazil. These animals are also found in plentiful numbers in the Gulf of Mexico and support a large fishery there.

For all the fear that sharks inspire in the popular imagination, biological facts make a number of shark species quite vulnerable—to overfishing. A shark's reproductive strategy is to produce a few, highly developed animals—as opposed to a striped bass, for instance, which produces a prodigious amount of eggs, few of which survive to maturity. In the case of the sandbar shark, a female will become sexually mature at about 15-20 years, producing then between six and 10 young after a one-year gestation period. Low fecundity places sharks at a disadvantage and so does their highly migratory nature: they can become the target of fisheries in numerous countries.

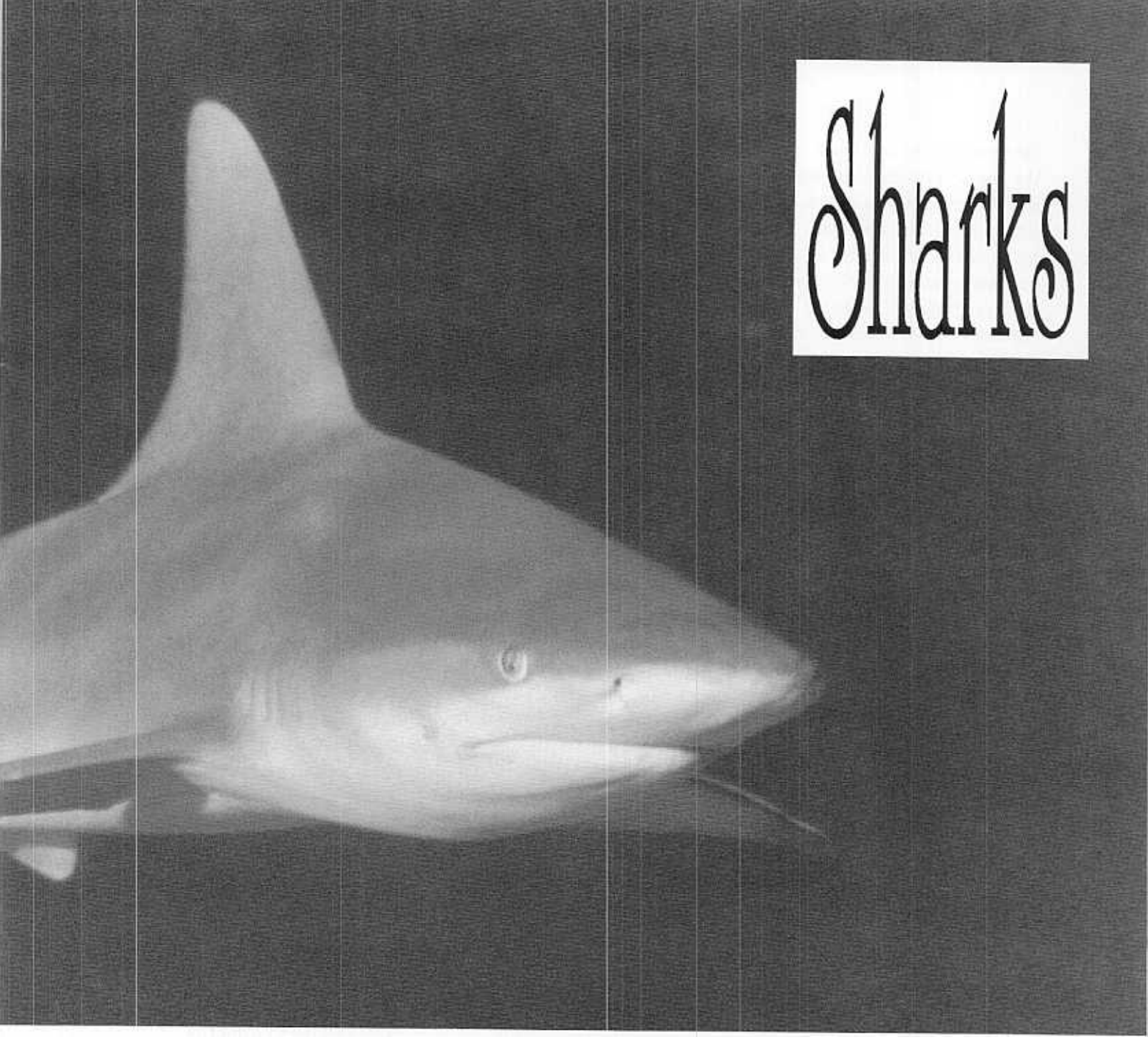
For almost 20 years, scientists at the Virginia Institute of Marine Science (VIMS) have been monitoring shark populations and their abundance. Two basic approaches were used: a long-line survey and tagging program; and most recently, genetic research.

The long-line survey and tagging program, directed by VIMS scientist John Musick, has been the source of a great deal of biological data about shark populations in the Chesapeake Bight region. The

continued on page 8



Carcharhinus plumbeus, *the sandbar shark. Photo by Frank Murru© of Sea World in Orlando, Florida.*



Sharks

Continuous monitoring is clearly the best way to assess what is happening to a species. What outsiders may not realize is that in the arena of science, funding sources can dissipate as rapidly as they appeared, often making long-term studies difficult.

Many sources have been responsible for maintaining an uninterrupted shark survey at the Virginia Institute of Marine Science. Virginia Sea Grant played a role when it supported research by Jim Colvocoresses and John Musick. Their work provided the groundwork for a limited spiny dogfish (*Squalus acanthias*) fishery.

Spiny dogfish may be small sharks, but they are capable of major predation on commercially important fish. As a consequence, control of spiny dogfish is considered important in maintaining ecological balance.

The Sea Grant research on sharks also added to the VIMS database on other shark species. It is interesting to note that Colvocoresses and Musick warned then, a decade ago, that fisheries for shark species other than *Squalus acanthias* be pursued on a small scale and in an exploratory manner—if at all. Recent reports (see article on the left) indicate that shark stocks in the mid-Atlantic region have declined. . .just as VIMS scientists predicted.

information gleaned from the survey and tagging program is an indicator of the different species which are present, the size of the various populations, the age groups which are utilizing various areas for feeding or pupping, and the type of foods the sharks are pursuing. This type of long-term survey takes on even more importance as the federal government prepares a shark fishery management plan for the East Coast. Without a meaningful assessment of the shark stocks, management plans would obviously be hindered.

In a technical report analyzing the long-line data since 1974, scientists John Musick, Steven Branstetter and James Colvocoresses indicate that the majority of shark stocks in the Chesapeake Bight region experienced a substantial, three-fold decline in abundance. An apparent reduction was evident among the most common species, including the sandbar, dusky (*Carcharhinus obscurus*), sand tiger (*Carcharias taurus*), tiger (*Galeocerdo cuvier*), and Atlantic sharpnose (*Rhizoprionodon terraenovae*) sharks. VIMS scientists suggest that continued unregulated exploitation will cause a total stock collapse for which recovery will probably require decades.

In the report researchers attribute the shark stock decline to many factors, the most obvious of which is a lack of timely management. During the last few decades sharks have been subject to more fishing pressure from recreational anglers and increased commercial fishing efforts. An expanded swordfish and tuna long-line fishery in the late 1970s and early 1980s also resulted in more sharks becoming part of the by-catch.

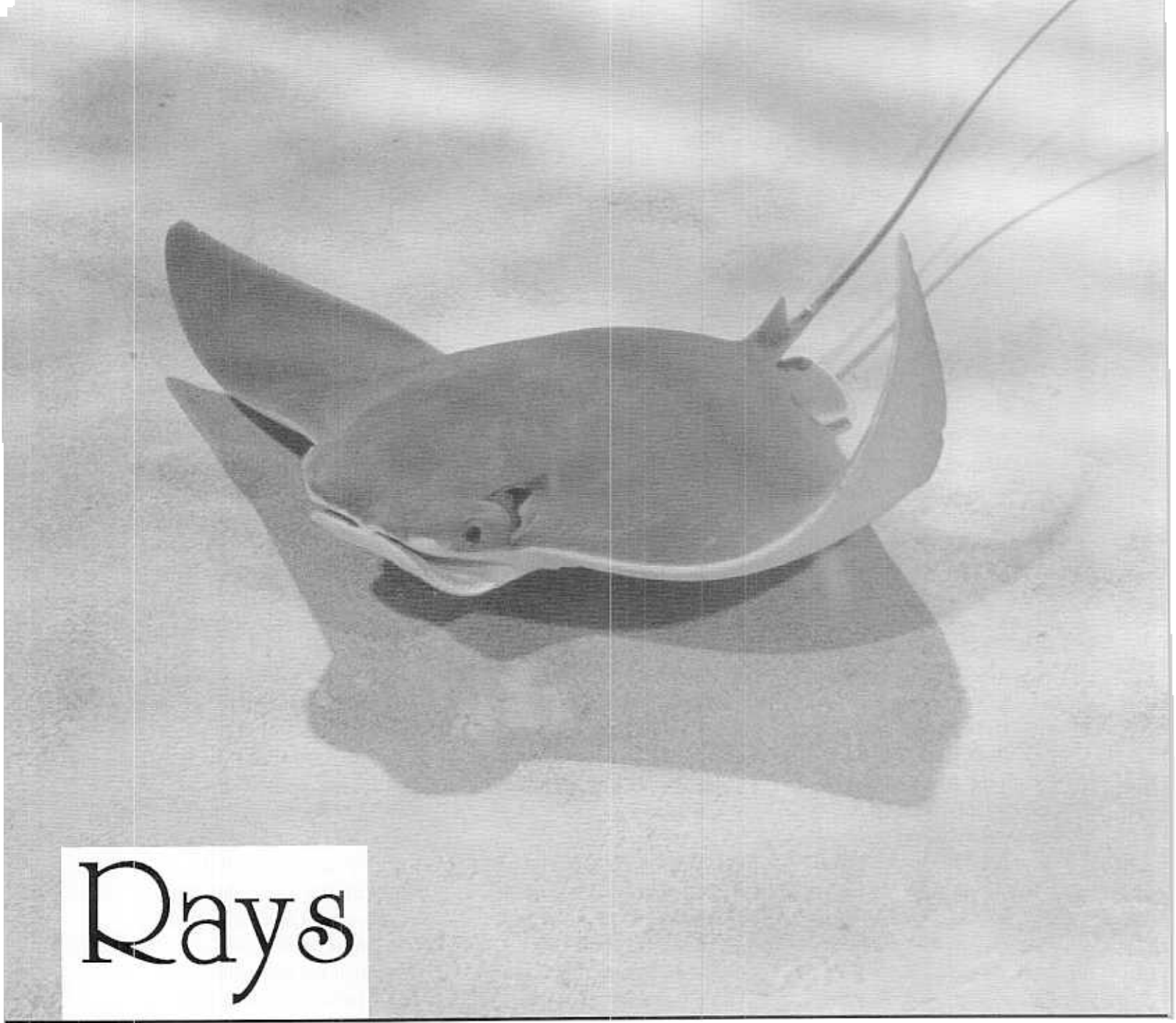
To determine what is happening to a population requires a number of approaches, each, hopefully, adding another piece to a complicated puzzle. While VIMS scientists have continuously employed a long-line survey and tagging program, they are also exploring the realm of genetics, the biology of inheritance, for more insight into shark populations.

By comparing the genetic information shared by the same species but in different locations, it can be determined if individuals are mating throughout a population or whether groups are actually distinct and do not commonly mingle in a reproductive sense.

Using genetics to determine if sandbar sharks from Virginia and the Gulf of Mexico are genetically homogeneous, is the focus of Edward Heist's doctoral work at VIMS. Heist looks at mitochondrial DNA, a small, rapidly-evolving loop that is separate from the majority of DNA in the cells. The work is complicated by the relatively low degree of genetic variability within sharks; Heist must determine the frequency of differences and then its significance. Understanding stock structures in sharks may prove important in establishing national and international regulations for the preservation of sharks.

Genetic research, combined with existing technology, is a powerful tool. Already it is being used in the Pacific to track populations of salmon, and is sophisticated enough to distinguish salmon spawned in different streams. Advances like this make it possible to use genetics in enforcement. For instance, while it is still permissible to fish marlin in the Pacific and sell it here, researchers expect that they will soon be able to determine the origin of the marlin from genetic information and not be reliant on paperwork attesting to it being from the Pacific. VIMS researcher John Graves is actively involved in using genetics to distinguish Pacific from Atlantic marlin.

❖ ❖ ❖



Rays

Rhinoptera bonasus is hydrodynamically designed to basically fly through the water. Schools of *bonasus* can range from a few individuals to massive schools of several thousand, with the tendency to form large schools evident especially during migration. Even the formation of a school may have a hydrodynamic purpose: to improve the mass movement through the water. Though it is generally believed that these rays school at the most in the thousands, one researcher at the Virginia Institute of Marine Science recorded a school in the millions, the rays basically stacked in the water three or four deep at any one point.

The manner in which cownose rays feed is a hydraulic mining of sorts. It is generally believed that the rays stir up sand and sediment with their pectoral fins, then draw in this water, sediment and hopefully bivalve mixture. Gravel is vented out the gill slits.

The Chesapeake Bay is a fine feeding and nursery area for *bonasus*, with few predators and plentiful food. The rays' ability to forage so well in the Bay, however, has caused bivalve growers and harvesters problems. To lessen predation on bivalves, researchers have proposed numerous remedies, including a small cownose fishery.

Rays are often maligned as dangerous and highly poisonous. Perhaps it is a combination of their odd appearance and their semblance to another elasmobranch fish—the shark—which makes people wary. A ray's use of its venomous spine simply is a defensive measure. Injuries are rarely reported in the mid-Atlantic region.

At least ten different ray species visit the Chesapeake Bay, the most common being the bluntnose stingray, the cownose ray and the the roughtail stingray. ❖

Photo by George Grall, National Aquarium in Baltimore.©

A Solution to a Costly Problem
A Ray Fishery

Vengeance, not a need for sustenance, prompted one of the first European explorers to sample ray. A bored John Smith was spearing fish for "sport and pastime" near the mouth of the Rappahannock in 1608 when he was stung by a ray. The pain and swelling was severe enough to cause Smith to direct his companions to dig his grave. Smith, who had a proclivity for both attracting and escaping calamity, survived to record for us that with unmitigated relish he had his "enemy cooked, and did eat a portion of him, to my great delight. . ."

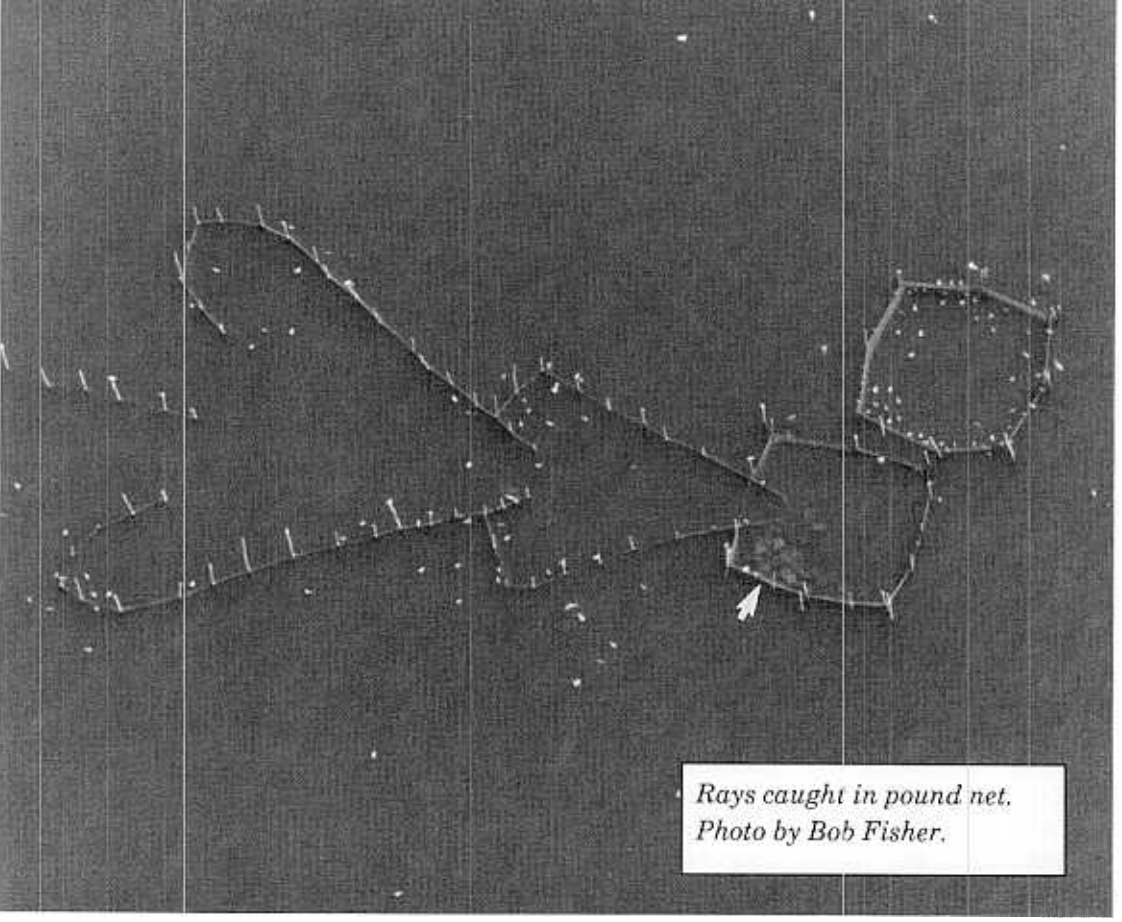
Utilizing cownose rays as a food source is currently being considered as a limited solution to a costly problem: when massive schools of cownose rays enter the Chesapeake Bay and its tributaries, they can and do wreak substantial damage to clam and oyster beds. Feeding schools invade intertidal and shallow subtidal areas during high tide, the vestiges of which appear from the air as meandering trails in the flats.

The range of *Rhinoptera bonasus* is from Brazil to Cape Cod. The Chesapeake Bay is a feeding and pupping ground for at least a part of the cownose population. The rays enter the Bay around May on the western side and depart in September or October on the eastern side. The young are born in late June, early July. While *bonasus* can reach a width of up to seven feet, the adult rays found in the Chesapeake Bay are around three feet wide.

The work being conducted now by Virginia Sea Grant is really a continuation of research performed almost two decades ago when watermen approached the Virginia Institute of Marine Science (VIMS) for assistance. Many reports of damage were reported, but one stands out: 1.8 million "little neck" clams were consumed by feeding schools of cownose rays in just a few days. Researchers John Merriner and Joseph Smith recommended possible physical or mechanical deterrents and also the possibility of a limited ray fishery. Over the years, the bivalve industry has attempted to protect grounds in a variety of ways, from erecting barbed wire to sonic cannons—deterrents which for the most part failed. At this point the concept of a limited fishery seems to hold the most promise.

The difficulty with a fishery is that domestic consumers tend to be conservative, selecting familiar species for the dinner table. In a joint effort, private industry; the Virginia Marine Products Board; and the Virginia Sea Grant Marine Advisory Programs at VIMS and Virginia Polytechnic Institute are exploring ways of creating a market and making it economically worthwhile to harvest rays.

Sea Grant Extension Agents Bob Fisher, Pat Lacey and Tom Rippen have been designing the optimum processing line and also determining costs. This involves collecting data on time, labor and capital to create a model which will be a reliable key to exact costs. The model will include all expenditures, including



Rays caught in pound net. Photo by Bob Fisher.

transportation and advertising. In terms of making the processing line more efficient, researchers were able to adapt existing machinery, thereby eliminating the need to process rays by hand. This trimmed one area of production down to a fifth of what it originally cost.

Rays have a cartilaginous skeleton and the texture differs throughout the wing. This means that various cuts will have to be prepared in different ways.

Before, rays were generally marketed for export as whole wings. Sea Grant specialists decided to further process the rays to determine if the difference favorably influenced buyers. Steaks were very appealing to restaurants because they did not have to spend time and money processing. Also, steaks are an efficient use of the resource, much better than filleting; because a ray's skeleton is made up of cartilage, a clean cut is made through the wing and none of the product is lost. Body cuts and wing ends are being tested as a value-added product. Sausage, ground patties and bite-sized portions (which are breaded and cooked) are product forms being offered.

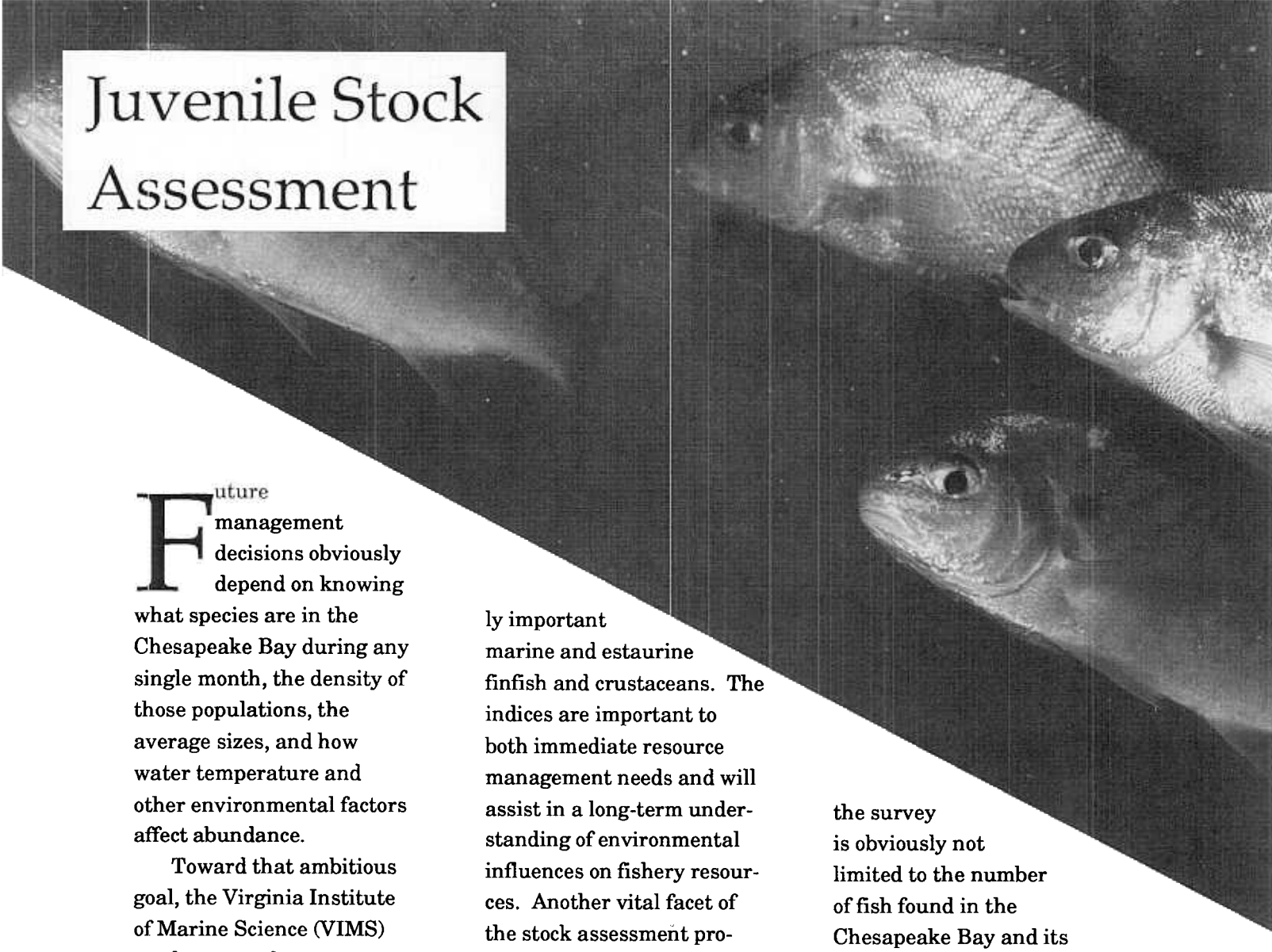
The final step in this whole process is to bring the product to the consumer, or rather, to create a demand. Already, the Virginia Marine Products Board has conducted restaurant and chef surveys to pinpoint the ideal market. To date, ray has been served in upscale restaurants as a novelty item and has received a positive response. Ray has also been served at special functions and even at the Hampton Bay Days. The results of questionnaires filled out at Hampton Bay Days gave a high rating to this product. Two-hundred and seven people ranked the product as good or very good; only 19 did not like it. When asked if they would purchase ray at a grocery store or restaurant, 184 would and 46 would not. The response that an unusual food "tastes like chicken" almost seems a cliche, but at least a few respondents thought that was the case. Some people believed ray tasted like monkfish and others praised its unique flavor. Only eight people had ever sampled ray before, and about half had tasted similar types of seafood such as shark or skate.

To utilize a resource should mean *all* of it, so Extension Agent Bob Lane is looking into waste utilization. A pet food company is currently testing a mixture of the carcasses with other foods. ❖

1990 VIMS Trawl Survey

Species	No. of Fish	Avg. Length (mm)
Bay Anchovy	371,701	51
Hogchoker	86,207	86
Spot	65,469	120
Northern Searobin	21,981	86
Atlantic Croaker	19,517	74
Blue Crab, Male	12,890	77
Weakfish	12,141	119
Blue Crab, Juvenile Female	10,356	58
Spotted Hake	8,361	108
Blue Crab, Adult Female	7,261	146
White Perch	5,647	132
Scup	4,601	109
Blackcheek Tonguefish	3,603	113
White Catfish	2,237	179
Smallmouth Flounder	2,000	84
Black Seabass	1,801	107
Summer Flounder	1,651	198
Butterfish	1,508	72
Silver Perch	1,195	119
American Eel	1,153	250
Inshore Lizardfish	1,122	143
Northern Kingfish	1,106	119
Oyster Toadfish	1,062	182
Striped Anchovy	867	79
Southern Kingfish	792	108
Channel Catfish	772	199
Harvestfish	621	69
Northern Puffer	568	99
Silver Hake	444	149
Windowpane	429	110
Striped Bass	302	158
Gizzard Shad	291	110
Blueback Herring	268	85
Atlantic Menhaden	267	125
Red Hake	238	152
Atlantic Spadefish	218	90
Northern Pipefish	199	154
Clearnose Skate	157	366
Naked Goby	121	42
Alewife	119	119
Atlantic Herring	112	299
Striped Searobin	109	126
American Shad	103	126
Atlantic Silverside	82	94
Spottail Shiner	80	81
Bluefish	79	95
Feather Blenny	65	72
Lined Seahorse	61	87
Blue Catfish	46	163
Tautog	43	321
Winter Flounder	39	97
Spotted Seatrout	32	192
Pigfish	30	149
Hake	27	156
Spiny Butterfly Ray	27	618
Atlantic Thread Herring	25	95
Kingfish	24	103
Spanish Mackerel	23	69
Skilletfish	23	49
Little Skate	23	378
Striped Cusk-eel	21	125
Spiny Dogfish	18	799
Fawn Cusk-eel	17	145
Common Carp	15	530
Southern Stingray	15	450
Threadfin Shad	15	87
Orange Filefish	13	84
Sea Lamprey	11	151
Seaboard Goby	10	42
Conger Eel	10	252
Pinfish	9	159
Mullet	8	71
Golden Shiner	7	94
Cownose Ray	7	555
Red Drum	4	85
Brown Bullhead	4	132
Pipefish	4	280
Lookdown	4	113
Striped Burrfish	4	237
Squid	3	250
Sandbar Shark	3	474
Smooth Dogfish	3	504
Atlantic Stingray	3	230
Banded Drum	3	28
Northern Stargazer	3	77
Tessellated Darter	2	76
Bullnose Ray	2	550
Northern Sennet	2	170
Herring	2	79
Chain Pipefish	2	291
Hickory Shad	1	119
Black Drum	1	185
Sheepshead	1	80
Bighead Searobin	1	95
Banded Killifish	1	136
Threespine Stickleback	1	51
Pumpkinseed	1	136
Round Scad	1	68
Rough Scad	1	63
White Mullet	1	66
Least Brook Lamprey	1	154
All Species Combined	652,531	

Juvenile Stock Assessment

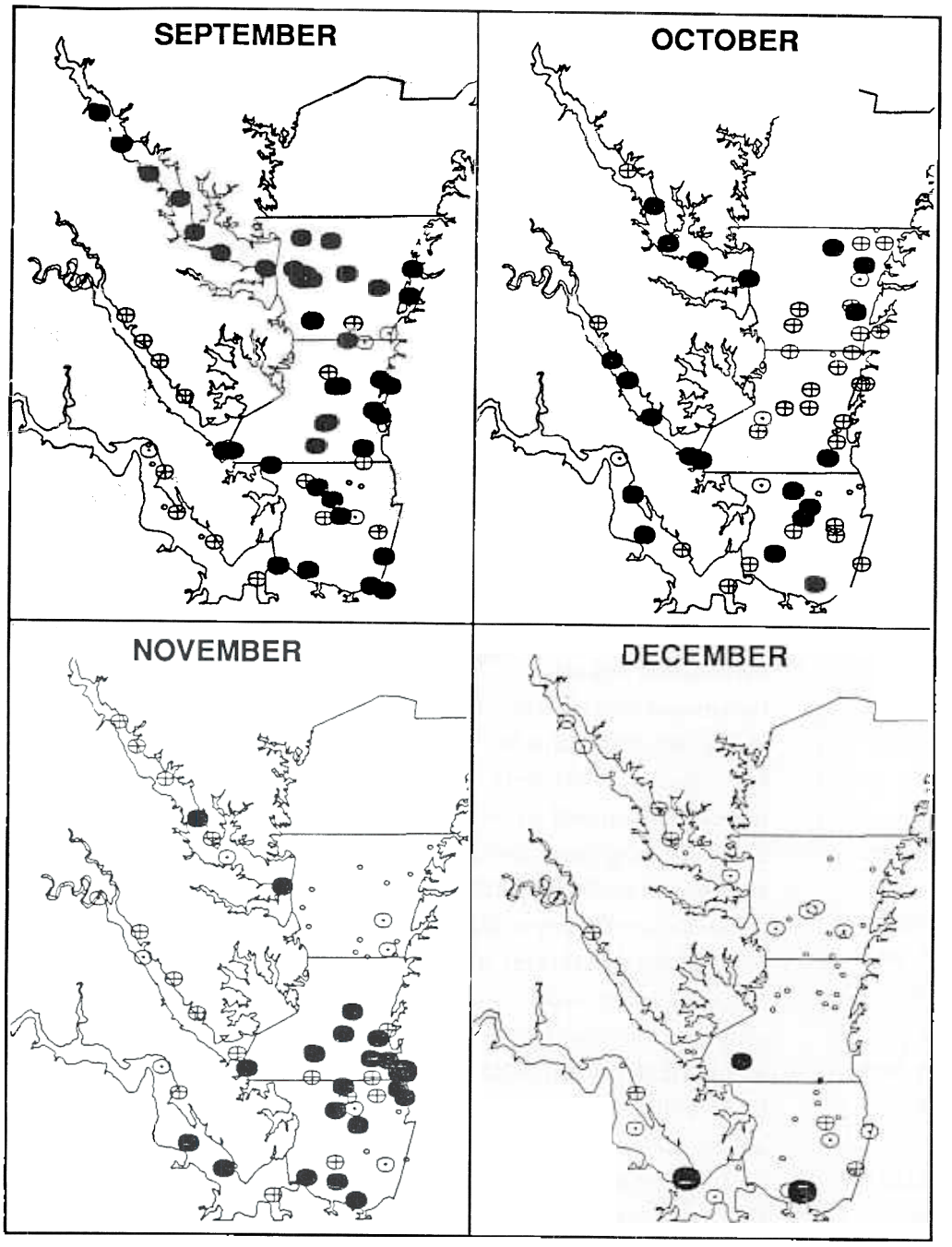


Future management decisions obviously depend on knowing what species are in the Chesapeake Bay during any single month, the density of those populations, the average sizes, and how water temperature and other environmental factors affect abundance.

Toward that ambitious goal, the Virginia Institute of Marine Science (VIMS) conducts trawl surveys throughout the estuary and in three major Virginia tributaries—the York, James and Rappahannock. Researchers James Colvocoresses and Rom Lipcius oversee VIMS' juvenile finfish and blue crab stock assessment program. Patrick Geer directs field operations. The primary goal of this long-term study is to provide indices of young-of-the year abundance of commercially, recreationally and ecologically important marine and estaurine finfish and crustaceans. The indices are important to both immediate resource management needs and will assist in a long-term understanding of environmental influences on fishery resources. Another vital facet of the stock assessment program is to document and monitor habitat utilization by juveniles and small adults. Life history studies and other concurrent scientific investigations relevant to fishery resource management are aided by the data collected by VIMS.

The table on the left is from the trawl survey report produced by VIMS. Because of space limitations, only part of the data is listed. The type of information which can be obtained from the survey is obviously not limited to the number of fish found in the Chesapeake Bay and its tributaries. VIMS scientists also record a host of environmental data as they track species month by month.

The results of the 1990 trawl survey demonstrate how different the Bay can be from year to year. December of 1989 was a month of record low temperatures across most of Virginia's coastal waters. In contrast, 1990 was one of the warmest years on record. What this meant in terms of the trawl survey was that during the



The movement of spot during the last four months of 1990. Researchers utilize the trawl data for juvenile fish and blue crab stock assessment, and to plot the movement of species.

first quarter of 1990, many species were either absent from the trawl survey nets or were drastically reduced in number. For example, bay anchovy catches for the year were down 50% from the previous year. At the opposite extreme, warm temperatures at the end of 1990 apparently attracted a larger than normal number of silver perch to the Bay, causing the species to rise to the 16th most abundant.

The total number of species found in nets was 101. Almost 300 resident and migratory fish have been recorded present in the Chesapeake Bay system, ranging from marine to freshwater fish.❖

Anadromy, Catadromy Variations on a Curious Theme

Of all the unusual journeys made, and of all the physiological changes which various marine animals undergo, the saga of anadromous fish is one of the more curious. An anadromous fish spends most of its life in salt water but migrates into freshwater streams to spawn. To do so, to move from salty ocean waters to fresh, requires pronounced physiological adaptations to salinity levels *and* to different habitats. Not only that, anadromous fish expend a great deal of energy in the quest upstream.

Anadromy falls under a broader category, diadromy—the term used to describe both the migration from saltwater to fresh and the opposite phenomenon, catadromy. Not all diadromy constitutes a quest made for reproduction. Various species migrate between freshwater and marine environments at certain life stages. When fish migrate between the two habitats for non-reproductive purposes, it is called amphidromy.

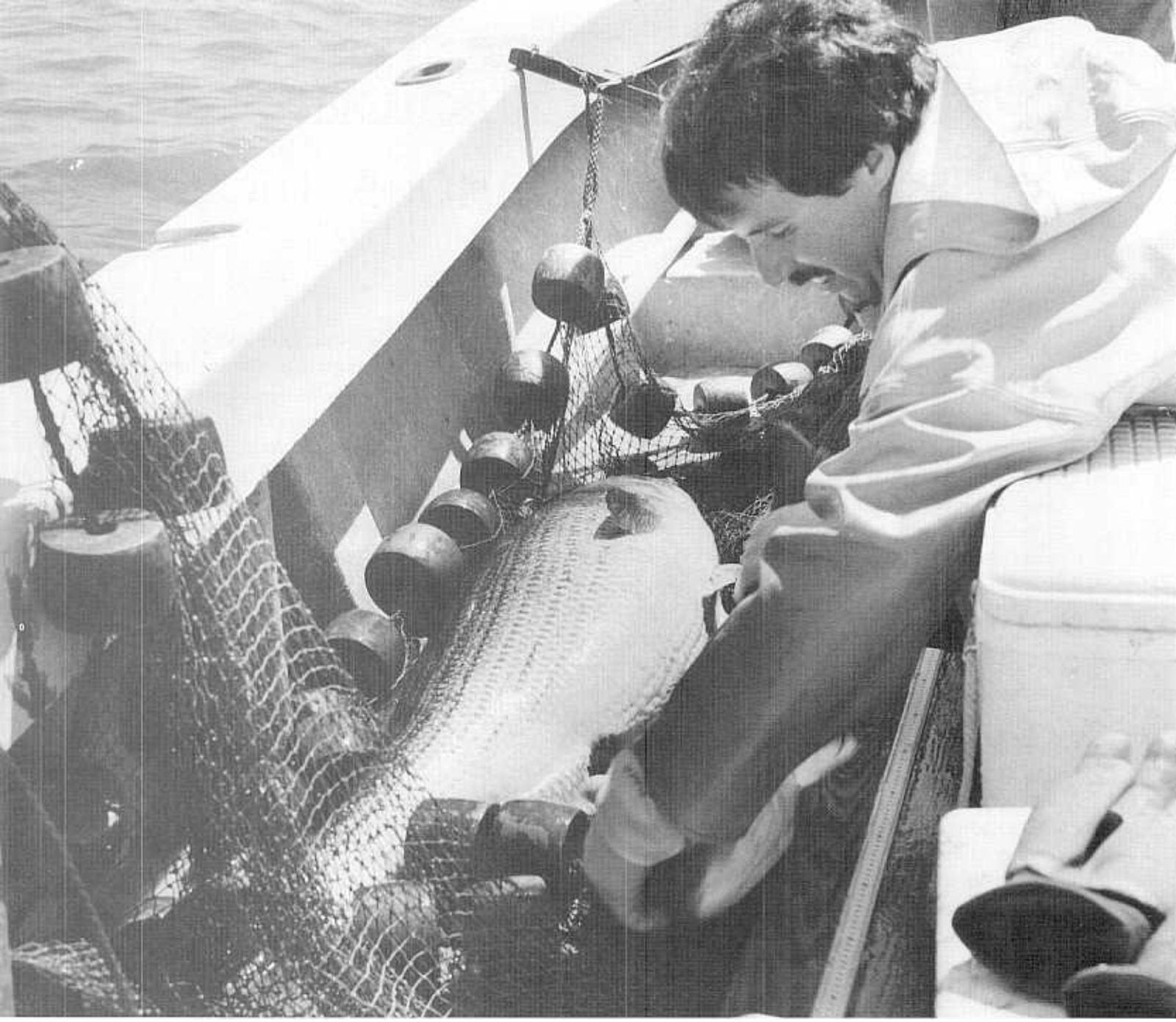
Baffling, certainly, is why diadromy exists or ever evolved. Over the years theories about diadromy have ebbed and flowed in popularity. Anadromy could indicate a marine species' origin in fresh water; eggs and sperm less tolerant of high salinity levels would seem to point toward that, with the converse true for catadromous fish. Other theorists believe diadromy harks back to when the earth's continental masses were one; the fish are returning to their point of origin.

One of the most amazing aspects of anadromy is the return to a "parental" or "home" stream. The migration back to a specific stream is evident in rivers which empty directly into the ocean; however, conclusive evidence is lacking for areas where tributaries enter a broad bay first.

Anadromous species migrate into the Chesapeake Bay and its tributaries and have supported fisheries for centuries (see sidebar on page 17 for more about the history). Anadromous fish are not just important because of their commercial value; they have a vital ecological role. For instance, juvenile *Alosa*,—alewive (*A. pseudoharengus*), American shad (*A. sapidissima*) and the blueback herring (*A. aestivalis*)—are the dominant pelagic prey species in their extensive freshwater and upper estuarine nursery grounds. After spawning, adults return to the sea and are the prey of many marine fish.

Current data, as well as historical data, are needed for accurate and meaningful analyses used in fishery management—the impetus behind the Virginia Institute of Marine Science's (VIMS) Anadromous program. The program is directed by scientist Joseph G. Loesch and is divided into two major areas. In the first area, striped bass migratory paths are monitored through an extensive tagging program. The commercial catch is also monitored and data collected for the young-of-the-year survey. The latter is used as an indicator of future stocks and is under the direction of scientist James Colvocoresses.*

**The striped bass program was written about extensively in the Summer 1990 issue of the* Bulletin.



Researcher about to weigh, measure and tag a large striped bass. Photo by Bill Jenkins.

The second area of the Anadromous Program is an assessment of the alosid stocks (American shad, alewife and blueback herring). This entails a monitoring program in which basic but essential data are collected: sex ratios, age structure, length-and-weight-at-age, and growth increments from scale and otolith analyses. Fishing effort and landings data are also collected. With the information, scientists are able to profile the structure of a population and also determine rates of natural mortality and exploitation.

The abundance of young-of-the-year alosid and striped bass is a vital component of the Anadromous Program at VIMS. The number of juvenile fish which are recruited, that survive to become adults, can change substantially from year to year. Establishing the strength of a year-class early on enables scientists and fishery managers to make realistic projections about a species' abundance in future years, and how heavily the species can be exploited.

VIMS' scientists are also involved in a striped bass broodstock study in the Pamunkey River and a striped bass mark-recapture study in the James River. The ultimate objective of the broodstock study is to determine if hatchery-grown juvenile striped bass, released into a "parental stream," will survive in sufficient numbers to enhance stock abundance.

The aim of the mark-recapture study is to determine how striped bass are exploited both within and outside the Chesapeake Bay region. The research will also provide clues to coastal migrating patterns as well as determining if striped bass return to a parental stream or to a general habitat.❖

In the Past

Before colonists arrived in Virginia, American shad (*Alosa sapidissima*) were caught in large quantities by Indians using crude nets made of bushes. Almost 300 years later, the Virginia Commission of Fisheries reported in 1875 that shad were once so abundant that children could easily spear them in shoal water. River herring, collectively the alewife (*A. pseudoharengus*) and the blueback herring (*A. aestivalis*), were also very abundant. By the latter half of the 18th century *Alosa* stocks declined conspicuously. Still, these species continued to support major fisheries. In 1880 the tributaries of the Chesapeake Bay yielded more than 2,268 metric tons (MT) of shad. In 1896 Virginia ranked second to New Jersey in shad production with 4,990 MT. During the early 1990s, Virginia usually ranked first or second in shad production. In 1908, Virginia's shad catch comprised about one-fourth of all shad taken in the United States. However, the catch of American shad has critically declined since the mid-1970s.

River herring catches in Virginia have had a pattern very similar to that for the shad. In 1920, river herring in Virginia ranked first in quantity and fourth in value, with a catch of 7,258 MT. As late as 1969 river herring in Virginia ranked third in quantify and fifth in value, with a catch of 13,608 M.T. Like the American shad, since 1970s the fishery has steadily declined.

Historically, the construction of dams, degradation of the environment, and overfishing were cited as causes for the decline of fish stocks. To varying degrees, the same explanations are offered as contemporary explanations for further declines in stocks.

Research in the Name Of *Caretta caretta*

The Atlantic loggerhead, *Caretta caretta*, is by far the most common sea turtle found in the Chesapeake Bay, entering the estuary in large numbers in late May and early June. Aerial surveys by the Virginia Institute of Marine Science (VIMS) indicate that between 5,000 and 10,000 loggerheads inhabit the estuary during summer months. While the Bay is apparently an ideal summer feeding area, the cold winter temperatures in the estuary are lethal to the turtles. In autumn, loggerheads leave to overwinter on the continental shelf in southern waters. VIMS studies with satellite transmitters suggest that loggerheads may have a better winter home than most of us, with some overwintering off Florida and in the Gulf Stream as far as Bermuda.

The Virginia ocean shore is normally the northernmost nesting area for loggerheads. In fact, the most nests ever recorded was nine, in both 1989 and 1991. Although Virginia has many miles of shoreline, much of the preferred habitat has been altered by human activity, the type of shoreline development found, for instance, at Virginia Beach.

The low nesting frequency may also be due to the shore's distance from the Gulf Stream, the oceanic current that Benjamin Franklin called a "river in the ocean." Found in the Gulf Stream is *Sargassum* weed, which is crucial to the survival of young loggerheads. Immediately after hatching, the turtles swim frantically offshore and seek refuge in mats of floating *Sargassum* weed. In this grassy web they avoid predators, as well as feed and drift with the currents. To the south of Cape Hatteras, the Gulf Stream is relatively close to turtle nesting habitat, but off Virginia the Gulf Stream is a hundred or more miles offshore. As a consequence, most hatchlings from Virginia never reach this habitat and probably die.

Another probable reason for *Caretta's* low nesting frequency in Virginia is the likelihood of cooler nests in this area—lower temperatures produce males and in the Atlantic only female loggerheads return to shore for nesting and then probably to the original site where they were hatched. The sex of a sea turtle is determined by the temperature of the nest during incubation. At 29°C a 50/50 sex ratio is achieved; higher temperatures produce mostly females, lower temperatures, males.

Former VIMS student Bill Jones monitored Virginia loggerhead nests for three years. His research profiled temperatures throughout the nest as they are impacted by solar radiation; rain and moisture; wind direction and speed. The actual depth of any one egg obviously also influences its temperatures (there are 100-175 eggs in a normal nest). The temperatures which are vital in determining sex take place during the middle section of the 60-day incubation period. Jones' research indicated that Virginia nest temperatures are cool and produce mostly males.

At VIMS, numerous studies have been conducted in the name of *Caretta caretta*, all of which were directed

Roy Drinnen

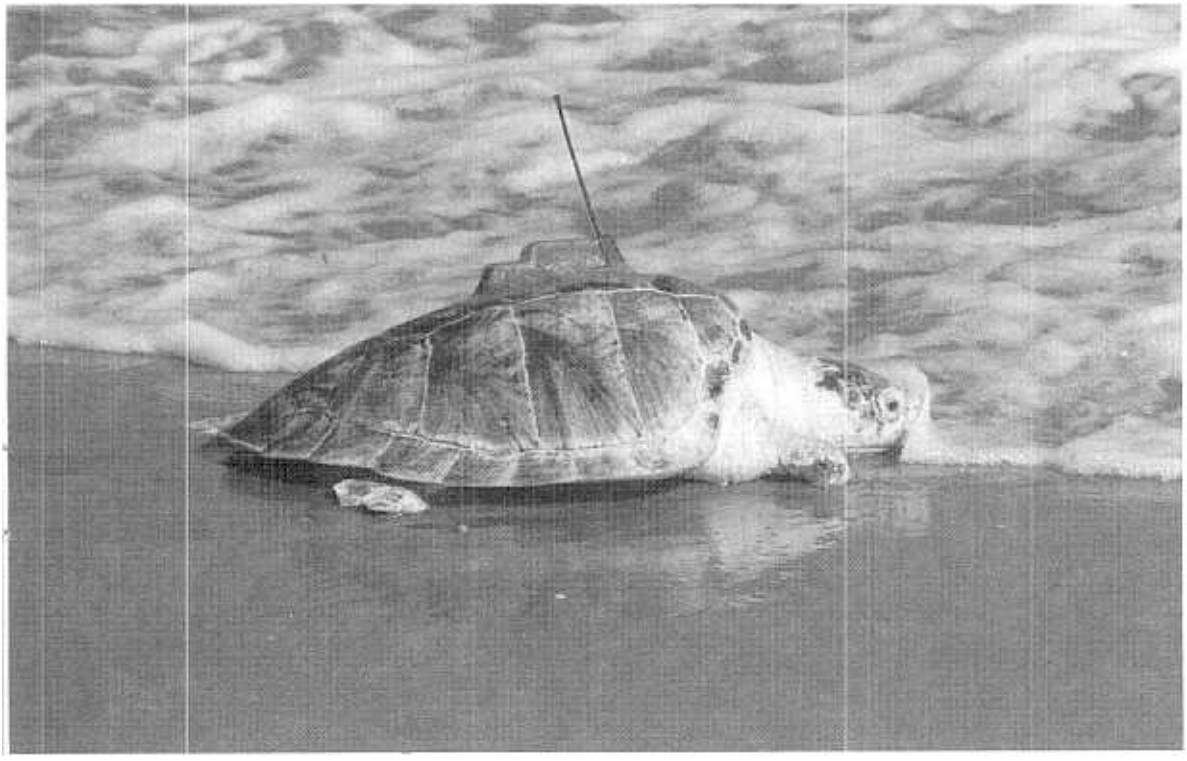
by John Musick. Satellite transmitters have been affixed to sea turtles to determine the migration routes and overwintering areas. VIMS also directed a headstart evaluation program to determine whether headstarted turtles would act as wild turtles once they were released. As the population of some sea turtle species declines, scientists want to ascertain whether ones grown at research labs would be able to survive once they were released into the wild.

VIMS also rehabilitates turtles in the "turtle greenhouse," under the direction of John and Debra Keinath. A number of loggerhead strandings during the spring immigration into the Chesapeake Bay prompted doctoral student John Keinath to research possible causes. It was generally believed that these strandings were caused by entanglement in poundnet leaders. However, the absence of net marks on the turtles plus a number of other factors led Keinath to look at other possibilities.

The main focus of Keinath's research is to determine if the physiological stress of a long migration, coupled with other factors—such as food availability—are responsible for the strandings.

Horseshoe crabs (*Limulus polyphemus*) are the food of choice as far as Chesapeake Bay loggerheads are concerned. However, when loggerheads enter the Bay, horseshoe crabs may be near the shore breeding and unavailable as a food source. Strong themoclines may also prevent loggerheads from feeding in deeper waters.

Keinath's dissertation work is divided into three sections. The first is a migration study which will map routes and distances as well as document swimming speeds. Keinath will also relate the water temperature to the timing of migration. The second part will entail determining what loggerheads eat through stomach content analysis; the exact location of horseshoe crabs during the spring migration; and the actual energy content of *Limulus polyphemus*. The last part of Keinath's research utilizes the others and concentrates on the energetic cost of movement. It also assesses the excess drag caused by fouling organisms attached to the turtles' shells and how much energy is needed for the migrations to and from the Bay. ❖



Big Brother's watching, or so it might seem if you, like this turtle, had a satellite transmitter affixed to your back. This Kemp's Ridley was found minus a flipper and was rehabilitated at the Virginia Institute of Marine Science. Being three-flippered did not hinder the Ridley from making a fast path down the coast. It took the turtle nine days last fall to travel from Back Bay Refuge in Virginia to Morehead, North Carolina.

Endangered: Sea Turtles

Sea turtles are ancient reptiles which predate us by millions of years. Unfortunately, their evolutionary journey could be brought to a halt by many factors, the most glaring of which is human activity.

The human causes of sea turtle mortality are unintentional but long-ranging: a reduction of nesting areas because of development, plastics in the ocean, and normal fishing operations. The last cause, which basically pitted commercial trawlers against agencies, culminated in an extended fray during recent years. The need to survive—from both the human point of view and the sea turtles'—was central to a heated controversy which involved commercial trawlers, especially shrimp trawlers in the Gulf of Mexico. Sea turtles can be an incidental catch and early observations tended to indicate that this was a major cause of sea turtle mortality.

Then entered TED, the turtle excluder device, designed to divert turtles out of shrimp nets. Some commercial fishermen said the use of a TED reduced the overall catch, and others believed there was another reason for the declining sea turtle population. Predictably, the tension between groups heightened, lawsuits were leveled, and many commercial trawlers thought their livelihood was being endangered.

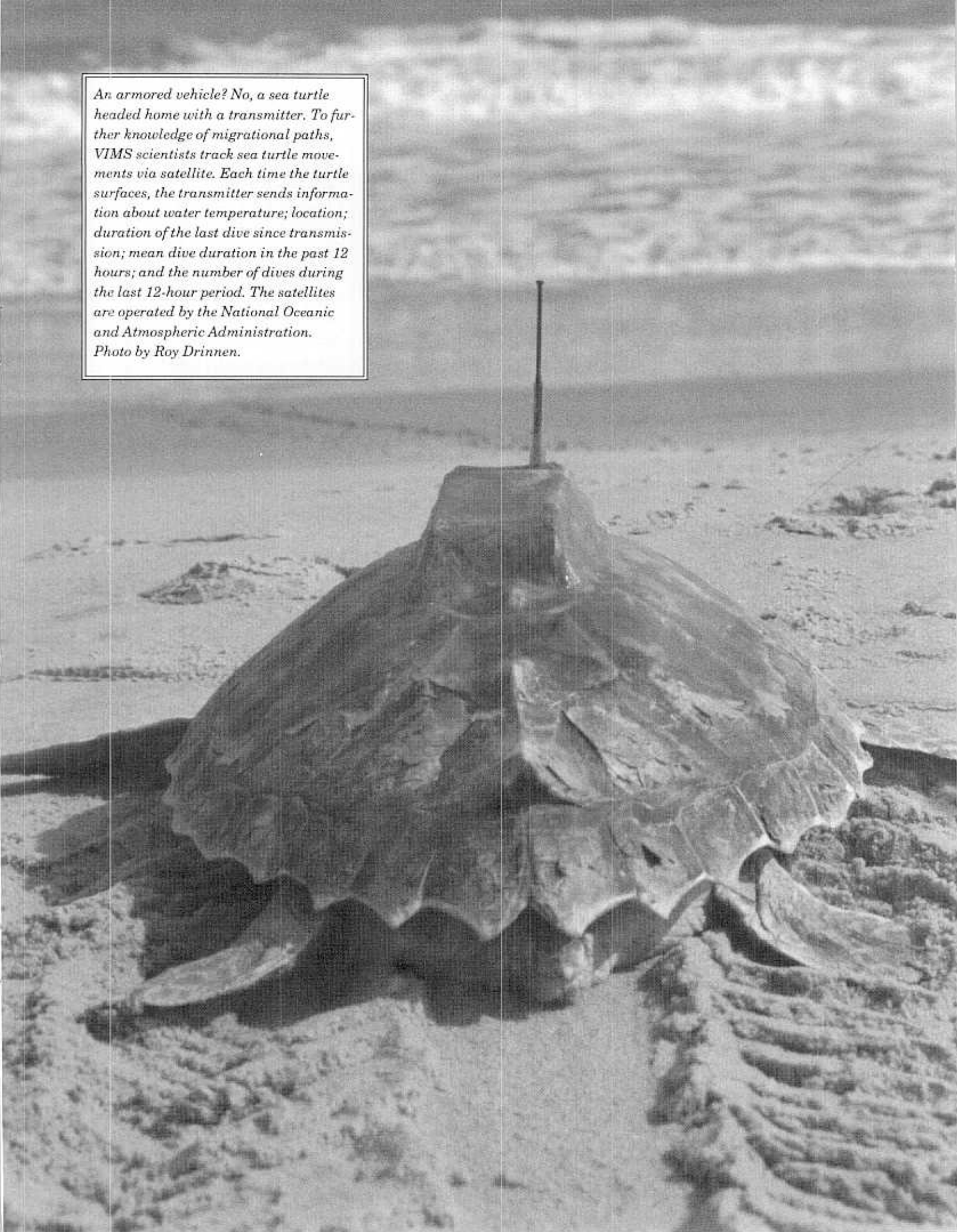
At the direction of Congress, the National Academy of Sciences formed a committee to research causes of the declining population and means for preventing any further reduction. Bill DuPaul, Director of Virginia Sea Grant's Marine Advisory Program and Professor at the Virginia Institute of Marine Science, served on the Sea Turtle Conservation Committee.

The real science of science is ferreting out the apparent cause among numerous variables. In this case, it necessitated examining the biology, population trends and distribution of Atlantic sea turtles. Then, perhaps was the most difficult task: ascertaining the natural mortality during the animal's critical life stages and the mortality associated with human activities.

Causes of mortality are many in the world of nature, where animals are both prey and predator. Eggs and hatchlings on the beach are vulnerable to a variety of animals. In the southeastern U.S. raccoons are major predators. Animals are not the only peril: tidal inundation, heavy rains and erosion can destroy nests. In addition, on the way from nest to ocean, hatchlings run a gauntlet of gulls and terns only to face the formidable hazards of the sea: sharks and other large predatory fish.

Under normal circumstances—and assuming the prey/predator ratio is balanced and that environmental conditions have not weakened turtles so they are overly susceptible to disease—losses to natural causes would not take on great significance. However, the natural world is only part of the picture. Human activities can have an impact, ranging from low to high in significance at any one life stage of a sea turtle.

Coastal processes are dynamic, meaning, ultimately, that shorelines change. Humans tend to have difficulty with that concept, seeing land as land. Even though shoreline engineering can often exacerbate erosion, beaches are, nevertheless, shored up in hopes that the stretch of developed shoreline will continue to be just that. These activities can disrupt or destroy nesting sites. Increased human presence, beach vehicles and



An armored vehicle? No, a sea turtle headed home with a transmitter. To further knowledge of migrational paths, VIMS scientists track sea turtle movements via satellite. Each time the turtle surfaces, the transmitter sends information about water temperature; location; duration of the last dive since transmission; mean dive duration in the past 12 hours; and the number of dives during the last 12-hour period. The satellites are operated by the National Oceanic and Atmospheric Administration. Photo by Roy Drinnen.

even beach lighting can cause problems. Except for beach lighting, the latter list is probably self-explanatory. Beach lighting and even the glow from large metropolitan areas can disorient hatchlings, which are programmed to head toward the lighter part of the landscape —the ocean under normal circumstances. Even after hatchlings enter the surf, they can be lured out by bright lights. Nesting females may also avoid areas which are overly bright.

The major human cause of sea turtle morality, according to the committee, was commercial trawling, an activity in which turtles can accidentally become part of the catch. This was mainly in the Gulf of Mexico and by shrimp trawlers.

Of course, it means practically nothing to establish the source of a problem, without any possible solutions. The committee suggested a number of potential means for sea turtle conservation, from continued protection of nesting areas and control of beach lighting and traffic, to further studies on how other fisheries might cause mortality and to maintaining captive breeding programs for Kemp's ridleys—the most endangered—to ensure a gene pool should the species decline drastically.

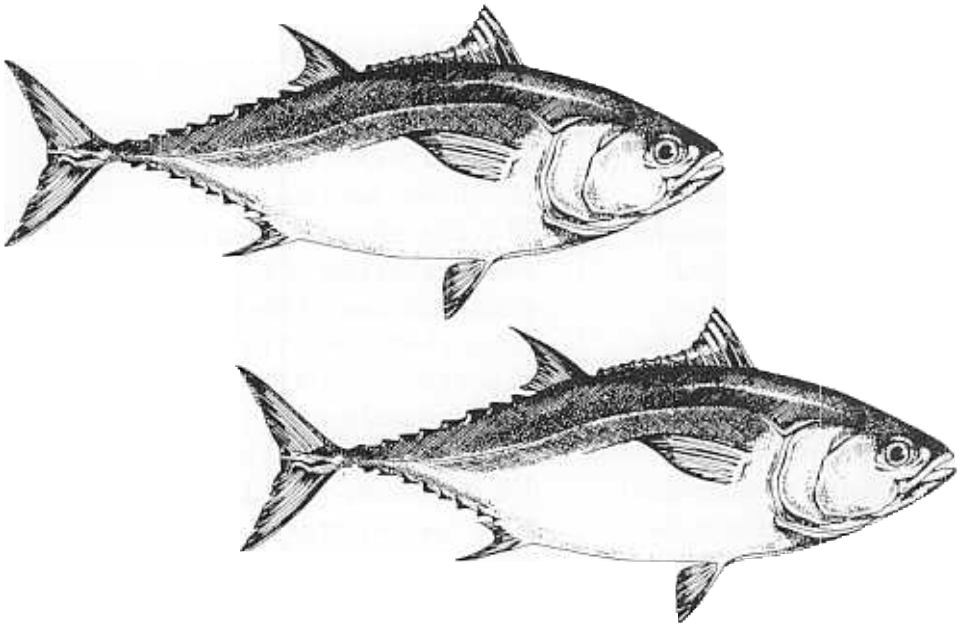
The most important recommendation by the committee was the implementation of TEDs. The committee asserted that the continuous use of TEDs would, at least theoretically, reduce the rate at which sea turtles were being captured to three percent of the rate without the devices. At the same time, the committee noted that the effectivenees of TEDs in cutting down on sea turtle capture could be complicated by sea grasses or debris, which could prevent turtles from escaping the trawl. In areas with debris or grasses, the committee suggested that tow-limits be used to prevent clogging. The use of TEDs, often considered a nuisance by fishermen, could sometimes be relaxed, said the committee, in selected locations when the probability of capturing sea turtles was low. Conversely, in locations adjacent to active nesting areas, a closure of the area for a specific time might be considered.

The full report about sea turtles is in book form and is entitled *Decline of the Sea Turtles/Causes and Prevention*. The publisher is the National Academy Press, 2101 Constitution Ave., Washington, D.C.

Five of the six sea turtle species which inhabit the Atlantic have been found in the Chesapeake Bay: the Atlantic Loggerhead (*Caretta caretta*), Kemp's Ridley (*Lepidochdys kempii*), Atlantic Leatherback (*Dermochely c. coriacea*), Atlantic Green Turtle (*Chelona m. mydas*), and Atlantic Hawksbill (*Eretmochelys i. imbricata*). Some sea turtles, like the loggerhead, arrive in great numbers and others, infrequently. Until 1990, scientists were skeptical about the Hawksbill ever having been found in the Bay. One shell at a museum labeled "Chesapeake Bay" was considered highly suspect. However, researchers were astounded when a fisherman recently caught a Hawksbill. Scientists believe it is likely that the turtle was swept up this far north by the Gulf Stream.

The reader interested in turtle identification and natural history may want to consult *The Sea Turtles of Virginia*, a Virginia Sea Grant publication written by scientist John Musick. The cost is $2, and it can be obtained by writing Sea Grant Communications, Virginia Institute of Marine Science, Gloucester Point, Virginia 23062.

Thunnus thynnus In Trouble



As fishery after fishery nears its harvesting limit, is actually driven to the brink of collapse, it should come as no surprise that the bluefin tuna, *Thunnus thynnus*, is in trouble.

Population estimates of the two Atlantic bluefin spawning stocks indicate that the western Atlantic stock, which spawns in the Gulf of Mexico, has fallen precipitously during the last three decades. The eastern Atlantic/Mediterranean stock, which spawns in the Mediterranean Sea, has fared slightly better but is also subject to heavy fishing pressure.

To counter the declining stock, national and international management agencies are seeking to limit the number of bluefin caught, regulations which are bound to provoke the ire of some anglers and charter boat captains. Management agencies believe that without tighter catch restrictions, the western Atlantic bluefin tuna will not be capable of returning to abundance levels which will sustain the stock.

The International Commission for the Conservation of Atlantic Tunas (ICCAT) adopted recommendations in November of 1991 to reduce the western Atlantic quota 10 percent by 1992/1993 and 25 percent by 1994/1995. Also, a provision was adopted by ICCAT to prohibit landing bluefin weighing less than 66 pounds in 1992, and to prohibit the sale of these fish. An eight percent tolerance by weight would be permitted. If a year's catch exceeded the limit, the next year's quota would be reduced.

The U.S. rod and reel quota for bluefin, like other quota categories (harpon, hardline, longline and purse seine) was established by an ICCAT agreement in 1983. The U.S. fishery shares the total western Atlantic quota of 2,660 metric tons (5,852,000 pounds) with both Canada and Japan. Proposed catch reductions apply to each country's quota share (U.S.—52%; Japan—26%; Canada—22%). The National Marine Fisheries Service is now working on proposed changes in fishing regulations (for instance, reduced bag limits and size limits) which would bring the U.S. into compliance with the new ICCAT management strategy. ❖

Hundreds of Miles, Millions of Dollars

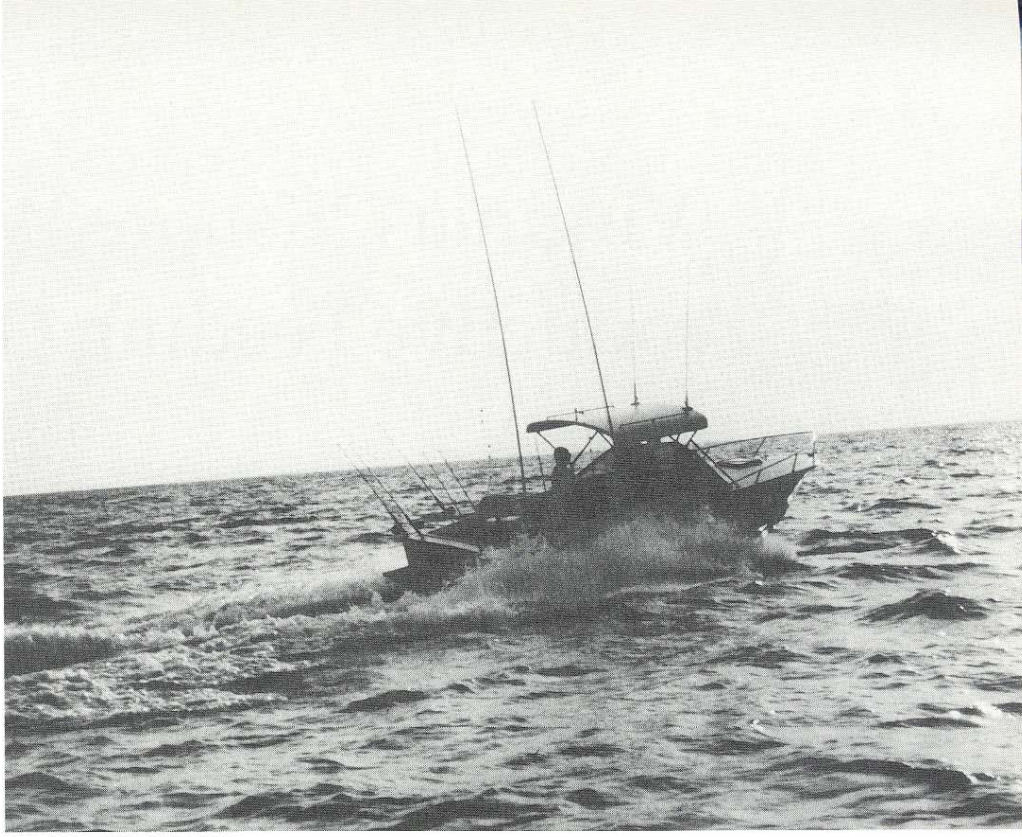
The massive migration of marine animals up the Atlantic coast is a prompt for yet another predator: man. Anglers drive hundreds of miles and spend millions of dollars to fish in the Chesapeake Bay and the mid-Atlantic ocean waters.

There was a time when watermen mainly plied these waters, and they did this for a livelihood. In the past half century, and especially in the last 20 years, the number of recreational fishermen has increased dramatically. Most recently, this growth rate has slowed considerably due to the changing age structure of the U.S. population. Still, recreational anglers are part of a fishery management process which is difficult to assess: how much of a given fish stock remains; how many new fish are being recruited; how much fishing pressure is there from commercial and recreational fishermen; and how does that combined pressure influence various fisheries. Those questions seem complicated enough, but at least one more variable has to be taken into consideration: like commercial fishing, marine recreational fishing also supports a diverse business infrastructure. Expenditures associated with fishing trips can range from the costs inherent in buying and maintaining a boat, to trip-specific expenditures for ice, bait, tackle, on-board food as well as the meals and entertainment after the trip. Clearly, any change in the resource or any fishery management decision can have economic ramifications far beyond what is immediately obvious.

Assessing the catch trends and determining the economic impact of recreational fisheries have been the focus of several studies completed by Virginia Sea Grant at the Virginia Institute of Marine Science (VIMS). Of special concern has been Virginia's recreational marlin and tuna fishery, a continuing lure for anglers.

The fishery, like many in the world, appeared boundless at one time. This is no longer true, and because of that, the need to more accurately record the recreational fishing effort and catches has become more pressing. Mechanisms for determining recreational catches have not been as reliable as those in place for the commercial fisheries. Annual studies by researcher Jon Lucy and former graduate students Eleanor Bockenek, Nancy Balcom and Charles Barr sought to fill in this information gap. Their work is part of an ongoing assessment of the tuna and marlin fishery. The results are intended for fishermen and fishery managers and for dissemination at scientific meetings. VIMS' research adds to a larger effort by the National Marine Fisheries Service (NMFS) to accurately assess the western Atlantic commercial and recreational fishery. For tunas and billfish, VIMS coordinates dockside and telephone surveys conducted by NMFS port samplers. Assisting NMFS allows VIMS access to data on the Virginia fishery which would otherwise be too expensive to obtain through normal funding channels. The cooperative effort also provides opportunities for graduate students to gain experience in applied research problem areas.

Virginia's marlin and tuna fleet is made up of about 1,000 vessels, of which approximately 70 are



charter boats. Principally targeting bluefin and yellowfin tuna, white and blue marlin, and dolphin, the fishery accounts for $8-9 million annually in direct expenditures, not counting the purchase of vessels.

Because of a decline in populations, fishery managers are likely to implement more stringent bag and size limit regulations on pelagic species. As a result, anglers will have to become more active in catch-and-release or tag-and-release fishing. Specialists at Virginia and New Jersey Sea Grant recently completed a project to make anglers more aware of this aspect of saltwater fishing. Surveys were first conducted to assess impediments to angler participation. This required contacting anglers in four states as well as interviewing tagging program coordinators and fishery managers from many east coast states. A workshop was also organized to bring these fishing groups together for discussions on issues and problems associated with enhancing angler involvement in marine catch/tag-and-release fishing. The project determined that many fishermen did not understand the benefits of tag and release programs. Oftentimes anglers were not even aware they existed. A report and educational brochure were produced to address this and other significant concerns. The report summarizes survey results from anglers and tagging program coordinators from Virginia to Maine as well as discussions from a workshop. It is entitled "Enhancing Catch/Tag-and-Release Fishing in the Northeast Region: Issues, Concerns, Potential." The brochure, distributed nationally, addresses concerns frequently expressed by anglers about tagging programs and the use of tag return data by scientists and fishery managers. It lists contacts for tagging programs requiring angler assistance to tag fish. Included is a directory of educational materials and commercial products which focus on achieving more effective fish release techniques and a stronger conservation ethic among saltwater anglers. The NMFS Saltonstall-Kennedy Fishery Development Program funded much of the multi-state cooperative Sea Grant project.

The 82-page report is available by writing Virginia Sea Grant Communications, Virginia Institute of Marine Science, Gloucester Point, Virginia 23062. The report costs $4.00. Checks should be payable to VIMS.

The brochure is entitled "Giving Something Back: Catch & Release & Tag and Release Fishing Resources." Single and multiple copies can be obtained free by writing Virginia Sea Grant Communications at the address listed above. ❖

Virginia Offshore Waters, Productive Feeding Grounds

While the Chesapeake Bay is an important stopping off point for up to 200 species of fish, the offshore waters of Virginia are also productive feeding grounds for juvenile northern bluefin and yellowfin tuna.

Migrational paths vary according to the size and species of tuna, with the western Atlantic bluefin, *Thunnus thynnus*, ranging from Brazil to Newfoundland. The extent of yellowfin (*Thunnus albacares*) on this side of the Atlantic is slightly less: from Brazil to Massachusetts. Not only do tunas migrate south and north, but a few may follow the Gulf Stream to the Bay of Biscay. During the summer, two- to three-year-old tunas can be found feeding 20 to 100 miles offshore Virginia. At this age bluefins average 24 pounds, yellowfins, 33 pounds.

A study conducted by Charles Barr, at the Virginia Institute of Marine Science, examined the food, feeding habits and trophic interaction of the two tuna species while in Virginia waters. Relatively few feeding studies have been conducted in the Atlantic, making this type of research useful in fishery management—especially since the bluefin stock is in danger of being overfished. Also,

Charles Barr, former VIMS graduate student, weighs tuna at the docks.

when the biological and ecological requirements of tunas are understood, steps can hopefully be taken to safeguard important habitats and feeding grounds.

Tuna samples from the primary Virginia tuna ports were weighed and measured. Location of capture and sea surface temperatures were also recorded. To determine what the juvenile tunas found palatable required the obvious: detailing the stomach contents. Though many of the prey were readily identifiable, others had been reduced to skeletons or shards of a skeleton. In the case of readily digestible food such as squid, a lone beak might remain. Instead of dismissing the more difficult prey as "other," as has been the case in some studies, Barr set about solving the equivalent of a marine science whodunit. Except in this case the victims were unknown.

A total of 220 bluefin and 259 yellowfin stomachs were analyzed. If the number of stomachs—half a thousand—seems sizable, the number of food items is gargantuan: 8,437 fish, squid and crustaceans. There were even insects caught incidentally by yellowfin as they pursued prey.

Tunas are fairly opportunistic feeders, meaning they can feed on a variety of organisms. They are also apparently capable of working together for the maximum result; bluefins have been observed schooling in a parabolic feeding formation, driving fish into that parabola, surrounding, then consuming the prey.

Barr's study showed that while bluefins sampled fish from eight fish families and yellowfins 21, the sand lance (*Ammodytes dubius*) was the food of choice for juvenile tunas in Virginia. *Ammodytes* are found in great quantities throughout the water column. The second food of choice for juvenile tunas was the butterfish, *Peprilus triacanthus* for bluefins, squid for yellowfin. Plastics, certainly not a source of nutrition but reflective of just how much humans can impact the environment, were found in three percent of bluefins, 12 percent of yellowfins.

Even though both tunas preyed on *Ammodytes*, Barr's research indicated that the two species feed in distinctly different habitats. Yellowfin are found in areas with warmer sea surface temperatures and areas of greater prey diversity. Characteristically, they are located from surface to midwater depths, with cold water temperatures and low oxygen concentrations serving as a significant barrier. Yellowfin will also orient around floating structures, which in this case meant floating plant material transported offshore by wind and storm action—vegetation which was also found in yellowfin stomachs. In contrast, bluefin contents included lower water and benthic species as well as gravel and small shells.

Not only were the feeding in different parts of the water column, but also in different marine habitats. Bluefin were tended to be found closer inshore; yellowfin were farther offshore on the continental shelf and slope, and in closer proximity to the warm Gulf Stream currents.

Barr's study was part of his thesis work for a Masters. He hopes future research will involve how fluctuations in *Ammodytes* population densities may effect the feeding pattern, diet characteristics and numbers of juvenile tunas in Virginia waters. Examining the relationship between these factors may provide useful information necessary to help prevent the current and future downward population trend of the western Atlantic bluefin tuna. ❖

Virginia Sea Grant has produced numerous brochures about fish and shellfish found in the Chesapeake Bay and Virginia's offshore waters. The brochures include both the natural history of the species and recipes. The species covered are shad, bluefish, seatrout, spot, flounder, black sea bass, croaker, blue crab, oyster, hardclam, soft shell crab, monkfish and tunas. The first copy is free; additional copies cost 10 cents. The publications can be obtained by writing Virginia Sea Grant/Virginia Institute of Marine Science, Gloucester Point, Virginia 23062.

The following, ambitious recipe is from the National Fisheries Institute in Washington, D.C.

Bouillabaisse

- 3 large garlic cloves, crushed
- 1/2 cup celery, chopped
- 1/2 cup spring onion, sliced 1/4" thick
- 1/2 cup green pepper, chopped
- 1/4 cup olive oil
- 2 bay leaves
- 1/2 tablespoon oregano
- 1/4 cup fresh parsley, chopped
- 1/2 teaspoon crushed red pepper
- 1 teaspoon salt
- 24 ounces canned tomatoes, chopped
- 4 ounces clam juice
- 1/2 cup sherry
- 1/2 pound shrimp, cleaned, medium
- 1 pint standard oysters, shucked ***or*** 1/2 pound sea scallops
- 1/2 pound squid, cleaned, cut in 1" squares or rings
- 1/2 pound white fish fillets, cut into chunks*
- 1/2 pound regular crabmeat, cartilage removed (can substitute blended seafood product)
- 2 cups water
- 1 1/4 pound lobster
- 12 littleneck clams, scrubbed
- 12 mussels, scrubbed

*other species to substitute are cod, haddock, monkfish, red snapper, striped bass.

In a large 4 quart pot, saute garlic, celery, onion and green pepper in olive oil until tender. Add the next five spices and tomatoes. Add clam juice and sherry and simmer for 2 hours. (Soup may be refrigerated at this point to serve the following day.)

Next Day:

Heat soup in a separate 4 quart pot, add 2 cups water; bring to a boil. Add the lobster, steam, covered 8 minutes. Add the clams, steam, covered 3 minutes. Add the mussels, steam until clams and mussels open—about 3 to 4 minutes. Keep hot.

While lobster is steaming, add shrimp, oyster or scallops and fish to hot bouillabaisse and simmer about 3 minutes. Add the crabmeat and squid; heat until squid is cooked—about 2 minutes.

Add steaming liquid from lobster to bouillabaisse. Divide the bouillabaisse among 6 servings, save 1-1/2 cup liquid. Add the clams and mussels to the servings. Divide the lobster evenly, pour remaining soup evenly over each servings. Yield: 6 servings.

For commercial and recreational fishermen

Lobster Regulations Not Only for Lobstermen

By Robert Fisher
Commercial Fisheries Specialist

New federal regulations governing the lobster fishery were enacted in 1987 by the New England Fishery Management Council, in cooperation with the lobster-producing states in New England and the mid-Atlantic. These regulations were the result of concern over the increased fishing pressure during the last decade, possibly affecting the long-term viability of the fishery.

Currently, there is no directed lobster fishery in the state of Virginia. Lobsters are, however, frequently encountered by Virginia scallop and offshore trawl vessels as an incidental catch. For various reasons, federal and state regulations concerning the possession of lobsters are not common knowledge to many Virginia fishermen. Though the regulations were directed toward participants in the lobster fishery, all vessels holding a federal fishing permit are subject to these regulations.

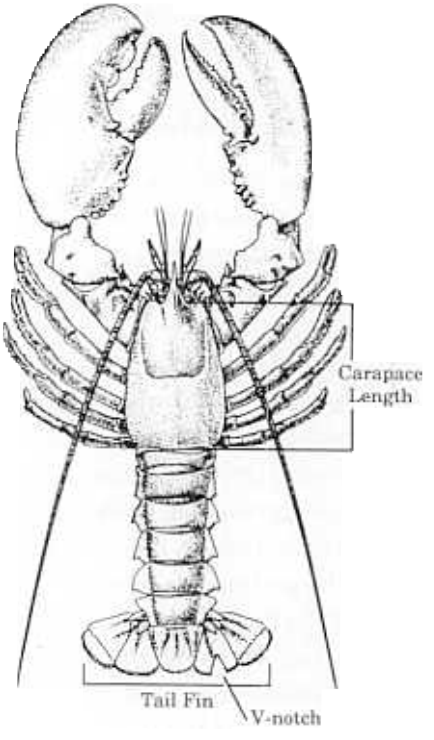


Figure 1

Enforcement of federal regulations is carried out by the U.S. Coast Guard and the National Marine Fisheries Service (NMFS). With the increasing number of commercial fishing vessels being boarded by the Coast Guard to deter drug traffiking, violations concerning the possession of illegal

lobsters have occurred and are likely to increase.

The state of Virginia also participates in enforcement of state lobster regulations through the Virginia Marine Resources Commission (VMRC). At the docks in the state of Virginia, the VMRC and the NMFS have the power to board a vessel and check the hold and other areas for by-catch species that are in violation.

Familiarity with these regulations may prevent unwanted problems and also assist in the conservation of a valuable resource.

Legal Size

The size referred to in determining if a lobster is large enough to keep is actually the length of the lobster's carapace. The carapace is the unsegmented body shell of the lobster (figure 1). Carapace length is measured from the rear of the eye socket to the posterior edge of the carapace as shown in figure 1. Currently, the minimum carapace length federally enforced is 3 1/4 inches. However, this length is subject to change and Virginia fishermen should periodically check with the VMRC or VIMS to keep aware of such changes.

A measuring device should be on board vessels which plan on retaining incidentally caught lobsters to ensure compliance with this size regulation.

Egg-Bearing Lobsters

Egg-bearing lobsters, or "berried" lobsters, are mature female lobsters which are carrying their eggs in a mass on the underside of the tail. These eggs, which could total up to 115,000 per female, have already been fertilized by the male and are developing. Eggs are carried by the female for 9-11 months, at which time hatching occurs and members of a year class are recruited.

Because the viability of the stock fished depends on successful recruitment, federal regulations nationwide prohibit the possession of egg-bearing lobsters.

V-notched lobsters

For some years now, Maine lobstermen and state officials have been implementing a procedure that identifies successfully reproducing female lobsters which, at time of capture, do not possess eggs. Females that possess eggs at capture, or become egg-bearing while being held in pounds, are marked by cutting a v-notch in one of the flippers in the tail fan, then are released. The flipper notched is the one just to the right of the middle flipper when viewing the tail fan from the top (figure 1). The rationale behind this practice is that an egg-bearing female is a proven "brood-stock" lobster that can continue to contribute to future spawnings if not harvested. It is thought that female lobsters that are notched will retain this notch through two molts. In the past, regulations prohibiting the possession of v-notched lobsters governed only the Gulf of Maine area, where the practice of notching was pretty much confined to that area. However, because v-notched lobsters may migrate out of the Gulf of Maine and be taken by fishermen in the southern range of the stock, the new regulation prohibits, nation-

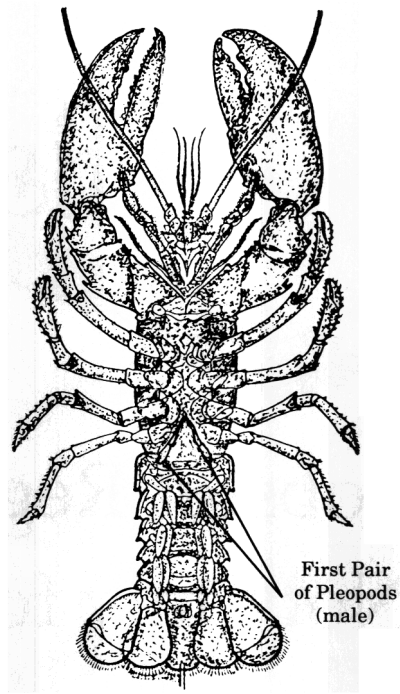


Figure 2

wide, the possession of v-notched female lobsters.

Mutilation

Under federal regulations, it is illegal for any person to remove meat or any body appendages from any lobster before landing. All lobsters must be landed whole. This prevents the taking of undersized lobsters, which, when mutilated, would be impossible to measure accurately. Legal size lobsters that are harvested with one or both claws missing are considered culls and are legal to retain.

Scrubbing

The removal of extruded eggs which are attached to the abdominal appendages (pleopods) of female lobsters is called scrubbing, and is not legal. Scrubbing violations are detected either by the presence of a few remaining attached eggs, or by a dye-test which identifies the glue used by the lobsters to attach eggs to the pleopods. Fines for scrubbing are the harshest, due to the nature of the act.

Landing of Cooked or Frozen Lobsters

Federal and Virginia state lobster regulations prohibit the landing of any lobster parts or picked meat in the cooked or frozen state. However, whole lobsters may be landed frozen or cooked.

Fines for violations

There are two penalty schedules in place which separate minor and major offenses.

Minor Offense Schedule

Violation	Fine
Shorts	$50/lobster
Berried	$250/lobster
Scrubbing	
V-notched	$25/lobster
Mutilation	$50/lobster

(1 lobster = 1 tail and 2 claws)

Major Offense Schedule

This schedule represents a sliding scale penalty for violations and is based on the number of offenses and number of illegal lobsters involved. The fines shown here will likely be increased soon due to an amendment of the Magnuson Act in November of 1990 which calls for fines to increase for most fish species.

Violation	Fine
Scrubbing	
1st offense	$2,500-7,500
2nd offense	$7,500-12,500
3rd offense	$12,500-20,000
4th offense	$20,000+
Mutilation	
1-10 lobsters	$100/lobster
10-20 lobsters	$1,000-2,500
20+ lobsters	$2,500-5,000

Sexing lobsters

Most non-lobstering fishermen respect the lobster fishery by releasing berried females and ones just at, or under, legal size. Many of these fishermen would also release legal size females if they could reliably differentiate between the sexes.

To determine the sex of a lobster, turn the lobster over and look at the first pair of abdominal appendages. These appendages, or pleopods, differ greatly between the sexes. In the female, the first pair of pleopods are soft,fan-like, and are similar to the other abdominal appendages. In the male, however, the first pair of pleopods are stiff, rigid, and are noticeably different from the rest (figure 2). ❖

On the cover: "Their manner of fishing in Virginia," a 1590 engraving based on a John White drawing. The observations of White and scientist Thomas Hariot were used to record life found in the New World and also as propaganda to lure colonists to this side of the ocean. Notice the marine life in the foreground: a ray, turtle, crabs, sturgeon and finfish.

Sea Grant Communications
Virginia Institute of Marine Science
Gloucester Point, Virginia 23062

Address correction requested