U.S. Commercial Fishing Industry Worth $6.7 Billion to National Economy in 1973

The U.S. commercial fishing industry, with a fish catch valued at about $907 million at dockside in 1973, may have had a cumulative impact on the U.S. economy of as much as $6.7 billion, according to a study prepared for the National Marine Fisheries Service of the Department of Commerce. The study of the economic contribution of the industry, conducted under contract by a private consulting firm, Centaur Management Consultants, Inc., of Washington, D.C., was the first of its kind. It was commissioned by the Commerce Department's National Oceanic and Atmospheric Administration.

The cumulative economic impact on the economy, NMFS spokesmen said, comes from the total of wages, earnings, and employment generated by commercial fish catching, processing, wholesale and retail trade, transportation, and related industries. Thus, the $907 million catch of 1973 was the base for the estimated $6.7 billion in associated commercial activity involving, as the study showed, almost 500,000 man-years of employment.

The study also examined the position of the U.S. fishery in relation to imports of foreign fisheries products, which have been steadily increasing in recent years. It was estimated that if imports from foreign nations were replaced by domestic production, the additional economic impact might approach $3 billion, with an increase of 200,000 man-years in employment.

NOAA Marine Safety Promotion Plans Told

The National Oceanic and Atmospheric Administration has announced that an improved electronic navigation system, Loran-C, is being added to 100 nautical charts this year. The move, long awaited by commercial shipping and recreational boaters, is a major step in safety at sea.

Loran—for long range navigation—is used by ships to plot their position. Loran-C is an improved version of Loran-A, which was developed during World War II, and is now widely used by commercial fishermen, shipping, and pleasure boaters. The Loran-C chart program is one of a number of steps taken to promote boating safety and assist recreational boaters, fishermen, and commercial shipping by NOAA's National Ocean Survey, National Weather Service, and National Marine Fisheries Service.

Loran-C can operate under all weather conditions, whereas Loran-A signals are often disrupted by atmospheric disturbances. Its addition to nautical charts results from the establishment of coastal loran stations that enable the program to function. With the construction of these stations along the coast, the program to add Loran-C to nautical charts will now go into full swing. Loran-C will be printed on one side of the chart and, where appropriate, Loran-A, the older electronic navigation system, will be printed on the reverse side. The Loran-A system will continue to be used until the Loran-C program is fully in effect, probably in five years. NOAA issues 960 separate nautical charts.

The Loran-C chart program is being carried out by NOAA's National Ocean Survey, which produces and publishes most of the nation's nautical charts. Loran-C charts may be purchased for $3.25. Information regarding the charts and their purchase may be obtained from the National Ocean Survey, Distribution Division (C44), Riverdale, MD 20840. The charts may also be purchased from National Ocean Survey authorized sales agents throughout the nation.

NOAA has also announced publication of the 44-page paper-bound booklet, "So You Bought a Boat," by Robert E. Williams, a NOAA commissioned officer. A limited edition was published last year under the University of Washington Sea Grant Program. As a regular NOAA publication, the booklet will receive much wider distribution and provide boaters with numerous safety tips and hints on cruising not normally found in more conventional books on boating.

The publication contains useful information on how to avoid trouble in a boat and, in some cases, how to get out of trouble. It has chapters on the nautical chart, use of fishing instruments for navigation, the radio, weather, compass, piloting, rules of the road, boat lights, the anchor and charting products. Copies will be available from the National Ocean Survey, Distribution Division (C44), Riverdale, MD 20840. Cost is $1 per copy.

The National Ocean Survey is also updating approximately 550 of its charts in the next year to help promote the safety of the nation's 50 million boaters. New information for this purpose is being constantly gathered by NOAA's hydrographic survey vessels and through the cooperative efforts of members of the U.S. Power Squadrons and the U.S. Coast Guard Auxiliary and from other government and private sources. Eight completely revised charts will also be issued during the year.

In a further effort to promote boating safety, NOAA's marine centers in Norfolk, Va., and Seattle, Wash., are sponsoring Cooperative Charting and Chart Updating Seminars for leaders of the U.S. Power Squadrons and U.S. Coast Guard Auxiliary to equip them better for volunteer investigations in support of the nationwide chart correction programs. A new training course on Cooperative Charting has been prepared by the U.S. Power Squadrons with technical advice from the National Ocean Survey.

In the Great Lakes area, the National Ocean Survey's Lake Survey Center is furnishing boaters with vital information on lake water levels, which can vary from those published on nautical charts by as much as 4 feet or more during fluctuating high waters. The difference between actual and charted depths can be obtained from the Lake Survey Center, Federal Bldg., Detroit, MI 48226, from the agency's free Monthly Bulletin of Lake Levels.

A key role in NOAA's program to enhance boating safety is carried out by the National Weather Service. This NOAA agency prepares forecasts for shore areas of the U.S. every 6 hours, more often when conditions change

rapidly. Forecasts cover specific coastal areas, such as Block Island, R.I., to Manasquan, N.J. When strong winds or hazardous seas are anticipated, these forecasts include statements of the degree of hazard and the areas where warning signals will be displayed. Similar forecasts and warnings are issued for the Great Lakes and many inland lakes, reservoirs, and waterways.

Boaters also receive pertinent weather information over commercial radio and TV. Most stations in coastal regions make a special effort to answer the needs of boaters and shipping in their weather forecasts.

In a growing number of shore areas, weather information can now be received through VHF-FM radio stations operated by the National Weather Service. The 77 stations in operation are on the air continuously, repeating taped weather messages every 4-6 minutes. Tapes are updated periodically, usually every 2-3 hours, and revised also to meet fast-changing weather. Special receivers or tuners are required since the weather forecasts are made on 162.55 or 162.40 MHz, considerably above commercial FM frequencies. Such receivers now cost from $15 to $200.

The National Weather Service has also established a more widespread distribution of its "Marine Weather Services Charts," which list for various coastal areas and the Great Lakes information on how to obtain up-to-date weather information. These charts are now available from the National Ocean Survey's 1,087 nautical chart sales agents.

The National Marine Fisheries Service will make available again to commercial fishing vessels safety placards on how to deal with emergency problems at sea. The placards will be suitable for posting aboard vessels.

Skywave Radar Scans Distant Sea State

Scientists are monitoring distant sea conditions in the North Pacific for the first time with a specially designed skywave radar that began test operations off the California coast in early summer. Project scientists say that, if the year-long tests of the over-the-horizon system are successful, operational versions of it could speed ships in their transoceanic cruises and could save ocean-related industries, including U.S. fisheries interests, tens of millions of dollars a year. This high-frequency radar is a key element in a cooperative research study known as Sea Echo being conducted by the Naval Research Laboratory (NRL), Washington, D. C., and the Commerce Department's National Oceanic and Atmospheric Administration (NOAA) and Institute of Telecommunication Sciences (ITS), both in Boulder, Colo.

The target area of the first research study is the Gulf of Alaska, selected for its severe and changeable weather, and its role in American energy plans. The Gulf will be crossed by the sea leg of the Trans-Alaska Pipeline, and proposed oil leasing areas on the Alaskan continental shelf are the subject of an intensive environmental study being conducted by NOAA for the Interior Department's Bureau of Land Management. Specifically, the radar-scanning technique employed is capable of helping scientists:

1) predict destructive wave activity along the northwest coast of America;

2) infer average wind conditions near the ocean surface for the prior 6- to 24-hour period;

3) improve warnings to coastal areas and ships likely to be damaged by the waves; and

4) predict where and when high waves will reach other regions.

Weather and sea condition data will be sent for analysis to the Navy's Fleet Numerical Weather Central in Monterey, Calif., and the National Meteorological Center of NOAA's National Weather Service near Washington, D.C. The Fleet Numerical facility and the National Meteorological Center employ automated computer models of global weather which tie together inputs from many sources and produce sea state and weather predictions. The Navy now uses Fleet Numerical predictions for optimum ship routing for savings in transit times and fuel costs.

Remote areas such as the North Pacific are sparsely measured and the Sea Echo data are expected to have a high potential in supplying needed information. Navy and NOAA scientists will test the radar data against the computer-generated models for a year or more to determine its reliability and accuracy before using it in real-time predictions.

Robert W. Bogle, Research Physicist for NRL, categorized the project as one of high technical promise. "Based on our extensive experimental data base and an advanced understanding of the phenomenology, we have been able to design a system which is uniquely suited to the purpose of remote sea sensing," he said. Donald E. Barrick, Chief of Sea State Studies for NOAA's Wave Propagation Laboratory, confirmed this. "It will be the first time," Barrick said, "that it is possible to monitor wave and sea conditions on a regularly scheduled basis by remotely sensing sea state out to as far as 2,000 nautical miles."

A Wave Propagation Laboratory report estimates economic benefits to U.S. interests of tens of millions of dollars a year from an operational, $12 million, two-site sea-scatter radar system scanning both oceans. With full and efficient use of an operational system, the report estimates annual savings of as much as:

1) $45 million by ships carrying U.S. cargoes; 2) $8 million by U.S. fisheries; 3) $16 million by U.S. naval operations and research; 4) $14 million by offshore oil drilling and pumping operations; 5) $5 million by marine scientific research; 6) $4 million from coastal damage prevented; and 7) $8 million by recreation.

The cooperative research program is guided by an interservice group consisting of Bogle, Barrick, Douglass D. Crombie, Director of ITS, and James H. Headrick, Manager of NRL's HF Radar Branch. Crombie is credited with the discovery in 1955 that long wavelength radar had a unique capability to sense the character of the sea. A group of engineers at Crombie's laboratory under Lowell Tveten has built and installed the sophisticated Sea Echo system. Headrick and his NRL group have performed extensive long range sea measurements with their powerful Madre radar, located on Chesapeake Bay. Theoretical and computer-oriented analyses are being done in his organization.

While other government-sponsored and university groups have explored the technology of remote ocean radar

sea sensing, the Navy and NOAA team, by pooling their resources, have been able to put together the only high-frequency (HF) radar expressly designed for this purpose.

The Sea Echo radar, resembling a monster radio station more than a typical radar, stands on a rocky shoreline at the north end of San Clemente Island, a test facility operated by the Naval Undersea Center in San Diego, 90 miles off the California coast. The prominent antenna consists of a 0.25-mile row of 150-foot towers and a spider-web of antenna wires. The sophisticated electronics and a full-size computer are housed in trailers. Because of the remoteness of the site, power is supplied by three diesel generators obtained from a concluded Atomic Energy Commission project.

From its perch on the north end of the island, the 1,200-foot (366-meter) long by 400-foot (121-meter) wide antenna scans a 1,550-nautical-mile (2,500-kilometer) long sector of the North Pacific Ocean and Gulf of Alaska. The radar's signals will be able to observe the coast of California, Oregon, Washington, and British Columbia as well as a wide section of ocean in the Gulf of Alaska. The Sea Echo radar will also be able to "zero in" on any of 400 designated 80 square mile patches of ocean within the antenna's range as far away as the westernmost tip of the Aleutian Island chain.

Unlike the familiar microwave radars operating with short wavelengths and "dish" antennas, the novel radar employed in this project uses very long wavelengths. At these long wavelengths, signals are reflected by the ionosphere to great distances over the horizon. (This phenomenon is familiar to motorists whose AM radios can pick up distant stations, particularly at night.) However, the most important aspect of the long radio wavelengths used is that they exactly match the wavelengths of the ocean. The use of this effect makes the Sea Echo system very sensitive to the conditions of the sea. Some of the sea-scattered radio energy returns to the radar over the same path. A computer at San Clemente records the time delays for the echo return as well as the echo frequencies, and analyzes the way the returning echo has been scattered at the ocean surface. From this information the computer produces contour-line maps showing differing wave heights, directions, and periods within the region scanned with as little as an hour and a half of echo observations.

New York Bight Waste Dumping Study Reports Some Damage But No Immediate Threat

A preliminary report on the life and environment of the New York Bight—a roughly pentagonal 15,000-square-mile area extending from an apex between Long Island and New Jersey to the edge of the continental shelf about 100 miles offshore—concludes that: 1) Despite significant evidence that ocean disposal of wastes off New York has caused some ecological damage, there appears to be no immediate threat to the public health or to Long Island beaches; and 2) Ocean dumping as now practiced there should cease once alternative disposal methods of lesser environmental impact are found.

The National Oceanic and Atmospheric Administration issued its report in mid-summer after 18 months study of the bight. The study is being conducted by the Commerce Department agency's Marine Ecosystems Analysis (MESA) program, part of NOAA's Environmental Research Laboratories. Now in its second year, the 7-year study is designed to provide a comprehensive look at how the New York Bight ecosystem copes with the environmental pressures of a major urban-industrial complex and some 20 million human neighbors.

Soon after its July 1973 start, the MESA New York Bight project began focusing on determining the specific ecological effects of offshore dumping of sewage sludge (a byproduct of wastewater treatment), dredge spoil, waste acid, and other materials at a rate of nearly 10.5 billion cubic feet per year. This is the picture that emerges from the first report.

The area of the New York Bight in which present dumping sites are located is swept by gentle currents along the seafloor, some of them part of an intermittent clockwise gyre that moves water northward toward Long Island, then seaward, then to the southeast across the continental shelf. Little sediment or dumped material is transported over the ocean floor in the dumping site areas except during the passage of major storms, when movement of as much as 1,200 feet has been observed over periods of several days. Water circulation in the area appears to be dominated by tidal currents, freshwater discharges from the Hudson and Raritan Rivers, and seasonal effects which tend to stratify Bight waters. Only in winter is there much vertical mixing in the water column.

There has been essentially no build-up of sewage sludge at the dump site. Sewage sludge is about 95 percent water, and much of its solids content is dispersed, mixed, and diluted as it joins the other suspended sediments which cloud Bight waters. Also, biological and chemical processes continually break down dumped materials. At the dredge spoil dump site, however, a mound of material some 30 feet high has accumulated over about a generation of dumping.

Nutrient levels (nitrogen, phosphorus, and silica compounds) are generally high near the sewage sludge dump, and slightly above "normal" around the dredge spoil dump site. Beyond these localized increases, nutrients in the Bight appear to be controlled mainly by the outflow of the Hudson and Raritan Rivers.

The unsightly black mud popularized as "black mayonnaise" does not indicate the presence of sewage sludge. In fact, the existence of muds in some topographic lows off Long Island is typical of transient muddy patches found along much of the Atlantic coast. There is a small admixture of what appears to be sewage sludge in mud samples taken off Long Island; however, it is not possible to say whether these materials came from the dumping site or from sewage outfalls. There is no evidence that a front of sewage sludge is stalking Long Island beaches, or that ocean dumping in the New York Bight has created an immediate threat to the public health.

Ocean dumping, however, may be a factor in certain observed signs of eco-

system damage. Concentrations of coliform (intestinal) bacteria in Bight shellfish beds appear to be increasing. Last year the Food and Drug Administration expanded the area closed to shellfishing near the dump site. Fish taken from the apex also have a higher incidence of fin rot than specimens taken elsewhere in the Bight. And, crabs and other crustacea in the dump areas show some shell deformities that could be pollution-related.

Antibiotic-resistant strains of coliform bacteria have been found in the Bight, suggesting that this acquired resistance, or "R-factor," is transmitted via harmless as well as harmful bacterial species. The public health significance of this last discovery is not known. "The importance of R-factor transmission among Bight bacteria is an area in which no one has much experience," explains Charles Gunnerson, director of the MESA program. "Next year we'll be emphasizing studies of possible public health impacts. We'll also begin measuring petroleum hydrocarbons in the Bight and try to determine whether 'fallout' from polluted air is a significant contributor of contaminants."

One crucial area of uncertainty, Gunnerson notes, has to do with determining the presence and source of sewage-derived materials taken from the Bight. "There is no way at present to measure sewage sludge in a given bottom sample, or to determine whether the sludge is from the dump site or some other source. There are still important questions as to when sewage sludge becomes something else in the sea. We are using a variety of measurements—trace metals, total organic carbons, and the ratio of total organic carbons to carbohydrates. This last shows some promise as a sludge indicator. Probably we will have to make a number of analyses and take our conclusions where the results of different tests converge."

The effects of ocean dumping are only one facet of the ecological picture NOAA scientists hope to get of the New York Bight. "If dumping stopped today," Gunnerson says, "we would still have a heavily stressed environment there. We're working in a corner of a bathtub. We know some of what we see here is influenced by what goes on elsewhere in the Atlantic. But we don't yet know how to assess the importance of observed effects, whether we should be thinking parts per million or parts per billion."

Meanwhile, NOAA scientists have agreed to help the Environmental Protection Agency study alternative dumping sites offshore, should the decision be to move present dumping farther out to sea.

"All our information points to some ecological damage from present dumping practices in the New York Bight," explains R. Lawrence Swanson, who manages the project from its Stony Brook, N.Y., headquarters. "We think that ocean dumping as it is now practiced in the Bight should stop. Alternatives could be either disposal ashore or additional cleansing of present wastes before dumping them at sea.

"These alternatives will not be available overnight, and because there appears to be no evidence of an immediate health problem or threat to Long Island beaches from dumping, we have recommended that the present dumping sites be kept active until alternatives can be developed.

"But we also want to be sure that any decision to move present dumping farther out into the Bight is guided by solid scientific data. That is why we are looking at alternative areas for the Environmental Protection Agency."

NOAA has urged that any move to alternative dump-site areas be preceded by at least a year of intensive study which EPA and NOAA have underway. In that interval, NOAA scientists hope, a clear picture of the currents, life forms, water chemistry, and bottom composition would permit them to locate the new dump sites where they would do the least ecological damage.

Scrap-Tire Rafts May Protect Shorelines

Use for discarded tires, now accumulating at more than 200 million per year in the United States, has been found by University of Rhode Island engineers. With support from the National Oceanic and Atmospheric Administration's Office of Sea Grant, a team headed by Tadeusz Kowalski, URI associate professor of ocean engineering, has developed a method of assembling scrap tires to form moored, floating breakwaters for protecting small boat marinas and shorelines vulnerable to erosion. "The scrap-tire rafts are not only inexpensive in comparison with conventional fixed breakwaters," according to Kowalski, "but they also are highly effective and ecologically sound."

The university's breakwater development effort, which began two years ago, has been funded by the Goodyear Tire and Rubber Company, as well as by the Commerce Department's Office of Sea Grant. During the 2-year period, the Sea Grant research team has designed, built, and tested three types of scrap-tire breakwaters. "The third design," Kowalski says, "is the simplest and the best." In this version, 18 tires standing on edge are strapped firmly together with stainless steel cable in a roughly diamond-shaped pattern, forming single units to be assembled into larger breakwaters. Each unit, essentially a small floating raft, can be tied together on shore in about 10 minutes. The units are then pushed into the water, where they are strapped together and moored to the bottom. The diamond-shaped rafts can be arrayed in a variety of configurations, depending on the requirements of the site, and the entire breakwater can be moved to meet changing seasonal or other conditions. The resulting breakwater, Kowalski says, can be as large as 500 × 22 feet, and would diminish a 3-foot wave to less than a foot.

Because the tires are set vertically, air is captured in their crowns and only several inches of their tops float above the water surface. The low-lying breakwaters should be well marked to avoid being hit by boaters, Kowalski points out, but the tires' resilience minimizes the possibility of damage to boats if collisions should occur.

One of the first uses of floating breakwaters was at Normandy to protect the allied invasion, but a major storm destroyed that breakwater. Research on floating breakwaters did not resume until the 1960's. Today, pleasure boat marinas have the greatest need for inexpensive floating breakwaters. Most naturally protected harbors already have been developed, so new or expanded marinas require some form of artificial protection.

Fixed breakwaters are expensive, especially if the water is very deep, and may not only interfere with shore processes and fish migration but may also alter the natural pattern of circulation and flushing that maintains good water quality within marinas. "The inexpensive floating scrap-tire breakwaters do not impede tides or natural current flows as fixed breakwaters may," Kowalski says. "Also, because they lie low in the water, they do not destroy the aesthetic values of the marina areas. Furthermore, experiments have shown that pollutants do not leech from the tires." During their tests, the Sea Grant team discovered that the scrap-tire breakwaters created an added bonus for sport fishermen. Seaweed and barnacles begin growing on the tires after a few months, just as they do on artificial reefs, providing food for small fish which soon attract larger fish.

The Rhode Island ocean engineers' latest breakwater design is being used by yacht clubs and marinas in Cranston and Providence, R.I., and Boston, Mass. At Cranston's Edgewood Yacht Club, the cost of the 500-foot breakwater was only $1,500, not counting the labor donated by club members or the tires provided free by tire replacement centers.

Managers of the 1975 Newport, R.I., International Sailboat Show are planning to build a 500-foot scrap-tire breakwater to safeguard the valuable craft on display. Last year, a four-part breakwater—including a 100-foot scrap-tire section constructed and installed by the URI team—was built to protect the show's boats from a north or northeasterly storm.

According to Paul E. Dodson, Jr., President of the Newport International Sailboat Show, the worth of the floating breakwater was dramatically proven when the Newport area was subjected to winds in excess of 20 knots. "The value of the boats and floating docks protected by these floating breakwaters exceeded five million dollars. Without this breakwater protection, damage caused by these winds could well have reached a million dollars," he says.

Now that the university's ocean engineers have completed their experimental work, they will monitor the new breakwaters to see how long they last and whether additional improvements can be made. The present breakwater design is effective only for waves less than four feet high. Kowalski and his group hope to develop a larger floating breakwater for use in the open ocean. "Such a breakwater might be effective for protecting coastal construction sites, oil drill rigs, and oilspill cleanup operations in heavy seas," Kowalski says.

NOAA Assesses Probable Oil Lease Impact on Alaska's Continental Shelf Environment

A Federal effort to assess the environmental risks of developing the offshore petroleum potential of the northeastern Gulf of Alaska has been expanded to cover five other key areas of the northern state's share—about 60 percent—of the nation's total continental shelf area. The multimillion-dollar program, conducted by the Commerce Department's National Oceanic and Atmospheric Administration under the auspices of the Interior Department's Bureau of Land Management, is examining the life forms and physical environment of these additional areas, selected for their petroleum potential: 1) Two areas along the northwest rim of the Gulf of Alaska, one centered off Kodiak Island, the other running southwestward along the Aleutian Shelf to the Shumagin Islands; the present environmental study is continuing in the northeast Gulf of Alaska; 2) two in the broad, shallow shelf area of the Bering Sea: one in St. George Basin, a prominent declivity north of the Aleutian chain; and one in Bristol Bay Basin, between the Alaskan "mainland" and the Alaska peninsula, which becomes the Aleutian chain; and 3) one in the Beaufort Sea, running eastward from Barrow to Alaska's boundary with Canada.

The 4-to-5-year program, which is being managed by NOAA's Environmental Research Laboratories in Boulder, Colo., seeks to provide a basis for predicting the primary environmental impact of petroleum development along the Alaskan shelf. The program is being carried out in concert with other federal and state investigations. These specific questions guide the research program:

1) What are the major biological populations and habitats subject to potential impact by petroleum exploration and development? 2) What is the existing distribution and concentration of contaminants commonly associated with petroleum development? 3) What are the nature and effectiveness of physical, chemical, and biological processes which transport pollutants? 4) What are the effects of hydrocarbon and trace metal contaminants on Arctic and sub-Arctic biota? 5) What is the likelihood and timing of recovery of populations from the effects of development? 6) What hazards does the environment pose to the safety of petroleum exploration and development activities? and 7) What conclusions may be drawn regarding the impact of Outer Continental Shelf petroleum development on the Alaskan marine ecosystem? To answer these questions, NOAA is drawing upon the expertise of its own scientists, and those in other Federal and State of Alaska agencies and in several universities.

Over the first two years of the program, investigators will be intensively studying Alaskan marine ecosystems. The marine food web from birds and mammals to planktonic life forms and marine microbes is being censused, and their pathologies determined. Scientists are attempting to define the peculiar adaptations of these life forms to their northern environment, and their susceptibilities to contaminants. Efforts are also being made to determine the role played by regional life forms in transporting, storing, and breaking down some hydrocarbon and trace-metal contaminants.

Alaskan waters are being investigated in detail, to determine how natural circulations, sediment transport, and other processes affect life there, what role these processes play in spreading contaminants from a site of petroleum development, and what natural hazards face oil development activities.

According to Wilmot N. Hess, director of NOAA's Environmental

Research Laboratories, the Alaska investigations present formidable logistical and operational problems. "These studies are taking us into some of the most difficult weather and terrain on earth," he says, "in areas about which relatively little is known. In terms of operating ships, aircraft, and land teams, it is comparable to the North Sea."

Each area will bring its unique set of problems. Along the Gulf of Alaska branches of the project, scientists are studying the comparatively narrow shelf which terminates at its southwestern end in the deep Aleutian Trench, one of the world ocean's major bathymetric features, in the ring of intense earthquake activity which borders the Pacific. Biological investigations are quite intensive throughout, but with special emphasis on the possible impacts of oil development on marine life in the Bering Sea and Bristol Bay areas. These are among the most biologically productive waters in the world.

Farther north, the investigations are being complicated—and finally will be dominated—by low temperatures and sea ice. "I think we have eight to ten years before possible oil and gas production activities along the Outer Continental Shelf of Alaska could be environmentally significant," Hess explains. "We hope in this time to develop an understanding of the undisturbed ecosystem and learn a great deal about the effects of oil under conditions unique to Arctic and sub-Arctic regions." "The value of this kind of work will be to help shape the regulations and operating orders which will govern what oil developers do here, and how they do it."

Seeding Technique Restores Bay Bottom

A University of Miami Sea Grant scientist, using a new seeding technique, has restored vegetation on a bay bottom denuded by heated water and silt from a power plant. Since the release of these effluents into Biscayne Bay ended, Anitra Thorhaug has succeeded in growing *Thalassium testudinum*—commonly called turtle grass because it is a favorite food of sea turtles—on the bay's bare floor. Her research is supported by the National Oceanic and Atmospheric Administration's Office of Sea Grant. In addition to the Commerce Department agency, the Florida Power and Light Company and the Atomic Energy Commission have helped finance the studies.

"Where turtle grass is, the fish are," Thorhaug says. "It provides food and protection for sport and commercial fishes during various stages of their life cycles. Fishermen know that one of the best ways to catch sea trout, for example, is to allow their boats to drift across carpets of turtle grass, trailing live shrimp as bait."

A vital part of bay ecosystems, seagrasses have been destroyed in many areas by dredging, siltation, and pollution. Earlier attempts to restore turtle grass, by cutting springs of *Thalassia* and planting them in new areas, met with limited success. And, if this technique were carried out on a large scale, it would damage the beds from which the springs were cut. Thorhaug had a new idea: Why not plant seeds of the turtle grass? So she took a diving crew to the Bahamas where, wearing scuba gear, they harvested 8,000 *Thalassia* fruits. Back at the University of Miami's Rosenstiel School of Marine Science, the crew separated 20,000 seeds from the fruits. Then the seeds were treated with root-growth hormones and suspended in running sea water until they could be planted by divers.

The divers planted the seeds in rows, anchoring them with brightly colored plastic. The seeds sprouted roots almost immediately after being planted and grew rapidly. Nine months after the diving crew had jabbed them into the bay floor, only 31 percent of the plants were dead, dormant, or missing.

Thorhaug estimates that her seeding technique can restore seagrasses 10 to 12 times faster than natural processes. It could hasten the comeback of vegetation in underwater lands blighted by dredging, siltation, chemicals, or sewage and could be used to grow seagrasses on underwater banks or canal sides. But much research remains to be done, she notes. The stresses placed on the young plants by fluctuating water salinity and temperatures must be evaluated. In the meantime, Thorhaug's diving teams are planting turtle grass seeds in an area of Biscayne Bay, between Miami and Miami Beach, where siltation and pollution long ago thinned out bottom vegetation and where few fish cruise.

Malaysian Prawn Culture Studied

A large, succulent crustacean from Malaysia could join shrimp and lobster in popularity with America's seafood consumers, if the efforts of South Carolina Sea Grant scientists are successful. With support from the National Oceanic and Atmospheric Administration, specialists at several South Carolina institutions are working together to develop successful techniques for cultivating the giant Malaysian prawn, *Macrobrachium rosenbergii*, in captivity.

Paul Sandifer of the South Carolina Marine Resources Research Institute, Charleston, heads the Commerce Department agency-sponsored project. Associated with him in the Institute effort is Theodore Smith, mariculture specialist. "In appearance, size, and flavor," Sandifer explains, "the Malaysian prawn lies somewhere on a scale between the shrimp and spiny lobster. Most important of all to the prospective grower, the prawn is known to reproduce and prosper in captivity."

Last spring and summer, the scientists stocked five outdoor freshwater ponds with about 25,000 laboratory-reared postlarval prawns. When the ponds were harvested three to five months later, 60 to 70 percent of the prawns had survived and grown substantially. The size of the harvested prawns varied, depending on their size when stocked and the length of time they lived in the ponds. The largest prawns harvested weighed more than an ounce. One pond, stocked with very small juveniles weighing about 0.01 ounce, yielded the equivalent of nearly 600 pounds of prawns per acre after only four months. The pond stocked with the largest prawns—averaging 0.1 ounce in weight—produced a yield equivalent to 1,400 pounds per acre after five months.

Artificial culture of creatures of the sea requires development of complex,

interdependent systems and techniques —tanks, circulating water systems, special diets, and methods of hatching and raising larvae to the adult stage. In the South Carolina Sea Grant project, Paul Zielinski and Walter Castro, engineers at Clemson University, have experimented with two types of tanks for rearing the prawn larvae. Their studies not only are advancing the design of tanks, but are also providing new information on circulating patterns within the tanks and on the use of small air-lift pumps. They have found that existing information on air-lift pumps does not apply to the small pumps that lift water less than 15 feet to provide circulation in culture tanks. Their efforts to fill this information gap will have wide application outside the field of aquaculture.

South Carolina's cooperative Malaysian prawn culture program includes two additional projects. John Manzi of the College of Charleston is investigating the value of algae-rich "green" water as a supplemental food source for prawn larvae. Jeanne Joseph of the Marine Resources Institute is studying the fat content of cultured prawns and the influence of diet on this content.

Pilot-scale commercial aquaculture of the species in the United States began in Hawaii and is now underway at several other locations in the United States. Related Sea Grant supported projects are being conducted by the University of Georgia, Hawaii's Department of Land and Natural Resources, University of Hawaii, Florida Atlantic University, and the Micronesian Mariculture Development Center at Palau in the Pacific Trust Territories. The South Carolina Sea Grant investigators are adapting much of the existing culture technology to the State's environment, improving and refining the techniques to fit local conditions. To develop prawns suitable for South Carolina's temperatures, two species of *Macrobrachium* that occur naturally in the state may be hybridized with the Malaysian import. If appropriate culture techniques can be perfected and adopted by industry, prawn growing would provide a new source of income for local residents and a significant new source of high-quality protein. At the Marine Resources Research Institute, postlarval Malaysian prawns are being produced routinely on a laboratory scale. A new hatchery facility now being developed will provide animals for all investigators participating in the program.

Foreign Fishery Developments

Soviet Fisheries Research Submarine, *TINRO-2*, Ready for Serial Production

A miniature Soviet fisheries submarine, used in studying the biological resources of the Continental Shelf, has completed a series of tests in the Black Sea and in the Atlantic Ocean, according to *Vodnyi Transport*.

The sub *TINRO-2* was designed to study fish, underwater plants, and mineral deposits at depths up to 300 meters (about 1,000 feet). It is equipped with navigational and hydroacoustic instruments as well as with television and automatic still and movie cameras. The two-man crew includes a pilot, who serves as the commander of the vehicle, and a research scientist who may be an oceanographer, ichthyologist, or marine geologist depending on the nature of the expedition. *TINRO-2* was designed by "Giprorybflot," the Soviet Federal Design Institute of the Fishing Fleet, primarily for use by the USSR Ministry of Fisheries.

In September 1974 the testing of *TINRO-2* in the Black Sea was completed: in 81 days at sea a total of 29 dives were made. The *Ikhtiandr*, *TINRO-2*'s mothership, left the Black Sea for the Atlantic Ocean carrying the submarine on board in a sort of a "hangar." The two vessels spent about half a year in the Atlantic continuing tests and trial dives. According to *Tass*, *TINRO-2* and the *Ikhtiandr* made two complete crossings of the Atlantic in 160 days, studying bottom structure, fish behavior, and plankton distribution. More than 50 dives were made to depths of 200-400 meters.

By April 1975, both vessels had returned to their home port of Kerch' on the Black Sea. From Kerch' *TINRO-2* is to be shipped to Leningrad to be displayed at "Inrybprom-75," an international exhibition of fish-processing machinery, equipment, and fishing vessels, to be held 6-20 August 1975. Meanwhile, serial production of the *TINRO-2* class of miniature fishery submarines is about to begin.

The Office of International Fisheries, NMFS, NOAA reports that "serial production" of the fisheries mini-submarine vehicle indicates that its prototype performed satisfactorily during the shake-down cruise. In 1960, Soviet underwater research scientists also planned the construction of a larger sub with an independent surface cruising range of 600 miles. This vessel, to be known as *TINRO-1*, would need no mothership and could remain submerged up to 20 days. Because of the large inside space, it could be equipped with a wide range of research instruments. A system of lock chambers with double doors would allow divers to leave the submerged vessel to conduct experiments under water. The 7-man crew, including a researcher, pilot, and engine mechanic, would work in two shifts. However, although *TINRO-2* has already gone into serial production, *TINRO-1* seems to have remained more or less "on the drawing board."

TINRO-1 and *TINRO-2* are alike in name only. The vessels, as already described, are very different in structure and operation. *TINRO-2* is small and dependent on a mothership, while *TINRO-1* is larger and built to cruise independently. Both of these underwater research vessels were originally planned for use by the Soviet Pacific Research Institute for Fisheries and Oceanography, whose initials in Russian spell "*TINRO*." Located in Vladivostok, this facility serves as the base