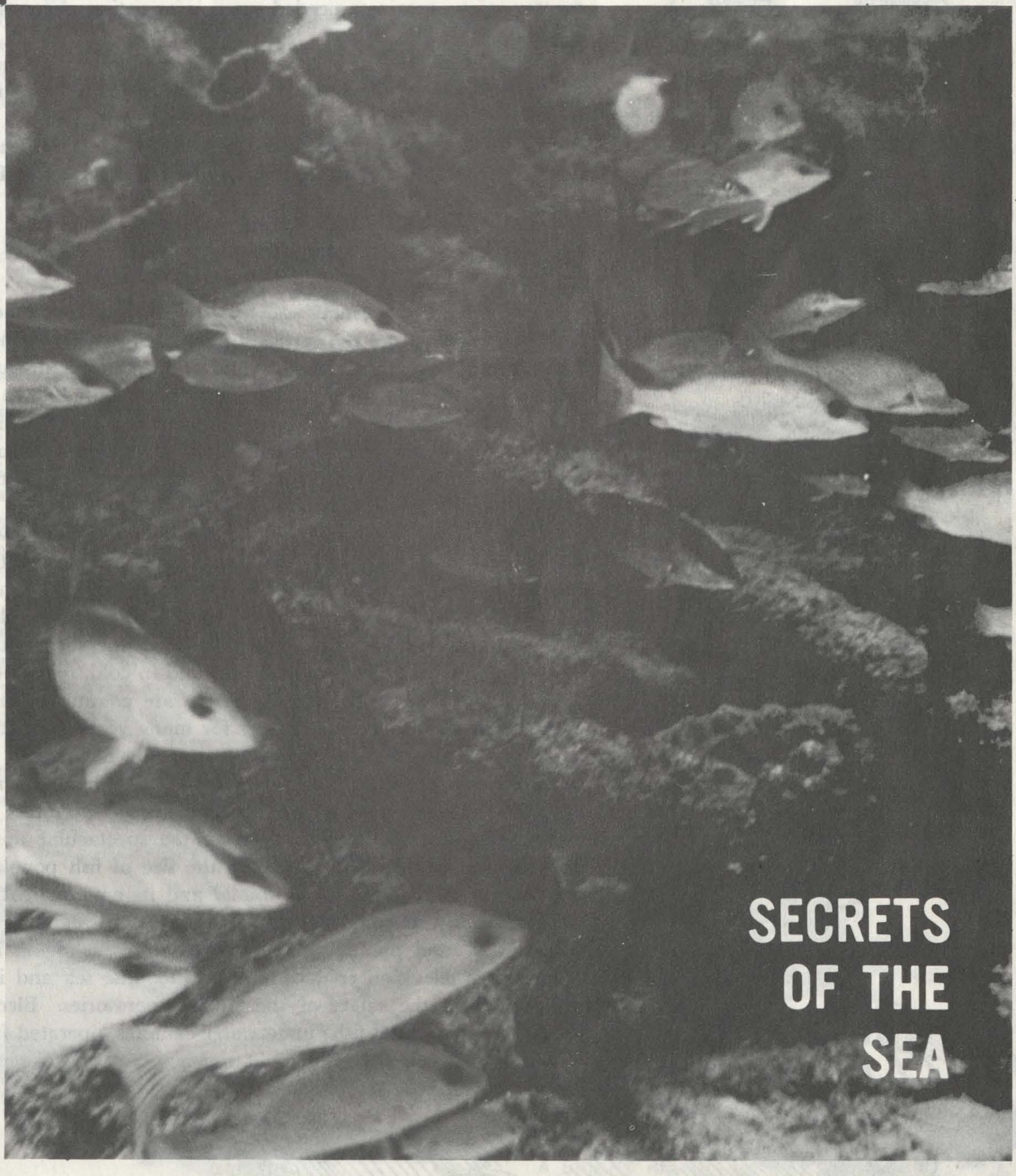
A UNITED STATES
DEPARTMENT OF
COMMERCE
PUBLICATION

OUR LIVING OCEANS

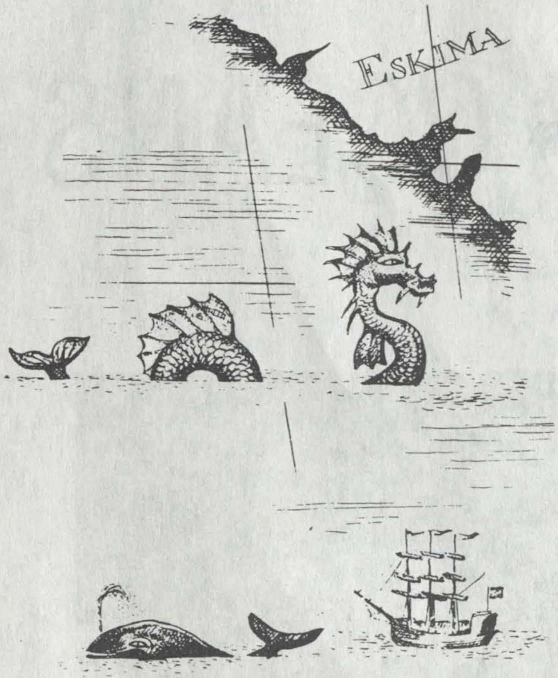


SECRETS OF THE SEA

U.S.
DEPARTMENT
OF
COMMERCE

National
Oceanic and
Atmospheric
Administration

National
Marine
Fisheries
Service



The Sea

The sea long kept its secrets locked deep in its mysterious depths. For centuries, man's interest in the sea was chiefly concerned with obtaining food from its shorelines and sailing his fragile crafts on its waters. Not until the middle of the 19th century did he undertake serious study of that strange world beneath the surface of the sea.

The sea scientists (who came to be known as oceanographers) were first interested in learning things about the sea that would aid shipping. Ship captains needed to know more about the great ocean currents. In what direction did the currents flow? How fast did they flow? For greater safety, mariners needed more information about the sea bottom, especially near the land.

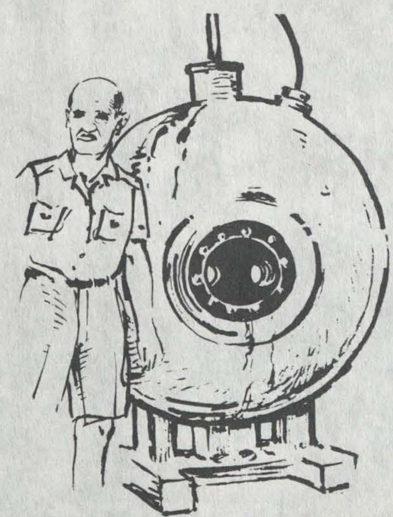
As the study of the sea progressed, exploratory cruises were made to various parts of the world by the ships of many Nations. The oceanographers began hunting the answers to such questions as: "How deep is the sea? What is the ocean floor like? How salty is the sea? How hot or cold are its waters? What chemicals occur in sea water? Is there life in the lower levels?"

UNLOCKING THE SECRETS OF THE SEA

How the Sea Was Studied

Answering these questions was a tremendous task, for the oceans cover nearly three-fourths of the earth's surface. At first the oceanographers had few instruments with which to work. Thus, special instruments had to be devised to help them "look" into that little-known world. With sounding line and later with echo-sounders and sonar, which sends back electronic echoes revealing the distance to the ocean floor, they began mapping the depths of the sea; with nets towed behind the vessel they collected many forms of sea life—from tiny animals and plants of the plankton to large fishes and squids. Water bottles were lowered over the side to collect animals and plants and water samples that would reveal the salinity (saltiness) of the sea water. In recent years, the bathythermograph, lowered by wire from the deck of a ship, has enable sea scientists to measure the temperatures of the sea from the surface to hundreds of feet deep, under burning tropical suns and in cold, foggy polar regions.

While such routine surveys of the sea are continuing in many distant parts of the world, oceanographers for many years have studied the seas more analytically. By the end of 19th century they began to realize that the sea is a living thing, that forces keep it continually in motion. Their inquiries led them to study, among other things, the forces producing the ocean currents; the causes underlying the spectacular migration of sea animals; the marked fluctuations in the size of fish populations; the intricate relation between a sea animal and its environment.



BATHYSPHERE AND BATHYSCAPH

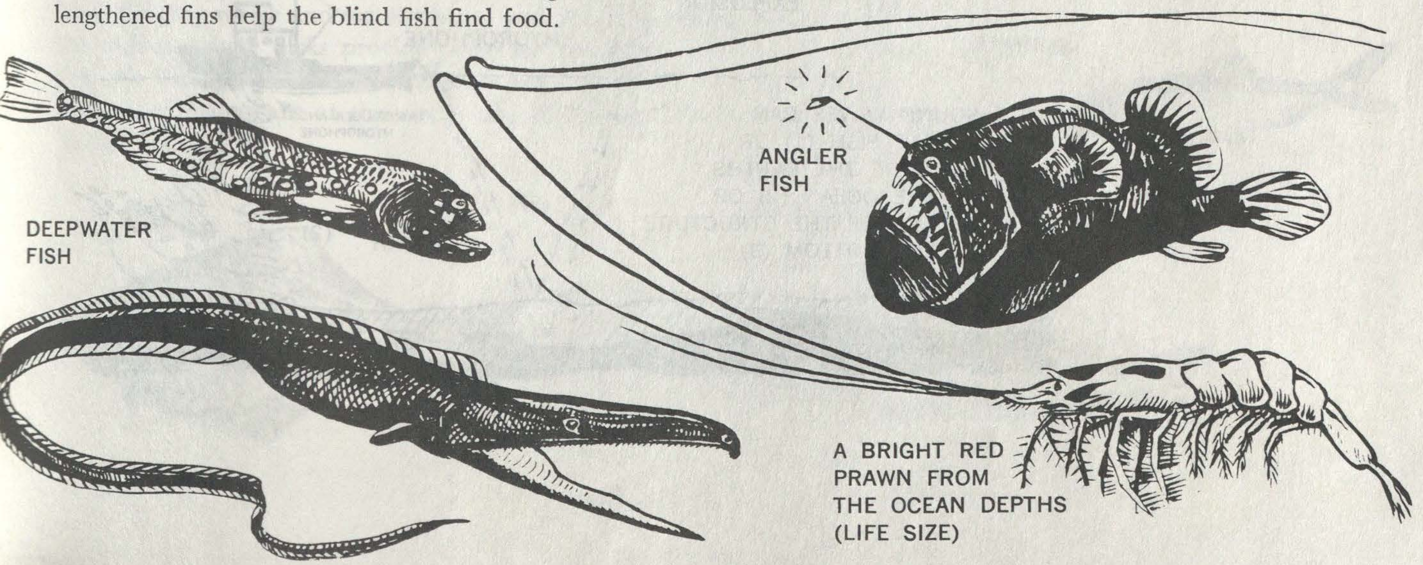
The recently invented bathyscaph lets man descend 6 miles into the sea to study and photograph animals and plants living in the depths. Underwater television enables him to study the sea and its inhabitants' behavior from the safety of the ship's laboratories. Electronic devices reveal the presence of fish; underwater cameras, operated from shipboard or triggered when the equipment touches bottom, take pictures of the ocean floor.

What the Oceanographers Discovered

The oceanographers learned many things. They learned that all the continents are surrounded by gently sloping platforms of varying widths, the Continental Shelves; descending abruptly from the shelves are the Continental Slopes; the slopes end in the great ocean basins. They learned the bottom of the sea is not a level plain, but that mountains and valleys exist in this submarine world. The largest mountain range in the sea is in the Atlantic Ocean—its tallest peak, 27,000 feet high, forms an island in the Azores. They discovered great depressions, or trenches, in the sea floor—probably the deepest one is the Mindanao Trench off the Philippines, with its bottom about 6½ miles below the sea surface. They found that great rivers cut through the sea, as the subsurface Cromwell Current in the central equatorial Pacific; that sea life is most abundant where there is a rapid exchange of nutrient-rich waters—as where great ocean currents come together or great tidal currents sweep certain coasts.

They learned that the floor of the Pacific is underlaid with basalt, while in other oceans it is granite; that the oceans vary in their salinity—the Atlantic being the most saline and the polar seas, because of melting ice and snow, the least salty; that sea temperatures range from 28°F. in the northern seas to 96°F. in the Persian Gulf. They found that great currents sweep from ocean basin to ocean basin, driven by the winds and urged on by the force of the earth's rotation. They learned that sea life does exist in the great ocean basins, which cover more than half of the earth's surface. That in these eerie depths animal preys on animal, for plants cannot live below 600 feet. From this forbidding, darkened world come fish with great eyes to take advantage of the faintest light; fish with luminous spots on their sides or heads; squid that expel shining clouds instead of the "ink" of their relatives of the upper layers; and at still deeper depths, where eyes are no longer useful, sensitive feelers or lengthened fins help the blind fish find food.

SEA SPIDERS AND BRITTLE STARS HAVE BEEN PHOTOGRAPHED AT GREAT DEPTHS



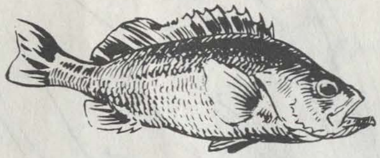
DEEPWATER FISH

ANGLER FISH

A BRIGHT RED PRAWN FROM THE OCEAN DEPTHS (LIFE SIZE)

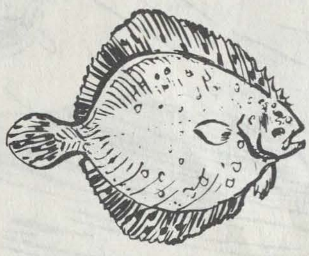
Practical Value of Sea Studies

How does man benefit by studying the sea? The benefits are many, but we will consider principally the living resources. The sea is a vast natural farm. It can produce great quantities of nutritious protein food forever if we manage this farm wisely. We need to know how much we can harvest from the sea each year; yet we also must leave enough behind to ensure the next year's crop. Scientists know how to obtain the information they need. But it is difficult and expensive to get accurate and sufficient information. How many fish reach catchable size each year? How many die? How fast do they grow? How many must survive to spawn? These are just a few of the difficult questions that need to be answered. When we have sufficient knowledge we can control our fishing so as to take the maximum possible catch year after year. Today we are reaping the maximum harvest from only a few of our many valuable fishery resources.



OCEAN PERCH

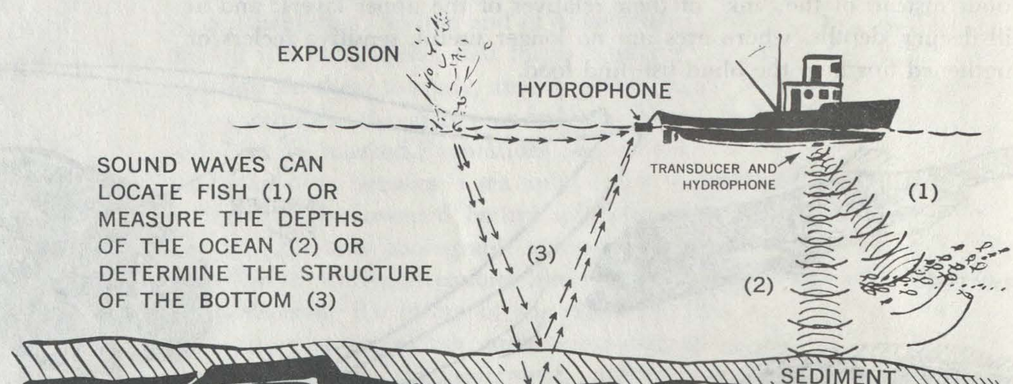
The next step will be to learn how to apply our scientific knowledge to increase the yield of food from the sea. To a limited extent we can do this now with oysters. We have ideas as to how other fishery yields can be improved, also. This could be done by adding nutrients (fertilizer). It could be done by transplanting marine animals from one place to another. It could be done by breeding fish and shellfish for desirable characteristics. Fast growth, disease resistance, and desirable flavor are some of the qualities that might be developed in this way. Before we can accomplish this magic we need to know much more about the relations between marine animals and their watery environment. We also need to learn how to make these improvements and at the same time reduce the costs of catching fish and bringing it to market. Then we may be able to farm the sea scientifically, just as our farmers on land now lead the world in agricultural production. This is the goal that fishery scientists hope to reach.



SAND FLOUNDER

Other uses, also, are made of the work of sea scientists. Through their study of ocean currents and drift and the mapping of ocean floors, they have contributed greatly to the safety of shipping. Charting of undersea mountain ranges and trenches are vital information for the submarine navigator and those laying undersea cables. Meteorologists need to know about the wind patterns at sea, and sea surface temperatures to predict ocean swells and weather accurately.

MACKEREL

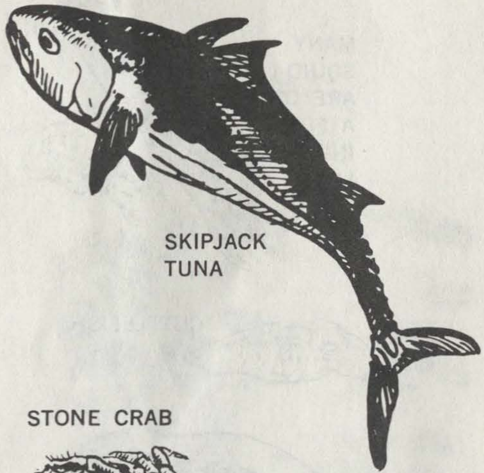


SOUND WAVES CAN LOCATE FISH (1) OR MEASURE THE DEPTHS OF THE OCEAN (2) OR DETERMINE THE STRUCTURE OF THE BOTTOM (3)

PRODUCTS OF THE SEA

Living Resources

When we speak of things that come from the sea, most of us probably think first of its fish and shellfish, such as cod, herring, halibut, tuna, oysters, crabs, scallops, lobsters, and clams. In 1961, the world catch of these sea creatures was nearly 91 billion pounds. In the United States, fishermen landed more than 6 billion pounds of fish and shellfish (including weight of their shells) at our ports—less than half of the catch of Japanese fishermen, however. About half the fish caught by our fishermen is utilized in feed for poultry, cattle, fur animals, dogs, and cats, and in other industrial products.



SKIPJACK TUNA

Fish are the main source of protein—an important body builder—for many people of the world, notably the Japanese. The average American uses only about one-seventh the fish consumed by the average Japanese. Fish are an economical way to obtain one's supply of protein. It comes as a surprise to most of us to learn that the amount of protein in an average serving of fish is equal to, and often higher than, that in an average serving of beef. Fish and shellfish also supply valuable vitamins—A, B, and D. Oysters and shrimp are excellent sources of iron and copper needed by our bodies in building blood, and they supply us with five times the magnesium and more phosphorus than is in milk. Seafoods have from 50 to 200 times as much iodine (needed to keep our thyroid glands functioning properly) as most other foods.

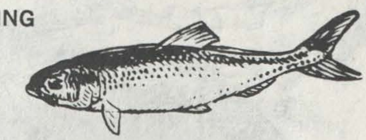
STONE CRAB

You probably are wondering how these important nutrients came to be in the fish and shellfish? Doubtless you have heard of the "food chain." You know that it means the passing of nutrients from one animal or plant to another, the chain progressing from the simplest to the most complex organisms. These nutrients—elements, minerals, and organic compounds, such as carbon, oxygen, nitrogen, phosphorus, chlorine, iodine, boron, magnesium, calcium, silicon, as well as proteins and carbohydrates—have been recycling in the sea for many eons. Billions of minute, floating sea animals and plants (plankton) use these nutrients to build their bodies. Juvenile fish, plankton-feeding fishes; such as the menhaden and herrings, crustaceans, and many other sea animals live on plankton. These animals, in turn, are fed on by larger carnivores as tunas, halibuts, sharks, and squids. When sea animals die, the nutrients return to the sea to be used by succeeding generations. When you eat fish and shellfish, you, too, take these nutrients into your body.

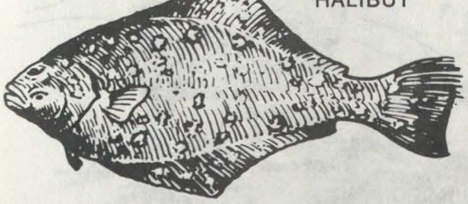
PLANKTON (Magnified)

Another valuable living resource the sea has given us, is our marine mammals. The sea otter and fur seal, highly regarded for their valuable furs; the gray whale and sea elephant, once nearly destroyed for their oil; the walrus, whose tusks provide ivory for the Aleut carvers of Alaska; and the California sea-lion, whose trained antics have entertained generations of Americans at the circus and in zoo pools, all live along our Pacific coast.

HERRING

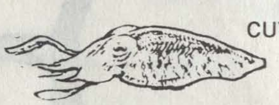


HALIBUT



COD

MANY SQUID ARE ONLY A FEW INCHES LONG



CUTTLEFISH

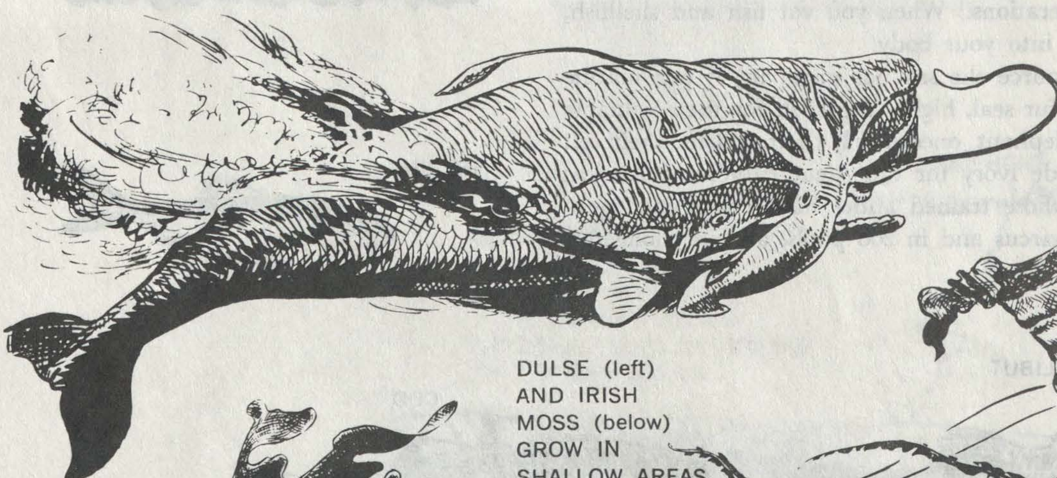
Squid are among the most abundant of sea animals. Large numbers are used each year for food by many peoples of the world. Medical researchers use their large nerve cells in studies of the primitive and simple nervous system. The cuttlefish, a relative of the squid, is probably best known to most of us from the cuttlebone that we give our cage birds. Unlike shrimp and crab, which have their skeletons on the outside, the cuttlefish has an internal skeleton. This is the cuttlebone; it is ground to a powder and used in dentifrices and polishes. When trying to escape an enemy, the cuttlefish throws out a dense brownish cloud. This "ink" known as sepia, once was used in water-color painting and in photography. Another relative of the squid, the octopus, is also much used for food in the Orient.

Sponges are another living resource of the sea. Only about a dozen of the thousands of kinds of sponges are of commercial value. Once a very large fishery (2½ million tons harvested in 1938), the harvest has fallen off because of disease among the sponges and the appearance of the synthetic sponge on the market. Sponges contain unique chemicals that some day may have industrial or medical value.

LOGGERHEAD, TUBE, AND BASKET SPONGES

The seaweeds along our seacoasts are among the sea's most valuable living resources. Americans make little use of them in their natural state, but apanese cooks prepare many tasty dishes from them. The greatest value of seaweeds in America comes from the chemical and industrial products derived from them. The derivatives, algin, agar, and carrageenin, are used in many ways: in foods, such as ice cream, candies, cake icings; in drugs, such as aspirin, and antiacid tablets, calamine lotions; in manufacturing processes producing rubber, textiles, acoustic tiles, and numerous other commercial items. A valuable derivative of seaweeds, mannitol, is used in explosives and medicinal drugs.

If our valuable living resources of the sea are to be preserved we must look well at the way we treat our seacoasts. Along these coasts, over the Continental Shelves, are found the world's most valuable fisheries. Here are the shellfish-producing areas and the nurseries of many of our important food fishes. How well we control industrialization along our coasts, disposal of the wastes of our cities and our ships, and the dumping of nuclear wastes in the sea will determine to a great degree the future well-being of the sea's great living resources.



SPERM WHALE FEEDING ON GIANT SQUID

DULSE (left) AND IRISH MOSS (below) GROW IN SHALLOW AREAS

WINGED AND BROADLEAF KELP

Mineral Resources

The ocean is the depository for the world's minerals. It has been said that the waters of the sea contain about 50 quadrillion tons of dissolved mineral salts. At least 50 of the basic elements have been found in sea water, and it probably is only a matter of time until all will be found there. Minerals have been accumulating in the sea for a billion years or more. Ashes from volcanoes sifting into the rivers are carried to the sea, bringing chlorine and sulphur; undersea volcanoes supply many minerals as boron, iodine, sulphur, and chlorine. Soil-laden waters carry calcium and silicon from weathering rock and eroding land down to the sea. Thus it is expected that the mineral wealth of the sea will continue to increase.

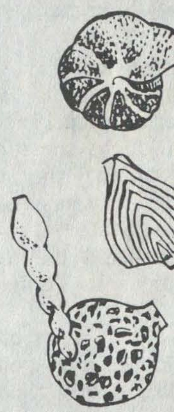
The sea holds 99 percent of the world's supply of bromine. Formerly iodine came entirely from seaweeds; now it is mined from brine deposits left by the great inland seas when they receded or is obtained from underground waters associated with oil-bearing rocks. Ancient seas that once covered our land gave us many other valuable minerals. As their waters withdrew, they left behind great salt beds in the northern United States from New York to Michigan; some beds are nearly 500 feet thick. Other minerals were left in our Southwest. Here were formed the great deposits of borax made famous by the 20-mule teams that carried this mineral across the country in early days. Also left here by the receding waters of those ancient seas are great deposits of gypsum, magnesium, and potash. The ocean is still the cheapest source of magnesium, however, as this mineral is more cheaply extracted from sea water than from rocks.

Our great petroleum resource also had its origin in the sea, whether along the edges of the sea where once-submerged lands have raised, as in the Middle East and in the Gulf of Mexico, or in areas once covered by ancient inland seas, as in Oklahoma. In recent years, geologists have tapped the Continental Shelves seeking oil deposits that might be held beneath the floor of the sea. As a result, offshore wells are producing oil today off the coasts of Texas and Louisiana in the Gulf of Mexico and off California.

"But why," you may ask, "are the waters of the sea salty while river waters are fresh?" The reasons for the saltiness of the sea are complicated, but a simple explanation is possible. Most rivers and other land drainage contain small quantities of dissolved salts. For billions of years this solution has been accumulating in the sea. The water, on the contrary, is removed from the sea by evaporation. It falls on the land as rain or snow and returns to the sea with more salt. The sea is so large that the concentration of dissolved salts increases very slowly indeed, too slowly for man to measure.

NODULES OF MANGANESE ON THE OCEAN FLOOR

FORAMINIFERA



FATTY RESIDUES FROM ANCIENT FORAMINIFERA CONTRIBUTED TO PRESENT OIL DEPOSITS

VOLCANIC ERUPTION

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Rockville, Maryland 20852

NOAA, The Marine Environment, and Oceanic Life

Since the ocean is one of our most valuable and most vulnerable resources, it is not surprising that a large number of Government agencies, both military and civilian, have responsibilities for the study, use, or conservation of the sea.

The principal civilian Federal agency in this category is the Commerce Deparment's National Oceanic and Atmospheric Administration—"NOAA" for short.

Before NOAA was created in 1970, our "ocean interest" agencies were scattered through various departments, each doing its own thing, sometimes with very little idea of what the other agencies were doing. As a result, research was often duplicated, as two or more agencies gathered the same or similar information for different purposes.

Putting everyone under one roof, it was felt, would help research dollars go further by cutting out duplicated effort, and would also make it easier to coordinate planning and priorities.

While most of the organizations that make up NOAA are concerned with physical aspects of the ocean and the atmosphere, the National Marine Fisheries Service deals with the living resources of the sea—fish and shellfish, marine plants, such as seaweeds, and marine mammals.

The work of the National Ocean Survey includes preparing charts of coastal waters and the Great Lakes. These are used in navigation, and sometimes, as an aid to fish-finding. Since fishermen know that certain types of fish prefer certain types of seabottom and tend to be found at certain depths, charts showing this type of information can cut down on the time required to track down the fish. In coastal areas, serious saltwater anglers fish by the tides, and tables predicting the times of high and low tides are regarded as an invaluable tool. Prediction of tides and tidal currents is another of the Survey's many activities.

Everybody talks about the weather—but weather can be literally a matter of life and death for those at sea, or for those who live in coastal areas. The National Weather Service provides a wealth of information useful and vital to users of the sea—special high-seas weather broadcasts, forecasts of sea state, water temperature, and surf—not to mention warnings against hurricanes and other disturbances, such as tornadoes, severe thunderstorms, and winter storms.

Very closely related to the work of the National Weather Service is the work of NOAA's Environmental Research Laboratories, which conduct studies aimed at improving our knowledge of the physical processes and mineral resources of the sea. Areas of study include the continental drift theory, major current systems of the ocean, air-sea interaction, and tsunamis (highly destructive "tidal" waves caused by earthquakes). NOAAs' Marine Minerals Technology Center is working to develop methods of tapping the mineral resources of the ocean floor without harming the marine environment.

The Environmental Data Service, through its National Oceanographic Data Center, processes and stores the world's largest collection of marine environmental data. Its National Climatic Center holds some 40 million marine weather observations, and the collection of the National Geophysical and Solar Terrestrial Data Center includes some marine geological and geophysical data.

The National Environmental Satellite Service, a leader in the search for better ways to use data collected by earth-orbiting instruments, has begun to create such ocean-oriented "products" as sea-surface temperature maps and monitoring systems for major current systems.

The Sea Grant Program is concerned with direct application of scientific research results to real problems. The three principal activities of the Program are research, education, and advisory services, with subject matter ranging from aquaculture through the legal, medical, and sociological problems that might arise from man's use of the sea.

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