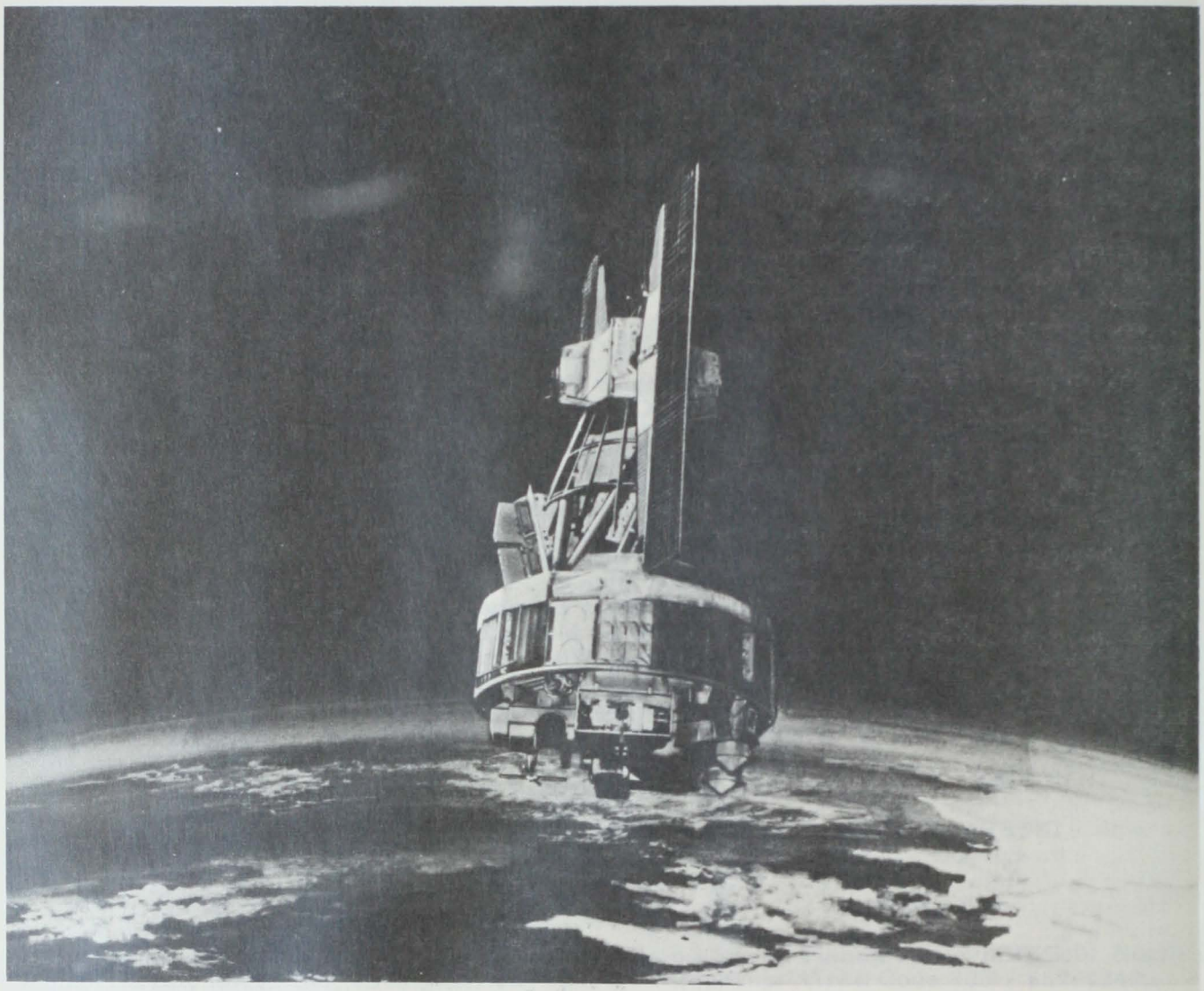


Nimbus (Photo: NOAA)

U.S. & CALIFORNIA MODERNIZE A FISHING OPERATION

Machines may replace men on the boats that fish mackerel, anchovy, and bonito out of San Pedro, Calif., if an experiment to mechanize wetfish purse-seining is successful. This is reported by Izadore Barrett, Acting Director of the National Marine Fisheries Service (NMFS) laboratory in La Jolla.

The experiment, begun in summer 1970, is sponsored jointly by NMFS and the California Marine Research Committee (MRC). It involves the 83-foot fishing vessel 'Sunset', reactivated after long idleness by its new skipper, Nick Jurlin of San Pedro.

Sunset Changes

Among the fishing improvements installed on Sunset by NMFS and MRC are a hydraulically driven net drum that winds up the large purse seine; before, it took half the crew to stack it on the stern. Another is an improved pursing winch that closes the bottom of the net and neatly stores its lines. A pump that sucks up the fish concentrated in the pursed net has replaced the laborious dip-net operation. With these and other improvements, Sunset has been operating with only 5 men, instead of the usual 10.

Effects on Crew

Mr. Barrett explained that in a fishery top-heavy with underpaid manpower, crew reductions that maintain equal, or produce greater, catching efficiency benefit owner and crew. The loss of jobs in the wetfish fleet as a result of such technological improvements can be absorbed by natural attrition, while the remaining higher-paying jobs will emphasize the essential skills of commercial fishing without the drudgery. A study by NMFS fishery biologists and economists has shown that the boat owner can pay off the cost of mechanization in 5 years--and should even make higher profits during this period.

At last reports, Sunset, fishing with a reduced crew, was a "high-liner" (a leader) among 21 boats fishing for anchovy. Results are being watched carefully.

Mr. Barrett notes that several boats have begun to instal fish pumps in what may be the first steps toward modernizing the San Pedro wetfish fleet.

U.S. WEATHER SATELLITES AID FISHERMEN

With the help of scientists at NMFS La Jolla (Calif.) laboratory, U.S. tuna fishermen now have an eye in the sky to warn them of impending storms and rough seas that affect fishing. In July 1970, an automatic picture-transmission (APT) satellite receiver was installed in lab to provide detailed photographs of weather patterns over fishing grounds. This information is transmitted from three U.S. weather satellites--NIMBUS IV, ESSA-8, and ITOS-1--as they move through sky in orbits covering principal tuna grounds from Pacific Northwest to eastern tropical Pacific.

Improve Fishery Advisories

Using the satellite photographs, Dr. Nathan Clark, Meteorologist, and James Renner, Fishery Biologist, have been able to improve accuracy of weather forecasts presented in fishery advisories. The advisories have been issued for the past 3 years, mainly for albacore fishermen. Forrest Miller, Meteorologist with Inter-American Tropical Tuna Commission, working under contract to NMFS, also uses satellite photographs to inform fishermen via radio of location, intensity, and movement of intertropical convergence zone and tropical storms.

New Research Project

Encouraged by APT's usefulness to influence fishing strategy, a new research project has begun at NMFS La Jolla to obtain direct readout of thermal infrared data from APT system--and to relate this information to sea-surface temperature patterns and gradients along Baja California and eastern tropical

Pacific. Dr. R. Michael Laurs, Leader of Fishery-Oceanography Group, is in charge.

How La Jolla Helps Fishermen

APT project is latest La Jolla effort to help U.S. fishermen catch more fish. La Jolla provides fishery advisories to albacore fishery off the West Coast, and to tropical tuna fleet west of Mexico and Central America. These advisories, said Izadore Barrett, Acting Director, consist of daily forecasts of weather and sea-surface conditions for specific fishing grounds. There is special emphasis on surface winds, sea temperatures, and sea state as these relate to special needs of tuna fishermen. The advisories also contain marine weather forecasts based on information from National Weather Service and Navy's Fleet Numerical Weather Central. Information on daily albacore catches is included.

BOTTOM-FISH DISTRIBUTION AFFECTED LITTLE BY TEMPERATURE CHANGES

Temperature changes over the past 20 years have had little effect on the distribution of bottom fish on the continental shelf between Nova Scotia and Long Island. So reports NMFS Woods Hole (Mass.) Laboratory. Its study of research-vessel distributional data and recent temperature trends did not show any important correlation.

Four key species were studied: American plaice, haddock, yellowtail flounder, and butterfish.

Temperatures Up Since 1957

Water temperature increased from the early 1940s to a maximum in 1952-53. Then temperatures declined through 1957. Since 1957, temperatures have trended upward. The effect of these changes on abundance of groundfish has not yet been examined.

CATFISH FARMING GROWTH CITED IN NMFS STUDY

The U.S. production of farm-reared channel catfish is expected to double within the next few years. This forecast is contained in NMFS study, "A Program of Research for the Catfish Farming Industry," conducted for Economic Development Administration (EDA) of Commerce Department.

The forecast is based on estimate of 22 million pounds of catfish produced in 1968 on 25,000 acres of water.

Industry Potential

The report states that the industry has the capacity to strengthen and diversify the economy of the southcentral States, where it is concentrated. Orderly growth of the industry, however, depends on expansion of markets and construction of processing plants to handle anticipated increased production.

The report reviews harvesting and processing techniques. It notes that mechanical harvesting units and skinning machines are being used.

NMFS & EDA Aid Industry

The technical assistance program for catfish industry is being continued by NMFS with EDA financial aid. The Catfish Farmers of America, a trade group, has requested EDA to help develop the industry.

A copy of the report may be obtained from U. S. Department of Commerce, Economic Development Administration, Publications Division, Washington, D.C. 20230.

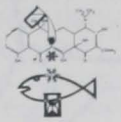
A NEW DEVICE SUCCESSFULLY TESTS NUTRIENT VALUE OF FISH FEEDS

A "fish nutrient chamber," a plastic bottle-type device, has tested successfully the nutrient value of fish feeds. The work was done by researchers of Interior Department's Bureau of Sport Fisheries & Wildlife.

The chamber holds a fish and allows oxygenated water and nutrients to enter at one end; at the other end, fish wastes exit with

water. The researchers can determine closely how much fish growth results from various kinds and quantities of feed.

Much of the research has involved rainbow trout, but it is believed that such other species as salmon and catfish can be used.



RAPID SALTING PROCESS DEVELOPED

Whiting can be salted, dried, and packaged in one day using a new process developed at NMFS Gloucester (Mass.) Fishery Products Technology Laboratory. The usual salting and drying process takes weeks to months.

The salted whiting was prepared in a few minutes for use in a fish cake mix. When taste-tested, the fish cakes were very acceptable.

Another positive feature of the salted fish is that it is stable. It retains good color, odor, flavor, and texture after more than a month's storage at 80° F.

More information willl be made available after a patent has been granted.

NEW SELF-DESTRUCT PLASTIC MAY BE PACKAGING MATERIAL

A new packaging plastic has been developed in Sweden. Reportedly, it will keep its strength as long as needed, but it will decompose after use. It is a chemically modified polyethylene with some additives, which give it strength--but will accelerate decomposition when exposed to sunlight.

For Wrapping & Packaging

The makers hope the new plastic will be adapted for use as container wrapping and packaging materials. For information: Tetra Pak, of Raabyholms, Alle, Lund, Sweden. ('Air Cargo', Nov. 1970.)

MERCURY FOUND IN FUR SEALS

Scientists of NMFS Marine Mammal Biological Laboratory in Seattle have found high concentrations of mercury in the livers of northern fur seals (Callorhinus ursinus) collected in 1970.

Mercury in liver samples ranged from 0.05 to 0.35 ppm in ten 3-month-old pups taken on St. Paul Island, Alaska; from 3.0 to 19.0 ppm in 29 young males ages 2 and 3 years taken on St. Paul Island; and from 19.0 to 172.0 ppm in 29 adult females ages 5-19 years taken off Washington State.

Age A Factor

The data indicate higher concentrations are associated with age. Among adult females, the youngest had the lowest concentration, and the oldest had the highest concentration of mercury. The source of mercury is not known, nor the possible effects on fur seals understood.

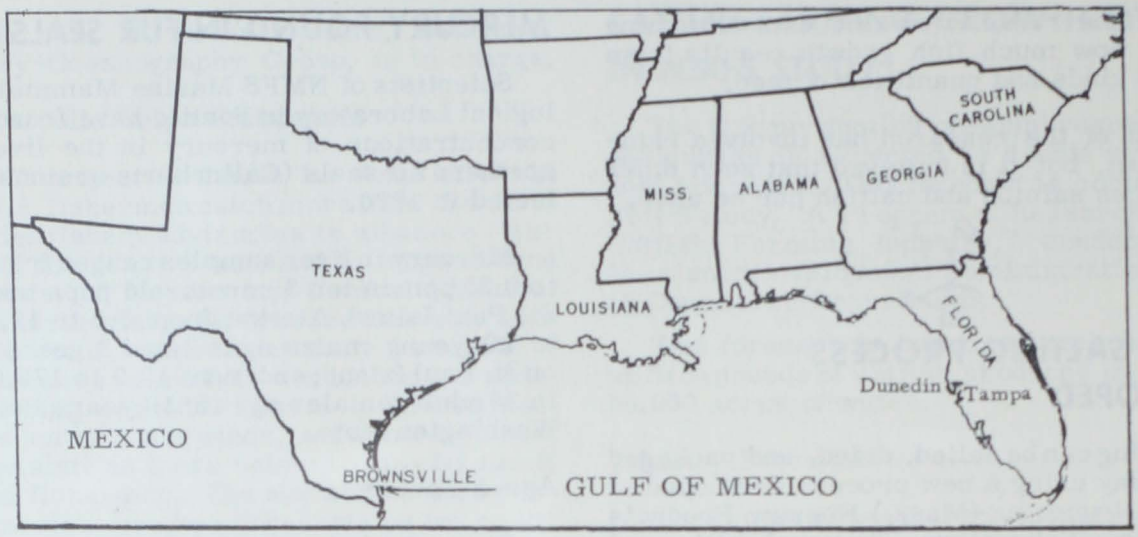
--Ray Anas

ARMY VETOES DREDGING PROPOSALS IN FLORIDA WATERS

The Secretary of the Army has upheld a recommendation by the Army Corps of Engineers that developers of Honeymoon Island in Pinellas County, Florida, be denied a permit for dredging and filling. The developers sought to dredge 9 million cubic yards of fill material from Gulf of Mexico to create a 120-acre enlargement of Honeymoon Island in Gulf of Mexico opposite City of Dunedin.

The Secretary's Statement

The Secretary said the work would not be in the public interest: "After thorough consideration of all facts of the case and close analysis of the views of responsible local, state and federal officials and agencies, there appears to be little justification for allowing a major alteration of the Florida coastline, with the resultant irretrievable damage to the environment and to fish and wildlife. The esthetic and environmental aspects of developing the shoreline of the Florida coast with



non-water-oriented facilities creates in the Department of the Army's view an unfortunate and undesirable reduction in natural shore conditions which cannot be considered to be in the genral public interest."

U.S.-STATE PROGRAM TO RESTORE SHAD TO CONNECTICUT RIVER

Juvenile shad resulting from the $3\frac{1}{2}$ million fertilized eggs planted in Spring 1970 by Interior Department's Bureau of Sport Fisheries and Wildlife in Connecticut River were being studied for growth and survival during their downstream migration in Fall 1970.

The upstream parts of the river have been closed to shad for more than 100 years because of high dams. A cooperative Federal-State restoration program is trying to restore runs to river's lower parts and tributaries.

1970 OREGON SHRIMP HARVEST IS STATE RECORD

A record catch of at least 13.3 million pounds of shrimp has been landed at Oregon ports in 1970, according to Jack Robinson, Fish Commission biologist. The total should reach 13.5 million pounds when all figures are in. The fishing season closed October 31. For the past 3 years, landings were about 10 million pounds. Dockside value to Oregon fishermen will top $1.5 million.

The Fishery

The Oregon shrimp-fishing industry began only 13 years ago with 6 boats; now it has 56. Shrimp boats, mainly oceangoing trawlers, range from 45 to 85 feet. When not shrimping, these boats fish tuna, bottom fish, crabs, and salmon.

Shrimp are caught with modified otter trawls--big nets with one end opened like a gaping mouth 4 feet high by 40 feet wide and tapering to a small closed end. The trawl is dragged along bottom, scooping up and trapping the shrimp in its narrow end. The net, constructed of $1\frac{1}{4}$-inch nylon mesh, catches commercial-size shrimp--but allows small shrimp to escape.

How Ports Ranked

Coos Bay landings totaled 4,680,000 pounds. Newport was second with 2,945,000 pounds and may top 3,000,000 pounds. Astoria-Warrenton reported over 2,600,000 pounds, and Garibaldi 1,340,000 pounds. Port Orford, which landed 74,000 pounds in 1969, made a major comeback with 1,205,000 pounds. Brookings, the southernmost port in Oregon, reported 520,000 pounds.

1971 Prospects Bright

The record 1970 catch contributes significantly to the state's economy. According to Robinson, the prospects for 1971 appear bright. The strong 1968-69 year-classes should contribute excellent-sized shrimp.

COLUMBIA RIVER SALMON CATCH IS EXCELLENT

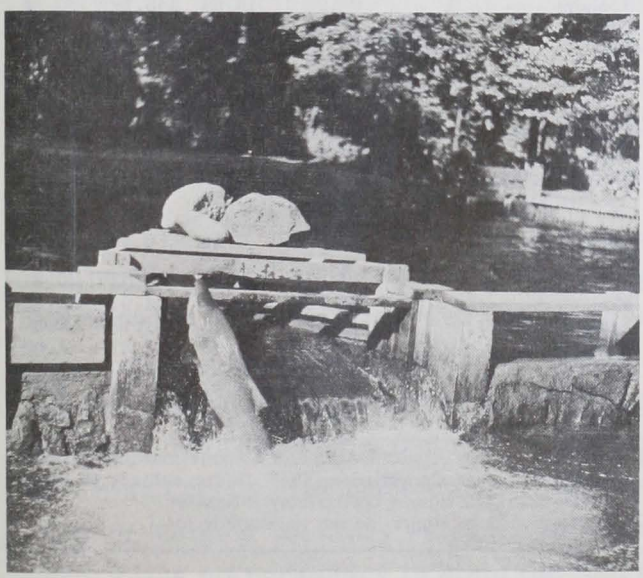
The Columbia River fall salmon fishery produced excellent commercial catches, reports the Oregon Fish Commission. Landings of coho approached 4.9 million pounds, the best since the mid-1920s. The bulk was taken below Bonneville. Only 184,000 pounds were landed in Indian commercial fishery above Bonneville; this reflects the general distribution of coho in Columbia River. Primary areas are in lower river. Few coho pass over Bonneville Dam and enter Indian fishery area.

Large % Hatchery Origin

Studies by the National Marine Fisheries Service (NMFS) and Oregon Fish Commission in 1969 show that 66% of coho taken below Bonneville and 48% of Indian catch above Bonneville Dam were of hatchery origin.

Chinook

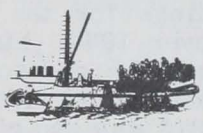
Columbia River chinook landings were the best since 1951, almost 4.9 million pounds: nearly 4.2 million pounds in commercial fishery below Bonneville Dam, and over 700,000 pounds in Indian fishery above Bonneville. A preliminary report by NMFS states that between 1964 and 1968 35% of commercially caught fall chinook below Bonneville Dam and 49% of Indian catch above Bonneville were of hatchery origin.



Return of the native. Back to hatchery comes chinook salmon released 4 years before as fingerling. (USIA)

Large numbers of fall chinook salmon have returned to Fish Commission hatcheries in Columbia River system. Some chinook hatcheries in Oregon and Washington did not receive enough adult chinook to satisfy their egg-take requirements, but Big Creek hatchery's record return of 17,500 fall chinook yielded 33.4 million eggs. Eggs surplus to Big Creek hatchery's needs were supplied to other state and Federal hatcheries. The needs of all Columbia River hatcheries have been satisfied.

The Oregon Fish Commission says the hatchery program is making a "meaningful contribution to Nature's production of salmon in Oregon."



SALMON RETURN TO WILLAMETTE RIVER

Salmon have returned to Oregon's Willamette River, once too polluted for them. The 1970 spawning run of coho and fall chinook salmon is greater than all previous migrations, reports NMFS.

Credit goes to cooperative efforts by industry, state, and Federal agencies that improved water quality. Modern fishways are being installed at the Willamette Falls industrial center.

Salmon Counted

Using a technique developed by NMFS engineers, TV camera and video tapes, more than 35,000 coho and 7,500 "lunker" chinook salmon were counted at a new fishway.

Oregon is building 2 more new fishways: 84% of funds provided by Department of Commerce and administered by NMFS; 16% by private industry. (Information from Dr. Fred Cleaver.)

ALASKA ENJOYS GOOD FISHING

Alaska's 1970 fishery landings will be about a half-billion pounds worth $85-$95 million to fishermen. These preliminary estimates show a very good year, reports NMFS Juneau. The 1970 fishing season, like 1969's, appears to have made Alaska No. 1 state in value of landings, and either No. 2 or 3 in quantity.

SALMON

Preliminary catch estimates indicate that 1970 salmon fishery may equal or exceed 1966 bonanza of 333.3 million pounds. This would be largest since 1949, when 346.4 million pounds were landed.

Estimated landings for the 5 species of salmon were up over 1969: kings 4%; pink 15%; coho 18%; chum 105%; and sockeye 123%. Although salmon pack did not meet preseason predictions, still 1970 was one of best years.

The season's canned salmon pack of 3.68 million cases was second largest in 20 years; it fell just under 3.91 million cases in 1966. Four of the 5 species gained over 1969: sockeye, pink, chum, and coho salmon packs increased and totaled 1,794,000, 1,327,000, 472,000, and 56,000 standard cases. King salmon dropped to 27,000 cases from last season's 35,000. Sockeye and pink dominated season's pack: Bristol Bay provided most of sockeye pack (1,151,000 cases); Kodiak alone provided about one-third (465,000 cases) of pink pack.

HALIBUT

Preliminary estimates indicate 1970 Canada-U.S. halibut catch will reach 58 million pounds. It will parallel closely the 1969 catch, by regulatory area, which totaled 58.6 million pounds.

The Canadian and U.S. fleets landed estimated 26.7 million pounds of halibut in Alaska in 1970; this was increase of 26% from 1969. These landings were worth about $8.5 million to fishermen.

SHRIMP

An estimated record Alaskan catch of 71 million pounds worth $2.84 million to fishermen is anticipated in 1970. This is a 48% increase over 1969's record 47.8 million pounds.

One of most spectacular aspects of Alaska's 1970 industry is "explosive growth of the Kodiak shrimp fishery." It may produce estimated 60 million pounds of shrimp worth $2.4 million, exvessel, by season's end. This quantity alone more than doubles combined shrimp landings expected from rest of Alaska, Washington, Oregon, and California.

CRAB

Alaska crab landings--king, Dungeness, and snow--are expected to approach 75 million pounds in 1970, down about 5 million from 1969. It appears that 1968/1969 trend will be repeated this season: Estimated landings of king and Dungeness declining 7% and 20% from 1969, snow crab increasing 36%.

The estimated average 1970 price to fishermen for king crab was 27 cents per pound, down slightly from 1969. Dungeness crab was steady at 14 cents, and snow crab increased from 10 to 11 cents.

Alaskan Landings and Value to Fishermen 1969 and 1970[1/]

Fishery	1969 Pounds	1969 Dollars	1970 Pounds	1970 Dollars
	(weight and value in millions)			
SALMON (Total)	211.87[2/]	42.58	333.31	59.85
King	11.81	3.81	12.30	4.12
Sockeye	64.97	16.64	145.19	30.93
Coho	7.67	2.14	9.02	2.39
Pink	104.46	16.75	119.69	16.76
Chum	22.97	3.24	47.11	5.65
HALIBUT (Total)	21.20	7.14	26.71	8.55
State Landings--U.S. Fleet	16.64	5.58	19.11	6.11
State Landings--Canadian	4.56	1.57	7.60	2.43
SABLEFISH	0.47	0.06	0.49	0.07
SHELLFISH (Total)	130.30	22.44	148.04	20.81
King Crab	57.75	16.17	51.03	13.52
Dungeness Crab	11.53	1.65	9.17	1.28
Snow Crab	11.21	1.13	15.23	1.68
Shrimp	47.84	1.91	71.00	2.84
Scallops	1.89	1.55	1.45	1.42
Clams	0.09	0.03	0.16	0.04

1/Data furnished by Alaska Dept. Fish & Game and International Pacific Halibut Commission; 1969 figures subject to minor revisions, 1970 figures preliminary estimates.
2/Due to rounding, figures do not necessarily total.

ANCHOVY SPAWNED SUCCESSFULLY IN LA JOLLA LAB

For the first time, an important commercial open-sea fish has been spawned successfully under artificial conditions, reports Izadore Barrett, Acting Director, NMFS Fishery-Oceanography Center, La Jolla, Calif. Anchovy larvae produced from this artificial spawning fed and grew as normally in an aquarium as their counterparts in the sea. Additional batches have been produced in succeeding months and are continually being used for experimental purposes.

No member of the clupeid family--to which the anchovy, sardine, and herring belong--has ever been artificially induced to spawn in the laboratory. The results offer unique opportunities to study the response of marine fish eggs and larvae to such environmental factors as pesticides and heated effluents.

How It Was Done

Roderick Leong, NMFS fishery biologist who achieved this scientific first, has been working on inducing spawning in laboratory fish for more than a year under physiologist Dr. Reuben Lasker. During the experiments, Leong subjected adult anchovies kept in large aquaria to 4 hours of light and 20 hours of darkness for 4 months at about 15° C.

The fish were all from the same school. At intervals, they were injected with several types, dosages, and combinations of hormones. The combination that produced heavy spawning included commercial preparations of human chorionic gonadotropin (HCG) plus carp or salmon pituitary extract. In either case, it was not necessary to strip the fish to obtain sexual products--as usually is done with salmon and trout--because the fish released and fertilized the eggs themselves. The percentage of eggs hatching from these trials varied from under 19% in one trial to over 80% in others.

Insure 1 Male & 1 Female

During the experiments, the anchovies were fed squid and trout food, supplemented occasionally by ground anchovies and brine shrimp. Not all the injected fish spawned. Leong says it is not yet possible to synchronize gonad development completely, or to recognize superficially the sex or level of sexual maturity in anchovies. Therefore, 15 to 20 fish were injected in each experiment to insure that at least one male and one female would be mature enough to spawn.

Several weeks after the induced spawning, Leong observed that one group of anchovies in a large holding tank began to spawn spontaneously. This group had been held under same light and feeding conditions as injected fish. New eggs were found in special collectors for several consecutive days; the percentage of viable eggs ranged from 30 to 80%. Leong is experimenting with temperature change as a method to induce spontaneous spawning because this may be a way to obtain eggs without hormonal injections.

An Important Fishery

The northern anchovy is one mainstay of commercial fisheries off California. Fishermen were expected to take about 110,000 tons between September 1970 and May 1971.

COPEPOD WAX MAY BE A KEY TO HUMAN METABOLISM

Studies of naturally grown and laboratory-bred copepods may hold keys to important factors in human metabolism, Scripps Institution scientists believe. The copepods are tiny, shrimplike, marine organisms that weigh as little as 1/140,000th of an ounce or grow to an inch long in the deep ocean.

Copepod investigations at Scripps Institution of Oceanography, University of California, San Diego, have led to these conclusions:

Half the Earth's production during photosynthesis is converted for a time to wax by the copepod, the ocean's most numerous and diverse marine animal.

The copepod population off California alone is estimated to have 800,000 tons of liquid wax, a much larger amount than the oil of the 'Torrey Canyon' or Santa Barbara spills.

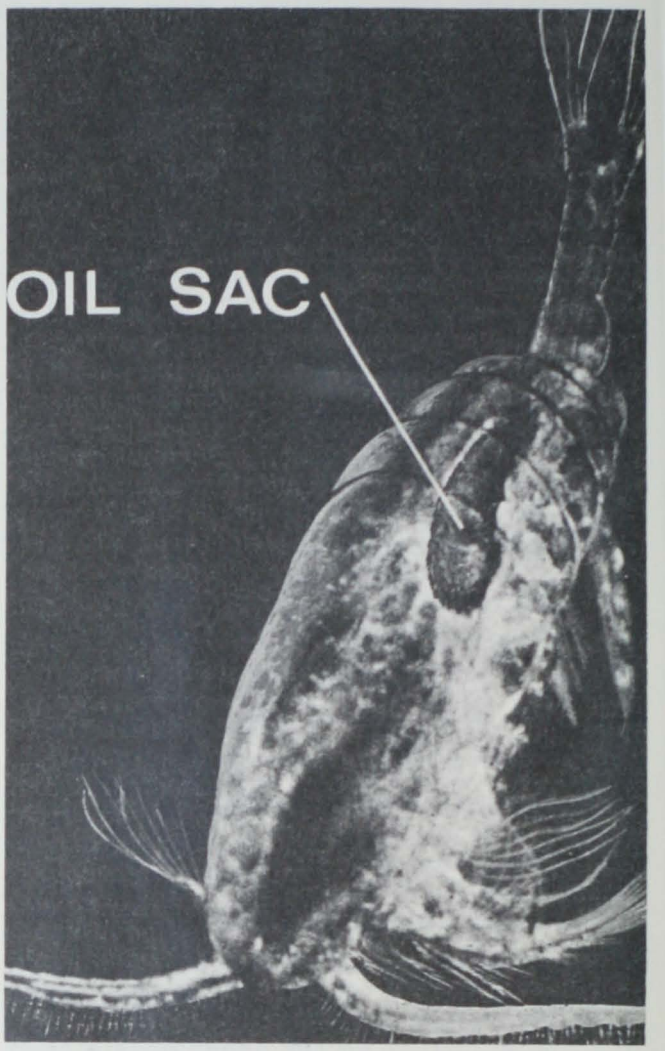
The copepod is the first animal in marine food chain. It is the predominant animal that can "graze" on microscopic algae (diatoms and dinoflagellates).

'Who eats whom' in the ocean may be determined by the nature of the wax and hydrocarbon compounds in the predator and the prey.

Scripps Study

Scripps has duplicated the complete life-cycle of the copepod in the laboratory. A team has been studying the occurrence of wax in copepods for more than a year. Copepods are called "insects of the sea."

The scientists report that wax appears to be a major medium for transferring and storing energy in marine organisms. The copepod lives upon microscopic plants called phyto-



Enlarged photo of $\frac{1}{8}$th-inch marine copepod 'Calanus', "insect of the sea." Oil sac is toward rear of its tiny body. Wax is used for energy storage and food supply during periods of starvation and hibernation in long winters. Wax is made from oils of algae that it eats (darker area below sac).

plankton and converts their fat into polyunsaturated liquid wax. It stores this in its oil sac.

These waxes are unique because they are metabolized readily by the copepod, which uses them as a reserve supply of energy. These waxes differ from plant leaf waxes, bees' wax, and animal waxes, which are not metabolized easily.

Dr. A. A. Benson, director of Scripps' Physiological Research laboratory, said: "Further along in the marine food chain the copepods are eaten by predators--sardines, anchovies, herring, and young salmon--who, in turn, convert the waxes back into common fats so widely used for human food. These fishes are the world's specialists in metabolism of waxes."

This wax metabolism helps control the copepods' ability to survive their hostile environment, Dr. Benson added, and it may serve a similar purpose in higher marine animals.

Waxes As Possible Keys

Waxes are compounds of ordinary fatty acids combined with fatty alcohol, the scientists say. They are studying the conversion of this fatty alcohol back to the fatty acids of fishes.

Dr. Benson notes: "Additional knowledge about this apparently complex chemical process may give us the key to an important factor in human metabolism. The intermediate compound which must participate in this conversion occurs as a major component of human heart muscle and brain, but its existence has never been explained. We hope that nature's specialists in this process, the copepods and anchovies, will give us clues to answers, with the possible end result that we might have a better understanding of the energy production of heart muscle and nerve activity in the brain."

The scientists estimated 800,000 tons of liquid wax were contained in the copepod population off California by actually counting the quantity of the organisms in a cubic meter of seawater.

The major copepod of the oceans, C. lanus, has been grown artificially by Dr. Michael M. Mullin of Scripps, and by Dr. Gustav A. Paffenhofer, a visiting German zoologist, on pure cultures of diatoms, green single-cell algae.

They grew the copepods throughout their life cycle by almost-hourly feedings.

"The well-fed Calanus contains 70 percent of its dry weight as wax, which is 40 percent of its total fat," reported Dr. Judd C. Nevenzel.

"We have analyzed the wax and fat content of single copepods weighing only 1/2,500th of a gram, or 1/140,000th of an ounce, added Richard Lee, a graduate student. "Deep-sea copepods are larger, nearly an inch long, and are 60 percent wax. Arctic copepods have been found that contain 70 percent lipid, which is made up of 91 percent wax."

WARM SPOT IN N. PACIFIC OCEAN CAUSING EASTERN U.S. TO GROW COLDER

Eastern U.S. and other parts of the world have been experiencing cooling trends in recent years. Explanations include: air pollution is blotting out part of the sunlight; increased volcanic dust may be doing this; the world may be experiencing a cyclical variation in the sun's energy output.

NOAA Expert Suggests Cause

A fourth possibility has been suggested by Jerome Namias, chief, Extended Forecast Division of National Weather Service, and research scientist for Scripps Institution of Oceanography. He points to oceans as a cause. Observed changes in ocean temperature seem linked to large-scale displacements of air currents around the globe, he notes.

Meteorologists generally accept that the oceans are generators of world weather. This is one reason why the two were brought together in 1970 in a new Commerce Department agency--the National Oceanic and Atmospheric Administration (NOAA).

The oceans cover about 70% of earth's surface. They change temperature much more slowly than air above, and so act as "a sort of governor" on global climate.

Namias Argument

Meteorologist Namias argues that air-sea relationship is so basic that "scientists may be overlooking the most important factor by neglecting this interaction" when trying to explain cooling trends. He believes it "quite possible" that warm surface water in North Pacific is responsible for colder winter in eastern U.S.

How could warm ocean water produce cold winds thousands of miles away? Namias says that you need to visualize the high-level river of air that undulates from west to east around Northern Hemisphere. This planetary flow, whose core is the jet stream, is a permanent feature of the atmosphere, although its distance from Equator and sinuous shape are changing constantly.

Winter Jet Stream Shifted

During the 1960s, says Namias, a persistent shift took place in winter jet stream. A pattern akin to that in accompanying map occurred more often than previously. Cold air from the north swept down repeatedly over eastern two-thirds of U.S. The result was that in the east "winter temperatures averaged 1 to 4 degrees Fahrenheit below the 1931-60 mean," he says, while "west of the continental divide, temperatures averaged above normal."

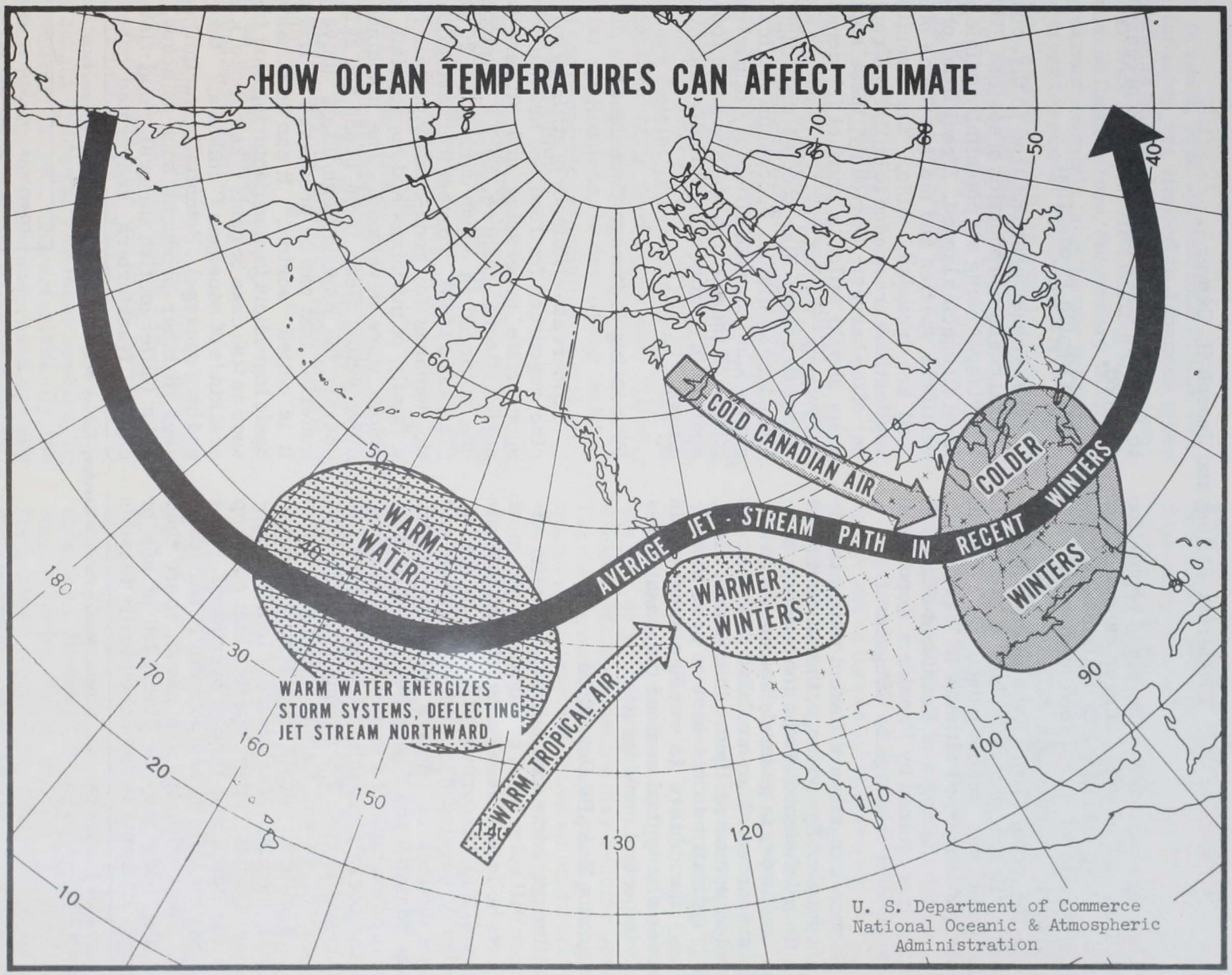
During practically all 10 winters, temperatures averaged below normal in eastern half of U.S.

The demonstrable link between global wind flow and this particular cooling trend makes it "unlikely" that air pollution and volcanic activity have much to do with it, Namias thinks.

More Probable Cause

Much more probable is an association with an ocean-temperature change in which "the sea surface over much of the North Pacific was abnormally warm." This has strengthened storm systems there. Ultimately, this generated more frequent wind flows than usual from Canadian Arctic into eastern U.S.

Even though we may not know what causes such oceanic warming, Namias notes, it is important to recognize significant effect it can have on climate. "It may be shortsighted to invoke extra-terrestrial or manmade activity to explain these fluctuations."


HOW OCEAN TEMPERATURES CAN AFFECT CLIMATE
COLD CANADIAN AIR
COLDER WINTERS
AVERAGE JET-STREAM PATH IN RECENT WINTERS
WARM WATER
WARMER WINTERS
WARM TROPICAL AIR
WARM WATER ENERGIZES STORM SYSTEMS, DEFLECTING JET STREAM NORTHWARD
U. S. Department of Commerce
National Oceanic & Atmospheric Administration