WILLIAM B. McCLOSKEY, JR.

THE NEW FISHERMAN

Hydraulic hoses and black boxes make fishing easier, but exact a price.

We took hail and spray in our faces and crouched monkey-style to keep pace while working the gear on a pitching deck glazed with ice. The wind blew a straight 35 knots and gusted 60. Up through the hydraulic block zipped a crab pot—a 7-foot-square by 3-foot steel-framed cage. Seven hundred pounds empty, it would now weigh 1000 to 2500 pounds, depending on the number of king crabs inside. Its trip up from the seafloor 60 fathoms below took about a minute. The pot surfaced in a froth of purple crab shapes and water. We braced it at the rail waiting for the proper boat motion, and swung it aboard, holding tight to prevent a wild swing. Then it was teamwork on the run, to prepare the line and buoys, pick and cull 50 to 200 seven- and eight-pound crabs, replace the bait, secure the lid, and send the pot back over the side. Each cycle took no more than five minutes. A successful boat works hundreds of such pots, over and over.

From Dutch Harbor in western Alaska we had traveled 140 miles of bucking seas, the 1125 hp engine throbbing steadily without missing a stroke. With Loran-C, we had then homed in to the first buoy of the first crab pot: barely a minute's search for a 2-foot pink buoy hidden in rolling seas during a snowstorm.

Despite the weather, we worked all night, black waves that could obliterate us towering over our deck; worked without stop through all the daylight hours and on through the next night until about 2 AM. At last, peeling off our raingear but nothing else, we groaned to our bunks.

By the first grey light, the skipper had the wheel again. He slowed the engine, a standard signal. Our fishermen's discipline responded with feet back into damp boots, salt-clammy raingear over our clothes. And so for seven days, until our tanks were filled. The engine took us back to port, the cannery unloaded us in a few hours, and out we pitched for the next trip.

Not all fisheries are so grueling—although some like halibut longlining can be even tougher, and hand tonging for oysters in the Chesapeake Bay is one of the ultimate back-breakers. The desirability of working this hard may be open to question, but the present intensity of a fishery like king crabbing would be

Up from the Bering Sea churns a crab pot of steel frame and nylon mesh, 7 × 7 × 3 feet, weighing 700 pounds empty but at least another 1000 pounds more if full of king crabs. The pot will be rested at a tilt on the hydraulic launcher (lower right). Astern are other pots with buoys and lines stored inside.*

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Working on the run as a team, a four-man crew removes 7- and 8-pound king crabs and rebaits a huge crab pot. The complete cycle between appearances of pots at the rail takes 3 to 5 minutes. The pace would not be possible without the hydraulic crab block (shaft above deck, left), which raises the pot from the seafloor 60 fathoms below in about 1 minute while automatically compensating for slacks and tensions on the line caused by the boat's motion in heavy seas.

impossible without the heavy engine, circulating pumps (to keep the crabs alive in fresh seawater), hydraulic block, and Loran-C receiver.

FORWARD FROM THE OLD DAYS

The fishing occupation covers a wide range of conditions throughout the world, from hand pulling to machine pulling, in one-man open dories to hundred-man factory trawler-processors. This article focuses on the conditions most typical in the fisheries of the U.S. and many other developed countries—privately owned boats (usually skipper-owned) ranging between about 30 and 110 feet in length, with crew complements up to six or eight. Except for the factory fishing operations of such nations as Japan, Russia, and Poland, the backbone of the world's fisheries for centuries has been these smaller boats on which men work close to the water.

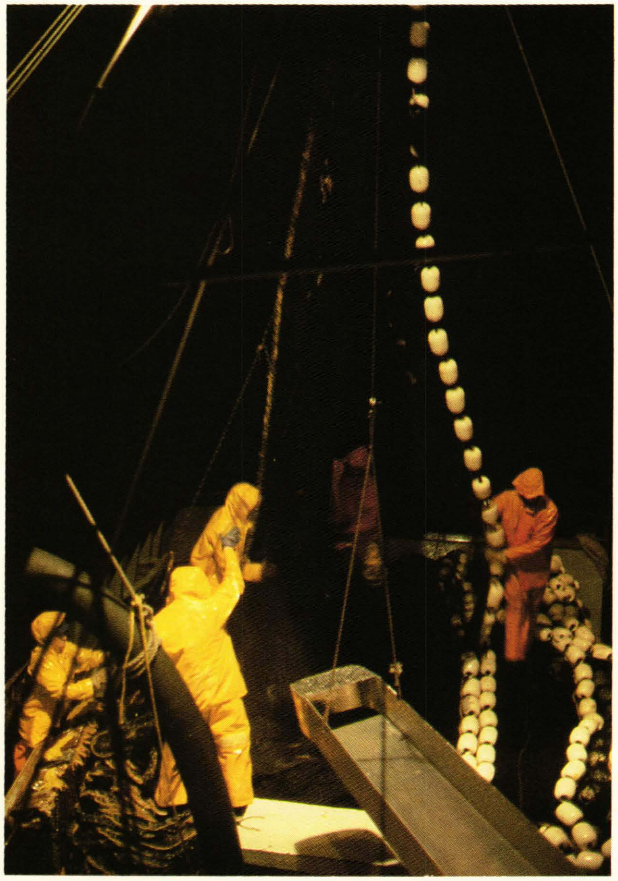
Machinery delivered fishermen from the heaviest bull-labor only gradually, despite the first adaptation of steam to marine use in the 1860's. Even ocean-going cargo ships were slow to convert to machine power—the Baltimore *Sun* of 13 February 1881 listed in port 65 sailing ships and only 7 steamships—and it took more than another generation before fishermen in any number could afford boat engines. The same delay occurred with winches powered from the engine, which were a luxury in 1913[1] and were not common until much later.

Men who still work the boats off Alaska and New England remember well their agonized backs and hands from grunting in nets or hand-cranking a longline "gurdy" for hours. Rudy Anich, a man still fishing in Alaska, recalled his salad days in the 1930's when he fished both Puget Sound and Kodiak. "From all the gripping and pulling web with your hands," he said, "your fingers would be locked tight each morning. Couldn't open them, couldn't hold a thing. We learned from the old-timers to urinate on our hands, and that would start them moving. Whether it was the warmth or something else, I don't know, but it helped the pain and started them opening. Your thumb and forefinger would open first, you'd start gripping with those, but oh, pulling that raw manila! Men would cry as they hooked their claws around the cold rope to pull up the anchor. It was all done by hand." (Quoted from the author's documentary novel *Highliners*.[2])

The sluggish pace continues of converting common technological developments into a form practical for fishermen. It was not until the late 1950's that hydraulic devices reached fishing boats in quantity, nor was it until the mid-1960's that radar in affordable models freed most boats for movement in fog or dark. Loran did not become attractive to fishermen until the design of compact quick-readout Loran-C receivers in the mid-1970's. The age of microprocessor equipment and computerized displays is only now approaching.

Fishing has always been a gamble. In fog or night, and beyond landfall, water is trackless. And the fisherman, even when he is able to locate himself, remains a hunter who never sees his prey until he has captured it and brought it to the surface.

The fisherman's first real aid against the sea's mysteries was the mariner's compass of the 14th century. It gave him a secure direction even when the weather blotted out his standbys—sun, moon, and polar star. The invention of the sextant and chronometer in the 1730's affected ocean seafaring more than fishing. (By then, using compass and dead reckoning, Basque and Portugese fishermen had already crossed 2500 miles of open sea to hunt for whale and cod in the waters off Newfoundland.)



Different hydraulic power blocks handle large and small seines. In the top photo, the crew of a herring seiner out of Gloucester, fishing through the night while the herring rise to feed, brings in a net several times the size of that on the Alaskan salmon seiner (bottom). In both instances the heaviest work of hauling aboard the wet net, corks, and leaded line is accomplished by the hydraulically operated power block suspended from the boom. Before the power block was introduced in the mid-1950's, it required more crewmen far longer to perform the same work. On the Alaskan seiner note the radar antenna above the wheelhouse. Boats of this size did not have radar until affordable transistorized versions appeared on the market in the mid-1960's.

It was 500 years after the marine compass that fishermen acquired their next revolutionary aid, the marine engine. At last, a skipper could head his craft in the direction he wanted to go regardless of where the wind blew.

The marine engine altered the character of seafarers, as noted wryly by the Norwegian writer Johan Bojer (1872 – 1959), whose own experience included fishing for cod under sail and oar. In his classic novel about Lofoten fishermen of the 1880's, *The Last of the Vikings,*[3] he wrote: "The modern motor fisherman is an industrial workman of the sea, who smokes cigarettes and is a member of a trades union." (While the early motor days were still a time remembered as taxing enough by the oldest fishermen still living, the life of Bojer's final Viking generation was hard beyond belief.) The great sea writer Joseph Conrad (1857 – 1924) experienced personally the transition from sail to steam as a ship's officer, and the men he depicted under steam (in *Typhoon*) were less grand, more prosaic, than those who worked under sail (in *Youth* and in *Narcissus*).

Early boat engines were far from handy. Rudy Anich remembers fishing Puget Sound in 1936 "with an enormous gasoline engine we called a '40-horse Standard.' We used to have to prime each little cup for each cylinder, then take a big bar and turn the flywheel and hope the heck it caught." A diesel engine of a slightly later period, recalls another fisherman, had to be completely lubricated every two hours.

Compact marine diesel engines were slow to reach smaller fishing boats even though versions had been manufactured since the 1920's, and boats in some fisheries had begun converting by the late 1930's; in the early 1950's aboard a Coast Guard cutter out of Ketchikan, we often raced to help troll fishermen whose boats had exploded from gasoline fumes in the bilges. By the late 1960's, however, a boat with a gasoline engine was considered antiquated in the major U.S. fisheries. The fuel shortages of the 1970's spurred most of the final holdouts into converting since diesel boat engines, while delivering fewer RPM's, give about double the mileage of comparable gasoline engines.

THE CHANGE IN MATERIALS AND MACHINERY

The present period for the world's fishing boats began in the 1950's when the military products developed during World War II began to be adapted to a scale that individuals could afford. The results affected four areas in particular: surface locating, machinery, underwater search, and materials.

In terms of effectiveness, the change in materials might appear the least important of the four. Yet anyone who has ever worked hours of heavy, wet manual labor while encased in rubber clothing or in actual "oilskins" (heavy cloth literally layered and layered with linseed oil) will appreciate the present tough but pliable plastic waterproof clothing which does not stink, crackle, leak, or rot. A recent addition are jackets and coveralls — still clumsy to work in — that will keep a man afloat if he falls overboard. They include strips that reflect back even a weak flashlight beam. Sponge rubber survival suits now save lives routinely in all the northern fisheries where men have decided to make the $400 investment.

Nylon and other synthetic materials have replaced hemp, cotton, and linen for every fiber product from rope to net. The resulting lines are smaller and lighter for the same load; they also coil more easily, and leave no slivers sticking in the hands like little needles. The old cotton fishing nets were not only heavier than nylon when dry, but they absorbed water to become heavier yet. Cotton nets also required a regular soak in copper sulfate — called "bluestone" by West Coast fishermen — to prevent them from rotting.

While hydraulic devices were not adapted to fish boat uses until the late 1950's, they now turn so many wheels to bring in lines and nets that younger fishermen would be lost without them. The "gurdy" for example. (This name still survives for the standard deck equipment that hauls in strings of gear such as a baited longline, so named by earlier fishermen because their hand-cranked drum required a constant motion like that to drive a hurdy-gurdy.) To quote Alfred Wolfe's reminiscence (*In Alaskan Waters*[1]) of a 1911 apprenticeship on a hand gurdy in the halibut dory fishery: "Turning! It sounded so easy. But it is backbreaking, killing work, when the gear is full of fish, or the hooks are dragging up rocks and corals . . . I would turn and strain until I was blue in the face; call upon what seemed to be the last ounce of strength and gain one more turn; then rest the handle of the gurdy across my thighs, which would serve as a sort of brake. . . " This was continuous labor for a 12- or 15-hour day, often with the usual fisherman's salt boils on the hands giving near-agony.

Hydraulic gurdies now do the pulling in, whether it be wet nets full of fish, 4-mile longlines with a thousand baited hooks, or 60-fathom lines attached to 2500-pound king crab pots.

The seine fisheries of the world were changed with the invention in 1954 of the Puretic power block. The block in its present form is essentially a big hydraulically powered wheel with treads that rotates to grip the net and pull it aboard. In its earliest form it was operated from standard deck machinery with a continuous rope drive. The practicability of driving it instead with hydraulics spurred manufacturers into a power block modification and then into other hydraulic conversions. In retrospect, the Puretic block is thus credited with starting the widespread use of hydraulic equipment on fishing boats.

For fishermen, all the Puretic block itself needed was a few dockside demonstrations, and word could scarcely have traveled faster. By 1958, it had become a staple of all seine-type fishing boats, drastically altering the work pattern and raising the efficiency for catching salmon, herring, menhaden, capelin, and other fish that school in large numbers. As a dramatic example, the U.S. tuna fleet changed beyond recognition, from an exhausting fishery where two or three men with poles connected to a single line hand-landed huge fish up to 800 pounds, one after the other, to the present one of big seiners where machinery pulls the weights. (In purse seining, a long net is drawn in a circle around fish near the surface, then is pulled quickly aboard from both ends.)

PROGRESS AND A SOFT BERTH NOT SYNONYMOUS

Work-saving equipment meant greater productivity per man and consequently smaller crews. For example, the same-sized West Coast and Alaskan salmon seiners reduced their complement from seven or eight men to four or five after the hydraulic version of the power block came aboard.

In Alfred Wolfe's account of pre-World War I fishing, he wrote appreciatively of all the innovations aboard the new wooden-hulled halibut schooner *Seymour* (which is still fishing halibut in Alaskan waters): "Her six dories were easily and quickly hoisted over the side by a winch, getting its power from the engine. . . . The *Seymour* also had electric

Loran-C has become standard equipment on fishing boats of all sizes. A Japanese fisherman, while trolling on deck for bonito in heavy rain, takes a quick break below in the cramped cabin to check his location with Loran coordinates. It must be a quick, accurate, and simple process to be of use to him. The 35-foot one-man boat is fishing about 15 miles from shore.

lights wherever they were needed. There were no coal-oil lamps below or coal-oil lanterns in the rigging, with all the entailing cares of keeping them full of oil and brightly burning. And instead of it requiring two men to scrape and wash the fish, one of them lifting the water up from the ocean in a bucket, that work was done by one man, with the engine pumping salt water through a light hose having a scraper on the end of it."

What of the men? The *Seymour* of 1913, according to Wolfe, carried 15 men. Now she carries six or seven. However, she still packs the same quantity of halibut in her hold, while the basic work of baiting, gaffing, dressing, and icing remains manual and unchanged. The improvement has increased each man's individual production without diminishing his hours. This appears to be an ironic truth of many fisheries, including king crabbing.

THE NEW ERA OF ELECTRONICS

The electronic equipment that has totally altered some areas of the fishing life followed the slow adaptive pattern. Two-way radios had reached such large fishery vessels as cannery tenders by the early 1940's, but they were huge and expensive. Their appearance on the boats began at the end of the same decade. At that period, fathometers also appeared and gradually supplanted the old hand-sounding method with a lead-weighted line. Regarding early boat radios, one fisherman remembers that "you had to holler in those big old ones to be heard."

Today, a typical 42-foot seiner in Alaska is equipped with at least one VHF radio (usually tuned day and night to one of the standard monitoring or emergency frequencies), a single sideband radio for communications beyond about 30 miles, and a CB radio for talk with boats close by and with the seiner skiff when making a set. A 108-foot king crab boat in the Bering Sea usually carries three VHF's and two single sidebands, one model of each being installed somewhere away from the wheelhouse to give another calling location in case of emergency. Communications have become integral to the highly competitive fisheries, where, for example, skippers working a buddy system may want to share a good haul or to bargain ashore with processors for their catch. Open radio has no greater privacy than an old-fashioned party line — every wheelhouse has one or two channels turned up. One new VHF attachment enables a skipper to scan all frequencies in sequence to locate which channels are being used, so that he knows where to tune in. With a radio direction finder he can then locate the transmitting boat. Many fishermen use elaborate code systems, but if they have hit the fish it may be hard to keep a poker voice. A radio scrambler for fishing boats has just reached the market. The most sophisticated means of communications privacy, for large boats that can afford it, is with the commercial Marisat satellite system, operated since 1976, which can provide the same security as a private telephone.

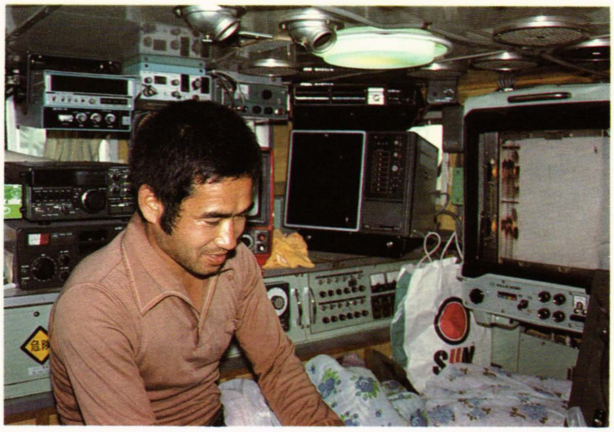
Recently a multitude of convenience electronics has found its way to the boats. Amplified intercom systems save shouting commands from wheel to deck above the engine noise. Cassette players are now common, with music (the heavy beat variety) blasted onto deck either by speaker or through the open galley door. Larger boats even have cassette TV.

Radar, despite its World War II origin and universal placement on cargo ships by the end of the 1940's (with appearances in cumbersome surplus models on some fishing vessels), did not become generally affordable for boats until the development of compact transistorized versions in the mid-1960's. The change, when it came, was particularly significant in places like Alaska, where rocks and shoals pepper the coast and the inland waterways. Before radar, no local fisherman with any sense traveled at night except in the most known, open waters. Fog and snow often obscured daytime visibility as well, and, while many fishermen chanced being under way, this was a game of Russian roulette that they sometimes lost. Rudy Anich recalls getting caught in Pacific Northwest fogs while under way to the grounds: "Take us three days to go five miles, all the while dropping the lead line and tooting the whistle." Now radar permits the boats to move when they want, wind and seas permitting. Not all good, given the drives and needs of fishermen. For example, radar has freed boats to be under way at night after an exhausting day or two of "clockaround" fishing. The resulting accidents caused by fatigue, according to Kodiak-based marine surveyor Norman Holm, account for the large portion of the most serious groundings and collisions in the Alaskan area that he services.

Loran, a navigational system based on chart location by the intersection of two synchronized radio signals transmitted from different shore stations, was another development of World War II. By the time it reached fishing wheelhouses in any number in the mid-1970's, the original Loran-A, requiring complicated master–slave signal alignments, had been replaced by lower frequency Loran-C whose more sophisticated receivers delivered a simple numerical readout of coordinates. The most dramatic use of Loran that I have seen was aboard Bering Sea king crab boats, when we traveled miles through open sea to pick our lead buoy "just outside the window," as one skipper put it. The skipper had simply noted the Loran coordinates on his chart when he set the crab pots, and then a few days later had headed back with Loran to the same spot.

Loran is a system maintained in the areas of U.S. waters by the U.S. Coast Guard, and by other nations in other parts of the world. There are also several alternative ground navigation systems — Omega and Pulse 8/Accufix, for example. The only one besides Loran that fishing boats use in any number is Decca, run by a private corporation in northern Europe that leases its equipment to users. The Decca system is considered less accurate than Loran-C, with its signals subject to distortion in bad

A Japanese purse seiner (foreground) in the South China Sea brings in a night's haul of sardines, mackerel, and other species around 3 AM. The fish will be "brailed" aboard the collector boat and stored in the holds between layers of hand-shoveled ice for the few hours to port before being sorted and re-iced for market.



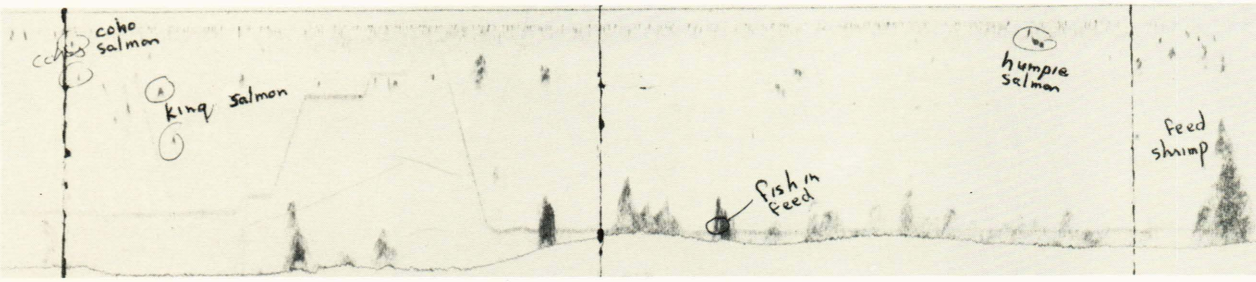
In the cramped wheelhouse of the Japanese seiner, the fishing master of the six-boat fleet sits on a quilt in his combination bed and command station, surrounded by electronics equipment that includes radios, direction finders, a color TV (beside his head), and two echo sounder "fish finders": a new color scope (immediate right of the TV) and an older stylus printer.

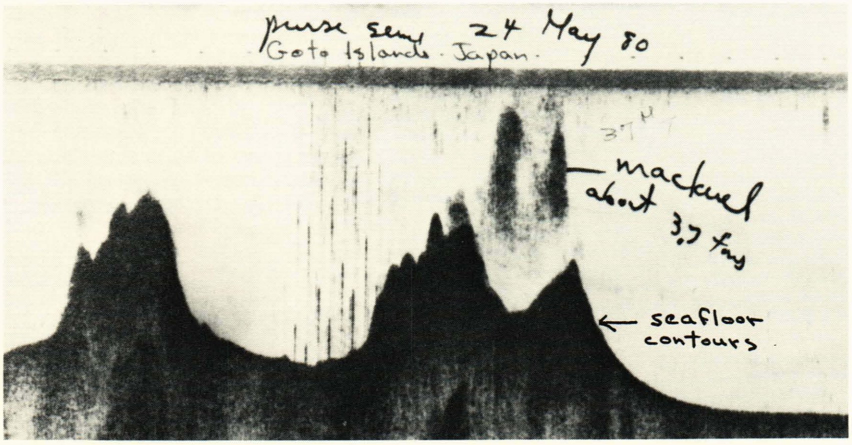
weather and at night. However, Decca's accuracy was greater than Loran-A, and it has the advantage of being available in some areas not extensively covered by Loran-C.

Transit navigation satellites, developed in the early 1960's for the U.S. Navy by The Johns Hopkins University Applied Physics Laboratory, became available for civilian use in 1967. However, they have only recently been adapted to the use of craft smaller than ocean-going ships. Transit/Navsat provides greater accuracy, but at least for the present, the majority of in-shore fishermen have shown little interest where fishing areas are well served by Loran-C signals. (Notable exceptions are in fleets in such high-sea areas as that for tuna out of Southern California; ranging the central Pacific where Loran signals are poor, they have converted almost exclusively to Transit.) Not only is Loran-C receiving and display equipment cheaper by more than half, but its readings are obtained instantaneously at any time. With Navsat, the position fix must wait for a satellite pass at a 15 to 75° angle to be effective, and this can take 1½ hours or more. (The newest civilian Navsat equipment is able to predict future passes and their angles.) It is possible that the Global Positioning System might alter the potential for fishing boat navigation when it becomes operational, but this would depend on the accuracies that the military make available for civilian use.

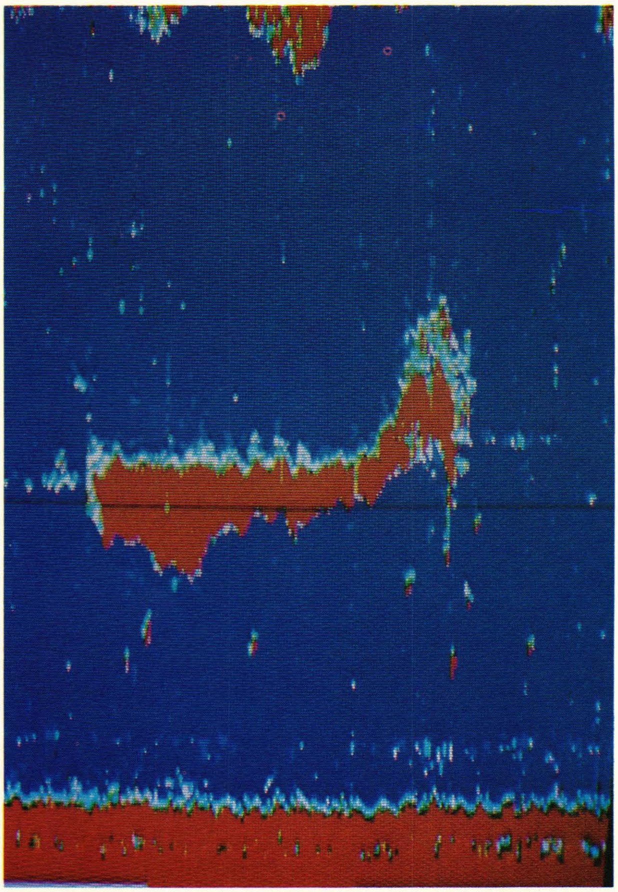
Both Loran and Navsat provide the basis for integrated computerized position plotter systems. Only an idea five years ago, these systems are now exhibited and marketed by such manufacturers as Epsco, Simrad, Furuno, and Decca. (Other large marine electronics manufacturers include Raytheon, Si-Tex, and Texas Instruments.) With the position plotter, the skipper can enter his destination, and the computer will feed his gyro both the appropriate courses and the course corrections made necessary by wind and sea conditions. (Nothing has yet replaced the lookout, if only to watch for approaching radar pips.)

At the Boston Fish Expo last October, exhibitors demonstrated the next further refinement—the track plotter—used in conjunction with Loran or Navsat. With the track plotter, a skipper can keep a permanent record on paper of his maneuvers. The paper, automatically aligned to Loran coordinates or latitude–longitude according to the scale selected, can record any amount of requested information. A crab skipper, for example, can push a button to mark the location of each of the pots he drops and can even punch in the number of each buoy. Then, on returning to the area after his pots have "soaked," he can align the system again with his boat and direct it to take him automatically to any of the previously





A stylus echo sounder in Alaskan waters depicts, to the experienced eye of a troller skipper (top), three different species of salmon, as well as other fish and bottom features. Another chart (bottom) shows a readout that a Japanese skipper identified as mackerel. The chart patterns also reveal information on seafloor contours and types (e.g., rocks or mud) that are important for setting such gear as crab pots and bottom trawls.



Concentration of red on the scope of a color echo sounder shows a school of cod at approximately 16 fathoms. Feeding fish are depicted on the seafloor at 39 fathoms. Photo from an Epsco "Chromascope," courtesy of Epsco Marine, Inc.

marked positions. With the track plotter, a trawl skipper can mark points at which his echo sounding equipment registers a potential school of fish as he passes over it and can then use the plotter's track to retrace his course for a second pass that duplicates the original one.

NEW EYES ABOVE AND BELOW THE SURFACE

Depth sounders that operate on the sonar principle (with a transducer signal bounced back to a shipboard receiver when it encounters an object in the water) have been standard fish boat equipment for three decades, starting with simple fathometers. The signal is recorded on a moving chart by stylus, which registers varying degrees of concentration depending on the size and density of any objects encountered. Fishermen in a given area have become adept at recognizing the type of bottom as well as the pattern of their own local fish in schools or, in the case of large fish like king or coho salmon, singly.

The sonar "fish finder" has proven its value particularly in the pelagic (midwater) trawl fishery. (A trawl is a bag-shaped net that is towed through the water while held open at the end nearest the boat and closed at the other to trap the fish.) Since the transducer sends and receives its signals straight down from the boat hull, the fish it registers will enter the area of the drag in just a few seconds. An alert skipper might alter course to intercept the fish in his trawl, or he might "tune" the net by altering its depth in the water — slowing the engine and/or slacking the cables to lower it, speeding up or pulling in to raise it. Norwegian and Russian trawlermen in the capelin fishery of the far northern Barents Sea routinely browse their grounds with nets and trawl doors raised above the water; when the fish finder shows a school below, they quickly plunge the net into the water to scoop in the fish.

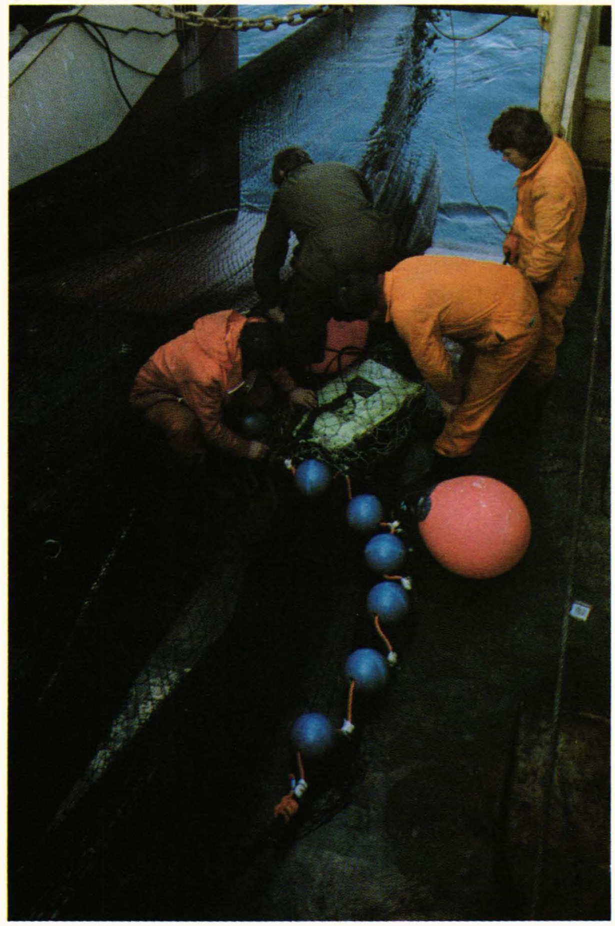
The echo sounder is useful with other types of gear as well. For example, the Japanese, whom necessity seems to keep particularly imaginative when it comes to fishing techniques, have devised this combination in the East China Sea: The fishing master aboard the seiner of a six-boat mackerel and sardine fleet cruises after dark, searching the water over several miles with his fish finder. When he picks up a likely concentration, he directs one of his catcher boats to the spot, where it beams giant floodlights into the water to attract and hold the fish. He next moves on to find another location and plant his second catcher boat. The business of encircling and capturing the entranced fish then lasts from about midnight until dawn.

BLACK AND WHITE REPLACED BY PRIMARY COLORS

The echo-sounding fish finder has recently blossomed into a spectacular new addition to the assortment of black boxes in a fish boat wheelhouse. Instead of registering schools of fish on a strip of paper rolling between two drums, the new echo sounder makes its report on a television screen in bright color. Different colors register different concentrations, with red representing the heaviest mass and light blue the most sparse (such as plankton). Empty water is dark blue. The signals can be taped, while the immediate reading can be frozen on the screen for closer examination. Typical equipment has six normal range scales and three expanded scales so that, for example, a mass of red can be studied in progressively closer detail—thus breaking it into finer color readings—to determine at what depth its greatest concentration lies. (This is important for the adjustment of a midwater trawl net, which, if too high or too low, will bypass the school.)

The close-up ranges can also help an experienced fisherman assess the mix of species he is watching by the shape and secondary colors of the echos. U.S. fishermen have used this feature recently in joint ventures with Soviet factory ships off the coasts of Washington and Oregon. While the target species was hake, permission to harvest the full allowable quota in the area was limited by the amount of incidental protected species. Hake often school with other species, and the detailed color sounder proved useful in assessing those fish masses that were too full of non-hake to risk taking.

None of this gradation is possible with the "old" stylus-chart echo sounder. However, the color equipment is new and expensive enough that fishermen appear to be using it only cautiously as yet. I saw color sounders in the wheelhouses of both the Japanese fleet seiner and a Canadian trawler on the Grand



Aboard a Norwegian trawler on the far northern capelin grounds between Norway and the Soviet Union, crewmen (top) attach a "net monitor" transducer to the mouth of a trawl that is about to be set. The monitor connects by cable to a console in the wheelhouse (bottom) to signal net position and water temperature. This information is useful in pelagic (midwater) trawling when the target species is known to swim at a particular depth or thermal area, or for adjusting a net when echo sounding equipment has located a school of fish. The console in the wheelhouse displays and coordinates all this and other readings from electronics equipment. The total package is more elaborate than that yet found aboard most American fishing vessels of comparable size.

Norwegian trawlers patrol the far northern capelin grounds between Norway and the Soviet Union with nets raised, ready to lower quickly for a set if the echo sounder reveals a school of fish below.

Banks, where they flickered their vivid yellows and blues with occasional reds while the skipper studied most closely the chart sounder on which experience told him he could rely.

The most sophisticated trawler consoles now combine their position plotters and echo sounders with other electronic tools such as the net monitor or "net sonde." This is a transducer mounted on top of the mouth of the net before it is set; it is connected by a long cable which relays net position and water temperature back to the wheelhouse. The monitor connects either by a long cable that is unrolled with the trawl cables on a separate drum or by battery-powered ultrasonic signals transmitted to a receiver on the boat. The first design delivers clearer information, but requires hundreds of feet of cable that might twist or foul. On the other hand, the remote signal design has a distortion problem, since the churning propeller sounds interfere with transmission; some of this is avoided by mounting the receivers on paravanes suspended from the side of the boat.

The net monitor information, recorded by chart and stylus, can be used by the skipper in conjunction with the fish finder to tell the position of his net and adjust it when he sees a school of fish at a certain depth. (It tells him nothing about the volume of fish in his bag — which another electronic device can now provide — but a fishing skipper soon recognizes the feel of a full net from his boat's motion.) The monitor also gives water temperature, which in some fisheries is important because the target species, or its feed, may swim only in certain thermal layers.

THE VARIOUS PRICES OF NEW TECHNOLOGY

As recently as five years ago, the standard electronics package on a fishing boat consisted of an AM radio, a depth sounder with chart recorder, and a radar, plus Loran for larger boats fishing beyond the reach of coastal radar fixes. The package represented an investment of between $5000 and $12,000. The package considered standard today costs between $15,000 and $30,000 on smaller boats, $80,000 on boats like king crabbers, and up to $200,000 on new trawlers. This often includes duplicate backup systems. (Backups are assumed on the big foreign factory trawlers, where the console packages are far more elaborate than those described above.)

Position plotters cost between $4000 and $7000, and they also require a receiver. A Loran receiver costs between $1500 and $4500, a satellite receiver between $6000 and $15,000. Color fish finders are priced from $5000 to $9000. Net monitor systems cost between $10,000 and $16,000. Boat radars range from $3000 to $24,000, VHF radios from $600 to $900, single sideband radios from $2000 to $5000. A standard flasher fathometer costs about $800, a chart fathometer that depicts the bottom, about $4000.

Even for those who can afford it, a wheelhouse full of gadgets does not automatically make a fisherman. As with most developments of the technological age, the usefulness of the fishing black boxes is proportionate to how well the operator understands them. Sea-sense must remain a fisherman's bedrock skill, but with the new options granted by electronics displays he must also think in three dimensions, to envision the relative but constantly changing positions between boat, fish, and gear.

The first skipper to try the newest equipment (with its inevitable high investment requiring amortization through bigger yields) may become the best producer within his local fleet — a "highliner"— but only if he masters his new equipment so that he can use it like any other tool. In the history of at least American fisheries, where little subsidy has ever existed at the

The Chesapeake Bay skipjack *Sigsbee* dredging oysters in December, under sail traditionally and by Maryland law. With the increased cost of fuel, men in fisheries long removed from sail are taking a new look. Sails have never completely disappeared from the vessels of some fisheries both for auxiliary propulsion and for holding steady on the gear — among them Alaskan halibut schooners and Norwegian cod-jigging boats — but few still rely as completely on sail propulsion as do those of the Chesapeake Bay fleet. While the numbers of the skipjacks may be diminishing with age (the 47-foot *Sigsbee* was built in 1901), it may be a sign of the times that a new skipjack was launched in 1979.

research level, as many pioneers have gone broke as have ended rich or even solvent. The highliner-survivors are those who drive hardest and use their heads besides.

Technology has obviously increased man's advantage over fish. It downgrades the respected old "fisherman's eye" and leaves a good haul less to chance. There is a parallel here with the developments that have made mass farming possible, since in both occupations the end result is more product per man-hour. But while in agriculture the size of the planting controls the harvest, in fishing the harvest comes only from available stocks. The wealth of the sea is far from infinite, as it once was thought to be, and overfishing made possible by technology has at least temporarily cleared many waters of some stocks. In the two decades before 1976 when the United States established its 200-mile limit, the uncontrolled efficiency of Russian factory trawlers depleted three species of fish in U.S. waters below commercially harvestable numbers. Another example: Alaskan halibut stocks have been decimated because so many of the young have died as incidental catch in both Japanese bottomfish trawls and American king crab pots.

Overfishing has also upset some of the natural food chains, so that marine mammals have begun competing with fishermen just at a time when the world has decided that the mammals should be protected. I have seen a hundred salmon in a single set with a ragged bite out of each, ruined by harbor seals that gorge from Columbia River driftnets or by sea lions trapped while feeding off the concentration in Alaskan seines. In Japan, the publicized slaughter of dolphins by the fishermen of Iki Island had its origin in overfishing of yellowtail, which has brought men and dolphins to compete for the remaining fish.

Fishing has become so efficient that governments have begun stepping in with increased frequency. The United States declared itself with the 1976 Fishery Conservation & Management Act, PL 94-265, which not only established a 200-mile jurisdiction over seafood resources, but also set up the machinery for government management of the stocks through quotas to both domestic and foreign fishermen. Following this action, all other coastal nations of the world claimed a 200-mile fishery jurisdiction, and the era began of internationally oriented fishery regulations — and fish politics.

On a local level, the State of Alaska prohibits seining for salmon in boats over 58 feet long, to protect local fishermen from being replaced by large-scale operations. The state further protects its salmon fishermen with "limited entry," by issuing permits only to a certain number of boats determined by previous years in the fishery. Extremely controversial, limited entry has proven to have serious drawbacks in exchange for supposed protection from a surfeit of boats in the fishery. The transferable permits, which originally cost a fee of a few dollars, now sell for between $5000 and $100,000 depending on the projected abundance of the season and the permit area. Young men can no longer afford to enter the fishery with their own boats unless they have outside financial backing or a relative who retires.

In the Bering Sea the high prices paid for king crab during the mid-1970's started a great rush of boat building and now, with crab stocks diminished, there are several times as many boats in competition as there were in 1970. These specially engineered Bering Sea crab boats keep rising in price, requiring owner-skippers to generate huge incomes simply to meet payments. (A 108-foot king crab boat cost $700,000 in 1974 and has a 1981 appraisal of $2.2 million.) Should there be limited entry for king crab also? The fight for it would be heated. The same overcapitalization is becoming a problem for many other fisheries. In Norway the government has started a plan to buy up 25% of the seine boats in the mackerel and capelin fleets (both controlled by limited entry) in order to remove them permanently from the competition.

Aboard a king crab boat in the Bering Sea. No development or new gear has changed the sea itself, which fishermen must still face as a primal force.

Working to catch the most product from the sea — even wresting a share from marine mammals — is not all greed and cruelty. As the world population continues to rise, the demand and need increases for fish, which is a direct protein food. (Beef is wastefully indirect; since it requires nearly a ten-to-one ratio of feed grain to produce, it is a luxury for nations rich in flat tillable land.)

Aquaculture and ocean ranching may provide answers. Japan has thought so for years; while there, I visited villages committed exclusively to fish farming. China has recently received attention for its carp breeding. Some Americans on the West Coast are giving salmon culture a try with limited but positive results. (But, will "hothouse" salmon, when mingling with their stream-spawned brothers in the open sea, endanger the homing balance of the latter? Helping nature seldom results in a total win.)

What next? The ironies may not all be over, with the devastating cost of fuel (which is helping to raise the cost of seafood beyond consumer affordability) forcing a possible return to some pretechnology ways. For example, fishermen who must cruise long distances to their grounds are beginning to look at sails for at least auxiliary power. The same fresh look is true of the old passive methods requiring less fuel to operate than cruise-type fishing, that make use of weirs, traps, and stationary nets. However, some of these are currently outlawed — e.g., salmon traps in Alaska — because they can be so efficient that they capture entire schools of fish and leave no stock for another generation; introducing them again would require reappraisal of current priorities and the acceptance of a new set of tradeoffs.

END EFFECT OF THE NEW FISHING TECHNOLOGIES

Both the fisherman and the farmer must be men-of-all-work to survive. For fishermen in the old days, this meant mastering marlinspike seamanship as well as skills like carpentry. (A fisherman still routinely ties knots, splices rope, and mends nets, and he's handy with a hammer.) With the coming of engines he needed to become a mechanic also, since he could seldom afford professionals to fix his breakdowns — which also might occur at sea while a current was taking him toward rocks. As equipment became more sophisticated, most fishermen taught themselves such new basic skills as welding and hydraulics repair. However, repair of the new plethora of electronics gear has begun to leave him at a loss. This is no more healthy for a fisherman, who must be self-sufficient, than for a modern navy if its ships have weapons systems that can be serviced only by Ph.D.'s.

The resulting situation leads to a change beyond equipment and advantages, which I have observed with regret among fishermen of several nations: a fisherman has lost some of his independence. The cost of the new tools keeps him in heavier debt than before and thus more driven to work longer for larger catches. If he fails to invest in the minimum new gear for his fishery, he often cannot make even a subsistence living because the local catch is taken more efficiently by others around him. Add to this an escalating burden of government regulations that requires him to become an accountant or hire one. The new pressures lead him to organize and become political, gaining collective power at the expense of remaining his own master.

From a tired-faced young fisherman in a north Norwegian village, who had invested in a large steel deep-sea longliner: "Now it is no more taking it easy in the winter when the bad weather comes, it is going out to work every week of the year to make payments. I see not so much of my family now as before." Another young man, from Kodiak, has a new boat with the latest equipment. He goes out in some of the most dangerous waters in the world, even in the worst winter weather, and loads his deck higher than is considered safe, in order to generate the largest catches and income possible to make his payments. As a respected older skipper in the same fishery told me: "Some day we'll be saying a service over where that boy's boat went down." Both the young Norwegian and the young Alaskan are high-line skippers, respected in town and among their peers. But as the older Kodiak fisherman told me recently: "A lot of the old freedom and fun's gone out of it."

Certainly the machinery of the last century and the further technologies of the past few decades have delivered fishermen, like farmers, from the bull-toil that produced iron men who often became crippled in middle age. However, no development or new gear has changed the sea itself. Land, once cleared, is basically tamed, while the sea remains as capricious and wild as when the first Viking left the safety of his fjord in pursuit of cod.

They still toll the bell annually in Gloucester and Kodiak — one stroke for each fisherman lost at sea during the year. According to recently tabulated figures,[4] fishermen of the U.S. northwest have a fatality rate twice that nationwide of miners and ten times that of all other industries. Almost any fisherman in northern waters can give examples. In May 1977, a sturdy king crab boat that I had worked aboard in the Bering Sea the previous November hit a sea the wrong way, swamped, and sank within five minutes. The crewmen had time to leap into survival suits and to radio a MAYDAY, and a boat picked them out of the water before any died. Much of this was luck, since one of the survival suits leaked and the wearer was already sinking into hypothermia; seas were relatively calm, and the boat was not fishing scores of miles from any other, as so often happens.

What of the fisherman of the future as technology, while helping him, burdens him with high operating costs and increased competition for a finite supply of fish? Changes in the old independence appear inevitable, both toward collectivization among fishermen and toward engulfing regulations from governments. Yet men who fish for a living could never become clock punchers any more than they can escape the violent motion, wet, and cold. They still must take their chances with bust or bonanza, with nature. The danger, the discomfort, and the gamble all remain basic to fishing, whatever alleviation technology offers.

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