The Traditional Central California Setnet Fishery

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ABSTRACT—*In 1984, the central California traditional (non-Vietnamese) setnet fishery was calculated to consist of 266 fishermen fishing from 133 different vessels. These men fished with set gill, trammel, and suspender nets predominantly for halibut, ; rockfish,* Sebastes *spp.; white croaker,* Gengonemus lineatus*; shark (Squaliformes); lingcod,* Ophiodon elongatus*; and sablefish,* Anoplopoma fimbria*. The estimated capital value of the traditional setnet vessels and the setnet gear in 1984 was $11,000,000. Fixed and variable costs (excluding crew wages) were estimated at around $3,500,000, and ex-vessel revenues were about $4,000,000. Results in this report pertain only to the traditional setnet fishery and should not be extrapolated to include either the Vietnamese fishermen or the fishery in which Vietnamese setnetters fish.*

Introduction

Setnets, curtainlike fishing gear designed to entangle fish or catch them by the gills, have been under study in recent years. In 1984, the California Department of Fish and Game (CDFG) began a study of the central California setnet fishery to determine its scope and the incidence and magnitude of captured birds and mammals. Concurrent with this study was a continuing project conducted by the national Sea Grant Program and the National Marine Fisheries Service to develop methods less controversial than setnet fishing and, where possible, to introduce new gear which would capture the desired fish but not birds and mammals.

Another reason for the study was a desire by industry and the CDFG for an economic assessment of the fishery. The California legislature wanted to learn the number of active setnet fishermen and the importance of setnet revenues to fishermen's total income. Two other areas of legislative interest were fuel consumption and safety conditions aboard setnet vessels.

The foremost objective of this study was to determine the number of active setnet fishermen and to provide an economic and descriptive profile of the setnet fishery. Secondary objectives were to assess the costs of setnet fishing and the ex-vessel revenues attributable to it, and to gather information about vessel fuel use.

The setnet fleet was known to consist of Vietnamese and non-Vietnamese (traditional) fishermen. Due to language difficulties, the author was unable to obtain information from Vietnamese fishermen. This report, therefore, represents only the traditional sector of the central California setnet industry.

Background

In California, setnets include gill nets and trammel nets. Trammel nets include the traditional three-wall trammel nets ("trammel" nets) and suspender gill nets ("suspender nets"). A gill net is a single-walled net which is hung taut (without slack) (Fig. 1A). Fish are generally caught in such nets by having their gill covers hooked on the netting; this is called gilling.

Trammel nets (Fig. 1B) are three-walled nets with a slack inner wall of small mesh and two outer walls of taut large mesh, one wall on each side of the inner wall. Fish swim through the larger outer mesh, strike the small inner mesh, and push the small mesh through the other outer wall. This loop of small mesh forms a pocket and the fish are trapped (Clark, 1931).

Suspender nets are legally designated as trammel nets in CFG Code 8700 and are identical to gill nets except that lines (suspenders) are attached between floatrope and footrope (Fig. 1C). The suspenders cause the single-wall net to bag or become slack. Suspender nets both gill and entangle fish. Fishermen who use suspender nets claim that they are easier to empty, less expensive, and catch a wider range of species. Trammel net users say that the three-wall net is better for catching halibut, , and that sharks and other fishes do not fall out of the net as easily as from suspender or gill nets.

In 1982, the Pacific Coast Groundfish Plan, developed by the Pacific Fishery Management Council (PFMC) and approved by the Secretary of Commerce as prescribed in the Magnuson Fisheries Conservation and Management Act of 1977, became law. This plan prohibits fishing for groundfish with set trammel or gill nets north of lat. 38½°N (Point Reyes) in the U.S. fishery conservation zone (FCZ). In areas south of lat. 38½°N, Article 5 of the CFG Code, Section 8680 through 8693, is the governing regulation in California ocean waters and the FCZ (PFMC, 1982).

In 1983, 1984, and 1985, Article 5 was changed, and in 1986 new CFG permit regulations were instituted. The new Article 5 does not apply to setnetters fishing in the FCZ[1]. The 1986 permits are nontransferable and obtainable by qualified fishermen only. The new regulations limit the number of permits to 135

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[1]Carper, H. A. 1986. Letter to Joseph C. Greenley, 6 March 1986, Sacramento, Calif.

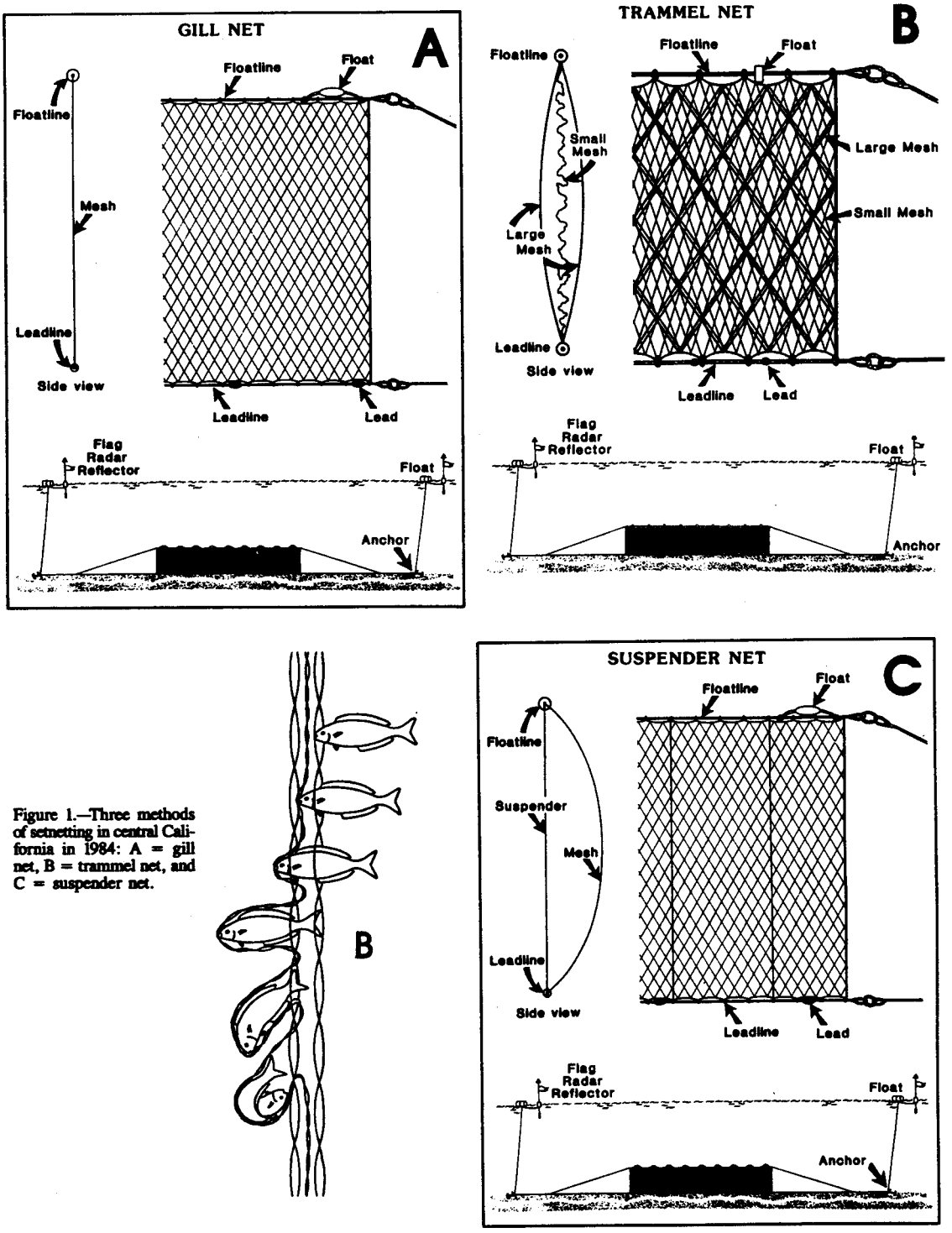
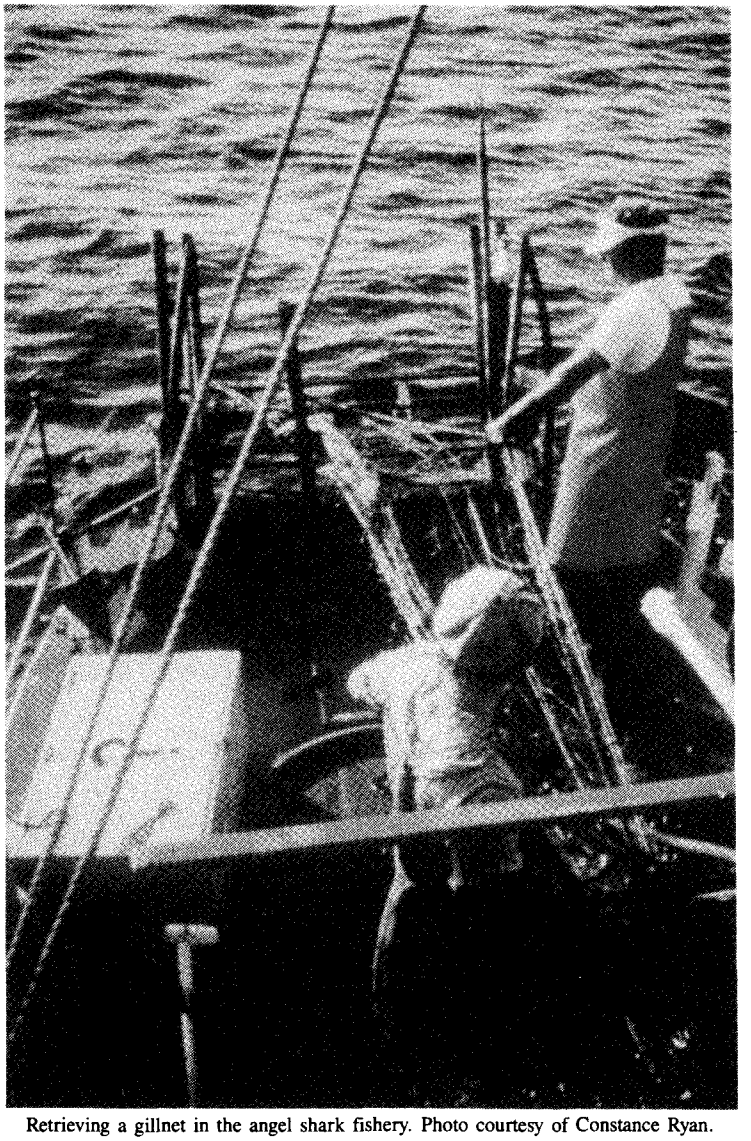


Figure 1.—Three methods of setnetting in central California in 1984: A = gill net, B = trammel net, and C = suspender net.



Retrieving a gillnet in the angel shark fishery. Photo courtesy of Constance Ryan.

in the nearshore trammel-net and suspender net fishery for halibut, , and the gillnet fishery for white croaker, *Genyonemus lineatus*, and nearshore rockfish, *Sebastes* spp. It is hoped that these regulations will diminish setnet interaction with other fishermen, birds, and mammals.

History

Setnets which gill or entangle fish have been used in the Americas for over 7,800 years. Archaeologists believe that the Chinchorro society, one of the oldest in the Americas, depended on setnet fishing for its supply of protein (Allison, 1985). Records of setnet fishing also exist from west coast North American native societies. Native Americans of Washington, Oregon, and Canada constructed setnets from line made of stinging nettle. The use of nettle to make line for fishing nets was also known in early Europe. "In fact the word 'net' is derived from 'nettle' " (Stewart, 1977).

In 1878, Spencer F. Baird, introduced setnets from Europe to Cape Ann, Mass., fishermen (Collins, 1882). These nets proved very effective and their use spread quickly. By 1888, gill and trammel setnets were being used in California and accounted for 76 percent of the value of all fishing apparatus in California excluding the value of the vessels (Collins, 1892).

By 1915, only trammel and gill nets were allowed south of Carmel Point, Calif., as trawl and paranzella nets were banned (Scofield, 1915). Set trammel and gill nets and drift gill nets were used in southern California to catch white seabass, *Atractoscion nobilis*; flatfishes, Pleuronectiformes; rockfishes, *Sebastes* spp.; Pacific barracuda, *Sphyraena argentea*; and crabs. White seabass was the most important species taken by setnets before 1930 (Whitehead, 1930), but halibut and rockfishes were also targeted.

The striking feature of all the set and drift nets used through the centuries by disparate peoples is their similarity. Setnets employed by native fishermen in 6000 B.C. were designed and fished exactly as the nets used today in central California. The only difference is the material used in net construction. Lines are no longer made of crushed nettle fiber, but synthetic nylon fiber. Floats of wood, reed, cork, or glass have been replaced by plastic. Anchors of stone have become the exception to the more common steel anchors, and footropes are weighted with lead, not rocks, waterlogged sticks, or ceramic clay.

Although materials have changed, setnets remain devices which gill (gill nets) or entangle fish (trammel nets). Set gill nets used in Calfiornia in 1888 had from 2- to 8-inch mesh; the set gill nets in 1986 had from 2⅛-to 9-inch mesh. Trammel nets in 1888 generally had an inner wall of 8-inch mesh; today 8-inch mesh is still the most frequently used.

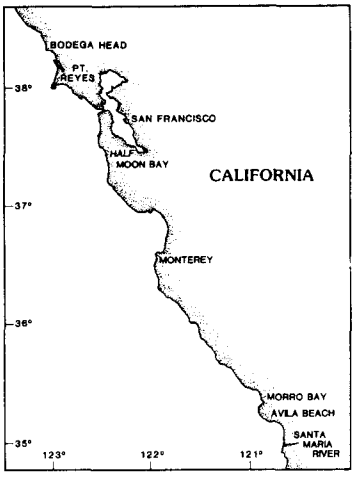
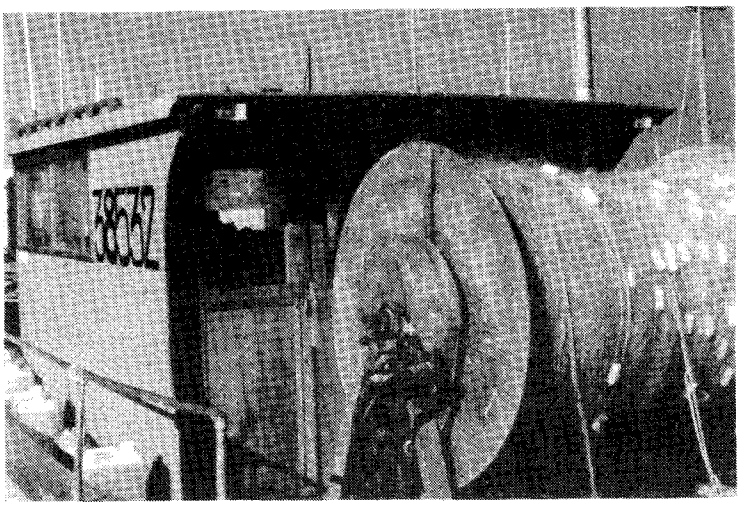


Figure 2.—The study area.



Gillnet on reel, Berkeley, Calif., 1984. Photograph by the author.

There has been a change in California in the public's perception of the deployment, quantity, location, and species which are exploited with set gill and trammel nets. Although fishermen have been using trammel nets to catch halibut and sharks continually since the 1880's, gillnetting of white croaker, rockfishes, and lingcod, *Ophiodon elongatus*, has mostly occurred since 1980. Much of this increase has been by ex-salmon trollers using trammel nets (Anonymous, 1986) and Vietnamese fishermen using gill nets. This expansion has caused public concern because of the incidental catches of marine birds and mammals reported in the media.

Methods

A list of all set gillnet permits was obtained from CDFG offices in Monterey and Menlo Park. These two offices issued over 95 percent of the permits to fishermen who fished from Point Sal (10 miles west of Santa Maria) to Point Reyes (30 miles west-northwest of San Francisco) (Fig. 2). In 1984, 586 setnet permits for fishermen were issued from Monterey and Menlo Park. From these, 120 permits were randomly selected and classified by surname as belonging to either the Vietnamese (40 permits) or traditional (80 permits) component of the fishery. Attempts to interview Vietnamese fishermen were unsuccessful because of language difficulties; therefore, survey results pertain only to the traditional component of the fishery and should not be used to generalize for the entire fishery.

Phone numbers, addresses, and other information, such as vessel locations or fishing companies, were gathered for traditional fishermen from the CDFG, processors, harbor masters, and fishermen's associations. Attempts were made to contact fishermen by phone or in person at their home port or buyer.

Vessel values were obtained from the vessel captains. Some captains felt their current wooden vessels could be replaced more cheaply with new steel vessels. When a captain stated the above, the lesser cost of a steel vessel was used to represent replacement value. The sample was expanded by the formula: Total number of permits (586) times the percentage of traditional fishermen in the sample (80/120) times the percentage of active traditional fishermen (27/80) in the sample [(586) (0.67) (0.34) = 132.51 ∼ 133] equals the number of active traditional permittees in the study. The vessel price actually paid was adjusted by the Consumer Price Index to represent the value of the 133-vessel fleet in 1984.

To determine the annual mortgage cost associated with this fleet required three steps. The first and second steps determined the sampled fleet's value and expanded this figure to the entire fleet. The third step required assigning one mortgage rate to the entire fleet value. This assumed that this value would prevail for all vessels, and that all vessels would have a 10-year mortgage. After discussion with persons familiar with marine vessel mortgages and lending institution mortgage rates in central California, a rate of 12 percent[2] was felt to be a usable estimate.

Results

Who Was Contacted

As mentioned, attempts were made to contact only the traditional, non-Vietnamese fishermen. Of these 80, 16 permittees (20 percent) could not be located; 64 (80 percent) were contacted. Thirty-seven fishermen (46 percent) were not fishing setnets in the ocean between Point Sal and Point Reyes in

[2]Personal communication with George Grundig, George M. Grundig and Assoc., 61 Moraga Way, 5, Orinda, CA 94563; and Michael Penzer, Bank of America, Box 37000, San Francisco, CA 94137.

1984. Twenty-seven fishermen (34 percent) were active in that area; however, only 23 (85 percent) of the 27 active fishermen were interviewed. One fisherman declined to be interviewed, and three were unavailable due to location or health. The following results and comments are based on the products of these 23 interviews and may not be representative of the entire traditional fleet nor are they in any way an indication of the magnitude of the Vietnamese setnet fishery in proportion, size or value.

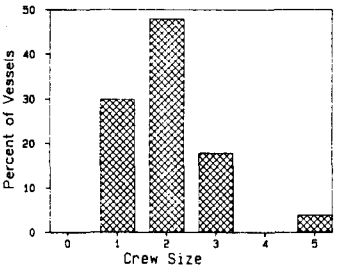


Figure 3.—Crew size (includes captain) of traditional central California setnet vessels in 1984.

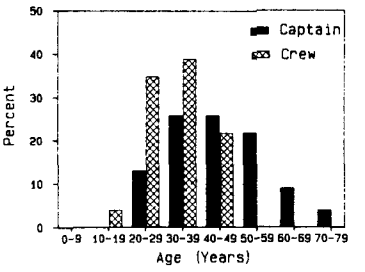


Figure 4.—Ages of captains and crew members on traditional central California setnet vessels in 1984.

Demographics of Fishermen

All except one of those interviewed were vessel captains. Three-fourths of them (17) were sole owners of their vessels, 8 percent (2) partly owned their vessels, and 17 percent (4) were nonowners. Crew size (including captain) averaged two people per vessel (range one to five). Vessels without crews (captain only) represented 30 percent of the fleet, 48 percent had two people, 18 percent had three, and 4 percent of the vessels had five people (Fig. 3).

Captains and crews of the vessels exhibited differences in age, education, and fishing experience. Captains averaged 45 years of age, with 14 years of education and 20 years of fishing experience. Crewmen averaged 31 years of age (Fig. 4), with 12 years each of education (Fig. 5) and fishing experience (Fig. 6). Over 80 percent of captains and crews were high school graduates. Forty-four percent of the captains had a post-high school education and 18 percent had a postgraduate education. Thirteen percent of the crewmen had post-high school education and none had postgraduate education.

One of the interesting aspects of the setnet fishery is the relationship between crew and captain. Most crewmen obtained the majority of their fishing experience with their current captain and averaged 7 years with this captain. Time spent with current skipper ranged from 1 to 26 years (Fig. 7), with 65 percent having had between 1 and 6 years with the current captain. The remaining 35 percent had been with the captain over 10 years. Sons of captains represented 13 percent of the total crewmen, and

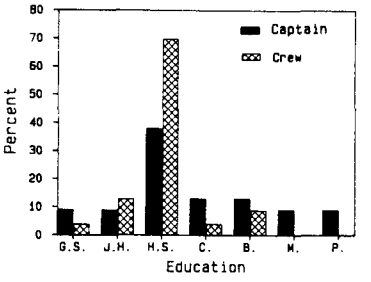


Figure 5.—Education of captains and crew members on traditional central California setnet vessels in 1984. G.S. = 3rd-8th grade; J.H. = 9th-11th grade; H.S. = high school; C. = some college; B. = bachelor's degree; M. = master's degree; P. = doctorate.

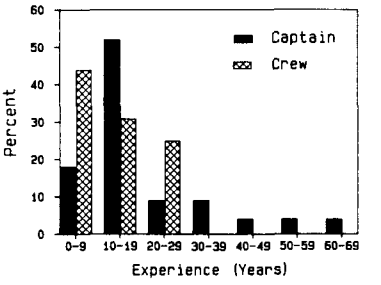


Figure 6.—Experience of captains and crew members on traditional central California setnet vessels in 1984.

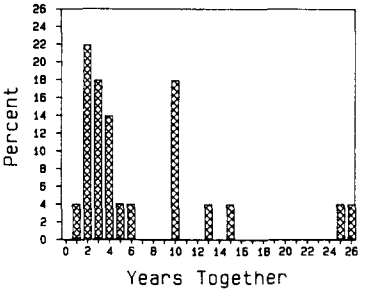


Figure 7.—Years captains and crew members on traditional central California setnet vessels have fished together through 1984.

cousins 9 percent. All related crew members' fishing experience was gained with their relative and this experience averaged 10 years. The 78 percent of the crewmen not related to the captain averaged 6 years experience. Unrelated crew members who had fished with only one captain (17 percent of the total) averaged 2 years fishing experience. The unrelated crew members who had fished with more than one captain (61 percent of the total) averaged 8 years fishing with their current captain.

Gear Characteristics

Fishermen often fish with different nets during a given year. Neither the type of nets used nor the combination of nets appears to be related to fishermen's experience. Less than 10 percent of the fishermen stated that they fish with different types of nets during one trip. Seventy percent of the fishermen fish gill nets, 35 percent with trammel

nets, and 43 percent with suspender nets. The total percentage exceeded 100 because some used more than one gear. Sixty-one percent used one gear only: Gill (35 percent), trammel (13 percent), and suspender (13 percent). Dual gear use was: Gill and trammel, 9 percent; gill and suspender, 17 percent; trammel and suspender, 4 percent; and all three net types, 9 percent.

Gill nets were grouped into three mesh-size categories: Small, 2⅛-3 inches; medium, 4¼-4⅝ inches; and large, 6-9 inches. The small-mesh nets are used to fish white croaker. The average effective fishing height of these nets (distance from floatrope [corkline] to footrope [leadline] when set) is 12 feet. The medium-mesh nets have an effective fishing height of between 12 and 18 feet and are used to fish rockfish, lingcod, and sablefish. Gillnets with the largest mesh have an effective fishing height of 16-22½ feet, and are used to catch rockfish, lingcod, starry flounder, *Platichthys stellatus*; and other flatfishes. These nets also can catch halibut and sharks, but are not considered optimal for these species.

Trammel nets have 8- to 10-inch mesh in the inner walls (81 percent were 8-inch) and 14- to 36-inch outer wall mesh (27 percent were 24-inch and 27 percent were 32-inch). The effective fishing height of these nets range from 6 to 18 feet (45 percent fished 18 feet). These nets are used to catch halibut, soupfin shark, *Galeorhinus zyopterus*, and other sharks, but rockfish, lingcod, and crabs are also caught.

Suspender nets have mesh sizes ranging from 7½ to 9½ inches, with 63 percent either 8 or 8½ inches. Effective fishing height ranges from 6 to 16 feet (30 percent fished 10 feet and 20 percent fished 15 feet). These nets are used to catch halibut, sharks, and rockfish, but other large fish are also caught.

Setnet netting is monofilament nylon and three-strand twisted nylon. Braided nylon was not being used, nor was multifilament nylon, although some fishermen indicated that they were going to build some multifilament nets, because of reports of less loss of captured fish.

All trammel nets were constructed of twisted three-strand nylon ranging in size from size 8 (0.038-inch diameter, 75-pound test) to size 16 (0.056-inch diameter, 135-pound test). Ninety percent of all suspender-net mesh was constructed of monofilament line from size 69 (19-pound test) to size 139 (28-pound test). Roughly half of the gill-net mesh was monofilament and the other half twisted three-strand nylon. Monofilament size was from 19-pound to 60-pound test line, while three-strand was between 50-pound and 170-pound test.

Anchors varied in type and weight among and between net types. The fishermen reported choice of type and weight to be a function of depth of water, length of net, time of year, and area of fishing.

Gill nets had the largest variety of anchor types (seven) and the largest weight range (24-90 pounds). The seven anchor types were Danforth[3] (35 percent), stock (23 percent), Northrop (12 percent), rocks (12 percent), cement blocks (6 percent), window heights (6 percent), and kedge (6 percent). Anchors used by trammel-net fishermen were the most homogenous: Danforth (80 percent), Northrup (10 percent), and kedge (10 percent).

Weight of trammel-net anchors ranged from 40 to 55 pounds (chain included). The average anchor weighed 51 pounds and 60 percent of the anchors weighed 55 pounds.

Suspender-net fishermen used Danforth or Northrop anchors 87 percent of the time and stock anchors the rest of the time. Anchors averaged 44 pounds and weights ranged from 30 to 80 pounds.

It appears that trammel-net fishermen have developed a coastwide consensus on the type and range of weights most suited for that gear. Suspender-net fishermen have the second smallest variance in anchors and appear to be adopting two types of anchors which weight about 40-45 pounds. Gill-net anchors, on the other hand, show no trend in type or weight. Fishing experience of the captain appeared to have little to do with either the anchor type or weight.

[3]Mention of trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

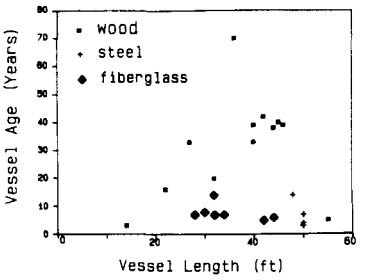


Figure 8.—Age of vessels vs. length relationship in the traditional central California setnet fishery in 1984.

All fishermen assembled their own nets. This generally requires the fishermen to attach premade netting or web to the footrope and floatrope and to attach bridles to the net for anchor, buoy, and flag. The fishermen's average annual assembly time for gill nets was 150 hours and for suspender and trammel nets 185 hours each. The gill net takes less time because only one item is attached to both foot- and floatropes.

Although obvious correlations were not found between types of setnet gear and fishermen's experience, age, or education, the gear used and the construction material of the vessel appeared to be correlated. Vessels were constructed of three materials: Wood (52 percent), fiberglass (30 percent), and steel (18 percent). Three-fourths of the wooden vessels were equipped with trammel and suspender nets and 58 percent with gill nets. Fiberglass and steel vessels were equipped with gill nets 82 percent of the time and trammel and suspender nets 55 percent. Vessel construction material was also correlated to vessel age. Wooden vessel ages ranged from 3 to 70 years, with an average of 31 years and a mode of 35. Fiberglass vessel age ranged from 5 to 14 years, with an average of 8 years and a mode of 7 years. Steel vessel ages ranged from 3 to 14 years with an average of 7 years and a mode of 6 years (Fig. 8). No significant correlation (r = 0.36; P = 0.08; n = 23) was found between vessel age and horsepower, but roughly three-fourths of the wooden and fiberglass vessels had diesel engines; the remainder were gasoline. All the steel vessels had diesel engines.

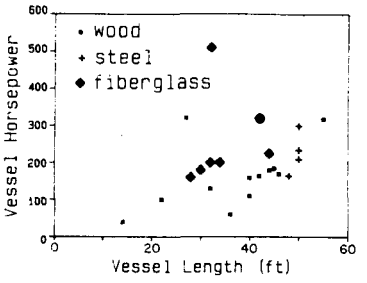


Figure 9.—Horsepower of vessels vs. length relationship in the traditional central California setnet fishery in 1984.

Engine horsepower averaged 155 for wooden, 227 for steel, and 256 for fiberglass vessels, but horsepower was not significantly correlated with vessel length (r = 0.28; P = 0.19; n = 23) or engine used (Fig. 9).[4] The hold capacity varied by construction material, with wooden vessel capacities averaging 13 tons (range from 0 to 30), fiberglass vessels 6 tons (range from 0 to 18), and steel vessels 28 tons (range from 15 to 30). No other obvious correlations between vessel characteristics, personnel, or gear were observed.

Characteristics of Fishing Operations

Many things affect the fishing operations of the setnet fishery. Included in these are fishing methods, kinship among fishermen, coastal mobility, and costs of fishing.

Fishermen using setnets off central California vary the length of time the nets are soaked, trip time, number of nets, length of nets, and method of fishing. These differences are in response to the species of fish being sought, weather conditions, vessel size, and time of the year. Most fishermen (96 percent) do not combine fishing methods during one trip. The remaining fishermen would use setnet and other gear, such as hook and line or traps. About one-fifth of the fishermen interviewed tended their nets and stayed in the area where the nets were set; the remaining fishermen (80 percent) set their nets and returned to port. Nets were generally set one day and pulled the next. Less than 10 percent of the vessels intentionally soaked the net longer than a day. When weather was bad, some nets would remain set until it was safe to retrieve. Fishermen generally avoided setting the net if the weather was too bad to retrieve or was believed to be turning bad. Trip length varied from 3 to 120 hours. A breakdown of trip length showed that almost two-thirds of the fishermen made trips of less than 2 days (0-12 hours = 18 percent; 12-24 hours = 23 percent; 24-48 hours = 23 percent). Eighteen percent of the fishermen made 3-day trips, 13 percent made 4-day trips, and 5 percent made 5-day trips.

Kinship is often an important aspect of a fishery and 70 percent of the captains in the setnet fishery had relatives in the fishing industry. All were male. Almost all of these relatives were fishermen, and most of them fished in central California. The remaining kin worked in the processing, wholesaling, or retailing sectors of the industry. Some fishermen purchased fish from other fishermen, and a few of these also processed fish for resale. A few purchased fish from other fishermen for another buyer, and some worked for a particular processor.

Mobility among fisheries and with a single fishery may decrease economic risk, allowing owners to fish where they believe economic returns will be the largest. Fishermen were asked to name their three most important fisheries. Seventy percent reported three fisheries, while 26 percent of the fishermen had participated in only two fisheries, and 4 percent in only one. Eleven fisheries were mentioned and the three most often reported were setnet fisheries for halibut (65 percent), Pacific herring, *Clupea harengus* (48 percent), and rockfish (42 percent). A total of six setnet fisheries was reported; the other three were shark (13 percent), white croaker (9 percent), and Pacific ocean perch, *Sebastes alutus* (4 percent). Other fisheries reported were round haul fishing with a lampara net for squid (13 percent) and chub mackerel, *Scomber japonicus* (13 percent), trolling for Pacific salmon, *Oncorhynchus* spp. (30 percent), trapping for Dungeness crab, *Cancer magister* (22 percent), and drift gillnetting for swordfish, *Xiphias gladius* (4 percent).

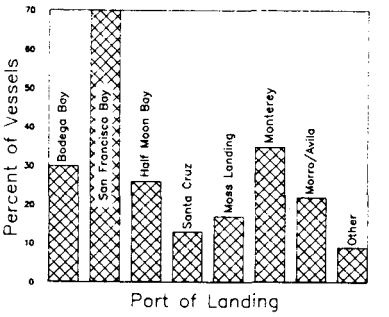


Figure 10.—Percentage of setnet vessels making landings in central California in 1984. Percentages do not equal 100 because vessels landed in more than one port.

Other gear used by 96 percent of the setnet fishermen was hook and line (70 percent-troll, longline, or pole), lampara net (30 percent), pots (20 percent—crab), and trawl (4 percent).

Setnet vessels not only fish in other fisheries and use other types of gear, but they also land at many different ports. Setnet fishermen in 1984 landed fish at only one port (22 percent of the fishermen), two ports (35 percent), three ports (31 percent), four ports (4 percent), five ports (4 percent), and six ports (4 percent). Landings were recorded in all ports from Bodega Bay to Avila Beach. Seventy percent of the vessels made landings in San Francisco, twice the percentage of any other port in the study area (Fig. 10).

Cost and Earnings

The costs of fishing are divided into two categories—fixed and variable. Fixed costs here include only the mortgage cost of the vessel. Variable costs include annual maintenance, repair and replacement of fishing nets, food, fuel, ice, insurance, vessel repair, vessel improvements, moorage, bookkeeping, and miscellaneous services. Crew remuneration could not be calculated from

[4]When one observation was excluded, a significant correlation was found between vessel horsepower and length (r = 0.49: P = 0.02, n = 22).

the data available.

Vessels' fixed costs were obtained by asking captains how much they actually paid for their vessels, how much they would sell their current vessel for, how much they would pay for a similar vessel, and how much it would cost to replace their vessel with a similar new one. The actual price and the willing-to-pay and willing-to-sell prices were all estimated to be near $10,000,000. This price is used as the surrogate for the total value of the 133 vessels in the calculated traditional fleet. The replacement price for the same vessels was estimated to be $15,000,000.

Fifty-seven percent of the surveyed vessels are mortgaged. Mortgages are held by private institutions (17 percent of all vessels), backed by government-guaranteed loans with private institutions (13 percent), or entail personal loans from relatives (17 percent) (no response 10 percent). Interest rates ranged from 8 to 13.2 percent, but 26 percent of all loans had no interest charge. These zero-interest loans required repayment in 2-4 years on a predetermined payment system. As previously noted, the traditional setnet fleet is valued at $10,000,000. If the entire fleet were mortgaged at 12 percent with a 10-year loan, the vessel owners would have an annual fixed cost of $1,750,000.

Although the total amount of the crews' remuneration could not be evaluated, the method was determined. Remuneration of setnet fishermen was generally on a lay (share) basis, which varied by vessel, area, ownership, fishery, and value of landing. Sixty percent of the fishermen were paid on a share of gross revenues, 36 percent on a shore of net revenues, and 4 percent were salaried. Crewmen receiving a shore of the gross revenue averaged 25 percent of the gross (range from 12 to 40 percent). Those receiving a share of the net revenue averaged 24 percent (range from 7.5 to 40 percent). Net revenue was determined by subtracting fuel and food from gross revenue. One vessel divided the food costs among owner and crew. Some crewmen received a higher percentage of the agreed-upon gross or net share when the revenues for the trip were low.

Table 1.—Minimum fixed and variable costs[1] attributed to setnetting in California, 1984.

Item		Costs	
Fixed cost of vessel: 10-year mortgage at 12 percent			$1,750,000
Variable cost of fishing			
Moorage	$ 67,000		
Insurance	264,000		
Repair and other	158,000		
Improvements	115,000		
Fuel	355,000		
		$959,000	
Net material 1984		550,000	
Labor: 31,000 hr @ $8.07/hours		250,000	
Minimum variable cost			1,759,000
Minimum 1984 setnet fishing costs			$3,509,000

[1]Variable costs not included are crew remuneration and miscellaneous costs.

Seventy-eight percent of the captains made their entire income from fishing. The remaining captains earned between 40 and 80 percent of their income from fishing. Setnetting earnings comprised from 2 to 100 percent of captains' earnings, with 30 percent earning between 2 and 19 percent, 26 percent between 20 and 39 percent, 13 percent between 40 and 59 percent, 13 percent between 60 and 79 percent, and 18 percent between 80 and 100 percent.

The 1984 variable costs to the setnet fleet which I could attribute to moorage, insurance, repair, improvements, and fuel was nearly $1 million dollars (Table 1). Nets owned by the fleet were valued at $850,000. The cost of materials used to build or repair these nets in 1984 was $550,000. Building and repairing the setnets owned by the fleet took an estimated 31,000 hours of labor. This work is estimated to be worth $250,000 ($8.07/hour).[5] Other variable costs, such as ice, food, crew remunerations, bookkeeping, and miscellaneous services, could not be estimated from available data and, therefore, the variable cost should be considered a minimum. Minimum variable costs for 1984 would be about $1.8 million and total costs, variable plus fixed, would be about $3.5 million.

[5]Blend of four 1984 hourly rate values. Hourly rate for a moderately-skilled government worker: GS-6 ($7.45), GS-7 (8.28). Weekly Federal Employers News Digest, Vol. 33, No. 36, 16 April 1984, Washington, D.C. Hourly rate for manufacturing total all categories: Humboldt County ($7.62), and San Francisco County ($11.38). 1985 County Business Patterns, U.S. Bureau of the Census, Wash., D.C.

Ex-vessel Revenue

Three problems exist due to the incompatibility of the data base used to determine ex-vessel revenue and the area and scope of the study. One problem was caused because the ex-vessel values in PacFIN[6] for 1984 were not accurately differentiated by gear. Only 19 percent of the fish from the study area in the "net" and "other gear" categories were attributed to the "net" category. In 1985, 59 percent of the fish in these two categories were net-caught. Therefore, the species breakdown from the 1985 report rather than 1984 was used to determine catch by species.

Ex-vessel value estimates from 1984 data were not considered reliable because the "other gear" category accounted for over 90 percent of the landings in the Monterey area. How much of this could have been landed by setnets is not known. However, the total ex-vessel values of the "other gear" and "net" categories for 1984 and 1985 were only 8 percent apart and I believe that the 1985 ex-vessel value breakdown is similar to the 1984 value.

Another problem existed because the study site area was different from the PacFIN data. PacFIN uses the Pacific Marine Fishery Commission areas designated Conception and Monterey. This covers the area from the Mexican/California border north to lat. 40½°30′ N (roughly Cape Mendocino, Calif.). This northern boundary of the Monterey area is 150 n.mi. north of the study area, and the southern border of the Conception area is 260 n.mi. southeast of the study area.

A third problem was that only the traditional fishermen were sampled and PacFIN data covers both traditional and Vietnamese fishermen. The final problem entailed combining price and quantity information for the "other gear"

[6]PacFIN is the Pacific Fishery Information Network data report published by the Pacific Marine Fishery Commission, Portland, Oreg.

Table 2.—California landings of "net" and "other gear" for the Pacific Marine Fishery Commission Monterey and Conception areas, 1984 (PacFIN[4] Report #009 and 054, 14 February 1985).

Species	Other gear Qty. (mt)	Other gear Price ($/kg)	Other gear Value ($K)[1]	Net Qty. (mt)	Net Price ($/kg)	Net Value ($K)	Combined total Qty. (mt)	Combined total Value ($K)
Flatfish	60	$.93	$56	52	$1.00	$52	112	$108
Rockfish	1,804	.91	1,632	2,893	.84	2,425	4,697	4,057
Lingcod	171	.73	124	99	.69	68	270	192
Sablefish	307	.68	210	33	.46	15	340	225
Other	1	.71	1	1	.63	1	2	2
Misc. groundfish	37	1.78	65	128	1.55	198	165	263
California halibut	73	4.11	300	421	4.04	1,700	494	2,000
Total	-		$2,388			$4,459		$6,847

[1]K = 1,000.

Table 3.—Estimated[1] ex-vessel revenue attributed to traditional setnet fishermen in central California, 1985.

Species	Landings by other gear Value[2] ($K)	Landings by other gear Setnet (%)	Landing values Gear ($K)	Landing values Other net ($K)	Landing values Total setnet ($K)	Value of traditional setnet fishery % Total[4]	Value of traditional setnet fishery
Calif. halibut	$300	100	$300	$1,700	$2,000	100	$2,000
Flatfish	56	80	45	52	97	90	87
Rockfish	1,632	50	816	2,425	3,241	50	1,621
Lingcod	124	50	62	68	130	50	65
Sablefish	210	50	105	15	120	35	42
Other	1	50			1	100	1
Misc. groundfish	65	50	32	198	230	70	161
Total							$3,977

[1]Author's estimate; see text for other estimates.
[2]K = 1,000.
[3]Percentage of PacFIN report estimated to be made by setnets in study area from the "other gear" category.
[4]Percentage of adjusted landings attributed to traditional setnet fishermen.

category. Precision is lacking because only some of the fish in the "other gear" category were believed to be net-caught, and a price differential may have existed among gears within the "other gear" category.

The incompatible PacFIN and study data were adjusted after discussions with groundfish biologists[7] and industry people familiar with the breakdown of landings. The largest adjustments were to the rockfish in the PacFIN "other gear" category north of Bodega Bay and the sablefish and rockfish caught south of Santa Maria. Total value for these areas before adjustments was $6,847,000 (Table 2). Final estimates which have been adjusted for area, other gear landings, and Vietnamese landings resulted in an ex-vessel value for the traditional setnet fishermen of central California of $3,977,000 (Table 3). Due to the many adjustments, this figure was rounded to $4,000,000. Other scientists and fishermen were also contacted and their suggested adjustments resulted in total ex-vessel revenues of $4,309,000, $4,274,000, $4,070,00, and $3,776,000.

[7]F. Henry, personal communications, California Department of Fish and Game, Menlo Park, Calif. K. Worcester and J. Richards, Sea Grant Advisors, Port San Luis, Calif.

Conclusion

The traditional sector of the central California setnet fishery was calculated to support a highly educated and experienced group of 266 fishermen, fishing from 133 vessels for many different kinds of fish. The estimated cost, excluding crew remuneration and miscellaneous costs of the setnetting, is in excess of $3.5 million and the fishery produces an ex-vessel revenus of around $4 million. Setnet revenues represented an estimated 41 percent of the captain's total earnings from fishing in 1984. The value of vessels and setnet gear was about $11 million.

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U.S.-U.S.S.R. Discuss Bering Sea Fisheries

United States and Soviet fisheries delegations met in Washington, D.C., 18-22 April to discuss a broad range of fisheries issues of mutual concern. The U.S. side was headed by Ambassador Edward E. Wolfe, Deputy Assistant Secretary for Oceans and Fisheries Affairs, U.S. Department of State. The Soviet side was headed by V. K. Zilanov, U.S.S.R. Deputy Minister of Fisheries.

Both delegations characterized the talks as highly productive. Pursuant to the undertakings to improve fisheries relations contained in the Joint U.S.-Soviet Summit Statement made by President Reagan and General Secretary Gorbachev on 10 December 1987, in Washington, D.C., and the joint statement made by Secretary of State Schultz and Minister of Foreign Affairs Shevardnadze during their negotiations in February 1988, in Moscow, the two delegations considered possible ways for the two sides to act together on a wide range of issues related to conservation, rational utilization, and management of living marine resources.

Pursuant to understandings reached in Moscow in January 1988 to form a Bering Sea fisheries working group (see article below), the two delegations discussed the conservation aspects of Bering Sea fisheries in light of the vastly increased level of fishing in the region beyond the respective economic zones of the two states. A full exchange of views was made with regard to the legal, scientific, and enforcement aspects of the Bering Sea fisheries both within and beyond the respective economic zones of both states.

It was agreed that most of the commercially fished species of the Bering Sea are common to the economic zones of the United States and the Soviet Union while stocks of walleye pollock, *Theragra chalcogramma*, range both within and beyond the economic zones of the two states. Both sides expressed strong concerns over the adverse impact of unregulated, large-scale fisheries beyond the economic zones of pollock stocks which are a part of the ecological complex of the Bering Sea.

The delegations agreed on the need to develop further cooperation between the United States and the Soviet Union in the exercise of their rights and duties under international law to coordinate conservation and management of living marine resources of the Bering Sea. In addition, both sides agreed to convene jointly a scientific symposium in the United States in 1988, inviting scientists from all states concerned, to review the status of fishery resources in the Bering Sea, particularly pollock.

The two delegations agreed to continue coordinating the actions of both sides on fisheries of the Bering Sea. The two sides also discussed the implementation of the interim fisheries agreement, signed on 21 February by Secretary of State Shultz and Minister of Foreign Affairs Shevardnadze, regarding U.S. access to the U.S.S.R. economic zone. The two sides also considered the expeditious preparation and conclusion of a comprehensive fisheries agreement between the United States and the Soviet Union to govern their mutual relations in the field of fisheries. This agreement would, among other things, address conservation and management issues related to fishery resources of the Bering Sea, including the area beyond the respective economic zones of both states. Because of the urgency of these issues, the delegations agreed to continue bilateral discussions in Moscow in the near future. (Source: IFR-58/38.)

U.S.-U.S.S.R. Fishery Talks

United States and Soviet fishery delegations met in Moscow during 26-28 January 1988, to discuss a broad range of fishery issues of mutual concern. Both delegations characterized the talks as highly productive. It was agreed that the two sides would soon conclude arrangements allowing access by U.S. fishing vessels to the Economic Zone of the U.S.S.R. on the same terms as the U.S.S.R. vessels now have in the U.S. Exclusive Economic Zone, as provided in the current U.S.-U.S.S.R. Fisheries Agreement.

The two delegations also agreed to immediately form a bilateral U.S.-U.S.S.R. Working Group on Fisheries of the Bering Sea. This group will include legal, scientific, and technical specialists from both sides which will develop recommendations for dealing with increased fishing in the Bering Sea. The talks included finalizing plans for a March industry-to-industry meeting in the Soviet Union to discuss possible fishery commercial joint ventures, and plans to address additional scientific and other issues to improve overall bilateral fisheries cooperation on a mutually beneficial and equitable basis.

U.S. Ends Certification of U.S.S.R. for Whaling

U.S. Secretary of Commerce C. William Verity has announced his decision to terminate the certification of the Soviet Union under the Packwood-Magnuson and Pelly Amendments for its whaling practices. The announcement was made in Moscow on 14 April during a press briefing at the end of the Joint Commercial Council (JCC) meeting, as follows:

"In concluding my remarks, I want to announce that I have received assurances from the Soviet Ambassador to the United States confirming that the Soviet Union has ceased commercial whaling and intends to work through the International Whaling Commission (IWC) for whale research and conser-

vation. The cessation of commercial whaling by whaling nations has been a major objective of global environmental groups and the IWC, supported by the United States. I welcome the Soviet decision and hope that it sets a pattern for similar decisions on the part of other whaling nations to work within the IWC for the purposes of research and conservation. We look forward to cooperating more closely with our Soviet colleagues in the IWC, our fisheries relations, and our broader bilateral agenda."

Secretary Verity sent a letter to U.S. Secretary of State George P. Shultz conveying his decision (see below). A *Federal Register* notice, required by law, explaining the reasons for his decision was also prepared for publication on 14 April (see below). The Secretary of Commerce has withdrawn the certification because the reasons for the April 1985 certification no longer prevail. The Soviet Union has confirmed that it has ceased whaling and intends to work through the IWC for whale research conservation. (Source: U.S. Embassy, Moscow).

Text of letter to Secretary George P. Shultz relating Commerce decision to terminate the certification of the Soviet Union for whaling practices:

Dear George, On April 1, 1985, Secretary of Commerce Malcolm Baldrige certified to the President that Nationals of the Soviet Union were conducting whaling operations that diminished the effectiveness of an international fishery conservation program under the Pelly Amendment to the Fishermen's Protective Act of 1967, 22 U.S.C. 1978 (1983 SUPP.) and the Packwood-Magnuson Amendment to the Magnuson Fishery Conservation and Management Act, 16 U.S.C. 1821 (1983 SUPP.). Following certification and consultations between the Departments of State and Commerce, Soviet fish allocations were reduced by 50 percent and all allocation available to the Soviet Union eliminated one year later. The Pelly Amendment requires periodic review of the basis for certification, and I have recently concluded such a review. I have determined that the conditions that prompted the certification of the Soviet Union no longer exist, and I am terminating the certification under both the Pelly and Packwood-Magnuson Amendments. I recommend that the Department of State promptly notify the Government of the Soviet Union of the termination of the certification. In addition, the National Oceanic and Atmospheric Administration will provide recommendations for fish allocations to be made available to the Soviet Union at the appropriate time. Sincerely, Secretary of Commerce.

Federal Register notice explaining the termination of Soviet certification.

Summary: Notice is published that the Secretary of Commerce finds the reasons for the certification of the Soviet Union, under the Pelly and Packwood-Magnuson Amendments for activities that diminish the effectiveness of an International Fishery Conservation Program, no longer prevail and that the certification has been terminated.

Supplementary Information: Under the Pelly Amendment to the Fishermen's Protective Act and the Packwood-Magnuson Amendment to the Magnuson Fishery Conservation and Management Act, the Secretary is responsible for determining if nationals of a foreign country, directly or indirectly, are conducting fishing operations in a manner or under circumstances which diminish the effectiveness of an international fishery conservation program. If the Secretary of Commerce so determines, such certification is reported to the President. On April 1, 1985, Secretary Malcolm Baldrige certified to President Reagan that the Soviet take of Southern Hemisphere minke whales had diminished the effectiveness of the International Whaling Commission (IWC) conservation program. The Secretary based his determination on the following facts: 2) The Soviet harvest of Southern Hemisphere minke whales was greater than the level the United States considered the U.S.S.R.'s traditional share, 2) The 1984-85 IWC quota for Southern Hemisphere minke whales was exceeded due to Soviet harvest and 3) there had been no indication that Soviets intended to comply with IWC standards.

The Soviet Union has ended its commercial harvest for Southern Hemisphere minke whales and has indicated its intention to cooperate in the conservation of whales within the framework of the IWC. Given that the reasons for the certification of the Soviet Union no longer prevail, the Secretary has terminated the certification under both the Pelly and Packwood-Magnuson Amendments. (Source: IFR-88/31.)

U.S., U.S.S.R. Sign Fisheries Agreement

A comprehensive agreement governing fisheries relations between the United States and the U.S.S.R. was completed on 23 May after a week-long negotiating session in Moscow; it was signed at the Moscow Summit on 31 May. The agreement provides for access by each nation's fishing vessels to surplus fishery resources in the other's Exclusive Economic Zone. Fishing vessels of both nations also can purchase supplies, effect repairs, and exchange crews at specified ports: Boston, Mass., Portland and Astoria, Oreg., and Dutch Harbor, Alaska, in the United States; Murmansk, Provideniya, Korf, and Oktyabrski in the Soviet Union.

The agreement states that the two countries have a common concern for conservation of shared stocks in the Bering Sea and for Pacific salmon, *Oncorhynchus* spp., resources, and will cooperate in data collection and scientific research. The agreement also provides for the establishment of a bilateral consultative committee to meet each year, and for the appointment of a U.S. fisheries attache at the U.S. Embassy in the Soviet Union. As an adjunct to the negotiation of this agreement, the two sides agreed to hold an international scientific symposium on Bering Sea walleye pollock, *Theragra chalcogramma*, resources to be held in Sitka, Alaska, in mid-July, and agreed to coordinate efforts to achieve third-party cooperation in conserving pollock resources.

NMFS Will Enforce Lacey Act in Bahamian Waters

It is illegal to possess fish or lobster taken in Bahamian waters, or to import

them into U.S. jurisdiction, or to sell them in the United States or to a foreign interest, or to attempt to import or sell them, Joseph Angelovic, Acting Southeast Regional Director of the National Marine Fisheries Service announced early this year. The Bahamas exercises fisheries jurisdiction over all waters to the East of the Fishery Conservation Zone/Exclusive Economic Zone line between Florida and the Bahamas depicted on U.S. chart 11460, 28th Edition, Feb. 22, 1986.

To clear up any possible confusion Angelovic stated, let it be known that any U.S. fisherman found fishing in Bahamian waters will be prosecuted by the National Marine Fisheries Service to the fullest extent of the law under the Federal Lacey Act. Penalties for felony conviction are up to 5 years in prison and up to $20,000 fine, plus loss of all fish taken, the vessel, trailer, vehicle, and equipment used to aid in the violation for most violations. Penalties for a misdemeanor conviction are up to 1 year in prison and up to a $10,000 fine, while civil penalties of up to $10,000 penalty per violation can be assessed. For further information or to report violations, contact Eugene Proulx at (813) 893-3145.

U.S. Fishery Export Picture Looks Good

The year 1987 was a banner year for U.S. fish exporters, with total overseas sales of fishery products a record $1.66 billion, up 22 percent over 1986, according to the National Oceanic and Atmospheric Administration (NOAA). NOAA said American joint-venture operations also set records last year. Exports and joint ventures in 1987 together amounted to more than $1.8 billion. Joint ventures are those in which U.S. fishermen sell their catch at sea to foreign processing boats.

According to NOAA economists, if this trend continues, fish sales to foreign buyers will top $2 billion this year, making the United States the world's biggest fish exporter. The volume of the catch rose too, to a record 525,000 metric tons, up 13 percent from 1986, the Commerce Department agency said. And the country's biggest foreign fish buyer, Japan, bought fish and fishery products worth a record $1.074 billion in 1987.

Also in 1987, seafood imports rose by $800 million to a record $5.6 billion. If nonedible marine products are included—mostly high value-added jewelry made with coral or pearls—that import figure increases to $7.9 billion. NOAA says it expects the 1988 balance-of-trade figures to look about the same. Part of the reason for the persistent trade deficit, says NOAA, is that the U.S. fishing industry cannot fully supply America's growing taste for high-priced products like shrimp, tuna, scallops, lobster, and farmed salmon. That demand is being met by imports.

NOAA Moves to Cut Dolphin Deaths

Foreign nations exporting yellowfin tuna to the United States caught in the eastern tropical Pacific Ocean must take steps to reduce the number of dolphins killed during purse seine fishing, the Commerce Department's National Oceanic and Atmospheric Administration (NOAA) announced early this year. Countries that do not reduce dolphin deaths will not be allowed to import yellowfin into the United States.

A new ruling by NOAA's National Marine Fisheries Service, requires foreign fleets that catch yellowfin tuna from purse seine vessels to establish regulations comparable to those required for the U.S. fleet. The ruling, which went into effect in mid-April, requires observers to monitor fishing activities and the use of gear and techniques that minimize harm to dolphins during yellowfin fishing. The ruling also requires that by 1991, the average annual rate of dolphins killed by a foreign fleet in the area is comparable to the yearly rate for the U.S. fleet.

Eight foreign nations, including Mexico, Venezuela, and Ecuador, fish for yellowfin in the eastern tropical Pacific. In 1986 they harvested almost 195,000 tons of fish. More than 46,000 tons, worth an estimated $35 million, was exported to the United States. In the eastern tropical Pacific where schools of yellowfin tuna swim beneath dolphin herds, fishermen search for schools of dolphins as an indication of tuna. The fishermen encircle both dolphins and tuna with huge purse seine nets. Although the vast majority of the dolphins escape or are released by fishermen, a few become entangled and drown.

NOAA Ship *Researcher* Is Renamed *Malcolm Baldrige* to Honor Late Commerce Department Secretary

The NOAA Ship *Researcher*, an oceanic research vessel operated by the Department of Commerce's National Oceanic and Atmospheric Administration (NOAA), was renamed the NOAA Ship *Malcolm Baldrige* on 1 March in honor of the late Commerce Secretary. Mrs. Baldrige participated in the renaming ceremony, hosted by Commerce Secretary C. William Verity, which began at 11 a.m. at the Washington Navy Yard, Pier 1. The ship was renamed *Malcolm Baldrige* in recognition of the late Commerce Secretary's public service to the Nation. Secretary Baldrige died in a rodeo accident 26 July 1987.

The 2,963-ton, 278-foot *Researcher/Baldrige*, the largest east coast ship in NOAA's fleet of 23 research and survey ships, conducts climate research in the Atlantic Ocean and Caribbean Sea. The ship is based at NOAA's National Ocean Service Atlantic Marine Center in Norfolk, Va., and operates out of NOAA's ship support base in Miami, Fla. The ship can carry 82 NOAA Corps officers, civilian crew members, and visiting scientists, and is equipped with a scientific laboratory, sophisticated communications and computer systems, and the latest scientific instruments for making environmental measurements at sea.

The ship was built by the Toledo Plant of the American Shipbuilding Company and launched on 5 October 1968. It has two 1,600-horsepower, geared diesel engines that power twin controllable-pitch screws and a 450-horsepower bow thruster that can be used to move the ship at very slow speeds or hold it steady on a position. With a cruising range of 13,000 n.mi. and a cruising speed of 14.5 knots, the ship can carry

6-month's worth of provisions for extended scientific operations in remote ocean areas, and can remain at sea for more than a month at a time.

New Federal Lobster Regulations Announced

New Federal regulations governing the American lobster fishery became effective on 31 December 1987. These new regulations were developed by the New England Fishery Management Council in cooperation with the lobster-producing states in New England and the Middle Atlantic. The regulations 1) increase the minimum carapace length for lobsters, 2) prohibit the possession of V-notched lobsters throughout the range of the stock, 3) implement a nationwide prohibition on the possession of V-notched and egg-bearing female lobsters and all lobsters smaller than the minimum carapace length taken and retained in violation of the Magnuson Fishery Conservation and Management Act, and 4) revise the gear identification/marketing requirement.

The minimum carapace length is scheduled to be increased from $3\frac{3}{16}$ inches to $3\frac{5}{16}$ inches by increments of $\frac{1}{32}$ of an inch per year over a 5-year period. An escape vent size increase is scheduled to take place at the mid-point of the carapace length increases. The new vent size will be compatible with a minimum carapace length of $3\frac{5}{16}$ inches. The industry will be notified before the end of 1988 as to the exact specification of the new venting requirement. Effective dates of the scheduled increases in carapace length are as follows:

Date	Minimum carapace length
1 January 1988	$3\frac{7}{32}$ inches
1 January 1989	$3\frac{1}{4}$ inches
1 January 1990	Escape vent size to be compatible with a minimum carapace length of $3\frac{5}{16}$ inches
1 January 1991	$3\frac{9}{32}$ inches
1 January 1992	$3\frac{5}{16}$ inches

Following each length increase, dealers and wholesalers will have a 180-day grace period to dispose of lobsters purchased or received in the prior year which do not meet the new minimum carapace length.

Secondly, these new regulations prohibit nationwide the possession of egg-bearing lobsters, V-notched female lobsters, and lobsters smaller than the minimum carapace length that were taken and retained in violation of the Magnuson Act. The possession prohibition applies to all lobsters found in commerce unless it can be shown that the lobsters were 1) imported, or 2) harvested by a vessel fishing exclusively in state waters, in which case regulations of the state will prevail. Lobsters from a vessel holding a Federal fishing permit, or a state permit that is endorsed for Federal waters, will be presumed to have been harvested from the Federal waters and will be subject to these new Federal regulations.

Lastly, these regulations revise the gear identification/marking requirement to provide increased flexibility. In addition to allowing Federal Permit Holders to use their state gear identification/marking system, the new regulations authorize gear to be marked with a "number assigned by the Regional Director" instead of simply "the Federal Fishery Permit Number." This means that gear may be marked with the vessel's 1) Federal Fishery Permit, 2) Official or Documentation Number, or 3) any number as authorized by letter from the Regional Director. For additional information on these new Federal regulations, contact Carol Kilbride of the National Marine Fisheries Service at (617) 281-3600.

Oyster Resource Disaster Aid

A total of $2.0 million was made available by late last year under the resource disaster provisions of the Commercial Fisheries Research and Development Act (P.L. 88-309) to the states of Delaware, Maryland, New Jersey, and Virginia, to assist in restoring the commercial oyster fisheries in Chesapeake and Delaware Bays, the NMFS Northeast Regional Office reported in December. Continuation of drought conditions experienced by the Mid-Atlantic states resulted in increased Bay salinities and, unfortunately, a favorable environment for spread of the haplosporidian parasite, commonly known as MSX. As a result, high mortalities and reductions of over 40 percent in yield of marketable oysters occurred, and adverse resource conditions could continue through 1990. Activities being conducted by the four states include dredging and planting of oyster shell for propagation purposes, and field trials of disease resistant strains.

Tagged U.S. Salmon Recovered in Greenland

NMFS Northeast Fisheries Center scientists, in cooperation with their Canadian and Danish counterparts, detected 146 coded-wire-tagged Atlantic salmon, *Salmo salar*, among over 25,000 salmon examined at four West Greenland fishing ports during August and September 1987. Of the 146 tagged fish, 82 were of U.S. origin, 19 of Canadian origin, and the rest of European origin (mostly England, Wales, and Ireland). Of the U.S.-origin tagged fish, 77, or 94 percent, were from Maine rivers. These tag recoveries are particularly significant because they represent the first year in which coded-wire-tagged salmon of Maine origin have been available to the West Greenland fishery.

Scientists examined the salmon after the fish had been bought by fish processors, but before the fish had been flash frozen and glazed. Scientists used special metal detectors to identify which salmon had the magnetically coded, 1 mm wire tags imbedded in their skulls. These coded-wire tags, which are undetectable by fishermen and thus necessitate the special sampling by scientists, are now in common use by the salmon-producing countries of the North Atlantic. The United States began applying these tags to 1-year-old salmon (smolts) in 1985.

Marine Debris Conference Slated for Hawaii, 1989

The Second International Conference on Marine Debris is scheduled for 2-7 April 1989 in Honolulu, Hawaii, according to Richard S. Shomura, Chairman. Sponsors are the National Marine Fisheries Service, the Marine Mammal

Commission, and the University of Hawaii's Sea Grant College Program.

Since the first (1984) international "Workshop on the Fate and Impact of Marine Debris," also held in Honolulu, a substantial body of information on the topic has been amassed, heightening scientific, legal, and political recognition of the problem. The second conference, says Shomura, is intended to provide a forum to present and evaluate the various aspects of the problem and potential solutions. Some of the topics to be covered include: New data on the types, amounts, sources, fates, and distribution of marine debris in different ocean areas; existing and potential methods for data collection; nature and extent of impacts on living marine resources; impacts on human health and safety of ships at sea; aesthetic and other impacts on coastal environments; effectiveness and future role of programs educating the public and promoting awareness of the problem; and programs necessary to assess the effectiveness of measures addressing the problem.

Early registration fee is US$125 (US$150 at the conference). Further information for prospective authors and participants is available from Richard S. Shomura, Conference Chairman, NMFS Honolulu Laboratory, 2570 Dole Street, Honolulu, HI 95822-2396 U.S.A. (telephone 808-943-1229; or telegram MDEBRIS; or Telex 6503504141 MCI UW).

Mackerel Spawn Heavily North of U.S. Border

Spawning by Atlantic mackerel, *Scomber scombrus*, was more intense in Canadian waters than in U.S. waters during the 1987 spawning season. That's a preliminary observation resulting from eight egg-and-larval surveys conducted by NMFS Northeast Fisheries Center scientists during late spring and early summer as part of a cooperative U.S., Canadian, and Polish effort to estimate the spawning stock biomass of Northwest Atlantic mackerel.

Detailed analysis of the surveys' samples and data shows that spawners in Canadian waters accounted for 89 percent of the adult spawning biomass; spawners in U.S. waters accounted for 11 percent. The Center's estimate of 1987 adult spawning biomass—based on these egg surveys—is 1.10 million metric tons (2.47 billion pounds). This estimate compares very favorably with estimates based on virtual population analysis.

Northwest Atlantic mackerel total stock biomass, as estimated by virtual population analysis, has fluctuated widely over the past 25 years. (Estimates of total stock biomass will always be somewhat larger than estimates of adult spawning biomass since the former includes all age 1 and older fish, whereas the latter includes hardly any age 1, a variable proportion of age 2, and almost all age 3 and older fish.) Total stock biomass increased from 0.30 million metric tons (0.67 billion pounds) in 1962-65 to 1.9 million metric tons (4.26 billion pounds) in 1970-71, decreased to an average of 0.49 million metric tons (1.09 billion pounds) in 1977-81, and increased to 1.50 million metric tons (3.36 billion pounds) in 1986.

Fish Processing Waste Effective as Fertilizer

NMFS Gloucester Laboratory experiments show that fish hydrolysate (a liquified fish mixture derived from the solid wastes of fish processing) is an effective plant fertilizer. This finding offers a possible solution to the recurring problem encountered by fish processors on how to dispose effectively, efficiently, and safely of the solid wastes from fish processing operations. This problem currently limits the restoration, maintenance, or growth of several commercial fishing ports in the U.S. northeast region.

Scientists compared fish hydrolysate that was made from Atlantic cod, *Gadus morhua*, "frames" (what's left after filetting) and that roughly had a 3-5-1 fertilizer value (percent content of nitrogen, phosphorous, and potassium), with a well-known commercial fertilizer with a stated 20-20-20 value. Under controlled but variable conditions of soil type, fertilizer concentration, and fertilization frequency, the fish hydrolysate increased yields in the test crop—greenhouse jalapeno peppers—from 20 to 123 percent.

Cooperative Ocean Cruise Seeks Data on Armorhead

Scientists from the NMFS Southwest Fisheries Center's Honolulu Laboratory returned in February from a 30-day cruise aboard the *Townsend Cromwell* collecting biological and oceanographic information from waters over and surrounding the Southeast Hancock Seamount, which is located about 200 n.mi. northwest of the Hawaiian Archipelago and just within the U.S. 200-mile Exclusive Economic Zone (EEZ).

"From a historical standpoint, the results would hopefully provide valuable insight into what once was a viable commercial fishery for Soviet and Japanese fishing ventures," said Richard S. Shomura, Director of the NMFS Honolulu Laboratory. Shomura added that the seamounts provided habitat for large concentrations of fishes, in particular the target species of fish known as the pelagic armorhead. In the spring of 1985, when armorhead were nearly exhausted by the fishing pressure applied by foreign vessels, the NMFS closed the seamounts within the EEZ to all foreign fishing. The Honolulu Laboratory has since continued to monitor and explore the dynamics associated with abrupt topographical features such as the seamounts present. Chief Scientist Michael P. Seki reported that fishery operations on the cruise involved primarily bottom longlines and bottom trawling gear. Collection of oceanographic data involved sampling along predetermined transects with such equipment as an acoustic Doppler current profiler, a geomagnetic electrokinetograph, hydroacoustic echo sounders, various small nets, etc.

In addition to Seki, scientific personnel on the cruise were research assistants Russell Y. Ito, Frank A. Parrish, Dennis Therry, and Christopher D. Wilson. Also participating on the cruise were cooperating scientists Jed Hirota and James Finn from the University of Hawaii Department of Oceanography, and Peter Koske and Thorsten Knutz from Kiel University in the Federal Republic of Germany.

Predation Limiting Hard Clam Production

Predation substantially limits the production of hard clams in Great South and Barnegat Bays, the largest clam production areas in New York and New Jersey, respectively. These findings come from separate field studies of these areas by NMFS Northeast Fisheries Center scientists, supplemented by laboratory experiments also conducted by the Center.

The Barnegat Bay field study was conducted in conjunction with a cooperative effort to create hard clam spawning sanctuaries throughout the Bay. At each of five study sites, scientists planted paint-marked juveniles (5 mm long) clams around stakes. At four of the five sites, there was at least 62 percent mortality of marked clams within 70 days, with most of it due to crab predation, although at one of those four sites, almost half of the predation was due to oyster drills. In the most extreme case, 96 percent of the marked clams at one site were crushed after four days, indicating crab predation.

In the Great South Bay field study, a scuba-deployed hydraulic suction sampler was used to collect clams at four sites in August 1986, and at six sites in August 1987. This 2-year effort permitted scientists to follow the mortality and growth of the Bay's strong 1985 "set" of clams. Between 1986 and 1987, the average density of these clams decreased from ten to three per square yard. We attribute the mortality largely to predation, mostly by crabs. (Incidentally, in 1987, when the 1985-set clams were 5-20 mm long, we found no other abundant size classes less than 40 mm long. Consequently, clam harvests in the Bay should decrease for 2 or more years until the 1985-set clams grow to a commercial size.)

Scientists also ran a laboratory experiment to evaluate the predation potential of sand shrimp and grass shrimp—which are often abundant on clam beds—on early-stage juvenile hard clams. Individual shrimp were placed in dishes which held 50 1 mm-long clams. In every case, all clams were consumed in 24 hours. The results of the field studies and laboratory experiments show the importance of predation in limiting hard clam production in the New York-New Jersey area.

Toxic Mackerel Liver Eyed in Whale Deaths

In response to the known deaths of 14 humpback, 4 minke, and 2 fin whales along the New England coast in December and January, the NMFS Northeast Fisheries Center began testing the toxicity of liver extracts from several fish species known to be prey—as juvenile or adults—of whales. On 18 December 1987 Center scientists found liver extracts from Atlantic mackerel to be toxic to laboratory test mice. Subsequent evidence gathered by the Center and other organizations has now implicated the consumption of mackerel containing paralytic shellfish toxins in the whale deaths.

Relatively low levels of toxicity were found in all mackerel liver extracts from samples collected within the western Atlantic range of this species (i.e., from Northumberland Strait in the Gulf of St. Lawrence to the Mid-Atlantic region). Mean toxicity levels were 185 μg of toxin per 100 g of liver, with up to 446 μg/100 g present in some samples. Interestingly, scientists found toxicity levels of 60 μg/100 g in liver extract from mackerel stomachs collected off Nantucket Island as long ago as April 1986. It is emphasized, however, that there is no danger to human consumption of mackerel as no toxicity has been detected in the muscle tissue, the edible portion.

No toxicity has been detected in the livers of other whale prey species such as Atlantic herring and silver hake (whiting), nor in the liver of goosefish (monkfish). Stomach contents of one whale—consisting mostly of bones—were tested and found to be only mildly toxic, causing delayed death of mice.

Baseline Established for 12-Mile Dumpsite

The NMFS Northeast Fisheries Center has now completed the first year and a half of sampling at the New York Bight's 12-Mile Dumpsite. The sampling to date has been designed to establish a baseline for determining the effects—primarily biological—of ending sewage-sludge dumping at the site. (The last dumping was in December 1987.)

With a year and a half of sampling completed, scientists can now begin to compare any seasonal trends. During the November survey of three stations, chosen to represent impacted, enriched, and less polluted habitats, some trends persisted from autumn 1986 to autumn 1987. The dominant bottom fishes were little skate (75 percent of the weight tow in 1986; 50 percent in 1987) and winter founder (19 percent in 1986; 15 percent in 1987). At the "impacted" station, the average weight per tow for all bottom fishes increased from 22 to 40 pounds. The dominant crustaceans were rock and horseshoe crabs which ranked first and second, respectively, in weight per tow for both 1986 and 1987. At all three stations though, the weight per tow decreased for both species between the two years.

These early comparisons, however, do not statistically indicate that any rapid significant shift from crustaceans to fishes has occurred. Continued sampling will be necessary to determine if any changes in the biological community in and around the site are related to the ending of sewage-sludge dumping.

Scientists Studying Seafloor Megaplumes

National Oceanic and Atmospheric Administration (NOAA) scientists are studying the origins of a geological process that sends massive amounts of hot fluids into the ocean from cracks in the seafloor. Called megaplumes, the rich, hot soup of mineral grains and dissolved minerals and gases can be miles wide and may have a major influence on ocean chemistry, according to Edward T. Baker of NOAA's Pacific Marine Environmental Laboratory in Seattle, Wash. The Commerce Department scientist said the process, caused by tectonic or volcanic activity suggests a geologic activity different from that which causes the continuous leaking of hot fluid from seafloor thermal vents.

The existence of the process was suggested a year ago when researchers aboard a NOAA ship, investigating seafloor venting along the Juan de Fuca Ridge off the Washington and Oregon coasts, discovered a huge, circular plume of hot water floating deep in the ocean. It was about 10-12 miles in diameter and more than a quarter-mile deep. Last September, again over the Ridge, investigators found a recurrence of megaplume activity.

"It closely resembled the original megaplume, formed by the expulsion over a period of a few days of hundred of millions of tons of superheated seawater from seafloor cracks," Baker said. Since September, he and colleagues Gary Massoth and Richard Feely have analyzed samples from the megaplume, finding them rich in silica, manganese, and iron leached by hot seawater from rocks in the ocean crust. They believe the phenomenon could be common in ocean areas where the seafloor is similar to that of the Pacific ridge.

Juan de Fuca Ridge is a seafloor spreading center where lava from the earth's core rises to form a new ocean crust as the North American and Pacific crustal plates separate. This seafloor spreading creates slow, steady venting of superheated seawater at many locations in the area. The program, called Vents, has studied the phenomenon for 3 years to understand its effect on ocean chemistry. The program operates at the Hatfield-Oregon State University Marine Science Center in Newport, Oreg.

1986-1987 Warmest Years Since 1953

The years 1986 and 1987 were the warmest two years in the contiguous 48 states since 1953, with only three fractionally warmer years this century (1934, 1931, and 1921), according to scorekeepers at the National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center (NCDC), Asheville, N.C. Average annual temperature for the two years was 54°F. Back-to-back warm years last occurred in 1953-54, with average temperatures of 54.7 and 53.9 degrees. The spring of 1986 was warm throughout the 48 contiguous states. The warmth of 1987 was especially noteworthy during the winter of 1986-87 and the spring of 1987 in the north central portions of the country, the Commerce Department agency reports.

	Winter 1985-86	Spring 1986	Summer 1986	Fall 1986
W	2nd warmest	7th warmest	12th warmest	21st coldest
NW	41st coldest	11th warmest	6th warmest	41st coldest
SW	4th warmest	4th warmest	22nd warmest	24th coldest
WNC	22nd warmest	4th warmest	18th warmest	20th coldest
S	25th warmest	7th warmest	42rd warmest	42nd coldest
ENC	24th coldest	5th warmest	37th coldest	22nd coldest
C	27 coldest	9th warmest	40th warmest	39th warmest
SE	40th coldest	36th warmest	9th warmest	8th warmest
NE	37th coldest	6th warmest	15th coldest	17th coldest
	Winter 1986-87	**Spring 1987**	**Summer 1987**	**Fall 1987**
W	40th warmest	5th warmest	42nd warmest	3rd warmest
NW	28th warmest	4th warmest	30th warmest	2nd warmest
SW	36th warmest	28 warmest	42nd coldest	24th warmest
WNC	the warmest	3rd warmest	35th warmest	12th warmest
S	35th warmest	42rd coldest	36th coldest	27th coldest
ENC	the warmest	2nd warmest	9th warmest	45th warmest
C	25th warmest	7th warmest	13th warmest	27th coldest
SE	41st coldest	33rd coldest	7th warmest	12th coldest
NE	42nd warmest	9th warmest	25th warmest	22nd coldest

Following is a breakdown by regions comparing each season of the recent two-year period with NCDC's records going back to 1895. Regions consist of the following states: West (W) = California and Nevada; Northwest (NW) = Idaho, Oregon, and Washington; Southwest (SW) = Arizona, Colorado, New Mexico, and Utah; West North Central (WNC) = Montana, North Dakota, Nebraska, South Dakota, and Wyoming; and South (S) = Arkansas, Kansas, Louisiana, Mississippi, Oklahoma, and Texas; East North Central (ENC) = Iowa, Michigan, Minnesota, and Wisconsin; Central (C) = Illinois, Indiana, Kentucky, Missouri, Tennessee, West Virginia, and Ohio; Southeast (SE) = Alabama, Georgia, Florida, North Carolina, South Carolina, and Virginia; and Northeast (NE) = Connecticut, Delaware, Massachusetts, Maryland, New Hampshire, New York, Pennsylvania, Rhode Island, Vermont, Maine, and New Jersey.

Seasons are defined as: Winter = December, January, and February; Spring = March, April, and May; Summer = June, July, August; Fall = September, October, and November.

Crab Analog Made From Pacific Whiting Surimi

The Utilization Research Division of the NMFS Northwest and Alaska Fisheries Center reports that it has successfully processed crab analog using Pacific whiting surimi. The surimi was produced during August and October 1987 using ocean-caught fish, and was processed into the analog in a production run at a commercial plan in January 1988. Successful production of the crab analog was made possible by the

incorporation of an inhibitor for the protease enzyme(s) present in Pacific whiting parasitized by the myxosporean *Kudoa* sp. The run of analog in the commercial plant consisted of 100 percent Pacific whiting surimi. No processing problems were encountered in any of the production steps.

Acceptability of the finished product is comparable to product prepared from Alaska pollock surimi. The product has been served to several groups familiar with the technical properties of surimi and analog products. One of these groups was the Pacific Fisheries Technologists at the annual meeting in February 1988. Without exception, everyone that tasted the product agreed that it is excellent and completely acceptable. This demonstrates the feasibility of using Pacific whiting for surimi from which crab analogs and similar type products can be fabricated.

A common method of measuring the quality of surimi for use in analog preparation is to determine gel strength of kamaboko prepared from the surimi. The gel strengths of kamaboko prepared from the two lots of surimi used in this commercial run were as follows:

	Gel strength	
Pacific whiting surimi lot	Control (no inhibitor)	Inhibitor added
August 1987	82.3	763.8
October 1987	36.0	722.3

The effect of inhibitor addition is obvious. The gel strength is increased 10 times or more. A gel strength of about 650 is needed to make a high quality analog product.

Yellowfin, Bigeye Tuna Tagging Program Underway

A forward-looking group of U.S. east coast sportfishermen, charter boat captains, and sportfishing clubs have joined leading tackle manufacturers, fishing journals, and outdoor writers in an ambitious tag-and-release program for yellowfin and bigeye tuna. This alliance has volunteered over $50,000 worth of prizes, incentives, and awards to anglers who tag and release yellowfin or bigeye tuna taken on rod and reel between 1 March and 1 December 1988.

The tags, which are being distributed through leading saltwater tackle stores that serve tuna fishermen, have been provided through the NMFS Cooperative Game Fish Tagging Program, with the costs underwritten by the tackle manufacturers. Named "Tag A Tuna For Tomorrow," this is an excellent example of government, industry, and the angling public cooperating to promote conservation of an important fishery resource.

Midwest Sends Less Nitrogen to Northeast Than Earlier Believed

The Midwest produces much less of the acidic nitrogen falling on the northeastern United States and Canada than is commonly believed, a computer simulation conducted by the Commerce Department's National Oceanic and Atmospheric Administration (NOAA) shows. More than half of the estimated 1.4 million tons of the material deposited annually in the Northeast comes from sources within the region, the simulation of the transport and deposition of acidic nitrogen concluded. It was conducted in two parts by Hiram Levy II and Walter J. Moxim of NOAA's Geophysical Fluid Dynamics Laboratory in Princeton, N.J.

The first portion of the study showed that 25-30 percent of known nitrogen emissions from auto exhausts and smokestacks in the United States are deposited on North America in rain and snow, as "acid rain," and between 25 and 50 percent in dry fall-out. Government monitoring networks support this finding, indicating that approximately half of the total acidic nitrogen falling on the United States and Canada comes from dry deposits.

In a second series of simulations, Levy and Moxim eliminated from the computer model all emissions of nitrogen oxides from sources outside of the northeastern U.S. and eastern Canada. They then compared the resulting wet and dry deposits in the Northeast with the earlier model. This revealed that about two-thirds of the nitrogen oxides deposited in the Northeast in precipitation came from outside the region, while 80 percent of the nitrogen oxides deposited through dry fall-out and about half the total acidic deposits falling on the northeast were emitted from sources within the region.

Based on the model results, the NOAA investigators, in a paper published in *Nature*, concluded that current monitoring in the northeastern United States and Canada exaggerates the role of acid nitrogen transport from the Midwest, Southeast, and the Ohio Valley, and underestimates the importance of local and regional emissions. The project also showed that emissions remaining in the atmosphere, after both wet and dry deposition, are carried off the continent, principally over the North Atlantic. The model indicates that no more than 200,000 tons of acidic nitrogen from North America reach Europe annually—less than 3 percent of the estimated European emissions of nitrogen oxides.

New Data Center Helps Assess Global Climate

The University of Delaware and the National Oceanic and Atmospheric Administration (NOAA) has announced the creation of a new Joint Center for Research in the Management of Oceanographic Data to be headquartered at Lewes, Delaware. "This cooperative endeavor will help discover the answers to global climate change and related regional oceanographic problems, such as sea level rise, along the east coast," according to Thomas N. Pyke, Jr., NOAA Assistant Administrator for Satellite and Information Services.

The new center has been established at the University's College of Marine Studies at Lewes as a clearinghouse for oceanographic data. It will manage the enormous amounts of oceanographic data available for U.S. east coast areas. The center, dedicated 5 May, will process data generated from NOAA's environmental satellites, which keep a watchful eye on many of the oceans characteristics, including surface temperature and the currents that transport pollutants along the coast.

Recent Trends in World Fish Harvests

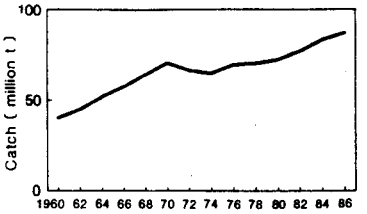


Figure 1.—World fisheries catch, 1960-86.

The world catch of fish, shellfish, and other aquatic organisms reached an all-time record of nearly 90 million metric tons (t) in 1986, according to a preliminary estimate prepared by the Food and Agriculture Organization (FAO) of the United Nations (UN). The estimated 1986 catch was a 5 percent increase over the previous record catch of 85.5 million t set in 1986.[1,2] Despite warnings from environmentalists concerned with rising levels of pollution, fishermen, are continuing to report increasing fishery catches. Since 1980, the world fisheries catch has increased an impressive 25 percent. Developing countries are responsible for most of the increased catch.

Preliminary data suggest that efforts by developing countries in the southern hemisphere to expand their fishing industries will result in continued increases through the year 2000, although this could be affected by a wide variety of economic and climatic factors. The 1986 increase was primarily due to the expanded Asian and, to a lesser extent, Latin American catches. Nearly 40 percent of the total world catch is taken by Asian countries, including Japan, which dominate the world fishing industry. The most rapidly growing catch, however, is in Latin America, where fishery catches have increased by 60 percent since 1980.

Catch Increases

The world fisheries catch has grown steadily since 1980. Annual increases have ranged from a high of 7.9 percent in 1984 to a low of 0.6 percent in 1983 (Table 1). The small 1983 increase was primarily caused by the effects of both the 1982-83 El Niño event in the Eastern Pacific and sharp price increases for fuel. Some observers suggested that the world fisheries catch was leveling off at about 70 million tons in the early 1970's (Fig. 1). The collapse of the Peruvian anchovy fishery in 1971-72 did cause overall world catches to decline during the early 1970's. The predictions, however, that the world catch had reached its maximum potential of conventional species proved erroneous. The expected leveling off did not materialize, and the world catch has expanded continuously since 1977.

The average annual increase during the 1980's was 3.3 percent. The catch since the 1982-83 El Niño has been well above that average level, suggesting that the expansion of the world catch has not yet begun to level off. The increases since 1982 have come mostly from developing countries, and have been achieved even though many countries, especially in Latin America, have had to scale back government-financed fishery development programs as a result of the world debt crisis. Many developing countries have benefited from commercial joint venture arrangements with distant-water fishing companies which in many cases have limited opportunities in their local fisheries and, as a result, have maintained their involvement in overseas fisheries.

Table 1.—Annual world fish catch increases, 1980-86.

Year	Catch (million metric tons)	Percent increase
1980	72.1	1.4
1981	74.9	3.9
1982	76.8	2.5
1983	77.3	0.6
1984	83.4	7.9
1985	85.5	2.5
1986	89.6	4.8
Average		3.4

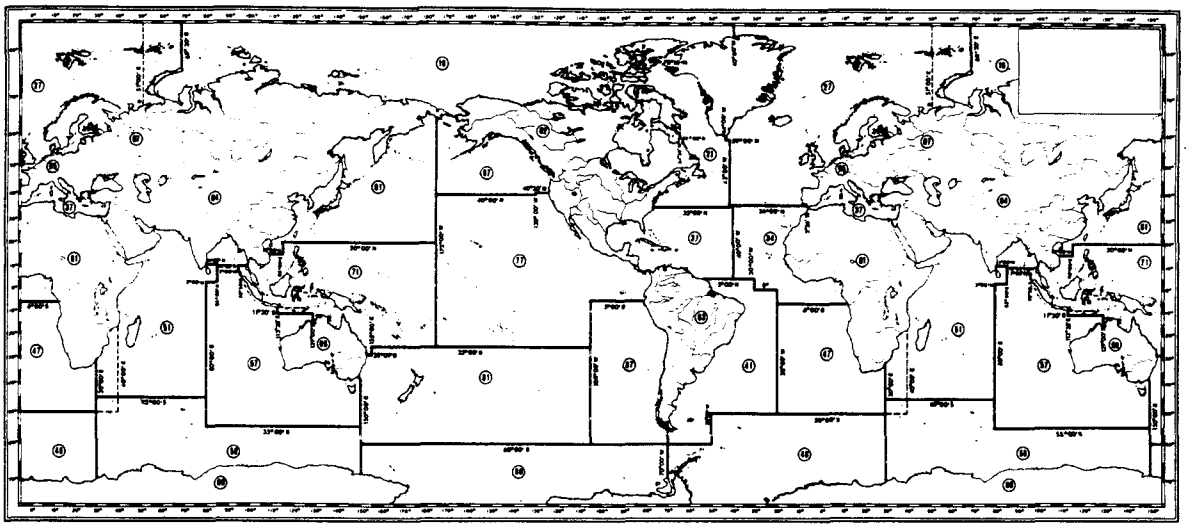
Source: FAO "Yearbook of Fishery statistics."

The NMFS Branch of Foreign Fisheries Analysis has prepared this article based on the quantity of fish and shellfish harvested. Some of the conclusions based on catch trends would be radically different if the value of the catch was calculated. The Branch, however, has decided to deal only with the quantities involved.

This decision is based on several factors. First, the collection and assessment of value data is a much more difficult undertaking, and would require a research effort that cannot at this time be justified. Second, value data includes many nonfishery components such as prices, interest rates, and exchange rates. As a result, such a study would often show fluctuations because of a number of economic factors other than developments in the fishing industry.

[1]This report was prepared as a combined effort of the NMFS Branch of Foreign Fisheries Analysis. Dennis Weidner coordinated the project and was responsible for the world trend and Latin American sections. Other contributors included: Milan Kravanja (Soviet and Eastern European sections), Paul Niemeier (Asian, Oceanian, Japanese, and Chinese sections), William Folsom and Michelle Miller (Western Euopean section), Melissa Zajk (Canadian section), and Steve Wilkshire (African section). It is based on preliminary FAO data available in mid 1987. More recent FAO estimates suggest that the 1986 catch may have hit nearly 91.5 million tons.

[2]For the purpose of this study, the Branch had adopted the widely accepted FAO statistical conventions. Catch data is attributed to the flag of the fishing vessels harvesting the fish and not by the national coastal zone in which it was harvested. Thus, Soviet catches off the coast of Angola are considered Soviet and not Angolan catches. The primary source used for these statistics is the FAO, which in turn relies on each individual country to supply national data. The year 1980 was selected as the base year to focus this report on recent catch developments and to limit the amount of statistical data assessed. As appropriate, the authors have referred back beyond 1980 to explain important longer-term trends.



Major FAO fishing areas.

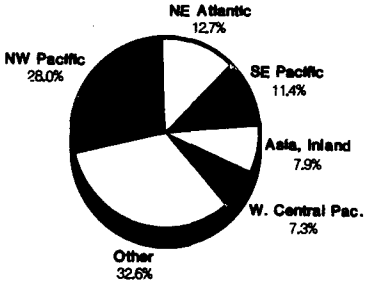


Figure 2.—World fisheries catch by fishing area, 1985.

Table 2.—World fisheries catch, by principal fishing areas, 1985-86.

Region	FAO fishing area	Catch (10^6 t) 1985	1986	1986 Percentage
Northwest Pacific	61	23.8	24.1	27
Northeast Atlantic	27	10.9	10.8	12
Southeast Pacific	87	9.7	11.9	13
Asia, Inland	04	7.1	7.1	8
W. Cent. Pacific	71	6.2	6.5	7
Others		27.7	29.2	33
Total		84.9[1]	89.6	100

[1]This world 1985 catch figure has been updated by FAO to 85.5 million t (Table 1). The updated figure, however, was not used here as the revised breakdown by FAO area was not yet available.

Table 3.—World fisheries catch by major species, 1985-86.

Species	Catch (10^6 t) 1985	1986	1986 Percentage
Alaska pollock	6.1	6.6	7
Peruvian anchovy	1.0	5.1	6
Japanese sardine	4.7	4.6[1]	5
South American sardine	5.8	4.3	5
Capelin	2.3	2.2	2
Atlantic cod	1.9	1.9	2
Chilean jack mackerel	2.1	1.8	2
Chub mackerel	1.8	1.8	2
Atlantic herring	1.4	1.4	2
Other	57.8	57.0	
Totals	84.9[2]	89.6	

[1]Estimated
[2]This catch figure, published in the FAO "Yearbook of Fisheries Statistics," 1985, has been updated by the FAO to 85.5 million t (Table 1). The updated figure, however, was not used here as the revised breakdown by FAO species group was not yet available.

For these and other reasons the authors have decided to focus this discussion primarily on catch trends. Readers should, however, be aware of the limitations of the data and conclusions presented in this report.

Fishing Areas

The world fisheries catch comes from three main geographic areas (Fig. 2). The two most important areas are located in the northern hemisphere: the Northwest Pacific, FAO area 61, and the North Atlantic, FAO area 27 (see map). Fishermen took about 34.6 million t of fish and shellfish from these two areas during 1985, over 40 percent of the world total and over 45 percent of total marine catch (Table 2)[3]. Both areas have large continental shelves supporting important fishery stocks, but their domination of world fisheries is also due to the fact that most of the major developed fishing countries (Japan, the U.S.S.R., China, the United States, South Korea (ROK), Norway, Denmark, Iceland, and Canada) are located in the two regions. The third major fishing area is the Southeast Pacific (FAO area 87), where coastal upwelling supports the massive fisheries for small pelagics off of Chile and Peru.

[3]The 1986 catch by area was not available when this article was written, but the basic pattern is unlikely to change significantly. The FAO data on which this article is based is catch data recorded by the flag of the vessel which caught it and can differ substantially from the area where it is eventually landed.

Species of Fish

Only about eight species are caught in quantities exceeding 1.0 million tons annually (Table 3). The world's single largest fishery in terms of quantity is Alaska pollock, *Theragra chalcogram-*

Table 4.—World catch by major FAO species group, 1980-86.

Name	FAO species group no.	Catch (10^6 t)						
		1980	1981	1982	1983	1984	1985	1986[1]
Small pelagics	35	15.5	17.0	17.9	17.6	19.7	21.2	
Cods	32	10.8	10.7	11.0	11.2	12.3	12.4	
Jacks/mullets	34	7.3	6.0	7.6	6.0	6.5	6.0	
Misc. freshwater[2]	13	5.2	5.5	5.7	6.2	6.5	7.2	
Redfishes	33	5.4	5.3	5.4	5.0	5.5	5.3	
Mackerels/snooks	37	4.6	4.0	3.8	3.7	4.3	3.7	
Tunas	36	2.6	2.7	2.8	2.9	3.1	3.2	
Shrimp	45	1.7	1.6	1.7	1.8	1.8	1.9	
Others, combined		19.0	20.0	20.7	20.9	21.4	22.0	
Total[3]		72.1	74.8	76.8	77.3	83.1[4]	84.9[4]	89.6

[1]Species group data not available.
[2]Does not include other freshwater species groups: Carps (group 11), tilapias (12), and sturgeons (21); the combined total of these three groups in 1985 was 1.3 million t.
[3]Totals may not agree due to rounding.
[4]These world 1984 and 1986 catch totals have been updated to 83.4 million t and 85.5 million t, respectively in Table 6, but are not to be used here as the revised breakdown by FAO species group was not available.

Table 5.—World catch increase of major species groups, 1980-85.

Name	FAO species group	Changes 1980-85	
		Amt. (10^6 t)	Percent
Small pelagics	35	5.7	45
Other (unspecified)		3.0	23
Misc. freshwater	13	2.0	16
Cods	32	1.6	12
Jacks/mullets	34	0.7	5
Tunas	36	0.6	5
Shrimps	45	0.2	2
Redfishes	33	−0.1	−1
Mackerels/snooks	37	−0.9	−7
Total		12.8	18

ma, and reported catches of that species totaled 6.6 million t in 1986. Most of the fisheries for these important species were little changed in 1986. The only major shift was a massive increase in the Peruvian anchovy fishery. Fishermen from Peru and Chile reported a 1986 catch of 5.1 million t, more than a 400 percent increase from the 1.0 million t reported in 1985.

North Pacific pollock fishermen reported the only other significant increase (+0.5 million t). Peruvian and Chilean fishermen reported the largest declines, in the sardine (−1.5 million t) and jack mackerel (−0.3 million t) fisheries.

The world catch is composed primarily of three species groups: Small pelagics, cods, and jacks, which had a combined catch of over 40 percent of the world catch for all species in 1985 (Table 4). The single most important group is small pelagics (anchovies, herrings, sardines, etc.) and catches of that group totaled 21.2 million t, nearly 25 percent of the world total for all species. About half of the increase in the world catch since 1980 has resulted from increased catches of these small pelagic species (Table 5). Other important increases were reported for various other marine fish and shellfish (up 23 percent), miscellaneous freshwater fish (up 16 percent), and cods (up 13 percent).

The massive increases of small pelagics is significant because the expansion of these fisheries means that the increase of the world catch has not resulted in a corresponding increase in the production of edible commodities. A large portion of the small pelagic catch is reduced to fishmeal, used principally for animal feed[4]. Catches of all major species groups used for edible products have been increasing at very low rates or have actually declined (Table 5)[5]. It should also be noted that small pelagic fisheries are subject to sharp annual fluctuations. Overall fluctuations may be less likely in the 1980's as fishing effort is now divided over a number of different stocks. In the early 1970's, small pelagic fisheries were centered on a single species, the Peruvian anchovy. The catch of Peruvian anchovy in 1970 was 13.1 million t, 60 percent of the world small pelagic catch of 21.4 million t. Obviously, significant changes in that stock had a major impact on the total world catch of small pelagic species. Catches are now more widely diversified over several different stocks in different areas. The most important small pelagic taken in 1985 was South American sardine, but its catch of 5.8 million t was only 27 percent of the 21.2 million t of small pelagics taken worldwide. Various small pelagic species react differently to climatic changes. Thus, while Peruvian anchovy declined after the 1972 El Niño, stocks of sardine and mackerel increased. Thus, when stocks are more diversified, fluctuations of one species may, to some extent, be offset by countervailing fluctuations of other species.

Developed and Developing Countries

A major shift occurred in the harvest of world fishery resources during the 1980's. Developing countries replaced developed countries as the principal world harvesters of fishery stocks (Fig. 3)[6]. The developed countries have traditionally dominated world fisheries. In 1980, developed countries reported a catch of 38.4 million t, or 53 percent of the world total (Table 6). Since 1980, the developed countries have reported only a modest catch increase of 12 percent to 42.9 million t in 1986. The combined effect of overfishing in the coastal waters of developed countries (primarily in the North Atlantic and North Pacific) and the increasing restrictions, placed by developing countries on distant-water fishermen have limited the recent catch

[4]Eventually, of course, most of the animals are slaughtered for human consumption, so even fishmeal production does increase food production. The increase of poultry and livestock produced, however, will only be a fraction of the amount of fish used to produce the fishmeal.
[5]Cods are the only major species group used primarily for direct human consumption that has increased more than 5 percent since 1980.
[6]The FAO's definition of developed and developing countries is used. The FAO breakdown is detailed in Table A-5 of the 1985 "Yearbook of Fishery Statistics." Data submitted by some developing countries should be considered rough estimates as they are often computed without an extensive data collection system.

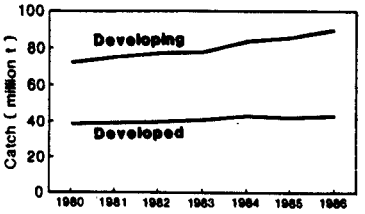


Figure 3.—Fisheries catch by type of country, 1980-86.

Table 6.—World fisheries catch, by type of economy[1], 1980-86.

Year	Catch (10^6 t) Developed	Underdeveloped	Total
1980	38.4	33.8	72.1
1981	39.0	35.8	74.9
1982	39.4	37.4	76.8
1983	40.4	36.9	77.3
1984	42.7	40.7	83.4
1985	41.9	43.6	85.5
1986	42.9	46.7	89.6

[1]Developed and developing countries are identified in Table A5 of the 1986 edition of the FAO "Yearbook of Fishery Statistics."

Table 7.—Catch and industry data for major fishing countries, 1986.

Country	Catch Amt. (10^6 t)	Share[1]	Type of Industry
Japan	11.9	13%	Private
U.S.S.R.	11.1	12	State owned
China	7.3	8	State owned
Chile	5.6	6	Private
Peru	5.3	6	Mixed
United States	4.9	5	Private
Korea (ROK)	3.1	3	Private
India	2.8	3	Private
Indonesia	2.5	3	Private
Thailand	2.1	2	Private
Norway	1.9	2	Private
Philippines	1.9	2	Private
Denmark	1.8	2	Private
Korea (DPRK)	1.7	2	State owned
Iceland	1.6	2	Private
Canada	1.5	2	Private
Other	22.6	25	
Total	89.6		

[1]Percentage of the total world catch.

Table 8.—World fisheries catch of major fishing countries by economic organization, 1986.

Type of Industry	Catch[1] (10^6 t)	Percentage
Private	41.6	62
State owned	20.1	30
Mixed	5.3	8
Total	67.0	100

[1]Only the catch of the major fishing countries detailed in Table 9 are computed in this table. These countries represent about 75 percent of the world catch.

increases of the developed countries. Developing countries, on the other hand, achieved a catch of 46.7 million t by 1986, or 52 percent of the world total. The 1986 catch of the developing countries was nearly 40 percent over 1980 levels. (From 1967 to 1971 the total catch of the developing countries increased sharply because of massive catches of Peruvian anchovy.) The steadily expanding catch of Chile and Peru and the rapidly expanding fisheries of several developing Asian countries account for most of the increase. Many developing countries, however, have not participated in this expansion. Few African countries, for example, have increased their catch since 1980, even though fish is a critical component of the diet in many of them.

Type of Industry

The economic organization of the major fishing countries varies sharply (Table 7). The two leading countries are classic examples of private (Japan) and state-owned (Soviet Union) fishing industries. Japan's fishing industry is the most modern in the world, efficiently providing food and jobs to Japan as well as tax revenues to the Government. In recent years, however, the Government has increasingly funded programs to assist Japanese fishermen adjusting to the ever tightening restrictions on distant-water fishing. The Soviet fishing industry, only slightly less productive than the Japanese, is markedly less efficient.

A rough estimate of the relative efficiencies of the two countries can be obtained by comparing their fleets. The Soviets, in 1986, reported a fleet of 2,800 fishing vessels totaling 3.7 million gross tons. The Japanese, on the other hand, exceeded the Soviet catch with a much smaller fleet, about 2,700 vessels totaling only 0.9 million gross tons. Precise data are not available on the profitability of the Soviet fishing industry, but it is widely believed that the real cost of the fish produced by the Soviets could not be justified by market-based prices. (An accurate comparison of the two countries would require a much more detailed assessment including differences in fleet deployment, target species, operating costs, markets served, and many other factors.)

The predominant pattern for fishing industries is private companies. Of the 16 leading countries in 1986, 11 with over 60 percent of the world catch had basically privately owned industries (Tables 7, 8). Three countries with 30 percent of the catch had state-owned industries. Only one major fishing country (Peru) had a mixed fisheries economy with ownership by both private and state-owned companies.

Pollution

Environmentalists warn that increasing levels of pollution may adversely affect fisheries production. The United Nations Environmental Program (UNEP) has attempted to address the oceanic pollution problem through its Regional Seas Program, but most observers continue to report rising levels of pollution in the world's oceans. Some small fisheries have been impaired, especially freshwater fisheries and estuarine-dependent coastal fisheries. Marine debris, especially "persistent" plastic materials, is causing increasing mortalities of several marine mammals, sea turtles, birds, and other marine life. Environmentalists, however, have not yet compiled conclusive evidence to substantiate their concerns regarding damage to the major marine fish stocks such as Alaska pollock, capelin, Japanese or Chilean sardine (FAO refers to some sardines as pilchards), or others as a result of marine pollution.

The world fisheries catch has expanded during the 1970's and 1980's despite increasing levels of pollution. Increases have been reported even in heavily polluted areas. For example, the Mediterranean is probably the FAO area most heavily polluted, but catches there

increased from 1.6 million t in 1980 to 1.9 million t in 1985. Some observers warn that pollution is affecting fish stocks, but the impact, if any, has so far been masked by other factors. Fish stock abundance has apparently been affected less profoundly by pollution than the combined effects of increasing fishing effort and climatic variations. The effects of these two variables may be masking the more limited impact of pollution on important marine stocks. Considerable caution should be used in using global catch statistics to assess the impact of pollution. Most of the increased fisheries catch since 1980 has come from a small number of small pelagic stocks (Table 5). A thorough examination of the pollution problem would have to assess possible impact on the much larger number of traditional species for which catches have increased only marginally despite substantially increased fishing effort (Table 5).

While scientists have yet to prove that substantial declines in catches of major marine species have been caused by pollution, there is mounting evidence that some marine stocks are being affected. While the catch of cods as a group has increased since 1980 (Table 4), scientists are increasingly concerned over Atlantic cod (Table 3). Atlantic cod catches have declined from 2.2 million t in 1980 to only 1.9 million t in 1985.

Pollution does result in the contamination of some fishery resources. However, concerns over product safety are for the most part limited to freshwater fish and marine or near-coastal species subject to incidental exposure to industrial and agricultural chemicals such as PCB's and pesticides. It should be noted also that many of the species likely to be affected are caught by recreational fishermen and may not be of major commercial importance. Individual countries vary in the extent to which they are alert to these problems. Some countries provide effective consumer protection through the issuance of public health advisories and, if judged necessary, by closure of selected fisheries. Action levels for specific contaminants are set with the added insurance of large safety factors, usually several orders of magnitude.

Table 9.—World fisheries catch by regions, 1980-86.

Region	Catch (10^6 t)							Percent increase
	1980	1981	1982	1983	1984	1985	1986	1980-86
Asia	30.1	31.5	32.3	34.0	36.0	36.7	38.2	27
Latin America	9.6	10.3	11.4	9.2	12.0	13.6	15.6	62
Europe	12.5	12.5	12.2	12.6	12.9	12.6	12.3	-2
U.S.S.R.	9.5	9.6	10.0	9.8	10.6	10.5	11.1	17
North America	5.1	5.3	5.5	5.7	6.2	6.3	6.6	29
Africa	4.1	4.3	4.1	4.4	4.1	4.1	4.2	2
Middle East	0.8	0.9	0.9	1.0	1.0	1.0	1.0	25
Oceania	0.5	0.5	0.5	0.6	0.6	0.6	0.6	20
Total[1]	72.1	74.9	78.8	77.3	83.4	85.5	89.6	24

[1]Totals may not agree because of rounding.

Geographic Regions

The world fisheries catch is dominated by Asian[7] fisheries (Table 9). Asian fishermen caught 38.2 million t of fish and shellfish in 1986, nearly 40 percent of the total world catch (Fig. 4). The most rapidly growing area, however, is Latin America, and catches in that region, especially in the Pacific, have grown over 60 percent since 1980 (Table 9a), primarily because of steadily increasing catches of small pelagic species by Chile, Peru, and Ecuador. Major developments in each of the important world fishing regions are given below.

Table 9a.—World fisheries catch increase, 1980-86.

Region	Percent increase (1980-86)	Region	Percent increase (1980-86)
Latin America	62	U.S.S.R.	17
North America	29	Africa	2
Asia	27	Europe	-2
Middle East	25		
Oceania	20	World average	24

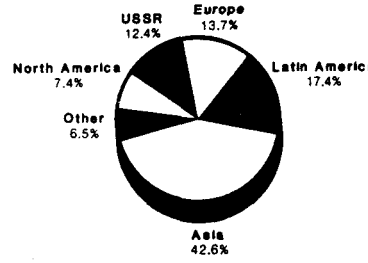


Figure 4.—World fisheries catch by region, 1986; total for 1986 was 89.6 million t.

Asia

Asian countries dominate the world fishing industry, accounting for over 40 percent of the total world catch in 1986 (Table 9). The Asian catch increased by 4 percent over the 1985 catch and has increased by over 25 percent since 1980. One of the most significant developments in Asia during the 1980's has been the steady increase of important aquaculture industries. At first, farmers in developing countries targeted low-valued species for local consumption, but many others increased the production of high-valued species for luxury markets. The most spectacular development has been the massive expansion of the pond-shrimp industry. The Branch estimates that Asian shrimp farmers harvested about 260,000 t of shrimp in 1986, nearly a 400 percent increase from the 55,000 t harvested as recently as 1982. The leading shrimp farming countries

[7]The Branch has chosen to assess fishery catch developments by continent because of interest in national developments. Such an analysis, however, is not a good way of organizing biological trends, especially for regions such as Asia and Latin America which have coasts spanning two or more oceans. An assessment by ocean region could provide useful insights, but for the purposes of this study this subject has been addressed only briefly. Note also that the following data is calculated on the basis of the flag of the fishing vessel, and not where the fish was caught. In some regions, especially Africa, the regional catch total would be much higher if the catch of the distant-water countries operating off Africa was added to the regional total.

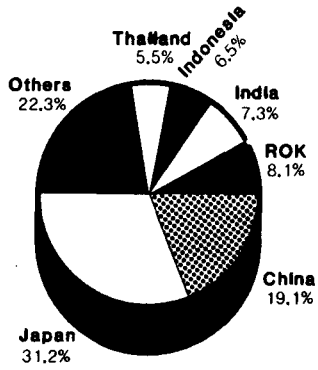


Figure 5.—Asian fisheries catch by country, 1986; total for 1986 was 38.2 million t.

are China, Taiwan, Indonesia, the Philippines, and India.

Japan is the single most important Asian fishing country, but the region's catch is divided among seven other major countries: China, South Korea (ROK), India, Indonesia, Thailand, the Philippines, and North Korea (DPRK) (Fig. 5). Eight of the world's 16 leading fishing countries are Asian (Table 7). These eight countries accounted for 87 percent of the 1986 regional catch. All of these countries, except for Thailand and the Philippines, reported catch increases in 1986. The fishing industry plays a much more important economic role in these countries than is the case for the United States or European countries. In Japan, for example, about half of the animal protein consumed is derived from marine organisms.

Asian countries reported several major developments in 1986. Japan harvested a near record 11.9 million t and reported increased aquaculture production and offshore catches, especially of sardines. China reported steady growth in all sectors of the fishing industry. The 7.9 million t catch increased 7 percent and included impressive increases in marine and freshwater fisheries and aquaculture. Chinese Government officials are projecting a catch of 9 million t by 1990, primarily as the result of increased aquaculture production. The ROK 1986 catch totaled 3.1 million t, an impressive 15 percent increase over 1985 results. Much of the ROK increase was due to the country's expanding U.S. joint venture fishery and entry into the squid fisheries of the North Pacific and Southwest Atlantic. The country's aquaculture industry has also continued to grow steadily.

India's catch of 2.8 million t has changed little since 1984, with most of the marine catch coming from heavily exploited inshore waters. The Indian Government has been trying to promote a deep-sea fishery since 1968, but has had only limited success. Indonesia reported a 1986 catch of 2.5 million t, an increase of 9 percent over the 1985 catch. Indonesia, like India, depends on artisanal fishermen using traditional methods for most of its catch. The 1986 increase was primarily due to the gradual mechanization of the Indonesia fleet, extending its range to more distant coastal fishing grounds. Government officials believe that the country can significantly expand the fisheries catch to as much as 8 million tons.

Thailand and the Philippines both experienced slight declines in 1986. Thai grounds are heavily fished and Thai fishermen are having increasing difficulty maintaining their fisheries off other countries. Filipino fishermen have some of the same problems and may be feeling the effect of using such destructive fishing practices as using dynamite and cyanide. Much of the decline in the Filipino catch is being offset by the steady growth in the country's aquaculture industry.

Latin America

Latin American countries report the world's second most important fisheries catch, representing nearly 20 percent of the world total. Over 80 percent of the Latin American catch is taken in the Pacific. Catches totaled 15.6 million t in 1986, a 15 percent increase over the 13.6 million t taken in 1985. The 15.5 million t total does not include the more than 1.0 million t taken by distant-water countries (primarily the U.S.S.R., Poland, and Japan) off various Latin American countries (primarily Argentina, Chile, and Peru). Latin American catches increased in 1986 to a level approaching the record regional catch levels taken before the collapse of the Peruvian anchovy fishery in 1972.

Two countries, Peru and Chile, dominate Latin American fisheries (Fig. 6). Chile is the leading country with a catch

The Taiwanese Fishing Industry

Taiwan's 1986 fisheries catch totaled a record 1,095,000 t, nearly a 6 percent increase over the 1985 catch of 1,038,000 t. The value of the 1986 catch increased even more (by over 18 percent) to almost $2 billion. The deep-sea fisheries catch, over 45 percent of the total, was nearly 500,000 t. Inshore, coastal, and aquacultural production totaled 276,000 t, 55,000 t, and 266,000 t, respectively.

Taiwan exported 265,000 t of seafood in 1986, valued at $1.2 billion, an increase of 19 percent by quantity and 43 percent by value over 1985 exports. (The large increase in value reflects, in part, the fact that the new Taiwan dollar appreciated by 13 percent against the U.S. dollar in 1986.) Shrimp, eel, and tuna continued to be the three major fishery export commodities, comprising a combined 43 percent by quantity and 76 percent by value of total 1986 fishery exports. Japan was by far the largest purchaser of Taiwan's fishery products, followed by the United States, Australia, Saudi Arabia, Hong Kong, Italy, and the Federal Republic of Germany. The American Institute in Taiwan has prepared a 28-page report on Taiwan's fishing industry in 1986-87 containing a general outline and sections on the fisheries catch, fleet, processing capability, development plans, trade, and international agreements. The report also includes a brief section describing opportunities for U.S. exporters of fishery products and equipment. U.S. companies can obtain a copy of this report for $12.95 plus a $3.00 handling fee (personal check or money order) by ordering report number PB88-209002/GBA from the National Technical Information Service, U.S. Department of Commerce, Springfield, VA 22161.

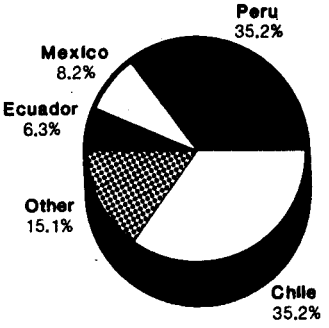


Figure 6.—Latin American fisheries catch by country, 1986; total for 1986 was 15.6 million t.

totaling 5.6 million t in 1986, followed by Peru with a catch of 5.3 million tons. The two countries combined accounted for 70 percent of the regional total. Almost all of the Latin American 1986 increase was the result of increased harvests by these two countries. Over 90 percent of the Chilean and Peruvian catch is sardine, anchovy, jack mackerel, and horse mackerel which is reduced to fishmeal. Peru reported substantially increased anchovy catches in 1986. Anchovy was the mainstay of the Peruvian fishing industry during the 1960's and early 1970's, but had declined to negligible levels in 1985. The Chilean increase was also due to increased anchovy catches, as the sardine and jack mackerel declined. Other important fishing countries in the region include: Mexico (1.3 million t), Ecuador (1.0 million t), Brazil (0.9 million t), and Argentina (0.4 million tons).

A few species dominate the Latin American catch. Latin American countries primarily harvested massive quantities of the reduction species mentioned above. Fishermen also conduct smaller fisheries, but in some cases more valuable ones, for hake, tuna, shrimp, and lobster. A wide variety of other species are caught in smaller quantities.

Several countries reported major fishery developments in 1986. Mexico significantly expanded its tuna industry, and now operates one of the world's most modern tuna fisheries. Ecuador reported record results in its pond shrimp industry which allowed it to become the second most important source of shrimp imported by the United States. Many observers believe that Ecuador may replace Mexico as the major source of U.S. imported shrimp in 1987.

Argentina achieved encouraging results because of a strengthening international market for groundfish, the country's principal fishery, but fishermen reported a declining shrimp catch. Argentine companies complained of increasing competition with the foreign companies operating off the Falklands. The British announced in 1986 that they planned to begin managing fishery resources off the Falklands. Chilean farmers have begun to harvest salmon; while harvests are still small, some observers believe it could develop into an important new fishery. Peru reported a sharp drop in its new scallop fishery, but Panama reported an increase. At the end of 1986, several Eastern Pacific countries began to report a mild El Niño event, but it apparently had little impact on year-end results. The event was centered in waters off Ecuador and northern Peru. Preliminary reports suggested that the 1987 catch of several countries might have been significantly affected.

Europe

European fishermen caught 12.3 million t of fish and shellfish in 1986, making Western Europe the third most important fishing area in the world. European catches, unlike those of many other regions, have remained stable during the past 7 years, ranging from a low of 12.2 million t in 1982 to a high of 12.9 million t in 1984. The major fishing countries are the Scandinavian countries and Spain (Fig. 7).

Eastern Europe

Eastern European countries harvested almost 1.4 million t of fish and shellfish in 1986, or over 35 percent more than in 1970 when the total catch amounted to only 1.0 million tons (Table 10). The most important country is Poland, which harvested 0.6 million t, nearly half of the total for the entire region. The Poles consume about 17 kg per capita of fishery products annually,

Peruvian Fisheries, 1986-87

Peru's 1986 fisheries catch totaled 5.5 million t, a 34 percent increase over the 1985 catch, mostly generated by a 300 percent increase in the anchovy catch. The catch of other major species declined. Fishery exports in 1986 were 780,000 t, an increase of 13 percent, mostly because of increased fish meal production. Fish meal exports accounted for about 8 percent ($200 million) of Peru's total 1986 export earnings. The Peruvian Government, in early 1987, initiated a Fisheries Reactivation Fund aimed at rebuilding the fleet and upgrading the equipment of the artisanal fishermen. The Fund will be financed by a 5 percent tax on the fishmeal exports earnings of the private companies.

The Government plans to increase nontraditional exports, including frozen shrimp and scallops, by making credit available and improving the management of these resources. The Peruvian Government is also promoting domestic consumption of fishery products by creating a state-owned fishing fleet (FLOPESCA) and negotiating joint venture agreements with distantwater-fishing countries. The U.S. Embassy in Lima has prepared an 18-page report reviewing the status of the Peruvian fishing industry in 1986 and 1987. The report covers the 1986 fisheries catch, impact of the fishing industry on the economy, state-owned companies, domestic consumption, modernization of the fleet, fishmeal production, new initiatives (shrimp and scallops), joint ventures (Cuba and the U.S.S.R.), 1987 projections, and implications for U.S. exporters. The report includes statistical tables, with data available up to June 1987. U.S. companies can obtain a copy of the report "Peru: Annual Fisheries Report, 1986-87" for $12.95 and a $3.00 handling fee (total $15.95, personal checks or money orders only) by ordering report PB88-205422/GBA from NTIS, Springfield, VA 22161.

the highest in Eastern Europe. Most of the Polish catch is taken by the country's distant-water fleet which extended its operations in the southern Atlantic.

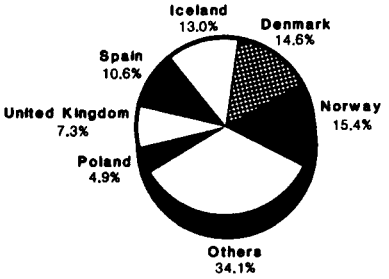


Figure 7.—European fisheries catch by country, 1986; total for 1986 was 12.3 million t.

The Poles currently conduct a major fishery for squid and southern blue whiting off the Falklands.

Bulgaria, East Germany (GDR), and Romania also obtain most of their fisheries catch from distant-water operations. Most of the Eastern European catches peaked in 1975 before the extention of 200-mile zones by many coastal countries. The major exception is Romania, whose catch has more than doubled since 1975. Yugoslavia and Albania, unlike the other Eastern European countries with marine coasts, fish primarily in coastal Adriatic waters. Both countries report only small catches. The isolationist tendency of Albania has discouraged the development of a fishing industry. Landlocked Hungary and Czechoslavakia harvest a

Table 10.—Eastern European fisheries catch, 1970-86.

Country	Catch (10^6 t)					Population in millions (1986)	Consumption (kg per capita)
	1970	1975	1980	1985	1986		
Poland	469.3	800.7	840.6	663.5	645.2	37.2	17.3
Romania	58.6	136.6	173.6	237.6	271.1	22.7	11.9
E. Germany (GDR)	321.8	376.2	235.3	197.7	208.9	16.7	12.5
Bulgaria	95.6	158.1	126.4	100.2	109.2	9.0	12.1
Yugoslavia	46.2	56.6	58.4	75.0	77.6	23.1	3.4
Hungary	26.0	30.8	33.7	36.9	36.1	10.6	3.4
Czechoslovakia	13.4	16.9	16.0	19.8	20.7	15.5	1.3
Albania	4.0[1]	4.0[1]	4.0[1]	4.0[1]	4.0[1]	3.1	1.3
Total	1,034.9	1,579.9	1,288.0	1,354.7	1,372.8	137.9	10.0

[1]Estimated

FRG SEAFOOD MARKET, 1986

The demand for fishery products in the Federal Republic of Germany (FRG) has increased from $1.0 billion in 1985 to $1.5 billion in 1986, and could exceed $2.0 billion by by 1990. German per capita consumption of fishery products rose from 11.8 kg in 1985 to 13.2 kg in 1986 because of greater consumption of frozen fish by private households, institutions, and "fast-food" restaurants. In 1986, frozen fish outsold fresh fish for the first time. Purchases of frozen fish products, particularly frozen fish sticks and fish fillets, are expected to continue and to contribute to growth in the German fish consumption.

Landings by the FRG fleet during 1986 decreased to 201,000 t from 229,000 t in 1985. Fishery landings are expected to decline to 185,000 t by 1990 due to the reduction of the fleet, which now consists of 7 fresh fish trawlers and 5 stern factory trawlers. As a result, imports will continue to supply most of the rapidly increasing German demand for fishery products. Fish and seafood imports in 1987 are expected to reach $1.1 billion compared with $0.6 billion in 1985. Imports of fishery products from the United States amounted to only $8 million in 1986. On the other hand, the United States imported $75 million worth of fishery products from the FRG in 1986. The U.S. Consulate General in Hamburg has prepared a 9-page report reviewing the market for fishery products in the FRG. The report includes statistical tables of landings, trade, and consumption, and lists of trade fairs, trade associations, and trade publications. U.S. companies can obtain a copy of "The Federal Republic of Germany's Seafood Market, 1986" for $9.95 and a $3.00 handling fee (total of $12.95, personal checks or money orders only) by ordering report PB88-114582/GBA from NTIS, Springfield, VA 22161.

Fish Consumption Grows in France

French consumption of fresh, frozen, and otherwise processed fish and shellfish during 1984 increased to some 680,000 t, or 11 kg per household. This 4 percent increase continues an upward trend observed since 1979. Sales of frozen seafood increased by 10 percent, while sales of smoked, dried, or salted seafood rose by 4 percent. Of the total fishery market, whole fresh fish represent over half of sales. Particularly important species are whiting, pollock, cod, hake, and sardines. Traditional methods of marketing fish in France (fishmongers, open markets) have given way to dominance by large supermarkets. During 1984, supermarkets handled more than one-fourth of all the whole fresh fish sold in France and 37 percent of the fresh fillets.

Despite steadily decreasing inflation in France since 1982, the average retail price for fish has increased more than 18 percent from 1984 to 1985, due to higher transportation and storage costs. The U.S. Embassy in Paris has prepared a 9-page report reviewing the French market for fishery products during 1984, including data on sales, pricing, and distribution of seafood. U.S. companies can obtain a copy of "The French Fishing Industry, 1984" for $9.95 and a $3.00 handling fee (total $12.95, personal checks or money orders only) by ordering report PB88-114640/GBA from NTIS, Springfield, VA 22161.

small catch from inland waters and growing fish culture operations.

Western Europe

Increases in catches have taken place mostly in Iceland, the Netherlands, and Ireland, while decreasing in Norway, the Federal Republic of Germany, Spain, and Portugal. The decline in the Western European catch was caused by overfishing, stricter enforcement of regulations in the heavily fished European waters, and the loss of traditional distant-water fishing grounds. Of particular concern to many European nations has been the decline in popular species such as Atlantic cod, saithe, and haddock catches in the North Sea. The discovery of rich squid fishing grounds off the Falkland Islands has helped maintain catch levels for the Spanish fleet, which has been particularly hard-hit in recent years. The European Community (EC) is actively seeking new fishery agreements with developing nations around the world which will permit EC vessels to continue fishing.

U.S.S.R.

The U.S.S.R. is the world's second most important fishing country. The Soviets reported a 1986 catch of 11.1 million t, a 6 percent increase from the 10.5 million t reported in 1985. (This does not include the fish taken by U.S. fishermen and then sold over-the-side to the Soviets. These joint venture purchases provided the Soviets an additional 223,000 t in 1986.) The Soviet Union has invested massively in developing its high-seas fisheries for both economic and strategic reasons.

From a relatively small catch of about 1 million t in the 1920's, Soviet fishermen expanded their operations into all of the world's oceans and harvested over 11 million t of fishery products in 1986 (Table 11). The Soviets first reached the 10 million t harvest in 1975, before most major coastal countries extended their fisheries jurisdiction to 200 miles (Fig. 8). In the years that followed, many coastal fishing countries severely limited (the United States and Canada) or prohibited (the EC) Soviet fishing operations. Soviet fishermen developed a reputation for ruthless exploitation of fishery resources and many coastal countries extended their coastal jurisdiction to 200 miles to protect their coastal resources from Soviet and other distant-water fishermen. As a result, the Soviet fisheries catch decreased by over 11 percent during 1977-78 and did not reach the 10 million t level again until 1984 (Table 11).

The Soviets were much slower than the Japanese in countering the limiting effects of extended jurisdiction by concluding joint-venture and fisheries-assistance agreements. Their state-owned company, Sovrybflot, though ad-

Table 11.—The U.S.S.R. fisheries catch, 1976-86.

Year	Catch (1,000 t)	Change[1] Tonnage	Change[1] Percentage
1976	10,121	157	1.6
1977	9,351	-770	-7.6
1978	9,000	-351	-3.8
1979	9,049	49	0.5
1980	9,476	427	4.7
1981	9,546	70	0.7
1982	9,957	411	4.3
1983	9,757	411	-0.2
1984	10,593	836	8.6
1985	10,523	70	-0.1
1986	11,100	567	5.4
10-Year change		+979	+9.7

[1]Change from previous years, in 1,000 t and percentage.

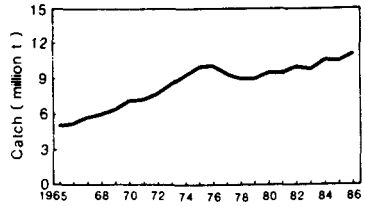


Figure 8.—Soviet Union fisheries catch 1965-86.

Norwegian Salmon Exports

Norwegian fish farmers seem set to break all previous records in farmed salmon exports. Total exports for 1988 could well outstrip last year's figures by as much as US$166 million, according to the Norwegian Information Service, *Norinform*. Production and exports have soared so far this year, and the final export figure for 1988 will be between US$500 and 590 million.

First quarter sales figures showed a first-hand turnover of US$107 million, compared with US$67 million last year. Production in the same quarter was 15,625 tons, against 11,720 million tons in the same period last year. Information officer Odd Ustad in the central sales organisation for fish farmers says that favorable temperatures have stimulated growth, and that the major disease problems appear to be under control. Demand in the markets is high, with France retaining its first place as recipient of Norway's farm salmon.

Norwegians Target Antarctic's Krill

Three Norwegian firms are planning to harvest the bountiful supplies of krill in the Antarctic to sell to the United States, Great Britain, and Japan, according to the Norwegian Information Service. Millions of dollars will be invested in projects which are scheduled to be under way as early as autumn 1988, when giant factory ships will move south to start the fishing.

The high-protein, shrimplike krill can, according to Norwegian sources, be eaten plain, ground into forcemeat, or served as krill "sticks." It can also be used as a coloring matter for other foods such as trout, salmon, and sausages. Furthermore, krill oil, rich in polyunsaturates, could be useful to the pharmaceutical industry, as a possible rival to cod liver oil, Norinform reports. About 200-250 tons of krill per day is believed a realistic target and the Norwegians believe that there will be no danger of depleting the enormous resources for "many years." However, they also warn that if the supplies of krill, the main food of seabirds and whales, were to be threatened, the entire ecological balance of the oceans could be disrupted.

ministered by capable and experienced managers, was saddled with numerous regulations and bureaucratic inefficiencies that are so prevalent in Soviet operations with foreign companies. This may change now that former Minister of Fisheries (V. M. Kamentsev) was appointed by General Secretary Gorbachev to become not only a member of the Soviet Council of Ministers, but also Chairman of the Federal Foreign Economic Commission. In this latter capacity, Kamentsev will oversee and determine the policy of joint ventures with foreign countries and companies.

One important trend in Soviet fisheries since 1980 has been an increasing reliance on coastal waters. Soviet catches in coastal waters (FAO areas 18, 27, and 61) totaled 6.7 million t in 1985, a 30 percent increase over the 5.1 million t reported in 1980. All of the increase has occurred along the Soviet Pacific coast as catches along the heavily fished Atlantic and Barents Sea coast have declined and catches along its northern Arctic coast are negligible. The Soviets have also shifted their fishing industry from the Atlantic to the Pacific (Fig. 9). Soviet fishery harvests (by FAO fishing area) have changed greatly during the last decade. In 1975, the Soviet Atlantic catch (5.0 million t) was more than twice the Pacific catch (2.2 million t). By 1985, this relationship had totally changed and the Soviet Pacific catch, at 6.2 million t was 50 percent larger than the Atlantic catch of 4.1 million t (Table 12).

The Soviet Atlantic catch has decreased in all regions, except the Southeast Atlantic (FAO area 47) off Namibia and Angola where the Soviets operate under the International Commission for Southeast Atlantic Fisheries (ICSEAF) regulations. In the Northwest Atlantic (FAO area 21), the Soviet catch has declined over 1.0 million t between 1975 and 1985 as the United States and Canada extended their fisheries jurisdiction to 200 miles and severely reduced distant-water fishing. In the Northeast Atlantic (FAO area 27) the Soviet catch has declined another 1.2 million t because of declining stocks and the fishing regulations enforced by the European Community (EC) and several

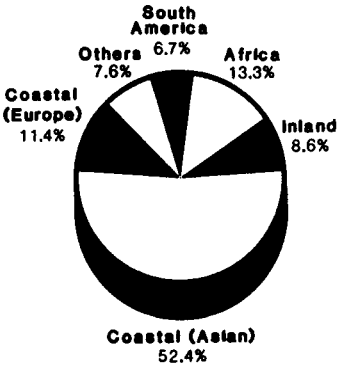


Figure 9.—Soviet Union fisheries catch by area, 1985; total for 1985 was 10.5 million t.

coastal countries. The Soviet fishery in that area is now limited to the Barents Sea and international waters between Iceland and the Svalbard Islands. Worried by a tottering resource base and the Soviet penchant for relentless overfishing, the EC has permitted no Soviet fishing since extending their coastal zone to 200 miles in 1977.

In the Western Central Atlantic (FAO area 31), the Soviet catch has always been small and proved such an economic burden that they abandoned it in 1977. The Soviets, however, retain a vessel repair and transshipment operation in Havana, Cuba. In the Eastern Central Atlantic (FAO area 34), the Soviets conduct one of their most important distant-water operations aided by bilateral agreements with several African countries and by fishing in the coastal waters of several countries with which they have no such agreements. Few African countries have effective surveillance and enforcement capabilities.

In the Pacific, the largest Soviet fishery has historically been conducted off their own coasts and the adjacent waters of the Bering Sea and Northwest Pacific (FAO area 61). The catch in this area has doubled during the past 10 years, but it remains greatly, and possibly dangerously, dependent on a single species, the Alaska pollock. The Soviet pollock catch, amounting to 3.3 million t in 1985, or 30 percent of the entire Soviet catch in that year. It is landed in Siberian ports and then primarily shipped by rail to population centers in the western part of the country where it is marketed to Ryba and other retail stores. Few other Pacific grounds are important to Soviet fishermen, except for the Southeast Pacific where the Soviets fish outside the 200-mile zones of Peru and Chile. Efforts to gain access to coastal waters failed when the Allende Government fell in Chile during 1973 and when the Peruvians refused to renew joint venture agreements in 1985.

In the Antarctic, the Soviets have attempted to initiate a krill fishery, and catches reached a record 0.5 million t in 1982. The operation, however, proved difficult and costly, and Soviets had difficulty marketing krill products. Catches declined sharply in 1983 and in 1985 totaled only 0.2 million tons. The Soviets announced in late 1987 some technical innovations which they believe

Table 12.—U.S.S.R. fisheries catch for selected years by major fishing areas, 1970-85.

Fishing grounds	FAO area	Catch (1,000 t) 1970	1975	1980	1985
Inland waters	7	855	944	753	906
Black Sea	37	303	350	391	345
Atlantic					
Northwest	21	812	1,167	108	133
Northeast	27	1,566	2,406	1,964	1,239
W. Central	31		69		
E. Central	34	613	1,166	942	706
Southwest	41	421	9	28	71
Southeast	47	423	421	825	696
Subtotal		4,993	6,532	5,031	4,100
Indian Ocean					
Western	51			37	32
Eastern	57				1
Subtotal				37	33
Pacific					
Northwest	61	1,448	2,719	3,196	5,462
Northeast	67	748	573	59	11
W. Central	71			4	10
E. Central	77	20	31		1
Southwest	81		45	70	66
Southeast	87			552	624
Subtotal		2,216	3,368	3,881	6,174
Antarctic					
Atlantic	48			424	188
Indian Ocean	58			103	28
Pacific	88				
Subtotal				527	216
Grand total		7,209	9,900	9,476	10,523

Source: FAO "Yearbook of Fishery Statistics," various years.

will make it easier to process krill. If successful, these innovations may justify an increase in Antarctic fishing effort in coming years.

In the Black Sea and inland waters, the Soviet fishery has stagnated. The Soviet Union has the potential to become a major producer of cultured fish, yet inland fisheries and cultured production have actually declined in recent years.

North America

The North American catch totaled 6.6 million t in 1986, a 5 percent increase over the 6.3 million reported in 1985. Data on the U.S. and Canadian fish catch are illustrated in Figure 10. Geographically, Mexico is located on the North American continent, but for sociological reasons, the Mexican catch has been included in the Latin American totals.

United States

The U.S. fish catch hit 4.9 million t in 1986, a 2 percent increase from the 4.8 million t reported in 1985[8]. While the overall catch increase was not large, specific fisheries exhibited some sharp fluctuations. Catches of Alaska pollock, shrimp, and crab increased, but catches of other important species such as menhaden, Pacific salmon, and cod declined. A variety of resource and marketing problems caused most of the declines. The salmon catch declined after records set in previous years, but 1986 was still above normal.

Canada

Canada's fisheries catch is slowly recovering, following a period of decline caused by heavy fishing off Canada's Atlantic coast. During 1986, Canadian fishermen caught 1.4 million t of fish and shellfish, an increase of 16 percent over the 1.2 million t caught in 1980. Canada's most important fishing grounds lie off the Atlantic coast, contributing 1.2 million t, or two-thirds of the total catch. Top groundfish and pelagic species landed in 1986, by quantity, were Atlantic cod (457,000 t), Atlantic herring (177,000 t), various flatfishes (85,000 t), redfish (75,000 t), and capelin (65,000 t). The top mollusk and crustacean species, by quantity, were scallops (56,000 t), snow crab (42,000 t), and lobster (35,000 t).

The International Court of Justice decision to award the disputed rich fishing grounds off Georges Bank to Canada (prior to this decision, both the United States and Canada were allowed to fish in the contested area off of Georges Bank), strict enforcement measures on fishing by domestic and foreign fleets in Canadian waters, and rigid management plans imposed on the stocks, have helped to increase Canadian catches in recent years, although many stocks remain depressed. Despite lower catches, the value of Canadian fishery landings has helped produce record incomes for Canadian fishermen, thanks to the strong demand for fishery products in the United States and on world markets. In 1986, the Canadian catch was valued at almost C$1 billion.

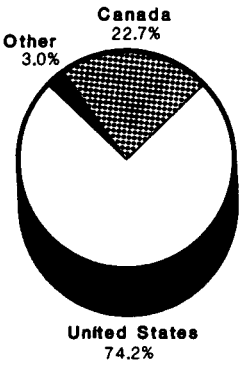


Figure 10.—North American fisheries catch, 1986; total for 1986 was 6.6 million t.

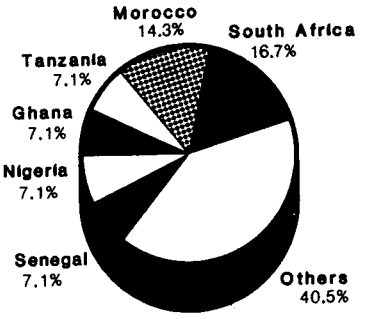


Figure 11.—African fisheries catch, 1986; total for 1986 was 4.2 million t.

Africa

The African fisheries catch has fluctuated between 4.1 and 4.4 million t since 1980. The 1986 catch was 4.2 million t, up slightly from the figure reported in 1985. African countries report a very small part of the world fisheries catch. In 1986, the African catch comprised only 5 percent of the world total, down 6 percent from 1980. The decline is a result of expanded fisheries in other areas, while African fisheries have experienced little growth. African catch data, however, do not include the extensive distant-water catch of the Soviet Union and other countries off the continent. The distant-water catch in 1985 totaled about 2.8 million t, which comprises about one-third of the total catch taken from African waters.

Seven countries (South Africa, Morocco, Tanzania, Ghana, Nigeria, Senegal, and Uganda) comprised nearly 60 percent of the 1986 African catch (Fig. 11). South Africa and Morocco are the two most important countries, and they accounted for about 25 percent of the African total, with 1986 catches of 0.7 million t and 0.6 million t, respectively. In 1985, Cape hake accounted for about 25 percent and anchovy about 40 percent of the South African catch; presumably, the composition of the 1986 catch is similar. In 1986, the sardine fishery supplied over 40 percent of the Moroccan catch, with mackerel accounting for nearly 20 percent. The remaining five countries each had 1986 catches in excess of 0.2 million tons each. South Africa's catch was stable, increasing by only 1 percent in 1986. Morocco's 1986 catch increased 25 percent, primarily because because its leading fishery for sardines increased an

[8]The preliminary U.S. catch data reported by FAO differs from "Fisheries of the United States, 1986," primarily because FAO calculates the live weight of mollusks while the United States calculated only the weight of the edible meats.

impressive 50 percent, according to statistics supplied by Morocco's Institute Scientifique des Peches Maritimes.

Middle East

Middle Eastern fishermen reported a catch of only about 1 million t in 1986. The small Middle Eastern catch is probably a combination of limited resources and lack of interest in developing the available resources. While small by world standards, the 1986 Middle East catch represented an increase of 25 percent over the 0.8 million t taken in 1980. Most of that increase occurred by 1982 and since then the catch has been stable at about the 1 million t level. The leading country in the region is Turkey, with a 1986 catch of 0.6 million tons. The Turkish catch has increased by nearly 35 percent from the 0.4 million t reported in 1980. European anchovy and horse mackerel made up about 70 percent of the catch in 1985.

Oceania

Fishermen in Oceania reported a catch of about 0.6 million t in 1986. The two major fishing countries are New Zealand (0.3 million t) and Australia (0.2 million t). New Zealand fishermen have reported steady growth since the early 1970's and achieved a new record catch in 1986. Much of the recent increase has come from expanding fishing effort to offshore fisheries and by careful management of the heavily fished coastal resources. Australian fishermen reported catch declines in 1985 and 1986. New management measures enacted to protect heavily fished stocks account for much of the decline.

Major Countries

World fisheries are dominated by 16 major countries which accounted for 75 percent of the catch in 1986 (Table 7). The two leading countries were Japan (11.9 million t) and the Soviet Union (11.1 million t). Other leading countries included China (7.3 million t), Chile (5.6 million t), Peru (5.3 million t), and the United States (4.9 million t). All have reported catch increases since 1980. The Soviet and Japanese increases are interesting as both countries heavily fish their own coastal waters and have also had to adjust to restrictions on their distant-water grounds by many coastal countries. The large increases reported by Peru and Chile were primarily due to a resurgence of the anchovy stock. While most of the principal fishing countries have reported catch increases in 1986, a few countries have reported declines: Norway (−10 percent), Iceland (−6 percent), and Thailand (−5 percent). The Norwegian trend in particular continues a trend begun in 1978. Major fishery developments in Japan, China, Chile, and Peru follow (U.S.S.R. developments were reported in a previous section).

Japan is the world's leading fishing nation, harvesting over 11.9 million t in 1986 (12.6 million t according to preliminary Japanese Government statistics), 13 percent of the world's catch. The 1986 catch is nearly a 4 percent increase over the 1985 catch of 11.5 million t and is second only to Japan's all-time record catch of 12 million t in 1984. Japan's catch has remained relatively stable since 1983, averaging about 11.7 million t annually.

Increasing enforcement of foreign 200-mile exclusive economic zones has kept Japan's distant-water catch fluctuating around 2.1 million t since 1979, with little possibility for growth. This factor has forced Japan to reevaluate its fishing strategy and to begin to fully develop its offshore and coastal resources, take a renewed look at aquaculture, and seek new fishing agreements with other countries. Although coastal production remained stable in 1986, marine culture and offshore fisheries grew by 9 percent and 5 percent, respectively. Sardines accounted for the largest increase in Japan's 1986 catch. Japanese fishermen caught about 4.5 million t, 9 percent more than in 1985. Sardine harvests in the waters off eastern Hokkaido and northern Honshu (both in the Sea of Japan and the Pacific) increased significantly in 1986. Other important species were Alaska pollock (1.4 million t), and Spanish mackerel (955,000 t); skipjack tuna registered the largest percentage increase in 1986, up 34 percent to 420,000 t.

China is the third largest fishing

Iceland's Fish Catch Steady, Value Climbs

Iceland's fisheries catch reached 1.7 million t in 1986, slightly less than Iceland's record 1985 catch. The value of the catch increased from $312 to $458 million. The cod catch again proved plentiful (366,000 t vs. 323,000 t) and the shrimp harvest rose by 44 percent from 25,000 t to 36,000 t, while the capelin catch (used mostly for reduction) declined from 993,000 t to 895,000 t. Large catches, high world prices, low oil prices, and a relatively low rate of inflation made 1986 a prosperous year for the Icelandic fishing industry. The debate over the pros and cons of fresh fish sales to Western Europe continued as representatives of the freezing industry expressed concerns over declining supplies of raw materials to meet demand for processed fishery products, mostly in the United States.

The U.S. market declined to 25 percent of the value of total Icelandic fish exports in 1986, while the continued growth in Icelandic sales to the United Kingdom makes it Iceland's most important market. The U.S. Embassy in Reykjavik has prepared an 11-page report reviewing Iceland's fisheries in 1986. The report includes sections on Iceland's fish, catch, the debate over fresh versus frozen fish sales, the growth of the United Kingdom market, foreign fishing in Icelandic waters, and the outlook for 1987. The report also includes statistical tables on Iceland's fish catch and how it is utilized, exports of fishery products by destination, exports by product form, exports to the United States, and Iceland's fishing fleet and number of fishermen. U.S. companies can obtain a copy of "Iceland's Fisheries, 1986" for $9.95 and a $3.00 handling fee (total of $12.95, personal checks or money orders only) by ordering report PB88-114566/GBA from NTIS, Springfield, Virginia 22161. (The handling fee is per order, regardless of how many reports are ordered.)

nation in the world, behind the Soviet Union, with a catch of over 7.3 million tons in 1986. The Chinese reported steady growth in all sectors of its fishing industry in 1986. The marine fisheries catch increased by 12 percent, to 3.9 million t. Principal marine species caught were croaker, hairtail, filefishes, mackerel, and shrimp. Equally spectacular growth was recorded by the freshwater fishery sector (+12 percent to 530,000 tons), marine aquaculture (+12 percent to 797,000 t), and freshwater aquaculture (+24 percent to 2.9 million t). Although China is a relative newcomer to high-seas fishing, its distant-water fleet has grown from about a dozen vessels fishing off West Africa in 1985 to over 30 fishing in the economic zones of seven countries by the end of 1986.

Despite this development, the prognosis is not overly optimistic for continued growth of China's marine fisheries sector. China's 1987 marine fisheries catch was expected to remain about the same as the 1986 catch. Chinese Government officials have predicted that fisheries production would reach 9 million t by 1990, with most of the increase coming from aquaculture. The breakthrough is expected to come in marine farming, with an estimated growth rate of over 11 percent per year. Major cultured marine species will include giant sea perch, shrimp, abalone, clams, mussels, scallops, sea cucumbers, and kelp. The main species used in freshwater culture are carp and tilapia.

Chile is the fourth most important fishing country with a 1986 catch of 5.6 million t. The fishing industry has been the fastest growing sector of the Chilean economy over the past 10 years. Officials were relieved that the 1986-87 El Niño did not adversely affect the 1986 catch, but were concerned about declining catches in 1987. Catches of the two most important species over the past few years (sardines and jack mackerel) declined in 1986, but were more than offset by increased anchovy catches. Most of the catch is reduced to fish meal, and Chile has become the world's leading fish meal exporter. Most companies are reporting good results, even though fish meal prices were substantially below 1980 price levels in constant dollars. While the large fish meal companies reported good results, Chilean fishermen reported declining catches in several traditionally important fisheries (shrimp, sea snails, sea urchins, langostinos, and several other valuable shellfish) in 1986. Other fishermen reported several promising developments in 1986, including expanded harvests of cultured salmon, small-scale surimi production, increased krill landings, and expanded landings of high quality fresh fish for the export market.

Peru was the fifth leading fishing country in 1986 with a catch of 5.3 million t. Peruvian fishermen reported a massive 25 percent increase over their 1985 catch. The increase was primarily due to the resurgence of anchovy stocks. Fishermen in northern Peru were affected by the 1986-87 El Niño beginning in late 1986. Fishermen along the central and southern coast did not begin to report catch declines, however, until mid-1987. (It is not known to what extent the declining 1987 catches in Peru and Chile were due to El Niño or other factors such as overfishing.) While the El Niño was affecting 1987 catches, most of Peru's reduction plants and canneries reported substantially improved results for 1986. The Government gave special priority to efforts aimed at increasing the catch of edible fish to increase supplies to the domestic market. An agreement was signed with Cuba to permit Cuban distant-water trawlers to operate in Peruvian waters and land their catch in Peru. The Government also provided funding so that the state food fish company, the Empresa Publica de Servicios Pesqueros (EPSEP), could acquire its own fishing fleet. Even though catches increased sharply, several long-standing problems plagued the industry in 1986, including labor strife, unused canning capacity, the inability to reach an agreement with the Soviets on joint ventures, high interest rates, low fish meal prices, and a sharp decline in scallop catches.

Aquaculture

While some have predicted that aquaculture, sometimes referred to as the "blue revolution," would rapidly replace wild capture fisheries (which many expected to decline), this has not proven to be the case. Capture fisheries have not declined, nor has aquaculture begun to account for more than a small share

Atlantic Canada's Aquaculture Industry

Atlantic Canada's 33 commercially viable fish farms produced 1,800 t of mussels, 500 t of salmon, and 110 t of trout in 1986. The leading province in Atlantic Canada's aquaculture industry is Nova Scotia (11 farms), followed by New Brunswick (9 farms), Prince Edward Island (6-8 farms), and Newfoundland (5 farms). In 1986, these aquaculture facilities generated about C$9 million and it is projected that this amount could be increased 30 times in 10 years.

Many Canadian fish farmers are short on working capital and technical knowledge. Provincial governments have limited themselves to providing technical aid, but not funding. Future expansion of aquaculture facilities is expected to be opposed by homeowners living near potential aquaculture sites. The region has limited access to processing facilities and the severity of Canadian winters are factors that need to be examined before Atlantic Canada's aquaculture industry can meet its full potential. The U.S. Consulate General in Halifax has prepared a 9-page report reviewing Atlantic Canada's aquaculture industry. The report includes sections on the scope of the industry, aquaculture legislation, funding programs, public opposition, technical problems, and comments. The report also includes list of Federal and provincial legislation in the field of aquaculture. U.S. companies can obtain a copy of "Atlantic Canada's Aquaculture Industry, 1986" for $9.95 and a $3.00 handling fee (total of $12.95, personal checks or money orders only) by ordering report PB88-114574/GBA from NTIS, Springfield, VA 22161. (The handling fee is per order.)

of the world's fisheries production. The combined total of cultured production and freshwater fisheries was only 8.4 million t in 1985, about 10 percent of the world total[9]. For the foreseeable future, fishermen will be able to catch most species in larger quantities and more cheaply than fish farmers will be able to culture them. Fish farmers have, however, reported some successes. The greatest commercial successes have come from efforts to culture high value species for luxury food markets. Efforts to culture salmon and shrimp have been particularly noteworthy. The Branch of Foreign Fisheries Analysis estimates that fish farmers harvested about 70,000 t of salmon and 310,000 t of shrimp in 1986. While small in quantitative terms, these are particularly valuable species and many observers believe that production will increase far beyond current levels. Other fish farmers have reported success with catfish, trout, mullet, oysters, and mussels. Experimental work is currently underway on a wide range of other species. In some cases, however, fish farmers will not increase the total world supply of food. Many fish farmers, for example, use low-value fish to feed the species which they are culturing. The operation is profitable, but may not result in a net increase of edible commodities. Several developing countries have pursued projects to culture tilapia, carp, mullet, and various other species. Some of these projects have resulted in increases of edible commodities. Increases in carp and tilapia catches and Asian catches of a wide variety of freshwater species suggest that aquaculture is gradually increasing the production of edible fish in developing countries, although statistical data separating aquaculture and freshwater fisheries is not readily available.

[9]Precise data on cultured harvests are not readily available, but the Branch believes that a rough estimate of aquaculture trends can be obtained by following catch trends in inland areas reported by FAO.

Potential

The world potential fish catch of edible species has been debated for some years. One widely accepted—although not undisputed—estimate in the world fisheries community, is that the world catch will continue to increase until about the year 2000 when it could total 100-120 million t of conventional species, a figure that many experts believe is the approximate maximum world yield. These estimates may have to be revised. If current trends continue, the 100 million t figure could be reached as early as 1990. However, several Latin American countries have reported declining catches in 1987, principally due to El Niño. Year-end results for the entire world may be about the same as or a small decline from 1986 figures.

Projections of future fish catches, however, are tenuous at best. A wide variety of factors will affect actual increases: Fuel prices, interest rates, national management and development measures, fish prices, technological developments, interest rates, and other developments. Many biologists currently believe that conventional stocks will not support catches significantly beyond the 120 million t level.

Further increases could, however, come from species not currently being utilized. If profitable ways of utilizing Antarctic krill, for example, could be developed, the world catch could expand significantly beyond the 100-120 million t level. Some experts have projected that an intensive krill fishery could double or triple the world catch, but more recent assessments have been more conservative. The 1985 krill catch was less than 0.2 million tons, mostly taken by the Soviets who have been

The Latin American Shrimp Culture Industry

Latin America is a leading world producer of cultured shrimp. Shrimp farmers in the region harvested over 50,000 t of shrimp in 1985, a 40 percent increase over the 37,000 t of shrimp cultured in 1985. Ecuador dominates the region's shrimp culture industry—nearly 85 percent of the Latin American harvest was produced in that country. The industry continues to expand in Ecuador and is rapidly growing in several other countries as well. Prospects for the development of important shrimp culture industries are especially good in Brazil and Colombia.

Ecuador reported major increases in pond harvests during 1987. Several other countries also reported substantial, if less spectacular, 1987 harvests. Based on these increases and continuing expansion of the industry, the NMFS Branch of Foreign Fisheries Analysis conservatively estimates that the cultured shrimp harvest in Latin America could reach nearly 115,000 t by 1990. That projection is based primarily on one country (Ecuador) and one species (*Penaeus vannamei*). As more countries enter the industry and technical advances enable farmers to increase yields and perhaps use different species of shrimp, it is likely that production will continue to increase during the 1990's. Many observers are unsure, however, about the impact of rising world production on the international shrimp market. If substantially lower prices result from the increased production, profit margins could be significantly affected. If so, many farmers may have to adjust their production and expansion plans.

The NMFS Branch of Foreign Fisheries Analysis has prepared an 80-page report reviewing the current status of the shrimp culture industry in Latin America. The report covers: harvest levels, the regional importance, traditional fisheries, quality/size control, species, government support, postlarval seedstock, variables (economic, technical, environmental, and political), investments, and a separate section on each country. The report includes extensive statistical appendices on harvests and exports and is a slightly updated version of the Latin American section in the U.S. Department of Commerce's "Aquaculture and Capture Fisheries: Impact in U.S. Seafood Markets," published earlier in 1988. U.S. companies can obtain a copy of "Latin American Shrimp Culture Industry, 1986-90" for $14.95 and a $3.00 handling fee (total $17.95, personal checks or money orders only) by ordering report PB88-210745/GBA from NTIS, Springfield, VA 22161.

reducing fishing effort in recent years.

Even within existing catch levels, the production of edible products could be substantially increased. Production of edible products from fisheries could be expanded by better utilizing existing catches. About 30 percent of the catch is currently used for reduction fisheries producing fish meal and oil. Animal feed, of course, is not lost to human consumption as most of the animals will be slaughtered for food. The amount of protein available, however, would be increased if the fish were consumed directly instead of being used for fish meal production. Perhaps as much as 10 percent of the world catch is lost as a result of poor handling and processing procedures. Many fishermen discard large quantities of unwanted fish at sea. Suggestions concerning utilization of fish currently reduced to fish meal, landing species currently discarded, improved handling, and other measures to increase food production are often presented in unrealistic terms. They must be tempered by economic reality. Processors must be able to produce a product that will appeal to consumers at affordable prices. (Source: IFR-87/63.)

Argentine Fisheries See Good Growth

Argentine fishing companies reported an excellent year in 1986. Higher international prices and the emergence of Brazil as a major buyer in the third quarter of 1986 were crucial factors in Argentina's improved 1986 export performance. Argentine fishery exports totaled $219 million in 1986, an 110 percent increase over the $104 million exported in 1985. Several long-term difficulties still plagued the Argentine fishery industry in 1986: An outdated fleet, limited port facilities, outmoded processing plants, and inefficient infrastructure, all of which prevented an even better performance. The Argentine Government has instituted some assistance programs for the fishing industry. Several companies were able to put vessels back into service during 1986 by taking advantage of a new credit line offered by the Argentine Development Bank which was designed to promote the renovation of the fleet. The Government also signed fishery agreements with Bulgaria and the Soviet Union which, it hopes, will result in export sales to the Soviet Union and Eastern Europe.

The U.S. Embassy in Buenos Aires has prepared a 24-page report reviewing the current status of Argentina's fishing industry. The report includes sections on landings, industry performance, economic conditions, foreign fishing, port facilites, fishing fleet, markets, and production. The report also includes extensive tables, including data on catch, exports, biomass, maximum sustainable yields, and fleet. There is also a list of Argentine fishery associations. U.S. companies can obtain a copy of "The Argentine Fishing Industry, 1986" for $11.95 and a $3.00 handling fee (total $14.95, personal checks or money orders only) by ordering report PB88-114475/GBA from NTIS, Springfield, VA 22161.

Open-Sea Salmon Farm Is Started off Norway

What Norwegian authorities describe as the world's first fish farm for salmon in the open sea, began operation in late April to the west of the island of Værøy, one of the Lofoten Islands off north Norway. The small fry have to be set out in June, and the first artificially cultivated deep sea salmon should be on the market next year, reports Norinform.

The development of the farm, budgeted at US$670,000, was planned in cooperation with industry in north Norway, and based on the technology used in the offshore sector. The depth of water at the farm will be more than 100 m, and waves up to 13 m in height have been measured at the location. The plant has therefore been dimensioned to tolerate wave heights up to 22 m. The facilities will comprise 20 enclosures firmly anchored to the seabed by heavy weights, and totalling 23,000 m^3, vs. the normal coastal farm size of 8,000 m^3. A ship anchored at the plant will steer operations.

The initiators took advantage of the fact that the location of the farm is outside the 4-mile concession limit. A spokesman for the Ministry of Fisheries has stated that the ministry may consider changes in legislation so that farms outside normal 4-mile limits also must comply with regulations. Free access for the establishment of fish farms in open sea conflicts with the intention of the law, which is to regulate such establishments out of consideration to public interests, says Gunnar H. Gundersen of the Ministry of Fisheries.

New NMFS Scientific Reports Published

The publications listed below may be obtained from either the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402 or from the National Technical Information Service, Springfield, VA 22151. Writing to the agency prior to ordering is advisable to determine availability, order numbers, and price.

NOAA Technical Report NMFS 54. Gooch, Janet A., Malcolm B. Hale, Thomas Brown, Jr., James C. Bonnet, Cheryl G. Brand, and Lloyd W. Regier. **"Proximate and Fatty Acid Composition of 40 Southeastern U.S. Finfish Species."** June 1987, iii + 23 p., 43 tables.

ABSTRACT

This report describes the proximate composition (protein, moisture, fat, and ash) and major fatty acid profiles for raw and cooked samples of 40 southeastern finfish species. All samples (fillets) were cooked by a standard procedure in laminated plastic bags to an internal temperature of 70°C (158°F). Both summarized compositional data, with means and ranges for each species, and individual sample data including harvest dates and average lengths and weights are presented. When compared with raw samples, cooked samples exhibited an increase in protein content with an accompanying decrease in moisture content. Fat content either remained approximately the same or increased due to moisture loss during cooking. Our results are discussed in reference to compositional data previously published by others on some of the same species. Although additional data are needed to adequately describe the seasonal and geographic variations in the chemical compositions of many of these fish species, the results presented here should be useful to nutritionists, seafood marketers, and consumers.

NOAA Technical Report NMFS 55. Krzynowek, Judith, and Jenny Murphy. **"Proximate Composition, Energy, Fatty Acid, Sodium, and Cholesterol Content of Finfish, Shellfish, and Their Products."** July 1987, iii + 53 p., 2 tables.

ABSTRACT

This document contains data concerning the proximate composition and energy, fatty acid, sodium, and cholesterol content of finfish, shellfish, and their products, as listed

The Management of Migratory Fishes

"Multi-jurisdictional Management of Marine Fisheries." edited by Richard H. Stroud, constitutes the "Proceedings of the Eleventh Annual Marine Recreational Fisheries Symposium" held in Tampa, Fla., in May 1986, and is published by the National Coalition for Marine Conservation, Inc., Savannah, Ga. Frank E. Carlton set the tone for the symposium with his introductory address "Fish Know No Boundaries," which was followed by then-NOAA Administrator Anthony J. Calio who assessed the Federal role in marine fisheries. Carl E. Nettleton then addressed the development of a fisheries resource management plan that would achieve optimum population levels. As with the earlier symposia, this one divided the presentations into several Panels: 1) Putting the challenge of fisheries management into perspective, 2) inter-jurisdictional problems, 3) case studies, 4) new directions for management, 5) to preempt or not, 6) NMFS, Councils, and the Act (MFCMA), ending with summaries of each panel's by the panel chairmen.

In large part, the presentations address the problems and opportunities in managing marine and anadromous fishes under the MFCMA by the various Councils; another important aspect covered was management by the creation of habitat for certain species. In addition, some very controversial issues were aired, including Federal preemption of state authority, Federal saltwater fishing licenses, the Native American role in fisheries management, and various interjurisdictional fisheries problems. In addition, floor discussions and panel debates are published which help air various sides of the issues. Case studies presented included discussions of state-Federal management of red snapper and gag; multi-state-Federal management of king mackerel, and international management of highly migratory tuna and billfishes. Unindexed, the hardbound volume is available from the International Game Fish Association, 3000 East Las Olas Blvd., Ft. Lauderdale, FL 33316-1616 for $15.00.

Game Fish Trophies, Articles Published

"World Record Game Fishes 1988" has been published by the International Game Fish Association, 3000 East Las Olas Blvd., Ft. Lauderdale, FL 33316-1616, under the direction of Elwood K. Harry. This year the "articles" section is devoted to presentations by four noted outdoor writers on some of the world's finest angling areas: Alaskan angling by Chris Batin, Hawaiian offshore fishing by Jim Rizzuto, Australia's Great Barrier Reef trophies by Peter Goadby, and America's blue-ribbon trout streams by A. J. McClane.

Also rewritten this year and considerably updated is the game fish species section, about 6 pages of data on popular fishes and which includes many new and improved illustrations, a number by NMFS biologist-artist Susan Smith.

in 228 articles published between the years 1976 and 1984. Also included is a systematic index of the species as referenced in this document listed alphabetically by scientific names.

NOAA Technical Report NMFS 56. Hirth, Harold F., and Larry H. Ogren. **"Some Aspects of the Ecology of the Leatherback Turtle *Dermochelys coriacea* at Laguna Jalova, Costa Rica."** July 1987, iii + 14 p., 13 figs., 12 tables.

ABSTRACT

The ecology and reproductive biology of the leatherback turtle (*Dermochelys coriacea*) was studied on a high-energy nesting beach near Laguna Jalova, Costa Rica, between 28 March and 8 June 1985. The peak of nesting was between 15 April and 21 May. Leatherbacks here measured an average 146.6 cm straightline standard carapace length and laid an average 81.57 eggs. The eggs averaged 52.12 mm diameter and 85.01 g weight. Significant positive relationships were found between the carapace lengths of nesters and their clutch sizes and average diameter and weight of eggs. The total clutch weighed between 4.02 and 13.39 kg, and yolkless eggs accounted for an average 12.4 percent of this weight. The majority of nesters dug shallow (<24 cm) body pits and spent an average 81 minutes at the nest site. A significant number of clutches were laid below the berm crest. In a hatchery 42.2 percent of the eggs hatched, while in natural nests 70.2 percent hatched. The average hatchling carapace length was 59.8 mm and weight was 44.6 g. The longevity of leatherback tracks and nests on the beach was affected by weather. One nester was recaptured about 1 year later off the coast of Mississippi. Egg poaching was intense on some sections of the Costa Rican coast. Four aerial surveys in four different months provided the basis for comparing density of nesting on seven sectors of the Caribbean coast of Costa Rica. The beach at Jalova is heavily used by green turtles (*Chelonia mydas*) after the leatherback nesting season. The role of the Parque Nacional Tortuguero in conserving the leatherbak and green turtle is discussed.

NOAA Technical Report NMFS 57. Brodeur, Richard D., Harriet V. Lorz, William G. Pearcy. **"Food Habits and Dietary Variability of Pelagic Nekton off Oregon and Washington, 1979-1984."** July 1987, iii + 32 p., 1 fig., 32 tables.

ABSTRACT

The food habits of 20 species of pelagic nekton were investigated from collections made with small-mesh purse seines from 1979-84 off Washington and Oregon. Four species (spiny dogfish, *Squalus acanthias*; soupfin shark, *Galeorhinus zyopterus*; blue shark, *Prionace glauca*; and cutthroat trout, *Salmo clarki*) were mainly piscivorous. Six species (coho salmon, *Oncorhynchus kisutch*; chinook salmon, *O. tshawytscha*; black rockfish, *Sebastes melanops*; yellowtail rockfish, *S. flavidus*; sablefish, *Anoplopoma fimbria*; and jack mackerel, *Trachurus symmetricus*; consumed both nektonic and planktonic organisms. The remaining species (market squid, *Loligo opalescens*; American shad, *Alosa sapidissima*; Pacific herring, *Clupea harengus pallasi*; northern anchovy, *Engraulis mordax*; pink salmon, *O. gorbuscha*; surf smelt, *Hypomesus pretiosus*; Pacific hake, *Merluccius productus*; Pacific saury, *Cololabis saira*; Pacific mackerel, *Scomber japonicus*; and medusafish, *Icichthys lockingtoni*) were primarily planktonic feeders. There were substantial interannual, seasonal, and geographic variations in the diets of several species due primarily to changes in prey availability. Juvenile salmonids were not commonly consumed by this assemblage of fishes.

Revised and updated, too, are the sections on international angling rules and world record requirements—particularly with the new additions to the world record eligible list like the queenfish, Japanese seabass, kahawai, bluefin trevally, and mutton snapper. For avid anglers, the "meat" of the publication is the listings of world angling trophies (freshwater and saltwater), plus fly-rod and all-tackle trophies and membership in the Thousand Pound Club and the 5, 10, and 20-to-1 clubs. Also provided are lists of state game fish record keeping agencies and organizations, worldwide recordkeeping organizations, and tag-and-release programs. The 320-page paperbound volume is available from the publisher for $9.75 (U.S.) and $11.95 (foreign).

Pacific Salmon and Their Management

Publication of **"Salmon Production, Management, and Allocation,"** edited by William J. McNeil, has been announced by the Oregon State University Press, 101 Waldo Hall, Corvallis, OR 97331-6407. Subtitled "Biological, Economic, and Policy Issues," it is a compilation of 20 papers presented at the World Salmonid Conference which was held in October 1986 in Portland, Oreg., by the Salmonid Foundation. The authors, ranging from scientists and aquaculturists to economists, fishery managers, and lawyers, have presented a wide variety of authoritative papers relating to the integration of aquaculture into the overall production of Pacific salmon, and the topics range from salmon biology and ecology to pertinent social and economic issues.

Lawyer Alfred A. Hampson discusses the laws and property rights relating to salmon ranching by public and private entities, and he suggests several legislative needs. A thorough review of Japanese salmonid programs, salmon supplies, and public policy is given by Yoshio Nasaka, while Frank Gjerset reviews the status and outlook for Norwegian Atlantic salmon farming, comparing characteristics of that industry with those of the U.S. catfish farming industry. Other articles include changes in the catch pattern of North American salmonids by Japan's high seas fleet by Colin Harris, while William Pearcy discusses factors affecting survival of coho salmon off Oregon and Washington, and Ernest Salo looks at the chum salmon as an indicator of ocean carrying capacity. And, Donald Rogers reviews the timing and size composition of Bristol Bay smolt migrations and the effects on distribution and survival at sea.

Additional papers discuss the problems involved in managing mixed-stock salmon fisheries; the culture, allocation, and economic value of Pacific salmon in the Great Lakes; conservation and allocation decisions in fishery management, the impacts on coastal communities of recreational-commercial fishery allocation of salmon; salmon markets, economics of recreational salmon fishing, potential hazards for spreading of infectious disease by transplanted fish, and directed and inadver-

tent genetic selection in salmonid culture.

Salmon harvests, after dropping to less than half their historic levels, began increasing nearly two decades ago, and are again approaching their historic levels. While naturally produced salmon still contribute most to the world's salmon harvest, aquaculture production is growing rapidly. This book examines many important issues, some very controversial, and should be of interest to those involved in salmon research, culture, marketing, and management. Indexed, the 194-page hardbound volume is available from the publisher for $31.95 postpaid.

The Marine Fisheries of Indonesia and Thailand

The International Center for Living Aquatic Resources Management (ICLARM), Manila, Philippines, has produced excellent new reviews on the fisheries of Thailand and Indonesia. **"Indonesia Marine Capture Fisheries"** by C. Bailey, A. Dwiponggo, and F. Marahudin, ICLARM Contribution 338, is part of the ICLARM Studies and Reviews Series 10. The authors have winnowed existing literature to provide a fine descriptive overview of that nation's fisheries and, in the process, pointed out areas in need of greater study and research. Following reviews of the nation's marine fisheries and fishery resources, the authors address fisheries management and development policies and programs, economics, fish marketing and distribution, socioeconomic factors of small-scale fisheries, and needs for further research. Included in the 196-page paperbound volume is an extensive list of references. The volume is available either from ICLARM at US$9.50 (surface mail) or US$18.00 (airmail) or, in the United States, from International Specialized Book Services, P.O. Box 1632, Beaverton, OR 97075 at $18.00.

ICLARM Technical Reports 17 is **"Growth, Mortality and Recruitment of Commercially Important Fishes and Penaeid Shrimps in Indonesian Waters"** by A. Dwiponggo, T. Hariati, S. Banon, M. L. Palomares, and D. Pauly. Data is presented in 61 plates and tables covering fishes ranging in size from 10 cm (*Secutor ruconius*) to 80 cm (*Katsuwonus pelamis*) and for areas from Jakarta Bay to the Arafura Sea. Altogether, 52 stocks of fish are covered, including 36 species, 21 genera, and 15 families of bony fishes as well as 9 annual cohorts from the Arafura Sea stock of the shrimp *Penaeus merguiensis*. Presented are estimates of von Bertalanffy growth parameters which were derived through application of the ELEFAN I program to length-frequency data from the various fishes. Derived quantities such as total, natural, and fishing mortality estimates, as well as selection and recruitment patterns were then obtained by application of the ELEFAN II program to the same length-frequency data. Some generalizations on the status of the stocks are presented, particularly for the demersal fishes off the north coast of Java and on *P. merguiensis* in the Arafura Sea. Paperbound, the 91 page volume is priced at US$4.50 (surface mail) and US$8.50 (airmail and the U.S. price from ISBS).

ICLARM Studies and Reviews 14 is **"The Economics and Management of Thai Marine Fisheries"** by Theodore Panayotou and Songpol Jetanavanich. Like number 10, this is a fine review of the relevant literature and presentation of data on Thai fisheries—one of the world's ten largest, having a fleet of more than 20,000 modern vessels and a harvest of around 2 million metric tons. Thailand fishermen supply 20 kg/capita of fish for a population of 50 million and earn the nation about $500,000,000 in foreign exchange annually. The authors document the profitability of the trawl fishery, small-scale fishermen's economic problems, overfishing in the Gulf of Thailand, and the problems and potential in the nation's management and enforcement capabilities. It also suggests a number of solutions to Thai fisheries problems. Price of the 82-page paperbound volume is US$5.00 (surface mail) and US$9.00 (airmail—and the ISBS price). ICLARM recommends orders to them be for airmail delivery owing to surface mail delays of several months and potential losses in transit.

ICLARM has also published ICLARM Bibliographies 7, "A Bibliography of Trochus (*Trochus niloticus* L.) (Gastropoda: Trochidae), by Warwick J. Nash, updating the annotated bibliography of Gail and Devambez of 1958. It includes over 130 citations, many hard to locate in conventional databases, along with subject and geographic indexes (price not listed).

What Is Ecology?

When Danish marine ecologist and professor Tom Fenchel received the first annual "Excellence in Ecology" award from the Ecology Institute, Oldendorf/Luhe, FRG, he found a string attached: He was expected to serve science and society by authoring a book along the aims of the Institute. Thus, the first book in the new series "Excellence in Ecology" is Fenchel's **"Ecology—Potentials and Limitations,"** edited by O. Kinne, Institute Director. Fenchel's book is aimed primarily at other ecologists, hoping to engage them in a debate on the definition of ecology, as well as to present central problems and results of ecology to biologists at large and to other scientists.

The author complains that ecology, per se, seems to be a "diffuse" or an "immature" science that many people would define differently, often in light of their own specialization. He notes that ecology differs from most other natural sciences in seemingly lacking a central core of ideas, concepts, methods, and goals upon which everyone can agree. Fenchel then strives to present what he sees as the "core" of that discipline, and to provide a synthesis of the field.

In so doing, the author begins with a brief historical background of contemporary ecology and presents his view of how ecology should be defined: "As the study of the principles which govern temporal and spatial patterns for assemblages of organisms." He discusses different types of theoretical models used in ecology and attempts to delimit ecology relative to other biological disciplines, such as natural history, evolutionary biology, physiology, behavioral biology, and biogeochemistry.

Section III, entitled "Concepts, ideas, and problems in ecology," presents a more detailed look at the "gist" of ecology—scales of size and time among living things, flow of energy and materials, resource competition, interactions between species populations, structure of biotic communities, evolution of life cycles, and more. The following section (IV) then presents selected examples to illustrate several of the general ecological principles given in the previous section.

Section V, "Ecology and society," is concerned with applied ecology, and here Fenchel warns his peers that, while applied research is necessary and desirable, some aspects of ecology may be especially vulnerable to intellectual corruption. This is an especially thoughful and interesting book, made all the more so because of the author's marine science background and the examples woven through it. The 186-page hardbound volume is available from the publisher, Ecology Institute, D-2124 Oldendorf/Luhe, Federal Republic of Germany; price is DM7, or about US$40 (depending on the exchange rate).

A Trolling Handbook for South Pacific Fishermen

"Trolling Techniques for the Pacific Islands," by G. L. Preston, L. B. Chapman, P. D. Mead, and P. Taumaia and illustrated by S. E. Belew is Handbook No. 28 of the South Pacific Commission, Noumea, New Caledonia. The handbook was developed as a training aid for the Pacific Island region to document some of the specialized and often unwritten knowledge and practical experience gleaned by SPC staff over the years, and the latter may be its greatest strength. The volume is thoroughly and well illustrated and clearly documents many of the techniques learned or proven in that region over the years.

Following a basic introduction to Pacific trolling, the authors illustrate, chapter by chapter, all aspects of that fishery for the individual small-scale fisherman: Vessel considerations and preparation (fish containers, trolling booms, handreels, gaffs, etc.); preparation of trolling lines and gear; types of baits and lures and their rigging; trolling conditions and techniques; fishing action—working the lines, the strike, handling fish on fixed lines and handreels, and boating and care of the catch; care of the boat and fishing gear and recordkeeping; coping with problems—injuries, accidents, breakdowns, signalling, and sea survival techniques. Another chapter describes the habits and characteristics of commonly caught species; appendices illustrate pole trolling in the Pacific Island tradition and give suggestions for additional sources of information. All in all, the book is an excellent guide for the region's fishermen. Paperbound, the 162-page volume is available from the SPC (price not listed).

Drying of Fish With Solar Energy

Drying fish is an ancient preservation method that is still of considerable importance, especially in tropical regions. Aspects of this, and appropriate techniques and research, are addressed in **"Solar Drying in Africa,"** subtitled Proceedings of a Workshop held in Dakar, Senegal, 21-24 July 1986, edited by Michael W. Bassey and O. G. Schmidt and published by the International Development Research Center, P.O. Box 8500, Ottawa, Canada K1G 3H9. Contributions address a range of studies including papers reviewing solar energy available in typical tropical locations and applications of solar energy in food production, and construction and performance of solar crop dryers. Studies are presented on the evaluation of various types of solar dryers—solar concentrator/dryer, flat-plate collector/dryer, and flat-plate collector/dryer-storage unit.

Another paper specifically addresses appropriate technology for solar drying of salt fish and fermented fish. Others discuss the application of natural- and forced-convection style solar dryers to various fishes and fish products, along with other agricultural commodities. Additional reports address the outlook for solar drying of fish in The Gambia, how solar drying can reduce post-harvest fish losses, and a variety of problems and developments in solar drying in African nations. The 286-page paperbound volume, IDRC-255e, is available from the IDRC (price not listed).

MACROALGAE AND ENERGY PRODUCTION

The energy crisis of the early 1970's spawned many efforts to gain new sources of energy; some went for deeper deposits of oil and gas, some turned to coal, and some, as the following volume attests, went to the sea, in this case to cultivate seaweeds for energy conversion. **"Seaweed Cultivation for Renewable Resources,"** edited by K. T. Bird and P. H. Benson, and published as volume 16 in the series "Developments in Aquaculture and Fisheries Science" by Elsevier Science Publishing Company Inc., 52 Vanderbilt Avenue, New York, NY 10017, goes well beyond simply reviewing seaweed as an energy source. Many of the advancements reported initially in various (and sometimes hard to locate) symposia, conference proceedings, technical reports, and journal articles are here condensed, synthesized, and collected into one volume.

The first four chapters deal with the giant kelp, *Macrocystis pyrifera*, the species which was the primary candidate in most marine biomass studies. Indeed, chapter 1 provides both a history of the giant kelp biomass program but reviews the early and current industrial development and utilization of kelp. Chapter 2 then describes successes and failures of the early efforts to cultivate kelp on offshore structures, while chapter 3 reviews the work on growing kelp in nearshore farm environments. Chapter 4 discusses the optimization of kelp growth in marine farms.

Chapter 5 then describes *Laminaria* culture in the far east and in North America, along with the idea of multicropping with a summer-adapted seaweed species for improved year-round productivity. C. K. Tseng then reviews the Chinese kelp cultivation industry and its implications for biomass energy systems.

Many other less well known seaweeds, of course, are adapted to warm water

habitats and the biology of such important tropical and subtropical species are reviewed by Clinton Dawes in chapter 7, along with physiological considerations in relating to their cultivation. Biomass production of *Gracilaria* in outdoor cultivation systems in Florida is discussed in chapter 8, along with factors influencing *Gracilaria* yield, research on other species of macroalgae (i.e., *Sargassum* and *Ulva*), and a discussion of other uses for biomass of macroalgae (i.e., hydrocolloid production, wastewater treatment, fish feed, fodder, and fertilizer). Additional chapters discuss tissue culture of seaweeds, nitrogen fixation in marine communities and its potential role in seaweed cultivation, biological gasification of marine algae, microbial degradation of marine biomass, cost analyses of energy from marine biomass, and a commercialization strategy for nori culture in Puget Sound, Washington. Each chapter carries a literature cited section, and a separate section at the end of the book presents a list of 78 technical reports on marine biomass for energy, along with suggested sources of additional data or reports (i.e., symposia proceedings, etc.).

The key to the future of marine biomass programs, the editors note, must be crop yield improvements, perhaps through breeding and genetic analysis to produce new crop candidates. While western biomass to energy programs are now idle, they have generated much important and useful information which this volume handily reviews. Indexed the 381-page hardbound volume is available from the publisher.

Toward a Sociology of Natural Science

Publication of **"Social Science in Natural Resource Management Systems,"** edited by Marc L. Miller, Richard P. Gale, and Perry J. Brown, as part of the "Social Behavior and Natural Resources Series, has been announced by Westview Press, 5500 Central Avenue, Boulder, CO 80301. Some natural resource agencies seem to have integrated social scientists and their studies into research and management programs and policies more than others and this volume examines a variety of such situations—including marine fisheries.

Presentations are divided into several parts: Following an overview of natural resource management systems, the section "Roles of Science" presents a discussion of natural resource sociology, utilizing forests and marine fisheries as the examples, and the authors suggest a need to strengthen natural resource sociology to be better able to respond to shifting social, political, and economic situations. Other contributions in this section examine the partnership between social scientists and park and resource managers, the practice and promise of social science in the U.S. Forest Service, the integration of social science into wildlife management, and the sociology of the forestry and marine fisheries sciences in the Pacific Northwest.

A third section, "Applications of Social Science," has chapters on park planning in Canada, planning and managing visitor activity in Canadian National Parks, social carrying capacity research in a wilderness area, and an interesting discussion of emotions in environmental decision making—rational planning vs. the passionate public. A final section presents reports on social science research and recommendations on three public land issues.

Early on, the editors present their concept of a natural resource management system (NRMS), a four-part system with the following elements: 1) natural resources, 2) management bureaucracies, 3) profit-seeking industries, 4) and diverse publics (organized and unorganized), in which they establish all four components as fair objects of social science research. In addition, they portray "management bureaucracies" as "embedded within" the NRMS, rather than as a "detatched steward." They then utilize this NRMS as a basis for comparing resource management experiences in later chapters. The book is aimed primarily at social scientists who, the editors say, "must establish their own niche in natural resource management systems." But it would also be of interest to resource biologists and managers who must also deal with social as well as resource issues on a daily basis. Paperbound, the 265-page book is available from the publisher for $22.50.

Marine Ecology Text Updated

The second edition of **"An Introduction to Marine Ecology"** by R. S. K. Barnes and R. N. Hughes has been considerably revised and updated by authors and republished by Blackwell Scientific Publications, Inc., 667 Lytton Avenue, Palo Alto, CA 94301. The volume is intended for students with a knowledge of basic ecology, but who are venturing into marine ecology for the first time. Thus, each chapter treats a distinct process or subsystem of the ocean.

Following a general introductory chapter on the nature and global distribution of marine organisms and their habitats, the authors succinctly review the planktonic system of surface waters, the benthos of continental shelf and littoral sediments; salt marshes, mangrove swamps and seagrass meadows; rocky shores and kelp forests; coral reefs, pelagic and benthic systems of the deep sea; fish and other nekton, ecology of life histories, speciation and biogeography, the marine ecosystem as a functional whole, and human exploitation and interference. Indexed, the 351-page volume is available in paperbound ($29.50) and hardbound ($67.50) versions from the publisher, and it provides a good concise introduction to the field.