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TUNA MANAGEMENT INFORMATION DOCUMENT

A Scenario of Forces and Trends Affecting Tuna Resources and Fisheries to the Year 1995

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U.S. Tuna Policy

More than a decade has passed since the U.S. Congress enacted the Magnuson Fisheries Conservation and Management Act (MFCMA) of 1976 and in doing so, revolutionized fishery policy in the United States and throughout the world. This Act brought the living marine resources within 200 miles (mi) of the U.S. coast under exclusive conservation and management by the U.S. It excluded, however, the tuna resources outside of 12 mi from those requirements, owing to tunas being "highly migratory" or in the course of its life span migrating well beyond the 200-mi zones of coastal nations. It also provided authority to embargo U.S. imports of tuna and tuna products from countries that disagree with this policy and seize U.S. tuna vessels fishing in their 200-mi. zones. This exclusion has since been an issue for heated debate, although it is consistent with a premise of U.S. policy for over 40 years - namely, that the only completely effective means for managing the highly migratory tunas is through international agreements.

Several documents have been written about the exclusion of tunas from the MFCMA, and valid arguments have been made for both maintaining this exclusion (e.g., Joseph and Greenough 1979; Greenough and Joseph 1986) as well as for amending the Act to include tunas (e.g., Van Dyke and Nicol 1987; Orbach and Maiolo 1988; Hudgins 1988). A review of the arguments would be redundant and is not the purpose of this document.

Since 1976, there have been new research results and concepts about the migratory behavior of tunas; management of resources under the rules of MFCMA has been implemented; and major global changes in tuna fisheries have occurred. In particular, new analyses challenge the belief that all tunas are "highly migratory." Evidence shows that although the temperate tuna species are long-distance migrants, perhaps only some exceptional individuals of the tropical species travel long distances. Furthermore, some nations, particularly island nations in the Pacific, have huge exclusive economic zones (EEZ or 200-mi zone) in which an individual or stock can complete its entire life cycle and as such may not fit the definition of highly migratory (Hilborn and Sibert 1988).

Analysis has shown that the habitat for tropical tunas is spotty with areas of good habitat surrounded by vast regions of poor habitat. Tunas are attracted to these "islands of suitable conditions" and tend to remain in them rather than migrate. However, fishing in these concentrations removes individuals and may create opportunity for new occupants, or immigrants from adjoining poor habitats (Mullen 1989). Long distant migration, hence, may not be the norm in tunas, but rather a situation caused by intense fishing or significant changes in these favorable habitats.

The U.S. has assumed jurisdiction for managing the billfishes, which may correctly be described as highly migratory within its 200-mi zone for over a decade, and its management performance has not been good (Greenough and Joseph 1986). For example, in 1977 scientific evidence showed that the Pacific blue marlin stock was overfished (Yuen and Miyake 1980), in 1979 analyses showed that the Atlantic blue marlin and white marlin stocks were overfished (ICCAT 1979), and in 1988, there was evidence of low spawning stock abundance of Atlantic swordfish. Despite these scientific findings of overfishing, the U.S. did not adopt fishery management plans for billfishes until 1987 for the central-western Pacific and 1988 for the Atlantic. Furthermore, none of these plans addresses the overfishing situation in a comprehensive way nor specifies effective performance objectives to rehabilitate the stocks within a specified time period.

During the 1980s, the U.S. tuna industry went through a major restructuring that greatly changed it from the industry that existed when the MFCMA was enacted (King 1987). The U.S. distant-water fleet was reduced by about 40% and its superior fishing technology, once a trade secret, was made widely available to competitors. The fleet also abandoned its heavy reliance on the eastern tropical Pacific (ETP) fishing area, and diversified to depend equally on both the ETP and western tropical Pacific (WTP) fishing areas. Access to the western Pacific fishing area was secured for 5 years in 1988 through a formal U.S. agreement with 16 south Pacific island nations (the South Pacific Regional Tuna Treaty), the nations claim jurisdiction over tunas in their 200-mi zones, which include most of the fishing area. Cost to the U.S. for the 5-year agreement is $60 million: $50 million paid by the U.S. government, and $10 million by U.S. fishermen.

During the 1980s, the U.S. tuna processing sector also underwent unprecedented restructuring. Capacity was reduced and concentrated in Puerto Rico and American Samoa, where costs were lower. Processors also increased their reliance on more pre-processed raw material, i.e., loins, from foreign sources (Colombia, Costa Rica, Ecuador and Mexico) for canning, and imported canned tuna from low-cost foreign processors for marketing under their labels and private labels in the U.S. Furthermore, foreign investors purchased major tuna processing-distribution firms in the United States: Van Camp Seafoods purchased by Indonesian investor (P.T. Mantrust) in 1988, and Bumble Bee Seafoods purchased by Thai investors (Unicord Co.) in 1989. Foreign interests currently control about 48% of the U.S. retail market share of canned tuna. The major U.S. interest, Star-Kist Seafoods, controls 35% of the market.

In 1988, the technical staff of the Southwest Region of the National Marine Fisheries Service felt that these events and other factors had significantly reshaped the global picture since the enactment of the MFCMA and that the effects on the U.S. tuna policy needed to be examined in light of the changes. The staff laid plans for an investigation to review technical information and to examine the effectiveness of tuna management with existing models. The investigation was executed in two parts: Part one was the review of relevant information on tuna resources and fisheries of interest to the U.S., and part two was the evaluation of this information as it might affect U.S. tuna policy.

Review of Relevant Information

The objective of part one was to review relevant information that had accumulated over the past 10 to 15 years on the tuna resources and fisheries of interest to the U.S. and to project the trends into the future, until 1996. The exercise was not to be a rigid forecast of the future, nor an endorsement of a particular set of events. It was designed to yield a probable scenario of what is likely to happen if current forces and trends were allowed to continue unabated until 1995 or beyond. Of course, many events foreseen or not, can and no doubt will, influence the future course and not all of them have been factored into the scenario.

The results of the review and projection are presented in the four chapters of this document: 1.0. Trends in tuna production and trade, 2.0. Trends in tuna fisheries, 3.0. Trends in tuna stock abundance, and 4.0. Trends in management and research arrangements.

The objective of the second part of the investigation was to draw upon information from the review and evaluate how the trends might relate to the U.S. tuna policy in the 1990s. The emphasis was on events or trends that might affect conservation and management objectives of interest to the U.S. The results of this exercise are presented in this chapter.

Review of Scenarios

Markets

The U.S. is second only to Japan in size of its market for tuna--consumption of 716,000 metric tons (MT) in 1986 or 23% of the world catch of the principal tuna species (Table 1). All but about 1% of this consumption is in the form of canned tuna, and canned tuna consumption is growing at a rate of 4% per annum. Consumption is projected to be about 1.1 million MT by 1995 with actual retail prices at historical lows for the U.S. consumers. Imports from foreign sources, particularly from developing countries (e.g., Indonesia, Korea, the Philippines, Thailand, Taiwan, Venezuela), will continue to capture a larger share of the U.S. market while domestic production either decreases slightly or remains static.

Fresh fish tuna production in the U.S., although increasing, will remain relatively small at about 10,000-20,000 MT annually (Peckham 1988) through 1995. Because a large share of U.S.-caught fresh tuna is exported to Japan, ex-vessel prices will continue to be largely influenced by the Japanese "sashimi" market, which will experience flat growth, but command premium prices for species that are low in abundance.

About 29% of the tuna consumed in the U.S. is caught by U.S. vessels and this percentage is decreasing--projected to be 18% by 1995. Developing countries are increasing their capability to harvest, process and export raw and canned tuna to the U.S. market for hard currency. Thai and Indonesian interests which have recently purchased two large U.S. firms (Bumble Bee Seafoods and Van Camp Seafood Co. respectively) that have a major share of the U.S. canned tuna market, join established Japanese interests (Mitsubishi Foods and Ocean Packing Co.) in having a major stake in processing and marketing canned tuna in the U.S. (Doulman 1989b, Iversen 1987).

The Japanese tuna market is the largest in the world (Table 1). Consumption is primarily of fresh fish (57%), but consumption of canned tuna (25%) is increasing as consumer preference shifts more to western tastes. Increased consumption of canned tuna is the trend as well in other countries with growing economies and increased standards of living, e.g. Korea and western Europe. Greater production is required to support this growth, and new low cost supplies of tuna may at times be less than required to support all markets in the future.

Fisheries

The U.S. had about 113 large purse seiners (greater than 400 MT capacity) operating in 1976. It was the largest and most modern fleet of its kind in the world, built to fish distant waters for yellowfin and skipjack tunas. In 1976, there were also about 1,000 small (up to 20 MT) U.S. vessels of various types fishing for tunas within the U.S. 200-mi zone, primarily on the West Coast. These coastal vessels targeted albacore (about 19,000 MT landed in 1976) on the West Coast, skipjack tuna (about 3,000 MT) in Hawaii, and principally bluefin tuna (about 2,000 MT) on the East Coast.

Since 1976, the U.S. distant-water fleet decreased to about 65 operating purse seiners in 1986 and lost its ranking as the world's largest tuna purse seine fleet. The catch, however, increased by about 6 to 8% as capacity was used more efficiently.

The U.S. coastal fleet for tunas, on the other hand, increased markedly to several thousand vessels, although this growth was not evenly distributed. Growth was exceptional on the East Coast with hundreds of longline, handline and recreational vessels added to the fleet as part- and full-time operations. This growth was driven by the high prices paid by buyers for large bigeye, yellowfin and bluefin tuna for export to the Japanese sashimi market as well as by buyers that supply the ethnic and up-scale restaurants in the U.S. (Peckham 1988). On the West Coast, the fleet decreased owing to declining availability of albacore and increased opportunities in alternative fisheries. In 1986, some of the larger vessels explored an alternative albacore fishery in the South Pacific. In the South Pacific, their efforts paid off and by 1989, about 45 vessels, constituting the U.S. distant-water troll fleet, were involved in the expanding albacore fishery. In the Hawaiian Islands, the fleet grew as more longline and handline vessels entered the fishery for large bigeye and yellowfin tunas. Strong local demand as well as strong export demand for fresh tuna kept prices high, and provided the incentive for growth. However, the net effect of these fleet changes on the total U.S. catch of tunas from coastal waters was a decrease from 20,000 MT in 1973-1975 to about 13,000 MT in 1986, of which most went to the high-valued fresh fish market.

The predicted trend in U.S. tuna fisheries is for no growth or even a slight reduction in the distant-water fleet, but a substantial growth in the coastal fleet by 1995. Increasing cost of distant-water operations and increased competition from lower cost producers: Indonesia, Korea, Mexico, the Philippines, Thailand, Taiwan, Venezuela and others will keep the U.S. fleet's size in check and eventually produce another round of fleet reductions (Doulman 1989a). The U.S. distant-water catch of all tunas will remain at about current levels through 1995, but will consist of increasingly greater amounts of skipjack. This trend will accelerate as more stringent regulations to prevent incidental catches in tuna fishing are adopted. Current measures, for example, to reduce dolphin kills in the ETP tuna purse seine fishery will encourage U.S. vessels to shift to the western Pacific, where skipjack tuna is the dominant species, to fishing on tuna schools in the ETP that are not associated with dolphins (schools frequently containing skipjack tuna), or to quit fishing altogether.

Growth in the coastal fleet for tunas will continue because of the low capital cost required for new participants and high value of the catch in the fresh fish market. Also, recreational fishing for tunas and other large pelagic species is increasing in popularity and being recognized in some regions as a way of enjoying fishing while offsetting part of the cost by selling the high-value catch. Despite greater fishing effort by this fleet, however, the total coastal catch (East Coast, West Coast and Hawaii) will not exceed an average of 15,000 MT, as the U.S. zone does not contain exceptionally large stocks of tuna. Furthermore, stocks that are available consist of mostly the less numerous larger individuals, that will continue to be the target of heavy exploitation, or stocks which are presently overfished (e.g., Atlantic bluefin tuna and north Pacific albacore).

In summary, the total catch by U.S. tuna fisheries in 1995 will be no different than today at about 240,000 to 260,000 MT. The catch by the distant-water fleet will continue to dominate the catch and the distant-water fleet will remain at, or slightly less than, its current size. The coastal fishing fleet, on the other hand, will grow substantially larger, but the catch will not grow in proportion to the increased number of vessels. Competition within and among user groups will become more severe.

On the global scale, the trend is for lower cost producers i.e., developing countries, to play an increasingly important role in global tuna production. Technology transfer from Japan and the U.S. in the 1980's has made fleets from Korea, Mexico, Taiwan, Venezuela and other countries, technologically competitive in distant-water tuna fishing. With their low production costs, these countries will continue to increase their share of global fishing and trade in tuna and tuna products, and eventually dominate the fisheries for both high-end priced (sashimi grade) and low-end priced (canning quality) tuna.

The trend is also for the public to demand that tuna be caught in an environmentally responsible way. Increased public concerns for incidental kills of marine mammals, sea birds and endangered species in tuna fishing, for example, are already changing the way tuna fishing is conducted in the eastern tropical Pacific for yellowfin tuna, and in the south Pacific for albacore. The initial effect will be lower production, followed by a recovery as fishermen adjust and find ways to catch tuna without catching large amounts of incidental species or ways to prevent wastage (drop-outs, dumping of small-sized tuna, dead, etc.).

Stocks tuna

Tunas are widely distributed throughout the temperate and tropical oceans of the world, migrate long distances, grow rapidly and are very fecund. These biological characteristics are widely believed to make tunas very difficult to overfish to the point of biological extinction (e.g., Greenough and Joseph 1986). Instead, free market economic forces come into play at a point where the stock is reduced and the low production creates economic hardship on the fishermen with subsequent collapse of the fishery. This point is thought to be well above that which results in extinction of the species or stock allowing the stock to restore itself to higher levels.

Not factored into this thinking are considerations that not all tuna stocks are highly migratory and that these more localized stocks may be more vulnerable to sustained and concentrated fishing than previously thought. Concentrated fishing on these stocks could lead to stock depletion through a process of recruitment overfishing (e.g., see Hilborn and Sibert 1988) as with any other fishery resource.

As some commodities become scarce their value increases faster than the cost of production; e.g., rhinoceros horn and ivory. Also, governments might subsidize production of scarce commodities to maintain production and the associated industrial infrastructure for sociopolitical reasons. In tuna fisheries, large bluefin tuna commanding upwards of $75.00/lb in the Tokyo fish market is an example of scarce commodity increasing in value, while Mexico's subsidized purse seine fleet is an example of production maintained for sociopolitical reasons. In such cases, the exploited stocks can be driven down to dangerously low levels before economic hardship takes its toll and reduces fishing mortality (i.e., very low bioeconomic equilibrium stock size (Hilborn and Sibert 1988)). Also, when tuna are caught incidentally in a fishery targeting other species, the fishery may be immune to tuna market forces and thus continue to reduce the tuna stock to extremely low levels. This is thought to be the case in the north Pacific drift gillnet fishery where large amounts of small albacore are caught incidentally to fishing for other species. Finally, changes in the environment may act to attenuate or to exacerbate the adverse effects of fishing on the stocks. Given these considerations, the concept that tuna stocks cannot be biologically overfished must be treated with caution.

Currently, all of the tropical tuna stocks (yellowfin, skipjack and bigeye) appear to be in good condition, but with only skipjack having considerably more scope for higher sustained yields with increased fishing. Higher sustained yields of yellowfin and bigeye are for the most part only possible with optimum deployment of existing fishing effort rather than with increased effort. The temperate tuna stocks (bluefin and albacore), on the other hand, are in poor condition or fast approaching this condition because of high levels of fishing mortality and continued high demand in apparently price-insensitive markets.

In the future, the tropical tuna stocks will be more heavily exploited with yields decreasing for some that become overfished, such as yellowfin and bigeye, and increasing for others, particularly skipjack tuna. All of the temperate tuna stocks will be heavily fished to a point where their abundance will be reduced well below maximum sustainable yield (MSY) levels and perhaps some to the verge of extinction. Candidates for extinction are the southern bluefin tuna of the Indian Ocean, and the northern bluefin tuna stocks of the Atlantic and Pacific. These stocks are currently at low abundance levels, command ever increasing value in the Japanese sashimi market, and continue to attract increased fishing pressure.

For tunas occurring in the U.S. EEZ, fishing pressure within and outside the zone will reduce stock abundance. High-priced species such as bluefin tuna will be less abundant by 1995. Albacore will be less available in the West Coast EEZ. Yellowfin and bigeye tuna, which are caught in the U.S. EEZ principally at larger sizes, will be less available owing to increased fishing within and outside the EEZ. Skipjack will be abundant, but their availability in the U.S. EEZ will be highly variable.

International Arrangements for Conservation and Management

There was a time when the concept of open and free access to tuna resources of the world was widely accepted, and international arrangements for management of and research on the resource were attempts to create some safeguards against overexploitation of the resource. These arrangements worked well in encouraging growth of the international tuna industry. The distant-water fishing nations benefitted disproportionately, because they held the technological edge for effective exploitation of the resources, and controlled the markets. Wide-scale rejection of this concept began at the time the MFCMA was enacted in 1976, and increased with the conclusion of the Convention for the Law of the Sea (CLOS) in 1982 and the transfer of modern purse seining technology to developing countries in the 1980's.

Under the existing international tuna management concept, research was central for meeting the objective of maintaining the population at a level which provides MSY, and a means for early warning of overfishing. Research is used to determine the condition of the stock and the effects, if any, that fishing has on the stock; i.e., to determine the level of fishing mortality for obtaining MSY. This role for research is implicit and supported in most international tuna management arrangements. In parts of the world where there are no international tuna management arrangements, bodies affiliated with the Food and Agricultural Organization of the United Nations or regional economic bodies, frequently have taken on the task of coordinating tuna research on an international scale with financial support principally from developed countries, or distant-water fishing nations.

For the most part, the international arrangements have served their purpose of encouraging tuna fisheries development. However, they have largely failed to manage the fisheries and prevent overfishing. Also, they have failed for the most part to adequately support research that contributes to management decisions for preventing overfishing. Aside from the Inter-American Tropical Tuna Commission (IATTC), none of the other international arrangements have demonstrated an ability to carry out and sustain the level of research effort required to provide scientific information for current and emerging management issues. Failures have been most evident with arrangements where individual nations fund and execute research required to solve allocation conflicts among user groups; for example, the bluefin situation in the International Commission for the Conservation of Atlantic Tunas (ICCAT). Furthermore, IATTC, though having a large and sustained research program, has not progressed in developing a mechanism for independent peer review to evaluate its scientific objectives nor methods for balancing the political influence of the major donor, the U.S., in setting its research agenda.

Coastal state jurisdiction of tunas is now becoming a commonly accepted concept either through ratification of CLOS or through adoption of CLOS wording into national laws. Along with this trend is the creation of regional arrangements for management of tuna fisheries, especially in regions where coastal states control most of the areas where the resource can be efficiently harvested. Access to a region's tuna resource may be allowed for a fee, if a surplus is available. The coastal states may form cartels to negotiate fishing access for distant-water fishing nations for a fee that maximizes benefits solely for the cartel members. Given this profit objective, the negotiations can include a wide range of economic issues with tuna being just one.

The role of research has also been reduced to a minor role in regional arrangements. The trend is to not link research responsibility closely with management arrangements and to recognition that research responsibility is with those who claim jurisdiction over the resource and who extract a rent. This point should become more obvious as the traditional distant-water fishing nations (developed countries), who have traditionally supported fishery monitoring and tuna research for conservation purposes, lose their dominance in the fisheries. The non-traditional distant-water fishing nations (developing countries), have not had a tradition of strong support for research and will be reluctant to accept the responsibility to support the cost of research.

Challenge for the U.S.

Given current trends, a pattern is emerging for the 1990s that will challenge the U.S. tuna policy. The challenge will result from conflicts within the different regions fished by the U.S. fleets -- conflicts within both the U.S. EEZ and in distant waters.

Conflicts in the U.S. EEZ

In the U.S. EEZ, the U.S. coastal tuna fleet, both commercial and recreational, is rapidly expanding, owing to new entries displaced from declining older fisheries and entries lured by the well-publicized high prices paid for fresh tuna. This presently uncontrolled expansion will result in lower catches of tuna for the individual participants, increased user conflicts, and increased political pressures for a management solution to improve catches or to allocate catches. The focus of the political pressure will be on amending the tuna provision of the MFCMA to allow the Fisheries Management Councils to insert stronger regulatory language into U.S. fishery management plans, and to allow the U.S. government to negotiate cutbacks in foreign catches on the high seas from a position of strength in the international arena.

Experiences with Council management of billfishes, and U.S. negotiations in the international tuna and billfish arena, indicate that the Council's approaches have failed to produce desired results and only exacerbate conditions (Greenough and Joseph 1986; Greenough and Rothschild 1989). In other words, there is no assurance that with U.S. jurisdiction over its coastal tunas, the U.S. will be effective in managing the tuna species in the EEZ for conservation purposes. The odds are that it won't. The reasons lie in the nature of the fishery management systems currently employed by the U.S. For example, there are basic differences in U.S. objectives from the national and international perspective of tuna management. The MFCMA specifies the principal objective of resource conservation, along with managing the U.S. fishery for optimum yield. Existing international management agreements specify an objective of conserving the resource by maintaining the stock at levels which will permit the MSY. The latter is mute on the objective for managing the fishery, but implies that it is for obtaining MSY for the commercial fishery. The former is also mute on how to optimize the yield and for whom. Complicating the situation and further reducing the assurance of success is the fact that the MFCMA fishery management processes have had a very low success rate, because the councils tend to set catch levels that are more attuned to the economic needs of U.S. fishermen than to the long-term conservation of the resource (National Fish and Wildlife Foundation 1990).

As long as most tunas and billfishes that occur within the U.S. EEZ spend some part of their life cycle outside the zone, managing the resource and fisheries with MFCMA objectives cannot be effective without coordination with other nations that exploit the resource outside the zone. This coordination cannot be successful if it relies only on existing international tuna management arrangements -- ICCAT for the East Coast EEZ, with no arrangements for the West Coast and Pacific island EEZs. New arrangements need to be developed that have conservation and yield objectives in tune to those of the MFCMA; are limited to only nations exploiting the stocks of interest to the U.S.; and have broad central administrative powers to limit the number of fishing units and to manage the fishery with minimal political meddling. In order for new arrangements to function effectively, a strong scientific support component must be part of the arrangements with a role that includes determining the safe level of harvest from the resource, optimum units of fishing effort to take the harvest, and options for optimum allocation. The scientific component must be adequately funded, competently managed, and be well insulated from political influence or manipulation.

Conflicts in distant waters

The U.S. distant-water fleets are currently enjoying prosperity and stability. The tropical fleet is divided between the ETP, where there is no access agreement, and the western Pacific, where there is a 5-year South Pacific Tuna Treaty agreement. The albacore troll fleet operates far offshore in the south Pacific where no access agreement is required. In the north Pacific, the U.S. has a reciprocal albacore access agreement with Canada.

In 1992 or sooner, the U.S. will begin negotiations to extend the South Pacific Tuna Treaty beyond the expiration date of June 1993. The probability is high that the South Pacific nations will enter the negotiations requesting a higher fee and more concessions (Doulman 1989a). Assuming an inflation rate of 5% per annum, it is not unreasonable to expect the asking fee to be at least $76.6 million, up from $60 million, for a new 5-year agreement. With the current division of contribution, such a fee will require $63.8 million from the U.S. government and $12.8 million from the tuna fishermen (currently $50 million and $10 million respectively). For U.S. fishermen to maintain the current cost of the fee per ton of tuna (about $90/MT, with industry paying about $15/MT) with the new fee, they must increase their current catch of 132,000 MT per year to 169,000 MT per year, or roughly equivalent to an additional fishing trip annually for each of the 35-40 vessels in the fleet. Of course, if the additional catches are not made, costs per ton will increase accordingly.

The western Pacific stocks are able to support this higher catch; however, it is not only the U.S. fleet that fishes in the western Pacific. The foreign fleets have aggressive plans for increased fleet sizes with modern ships (San Diego Union, Jan. 7, 1990) and catches to support their growing processing-distribution sectors and exports to the U.S. The U.S. fleet, in contrast, will remain at about current size or increase to the maximum of 50 vessels, which the current Treaty allows, with older vessels and technology. These factors will make for greater competition for the U.S. both on the fishing grounds as well as at the negotiating table with the South Pacific island nations.

The increased cost used for illustrative purposes in this example appears to be manageable for the U.S. fleet; hence, it alone should not be a contentious issue in the negotiations. Of course, this fee may not match the actual fee requested. Less certain is the willingness of the U.S. public to continue paying the lion's share of the fee. If the public is unwilling to pay the lion's share, which is in line with current government policy that user group pays the major share, the fee will be a burden and a contentious issue in the negotiations and no agreement would likely result.

If there is no agreement in 1993, it is likely that the U.S. fleet in the western Pacific will remain at existing strength for the short term. Basically, the fleet will not have much choice except to remain in the region, fishing illegally if necessary because the only other comfortable alternative for U.S. fishermen is the ETP fishery, which they know well. In the ETP, however, the fleet has no access agreement to the productive inshore area, and can not fish profitably in the offshore areas without targeting dolphin-associated schools. Currently, it has a limited market for tuna taken with dolphins, and this market's continued existence is uncertain.

By 1993, the ETP fishery will probably be feeling the effects of overfishing and excess fishing capacity. The Latin countries will increase surveillance for illegal fishing in their EEZs and be less liberal in licensing or tolerating foreign fishing in their zones in competition with their fleets. This will make it harder for U.S. vessels to operate in the

ETP economically. It would probably be disastrous for everyone in the area if suddenly the fishery had to absorb 35-50 additional U.S. vessels from the western Pacific.

Without an agreement in the western Pacific and deteriorating conditions in the ETP, vessels in the U.S. fleet will go bankrupt or will fish illegally in the western Pacific, risking seizures. This situation stems not only from the tuna policy provisions of the MFCMA, but from U.S. sanction by reimbursing the fishermen for losses resulting from such seizures, and also because of poor preparations by the U.S. government. As examples of poor preparation, the U.S. (1) does not have other agreements as alternatives to the South Pacific Tuna Treaty which would strengthen its negotiating position and provide an alternative for the fleet; (2) is not preparing the private sector to absorb a larger part of the fee burden, nor educating the public to recognize that the fee includes public sector benefits as well; (3) has not worked with the private sector to control the size of the fleet and fleet deployment; and (4) has not developed an enforcement capability in the region to deter illegal distant-water fishing by U.S. vessels, when required.

Conflicts over U.S. tuna fishing (e.g., vessel seizures and U.S. embargoes) in the western Pacific will be a grim reminder of events in the late 1980s that led to the U.S. signing of the 1988 South Pacific Tuna Treaty as well as a rekindling of animosity towards the U.S. in general (Van Dyke and Nicol 1987). This time, however, the south Pacific nations will orchestrate world support for their cause, and a condemnation of U.S. heavyhandedness in employing retaliatory embargoes against nations that do not adhere to the U.S. tuna policy.

In 1993, there will be a lot more boats competing for fishing access in the western Pacific than there were in 1988 (Doulman 1989b). With the cessation of purchases of tuna caught in association with dolphins by U.S. tuna processors in 1990, other processors will likely follow. Some purse seiners will not be able to operate in the ETP under this condition, and will switch to other fishing areas, such as the western Pacific, where dolphin-associated fishing is not a problem. Furthermore, the non-U.S. fleets are growing and expanding their involvement in the Pacific. This could result in higher fee demands by the South Pacific countries and greater competition in securing a U.S. access agreement.

Korea, Taiwan, and Thailand are among the low cost producers. With newer boats and better technology, they will have higher efficiency than the U.S. fleet in general, enabling them to pay a higher fee than the U.S. for fishing in the western Pacific (Doulman, 1987). The newer boats are 40% more efficient in fuel usage than the average U.S. seiner (San Diego Union, January 7, 1990). Foreign fleets will agressively try to out-bid and eliminate the U.S. fleet from the region. Their contribution will offset revenues which the South Pacific nations would otherwise obtain from extention of the U.S. agreement, so the South Pacific nations will be less willing to settle for low fees to subsidize a high cost producer. They are also almost immune to a U.S. threat of embargoing their tuna exports to the U.S. Only Vanuatu, of the 16 island nations exports significant amounts of tuna to the U.S. (Table 2). A U.S.-South Pacific nations conflict over the tuna agreement, however, will have a serious affect on operations of U.S. vessels and processors, particularly those in American Samoa which depend heavily on the catch of the U.S. fleet (Doulman 1989b).

If the conflict is a long drawn-out battle, it will permanently cripple the U.S. fleet, and cause a restructuring of the processing sector as well.

Such a conflict may generate even more pressure in the U.S. to amend the MFCMA to include tunas. Unfortunately, such an amendment would only address a symptom and would not be a solution to the underlying problem. Amending the Act will bring the U.S. law in step with prevailing thinking for coastal state jurisdiction over tunas and defuse the embargo provision, which is a source of ill will; but it will not solve the underlying problem of the U.S. fleet being a high-cost producer that cannot compete economically if it must pay high access fees. Furthermore, it is widely believed that the access fee negotiated in 1988 set a precedent for being partly a fee for political and defense security benefits derived by the U.S.

In the ETP, overfishing of the yellowfin tuna stock, over-capacity of the international fleet, and regulations for the protection of dolphins will challenge the U.S. fleet to remain competitive in the 1990s. They will have a difficult time competing in the region without an access agreement for fishing in EEZs of Latin countries. As the stock declines, or as more stringent dolphin protection regulations are adopted, access to the inshore areas will be required to sustain the fleet. Without an access agreement, vessels will fish the inshore areas and risk seizures. If there are seizures, the U.S. is required to embargo tuna from the involved countries. The resulting turmoil and cost of extracting U.S. ships from arrest will provide further impetus to amend the MFCMA and to reaffirm coastal country jurisdiction over tuna.

A U.S. tuna embargo on an ETP coastal nation will have little effect on the nation, unlike the situation in the early 1980s. The vulnerable nations have diversified their export markets and are not now dependent solely on the U.S. market. Currently, only Mexico and Ecuador export significant amounts of tuna to the U.S. (Table 2). Their exports, however, are relatively small and can readily be sold in alternative markets should they face a U.S. embargo.

The U.S. processors, particularly in Puerto Rico, depend on the U.S. and other fleets for a significant amount of raw material from the ETP. Lower yields from the ETP stocks or fishing conflicts there will make it harder for them to maintain normal operations in the short term. Alternative sources of raw material, i.e., imports, will be found to make up the shortfall in supplies. However, for the long term, with rising operating costs and less raw material from the ETP, processors in Puerto Rico will scale back operations (Doulman 1989b).

ETP countries will probably not use a tuna fishery conflict with the U.S. to organize world opinion to criticize the U.S. tuna policy, such as a conflict in the western Pacific, simply because the tuna issue is no longer a major sore spot in U.S.-Latin America relations. Nonetheless, a conflict in the area as previously mentioned, will generate U.S. domestic interest to amend the MFCMA and defuse the embargo provision as a solution to the conflict. As in the case in the western Pacific, the amendment would not be the total solution to problems in this fishery. Most of the Latin American countries have tuna fishing fleets and wish to reserve stocks in their EEZs for their own economic development. They are not interested in allowing the U.S. fleet access to their zones to compete with their fleets, as demonstrated by the several failed U.S. attempts to establish a new management organization in the region (Joseph and Greenough 1979; Greenough and Rothschild 1989). In other words, with or without an amendment to the MFCMA, it is doubtful that the Latin American countries will change their objectives and negotiate tuna fishing access for U.S. vessels to their zones for a reasonable fee.

As a position to negotiating access agreements in the ETP, the U.S. has insisted on the international management concept and clings to the IATTC arrangement. In practice, the concept is inoperative because the IATTC is powerless to impose a management regime without having all the major nations as members and in agreement; furthermore, its rules almost guarantee failure in meeting the conservation objective for reasons presented in Chapter 4. Also, by insisting on the IATTC arrangement, which has no requirements for dolphin protection, the U.S. is undermining its objectives of the Marine Mammal Protection Act (MMPA). The MMPA provides for embargoes of tuna from countries which do not subscribe to U.S. dolphin protection measures. These embargoes, however, are likely to have the same effect as those arising from current U.S. tuna policy. The secondary embargo provisions of the Act on the other hand, may be far-reaching in their effects on the global tuna situation.

Within this probable scenario, and given these limitations, the paramount issue in the 1990s will clearly not be open access for the U.S. fleet or other distant-water fishing fleets to the ETP resource, but rather limited access and reduced international fishing effort in order to save the resource, to ensure that allocations are equitable, to prevent the excess effort from being diverted to other fully exploited tuna fisheries, and to protect the dolphin stock from excessive incidental kills. Without recognition of this issue by all players, and continued insistence by the U.S. on the IATTC or ICCAT models for managing tunas, there will be no common ground for serious negotiations for a new arrangement to protect the resource from overfishing and for managing the fishery for stability and equity. This will be the case with or without a tuna amendment to the MFCMA.

Furthermore, the U.S. distant-water troll fleet operates primarily in international waters, so access agreements are not crucial for its survival. The existing tuna provision of the MFCMA, hence, does not directly affect the fleet. Conflicts faced by the fleet in the 1990s will require accommodations for resolutions that have not been demonstrated by the existing U.S. tuna policy. Reduced stock abundance and competition with other fleets will be the sources of conflicts for this fleet in the 1990s. As the albacore stocks are exploited more heavily, there will be less available or less to divide among the users, and more effort required to obtain a smaller catch. The U.S. fleet will be hard pressed to compete economically under these circumstances especially because foreign, lower cost operators will have an advantage. Relief for the U.S. fleet, as well as for the resource, will require international agreements of a new type that control fishing effort and catches to protect the stocks; and that reduce conflicts and create some stability in the international harvesting sector. So far, the U.S. has not developed a tuna management model that takes these considerations into account, and with or without the tuna provision of the MFCMA.

Including tuna within the MFCMA will not affect U.S. tuna processors and canned tuna consumers as it might have in the past. The U.S. is heavily dependent on foreign sources for raw material in the majority of canned tuna produced, marketed and consumed in the U.S., and this dependence will increase in the 1990s. The major sources for raw supplies; e.g., Ghana, Japan, Korea, Taiwan (Table 2), and for canned products; e.g., Indonesia, the Philippines, Thailand, are coastal countries located in areas where the U.S. is unlikely to have tuna fishing access conflicts or be affected by an embargo. Consequently, embargoes will not significantly disrupt the supply of canned tuna to U.S. consumers.

In summary, the probable scenario shows that the U.S. distant-water tuna fleet will face difficult times in the 1990s. In the ETP, deteriorating stock condition, fleet overcapacity, and increased dolphin fishing regulations will challenge the competitiveness and the survival of all fleets operating there. The ETP coastal nations will be more resolved in not allowing access of distant-water fishing vessels to their EEZs and in rejecting the IATTC concept for tuna management as being in their best interest.

In the western Pacific, access will be offered to the U.S. by the island countries. However, the access fee and concessions will be unaffordable to the U.S. fleet without substantial government subsidy. Other fleets will be prepared to accept terms of the South Pacific countries and see the U.S. fleet driven from the region.

In both the north and south Pacific, decreasing albacore stock abundance due to heavy exploitation and increasing competition from lower cost producers will challenge the competitiveness of the U.S. troll fleet. Without international agreements to limit fishing effort and protect the stocks, the U.S. fleet will find it difficult to be competitive. In all of these cases, including tuna in the MFCMA is not the crux of the problem, and amending the act is not a solution to the imposing difficulties. In fact, the existing provision has neutral effect or is a disadvantage because it serves to rally world opinion against the U.S. for a tuna policy that is thought by many user nations to be out of date or unrealistic.

For the U.S. fleet to survive and grow, changes in these trends must occur. The solutions to the new and emerging problems are complex. They will require new approaches and arrangements, active and timely government involvement, flexibility and resource conservation commitment by the private sector, less focus on the tuna exclusion provision of the MFCMA as a barrier and solution, and de-emphasis on saving and using existing international tuna management arrangements for solving the problems.

For the tuna processors in the U.S., rising labor and other costs, including costs associated with reducing environmental polution, as well as greater international competition for raw material, will challenge their ability to operate profitably with canneries in the U.S. If their raw material supplies are disrupted because of the U.S. tuna trade policies, they will likely move their operations to foreign locations.

For U.S. consumers, the supply of canned tuna at a competitive price will probably continue up to about the mid-1990's. As foreign markets for canned tuna expand, e.g., Japan, Korea, and Western Europe, and grow faster than the supply, the U.S. consumer could face substantial price increases. Furthermore, prices will rise as producers pass on the cost for instituting environmentally responsible ways of catching and processing tuna; e.g., "dolphin-safe" tuna.

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Table 1. Estimated supply and consumption of tuna (in 1,000 MT) for selected countries. (Source: Bhatia, et al. 1989; Gomez-Hall 1987; Katsuo-Maguro Tsushin 1988; McElroy 1989; Yamashita 1986; NMFS.)

Category	Indonesia 1986	Korea 1986	Japan 1983	Mexico 1986	Thailand 1986	U.S. 1983	U.S. 1986
Catch	235	123	710	107	83	266	243
Imports							
Raw for canning	-	-	*	-	205	224	268
Fresh	-	-	136	-	-	*	*
Canned	-	-	*	-	-	123	238
Total	-	-	136	-	205	347	506
Processed							
Canned	4	28	222	33	288	483	474
Fresh	231	~ 66	408	*	-	7	6
Dried	-	-	161	-	-	-	-
Total	235	94	791	33	288	490	480
Exports							
Raw for canning	22	29	55	74	-	*	31
Fresh	3	~ 66	*	*	-	~1	~2
Canned	4	*	35	*	288	*	*
Total	29	~ 95	90	74	288	1	33
Consumption	206	28	756	33	*	612	716

* Less than 1,000 MT.

Table 2. 1988 U.S. imports (MT) of raw tuna for canning by country.

Country	Albacore	Skipjack	Yellowfin	Principal Source
Ecuador	0	1,170	5,628	Eastern tropical Pacific
France	203	16,603	4,112	Indian Ocean
Ghana	0	20,360	3,649	Eastern tropical Atlantic
Japan	10,270	9,500	457	Pacific
Korea	11,217	19,566	7,400	Indian and western Pacific
Mexico	0	3,382	3,898	Eastern tropical Pacific
Spain	132	10,535	2,701	Indian Ocean
Vanuatu	0	6,169	6,325	Eastern tropical Pacific
Venezuela	21	2,139	7,231	Eastern tropical Pacific
Taiwan	63,620	3,089	2,570	Atlantic and Indian Ocean
Others	4,087	12,604	3,669	
Total	89,550	105,117	47,640	

LIST OF CHAPTERS

1.0. TRENDS IN TUNA PRODUCTION AND TRADE

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1.1. Introduction

Worldwide catches of tuna and tuna-like species[1] have increased rather steadily in recent years, from 2.5 million metric tons (MT) in 1979, to 3.4 million MT in 1986; an increase of 39% in 8 years (Table 1.1). From 1979 to 1985, global processing of canned tuna rose from 607,000 MT to 703,000 MT; an increase of 16% (Table 1.2). While these increases in production and processing are impressive in themselves, perhaps more striking is the considerable development in the harvesting and processing capabilities of less developed countries relative to that of the historically dominant tuna producers and processors, namely Japan, the United States, Spain and France. The rapid development of tuna industries in southeast Asia, Latin America, the western Pacific and Africa in most cases has been due to their proximity to abundant tuna resources, relatively low-cost labor sources, strong government backing, and foreign investment. However, while these are necessary conditions, the impetus for developing tuna industries in these areas relates to a growing worldwide demand for tuna and processed tuna products (Herrick 1987).

In this section of the Tuna Management Information Document, recent trends in global catches of raw tuna and tuna-like species, and canned tuna production are analyzed. Historic patterns of growth in these areas on the part of nations with developed tuna industries (developed nations), and on the part of nations with developing tuna industries (developing nations) -- as distinguished by the Food and Agricultural Organization of the United Nations -- are initially reviewed. These data are then used to construct simple extrapolative models to project future tuna catches and canned tuna production by developed and developing nations. In this same context, international trade in raw and canned tuna is examined and forecasted.

The analysis then takes a closer look at recent developments in the U.S. tuna industry. Attention is focused on changes in the relative contributions of domestically-caught and imported raw tuna and tuna-like species to U.S. canned tuna production, and on changes in the import share of the aggregate U.S. canned tuna supply. Movements in U.S. exvessel tuna prices are reviewed and projected, as are changes in U.S. canned tuna

[1]Catch statistics in this chapter 1.0 are from FAO as of June 1988, and may be different from statistics reported in other chapters of this Tuna Management Information Document. Global statistics include all tuna and tuna-like species, i.e. tunas, bonitos, billfishes, etc. In 1986, the catch of principal tunas (yellowfin, bigeye, albacore, bluefin and skipjack) was 68% of the total, 3.4 million MT.

prices at wholesale and retail, and in domestic consumption of canned tuna. Some concluding remarks follow.

1.2. Global Tuna Catches

Catches of tuna and tuna-like species worldwide have increased steadily between 1979 and 1986 at an annual average rate of 5%, as shown in Figure 1.1 and Table 1.1. Most of this increase was due to growth in the fishing operations of developing nations. As indicated in Figure 1.2 and Table 1.1, growth in the catches of developing nations over the period increased at an annual rate of 6%, from 1.2 million MT in 1979 to 1.9 million MT in 1986. This compares to annual growth rate of 3%, with much more variability, for developed nations, with their catches ranging from 1.3 million MT in 1979 to 1.5 million MT in 1986 (Table 1.1, Figure 1.3).

Of the developed nations, Japan was the leading harvester over the period on the basis of total tonnage, 794,000 MT annual average, with the U.S. next and Spain and France following (Table 1.1). Spain exhibited the greatest overall growth in catches of tuna and tuna-like species over the period, 81%; the U.S. showed the least, 14%. For all the developed nations listed in Table 1.1, catches displayed a high degree of variation from 1979 through 1986.

By 1986, the developing nations shown in Table 1.1 accounted for more than half of the world's annual tuna and tuna-like species catch. Indonesia was the leading harvester among the developing nations, and second to Japan in total catch by country in 1985 and 1986. The Philippines, which was second to Indonesia in 1986 catch, also out-produced the U.S. in 1985 and 1986. Venezuela's annual catch of tuna and tuna-like species increased a phenomenal 308% from 1979 through 1986, the greatest increase for both developed and developing nations. This overall increase reflects an average annual growth rate of 23% over the period, the same as that for Thailand, highest among the developing nations. Of the developing nations, only the Republic of Korea, which had relatively large, but highly fluctuating catches over the period, had a catch growth rate lower than any of the developed nations.

Linear trend models were fitted to the 1979 through 1986 global catches, developing nations' catches and the developed nations' catches (the estimation results are presented in Appendix 1.0), and used to predict the respective catches through 1995. The catch trends, projections and 95% confidence bands are shown in Figures 1.1 through 1.3 for global catches, developing nations' catches and developed nations' catches, respectively. From these models, the global tuna and tuna-like species catch is predicted to reach 4.5 million MT (plus/minus 300,000 MT) by 1995; the developing nations' catch is estimated to be 2.7 million MT (plus/minus 200,000 MT) by 1995; and, the predicted catch by developed nations in 1995 is 1.8 million MT (plus/minus 400,000 MT).

1.3. Global Canned Production

Globally, canned tuna production grew at an average rate of 3% annually from 1979 through 1985 as shown in Figure 1.4 and Table 1.2. The rapid development of canned tuna processing capability in developing nations over the period accounts for most of this growth. From 1979 to 1985, canned production by developing nations increased 84%, at an average annual rate of 11% compared to a 5% increase for developed nations, at an average annual rate of 1% (Table 1.2, Figures 1.5 and 1.6).

Based on the canned tuna production figures for developed nations reported in Table 1.2, their share of global production declined by 8% from 1979 through 1985. The U.S. was, by far, the leading processor of canned tuna from 1979 through 1985, averaging 269,000 MT of canned product annually. Nonetheless, U.S. production in 1985 was 12% below that in 1979, having declined at a 2% annual rate. Japan was the second largest producer of canned tuna, averaging 113,000 MT annually. Its production increased 27% over the period at a 4% annual rate. France exhibited the greatest overall growth in canned tuna production over the period, 56%, with Italy not far behind at 51%.

By 1985, the developing nations shown in Table 1.2 accounted for 22% of the world's annual canned tuna production vis a vis 14% in 1979. Thailand dominated this growth, accounting for 54% of the total developing nations' production in 1985, and 12% of the world total, up 5% and less than 1% respectively from 1979. Thailand's annual growth rate averaged 69% over the period, and its overall production increased a remarkable 2000%. The Philippines also experienced substantial growth. Its production was up 525% over the period, increasing at an average annual rate of 46%.

Linear trend models were estimated using the 1979 through 1985 global, developing nations' and developed nations' canned tuna production data presented in Table 1.2 (estimation results are reported in the Appendix). Using these models, canned tuna production was predicted on a global, developing nation and developed nation basis through 1995. The respective production trends, projections and 95% confidence bands are shown in Figures 1.4 through 1.6. From these models, the global canned tuna production is predicted to reach 900,000 MT (plus/minus 200,000 MT) by 1995; the developing nations' production is estimated to be 270,000 million MT (plus/minus 60,000 MT) by 1995; and the predicted production by developed nations in 1995 is 630,000 MT (plus/minus 150,000 MT).

1.4. International Trade

Accompanying the recent expansion of tuna fishing and canning operations on a global scale has been an increase in international trade in raw (fresh/frozen) tuna and tuna-like species, and in canned tuna products. As shown in Tables 1.3 through 1.5 and Figures 1.7 through 1.15, imports of fresh/frozen tuna and tuna-like species by major importing countries increased by 47% over the period 1979 through 1986; imports of canned tuna by major importing countries increased by 117%; and exports of canned tuna by major exporting countries increased by 185%.[2]

The most significant growth in fresh/frozen tuna and tuna-like species imports has occurred in the developing nations (Table 1.3 and Figure 1.8). Imports into the developing countries listed in Table 1.3 increased 316% from 1979 through 1986. Most of this growth can be attributed to the rapidly developing canning operations in Southeast Asia (Thailand and Singapore) and the west coast of Africa (Ivory Coast and Senegal). Imports of fresh/frozen tuna and tuna-like species by developed nations (Table 1.3, Figure 1.9) remained relatively stable, increasing only 4% over the period. The European countries of Portugal, Spain, France and Italy experienced the greatest import growth among developed nations.

Linear trends were estimated for fresh/frozen tuna and tuna-like species imports, globally, by developing nations and by developed nations (the results of these estimations are reported in the Appendix), and are shown in Figures 1.7 through 1.9 respectively. Based on these trends, by 1995, global imports of fresh/frozen tuna and tuna-like species will approach 700,000 MT (plus/minus 450,000 MT); imports by developing nations will approach 500,000 MT (plus/minus 300,000 MT); and imports by developed nations will approach 470,000 MT (plus/minus 170,000 MT).

Based on the figures presented in Tables 1.4 and 1.5, most of the canned tuna produced by developing nations does not appear to be consumed domestically, but is exported to major markets in North America and Europe. The U.S. was the major importer of canned tuna over the 1979 through 1986 period: imports increased from 26,700 MT in 1979 to 84,100 MT in 1986 - 215%, at an average annual rate of 20%. The United Kingdom also experienced substantial growth in canned tuna imports - a 248% increase over the period. By 1980, the developing nations were supplying over half the world's exports of canned tuna, and by 1986, they were supplying 83% (Table 1.5). This unprecedented growth was led by Thailand, which first reported exports in 1981 (Table 1.5). By 1986, Thai exports had increased almost 3,000%, accounting for 50% of the world total.

Linear trends were fitted to the worldwide, developing nations' and developed nations' canned tuna import and export data displayed in Tables 1.3 through 1.5 (the results are reported in the Appendix), and are shown in Figures 1.10 through 1.15 respectively. These trends indicate that by 1995, global canned tuna imports will approach 375,000 MT (plus/minus 115,000 MT); imports by developing nations will approach 12,000 MT (plus/minus 19,000 MT); and, imports by developed nations will approach 380,000 MT (plus/minus 100,000 MT). Global exports of canned tuna will approach 490,000 MT (plus/minus 100,000 MT) by 1995, with 440,000 MT (plus/minus 115,000 MT) provided by developing nations, and 50,000 MT (plus/minus 28,000 MT) provided by developed nations.

[2]The differences in aggregate canned tuna import and export statistics are due to discrepancies and delays in reporting. These differences result in an inequality in the aggregate canned tuna import and export projections discussed later.

1.5. The U.S. Tuna Industry

From 1979 to the present, the U.S. tuna industry has undergone some extremely significant structural changes -- these include reductions in fleet size, closing of plants, changes in its institutional setting, increased demand for tuna packed in water, and increased demand for health foods such as fish -- which have resulted in the unstable growth observed in its harvesting and processing sectors.[3] Here, changes in the harvesting and processing sectors of the U.S. tuna industry over the 1980 through 1987 period are reviewed and linear trends are estimated. The estimation results are reported in Appendix 1.0.

From 1980 through 1987, U.S. landings of all tuna species varied between 226,800 MT and 284,600 MT (Figure 1.16, Table 1.6), with an annual average of 245,640 MT. Average annual growth in domestic landings was 4% over the period as shown by the trend in Figure 1.16. When this trend is projected to 1995, landings approach 320,000 MT (plus/minus 100,000 MT).

The other source of U.S. cannery inputs is imported raw tuna. Over the 1980 through 1987, there was an overall decline in raw tuna imports as displayed in Table 1.6 and Figure 1.17. Imports in 1987 were 26% below imports in 1980. Average growth in raw tuna imports over the period was -3% annually which the linear trend in Figure 1.17 indicates. Projecting this trend to 1995 shows raw tuna imports declining to 100,000 MT annually (plus/minus 200,000 MT).

The pattern of total cannery inputs, domestic landings plus raw tuna imports, is shown in Table 1.6 and Figure 1.18. There was an overall decline of 5% in total cannery inputs from 1980 through 1986, but the total cannery supply, led by domestic landings was on the rise towards the end of the period. Nonetheless, the linear trend for total cannery inputs, based on the pattern for the entire period, is declining and shows that by 1995, total cannery inputs will have fallen to 450,000 MT (plus/minus 220,000 MT).

U.S. canned production over the 1980 through 1986 period was quite inconsistent, ranging from a low of 244,300 MT in 1982 to a high of 297,300 MT in 1987 (Table 1.6, Figure 1.19). When a linear trend was fitted to this pattern, average growth in domestic production was 2% annually over the period. Projecting this trend reveals that by 1995 U.S. canned production will reach 300,000 MT annually (plus/minus 100,000 MT).

While U.S. canned production displayed overall moderate growth over the period, growth in canned tuna imports was spectacular (Table 1.6, Figure 1.20). From 1980 through 1986, canned imports increased 273% then fell back to 1985 levels in 1987. This represents an average annual growth rate of 20% as exhibited by the linear trend shown in Figure 1.20. If import growth continues at this pace, imports will reach 200,000 MT (plus/minus 60,000 MT) by 1995.

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[3]For a more detailed discussion of events and actions associated with the changes occurring within the U.S. tuna industry over this period the reader is referred to: Herrick (1984), Herrick and Koplin (1984, 1986, 1987), and Herrick, Parks and Donley (1988).

Combining domestic production with imports shows that the overall U.S. canned tuna supply was 30% greater in 1987 than in 1980 (Table 1.6, Figure 1.21). A linear trend fitted to the total annual canned tuna supply over the period shows an annual growth rate of 4% (Figure 1.21). If this trend continues into the future, by 1995, the total U.S. canned tuna supply will reach 475,000 MT (plus/minus 100,000 MT).

For the most part, the 1977 through 1987 period was one of declining prices at the exvessel, canned wholesale and canned retail levels. Movements in exvessel prices, represented by the exvessel price index (1986 = 1.00) for all tuna species, initially increased, then declined, and then rose dramatically in 1987 (Figure 1.22). The linear trend fitted to this pattern is gradually increasing, at 5% annually. At this rate, the exvessel price index will reach 1.70 (plus/minus 0.9) in 1995.

Canned wholesale prices (average price per standard case of advertised and private label light meat tuna in 1972 dollars) displayed an overall decline from 1977 through 1986 (Figure 1.23). A linear trend estimated from the wholesale price data indicates an annual growth rate of -5% in wholesale prices (Figure 1.23) which when projected to 1995, yields an average wholesale price of $6.90 (plus/minus $8.10) per case.

The retail price (1972 dollars) for a pound of light meat tuna (6.5 ounces per can) tended to mirror the wholesale price of canned light meat tuna during this period. From 1977 through 1984, the retail price fell 24%, at an average annual rate of -4% based on the estimated linear trend shown in Figure 1.24. If the retail price continues to decline at this rate, it will fall to $.60 (plus/minus $.40) a pound by 1995.

Consumption of canned tuna in the U.S. ranged between 2.7 and 3.6 pounds per capita (civilian population) from 1977 through 1987 (Figure 1.25). Although per capita consumption was slightly erratic over the period, it grew at an average rate of 2% per year according to the linear trend shown in Figure 1.25. At this rate, per capita consumption will reach 3.7 pounds (plus/minus .9 pounds) by 1995.

1.6. Concluding Remarks

Worldwide tuna fishing and processing have grown fairly steadily over the past 8 to 10 years. This is mainly in response to increased consumption mainly in North America and in western Europe. Barring any major structural changes, and the ability of the tuna resources to support expanded production, global output of raw and processed tuna may increase by as much as 30% from 1986 based on prevailing trends. If recent patterns of growth continue into the future, this expansion is likely to be led by developing nations with burgeoning tuna industries particularly in southeast Asia, central and south America, and west Africa, especially as these nations cultivate domestic consumption of tuna and processed tuna products. Regardless, the tuna industries of the developed nations will continue to face more intense competition both on the fishing grounds and in the marketplaces.

The U.S. tuna industry appears to have survived the structural upheaval that took place during the early 1980's. Domestic tuna consumption and economic conditions within the industry have improved in the most recent years, which may shift the longer term trends upward pointing to more prosperous future.

1.7. Summary of Trade Statistics

Tuna production statistics (Source: FAO) for 1986 and the outlook for 1995 are summarized below (Table 1.7). Emphasis is on statistics of interest to the U.S. Note that the statistics are in metric tons round weight except for canned supply, in weight of edible product, and per capital consumption in pounds product weight. World statistics include tunas and tuna-like species, whereas U.S. statistics include only principal tuna species (yellowfin, skipjack, bigeye, albacore, and bluefin).

1.8. References

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Herrick, Jr., S.F., W. Parks and P. Donley. 1988. U.S. tuna trade summary, 1986. SWR Admin. Rep., Terminal Island, SWR-88-3, 36p.

Table 1.1. Annual tuna and tuna-like species catches (1000 MT) by major producing countries, 1979-87.

Country	1979	1980	1981	1982	1983	1984	1985	1986	1987
Japan	760	814	730	758	773	884	756	873	
United States	230	247	240	214	281	278	248	263	299
Spain	109	116	136	144	143	172	195	197	
France	67	68	73	69	85	89	101	109	
Tot. Developed	1229	1318	1248	1267	1361	1501	1386	1526	
Indonesia	160	189	209	244	261	263	280	305	
Philippines	217	218	224	240	268	245	279	286	293
Rep. Korea	149	137	126	127	113	103	120	146	
Taiwan	163	182	157	176	159	162	178	195	
Mexico	43	48	86	65	53	92	107	119	
Thailand	29	25	36	60	100	87	99	99	
Venezuela	24	25	35	52	65	70	72	98	
China	42	52	48	61	62	75	91	94	
India	50	61	46	56	53	51	66	70	
Ghana	20	26	22	41	48	52	45	44	53
Malaysia	24	28	48	33	36	32	32	32	
Tot. Developing	1231	1316	1401	1530	1594	1621	1779	1888	
World Total	2462	2635	2650	2793	2944	3091	3186	3418	

Note: Totals may not sum exactly due to rounding.
Source: United Nations, Food and Agricultural Organization, GLOBEFISH data base.

Table 1.2. Major processors of canned tuna (1000 MT canned product) 1979-86.

	1979	1980	1981	1982	1983	1984	1985	1986
U.S.	283	275	287	246	268	275	250	
Japan	95	95	111	113	126	130	121	
Thailand	4	5	8	15	28	59	84	
Italy	43	48	49	48	52	59	65	
France	27	25	23	30	35	37	42	
Spain	59	55	57	56	54	49	52	
Total Developed	522	510	545	508	550	578	547	
Mexico	13	15	20	13	11	22	27	13
Ivory Coast	14	16	18	20	23	23	22	
Philippines	4	11	18	19	24	23	25	26
Others	69	62	85	78	88	99	101	
Total Developing	85	90	125	116	130	148	156	
World Total	607	600	669	624	679	726	703	

Note: Others category contains both developed and developing nations.
Source: United Nations, Food and Agricultural Organization, GLOBEFISH data base.

Table 1.3. Annual fresh/frozen tuna and tuna-like species imports (1000s MT) into major importing countries, 1979-87.

Country	1979	1980	1981	1982	1983	1984	1985	1986	1987
United States	286.5	268.7	273.6	222.1	199.2	183.4	183.3	207.4	199.7
Japan	111.7	91.9	100.7	126.8	142.2	111.4	146.3	148.0	202.0
Italy	75.1	77.2	71.3	77.3	74.4	83.0	104.5	110.5	119.6
France	10.6	10.8	12.1	20.0	19.1	18.9	19.4	22.4	
Spain	8.2	12.1	28.2	42.7	21.9	14.6	14.1	22.4	
Canada	9.2	13.6	11.1	15.2	12.6	11.1	12.3	0.9	
Portugal	3.0	4.0	8.2	6.8	7.2	9.4	6.8	11.0	
Total Developed	505.3	480.6	506.8	512.2	477.5	432.4	487.0	523.4	
Thailand	0.0	0.0	0.1	0.0	0.0	21.1	81.1	205.4	159.0
Ivory Coast	8.1	13.8	14.5	25.3	28.2	33.9	35.5	38.4	
Singapore	6.5	13.7	15.1	9.2	18.1	19.9	20.4	29.3	41.6
Senegal	11.5	14.4	20.4	14.2	23.1	20.5	24.0	24.5	
Ghana	39.1	28.2	26.8	17.3	19.6	15.0	21.0	18.0	
Vanuatu	8.0	8.5	5.1	3.9	4.7	4.1	4.1	4.2	
Total Developing	81.1	82.8	85.8	74.5	98.0	121.4	189.0	337.2	
World total	586.3	563.5	592.6	586.7	575.4	553.9	680.6	860.6	

Source: United Nations, Food and Agricultural Organization, GLOBEFISH data base.

Table 1.4. Annual canned tuna imports (1000s MT) into major importing countries, 1979-87.

Country	1979	1980	1981	1982	1983	1984	1985	1986	1987
United States	26.7	28.8	26.5	28.8	48.0	58.5	74.3	84.1	78.8
France	23.4	25.6	27.7	29.8	34.0	32.5	36.9	35.6	
United Kingdom	10.5	11.1	19.2	13.3	17.6	24.1	24.0	36.5	34.7
Germany	15.0	15.2	13.6	14.9	16.1	19.1	19.8	25.4	31.5
Canada	9.9	8.8	9.7	7.0	10.7	11.6	11.0	17.8	23.1
Others	27.1	30.6	25.9	24.5	25.1	30.3	39.9	45.1	
Developed	102.1	107.4	113.5	110.3	147.4	168.8	192.1	230.9	
Developing	10.6	11.6	9.1	8.1	4.1	7.2	13.8	13.5	
World Total	112.8	119.0	122.5	118.3	151.5	176.0	205.9	244.5	

Source: United Nations, Food and Agricultural Organization, GLOBEFISH data base.

Table 1.5. Annual exports of canned tuna (1000 MT) by major exporting countries, 1979-87.

Country	1979	1980	1981	1982	1983	1984	1985	1986	1987
Japan	38.2	38.3	34.9	35.7	36.9	45.6	34.0	29.6	15.5
France	0.7	0.9	1.4	1.4	2.4	4.7	4.7	6.4	
Spain	6.5	8.0	11.6	2.1	4.1	4.2	4.9		
Portugal	1.7	2.4	1.1	2.4	3.4	2.7	3.1		
Italy	3.2	1.5	2.1	2.1	1.9	1.7	2.1		
Total Developed	51.4	53.0	52.9	45.9	52.1	61.1	51.3	48.2	
Ivory Coast	14.5	17.5	17.1	18.7	23.7	22.4	22.2	23.8	
Philippines	4.1	11.2	18.0	19.4	23.5	22.6	25.5	26.4	26.1
Senegal	11.6	11.5	15.2	16.2	20.1	22.7	20.6	19.6	
Thailand	0.0	0.0	4.7	8.5	18.1	39.9	87.1	142.0	114.9
Mauritius	1.4	1.2	1.5	1.4	2.0	2.6	3.2		
Indonesia			0.4	0.8	2.2	2.2	1.2		
Malaysia	4.1	3.2	4.1	2.8	3.7	2.9	4.1		
Ecuador	2.2	3.2	4.0	3.9	2.5	2.0	2.9		
Total Developing	49.1	57.4	89.9	90.9	119.8	138.7	191.5	238.1	
World Total	100.5	110.4	142.8	136.8	171.9	199.6	241.1	286.3	

Source: United Nations, Food and Agricultural Organization, GLOBEFISH data base.

Table 1.6. U.S. canned tuna supply (1000 MT), 1980-87.

	1980	1981	1982	1983	1984	1985	1986	1987
Landings	226.8	222.2	214.6	265.8	264.4	234.1	252.6	284.6
Imports	349.5	349.1	267.4	242.0	225.5	219.0	257.4	260.2
Cannery Inputs	576.3	571.3	482.0	507.8	489.9	453.1	510.0	544.8
Domestic Prod.	273.1	284.4	244.3	267.9	278.6	247.2	288.9	297.3
Canned Imports	28.8	32.1	39.7	55.5	73.6	97.1	107.3	96.2
Total Supply	301.9	316.5	284.0	323.4	352.2	344.3	396.2	393.5

Source: United Nations, Food and Agricultural Organization, GLOBEFISH data base.

Table 1.7. Summary of tuna production statistics for 1986 and projects for 1995.

	1986	1995 Average	1995 95% Confidence Limit
World			
Total Catch (Tuna and Tuna-like species)	3.4M	4.5M	±300K
Developed countries	1.5M	2.7M	±200K
Developing countries	1.9M	1.8M	±400K
Total Canning	703K[1]	900K	±200K
Developed countries	547K[1]	630K	±150K
Developing countries	156K[1]	270K	± 60K
U.S.			
Canning, raw supply (Tuna)	510K	450K	±220K
Domestic	253K	320K	±100K
Foreign	257K	100K	±200K
Canned supply	396K	475K	±100K
Domestic	289K	300K	±100K
Foreign	107K	200K	± 60K
Per capita consumption (lb)	1.64	1.68	±0.41

[1] Latest available statistics are for 1985.

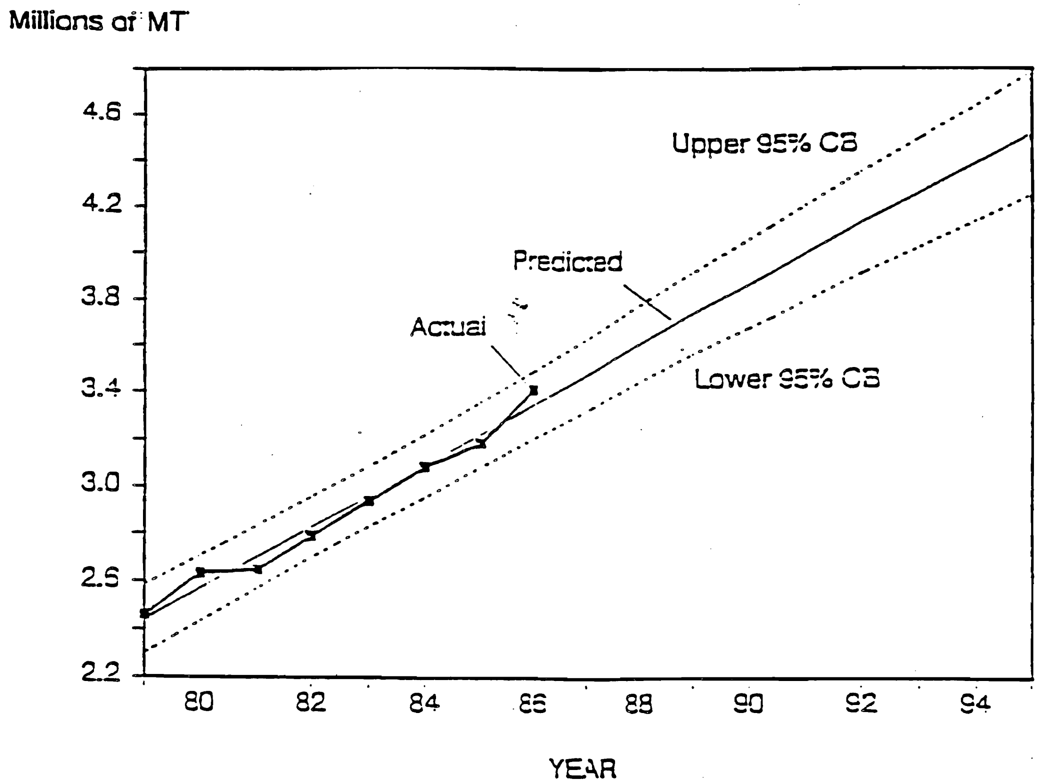

Figure 1.1. Actual and predicted global tuna and tuna-like species catches, 1979-1995.

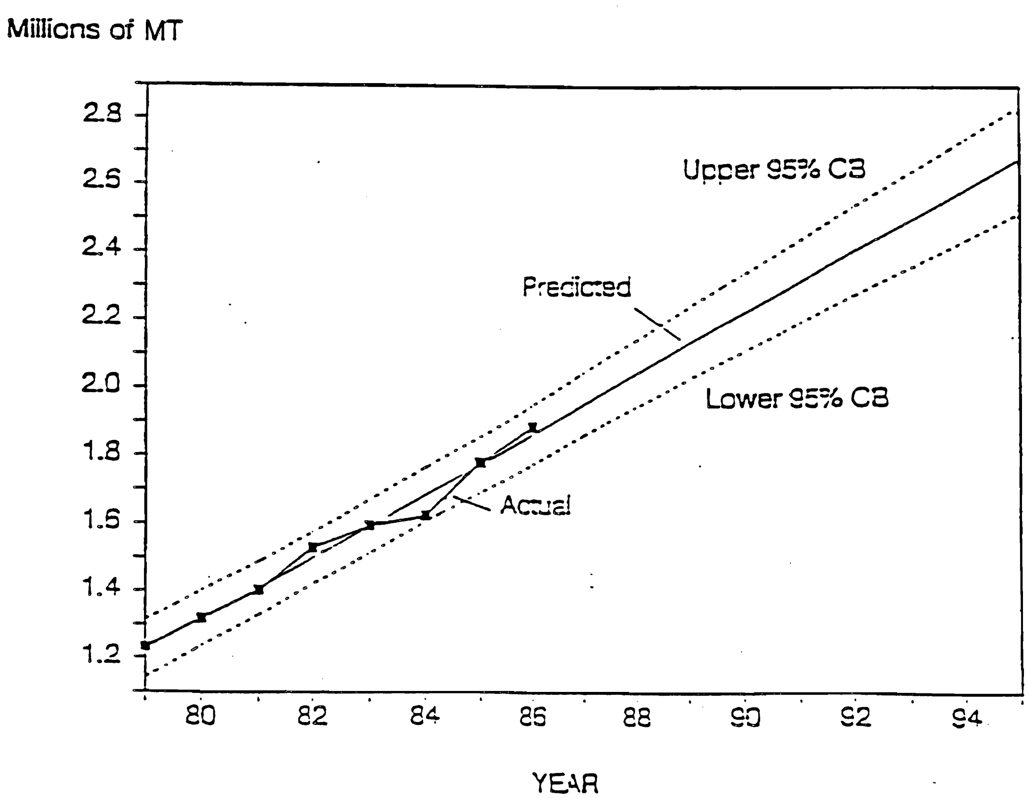

Figure 1.2. Actual and predicted tuna and tuna-like species catches by developing nations, 1979-1995.

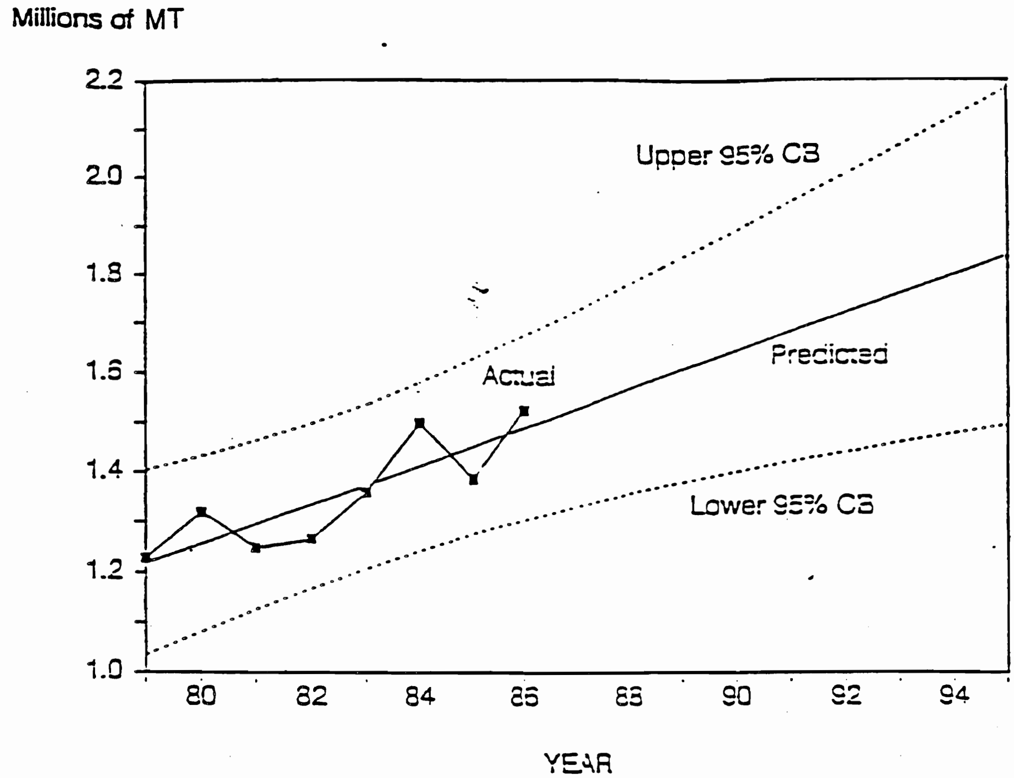

Figure 1.3. Actual and predicted tuna and tuna-like species catches by developed nations, 1979-1995.

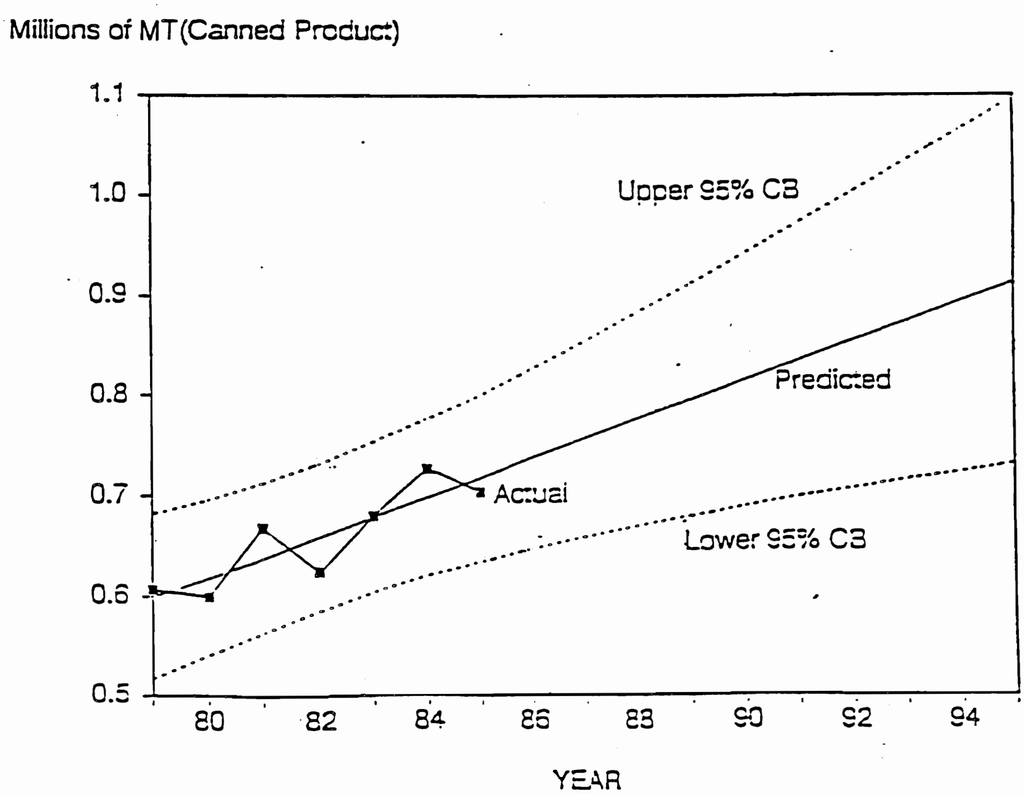

Figure 1.4. Actual and predicted global canned tuna production, 1979-1995.

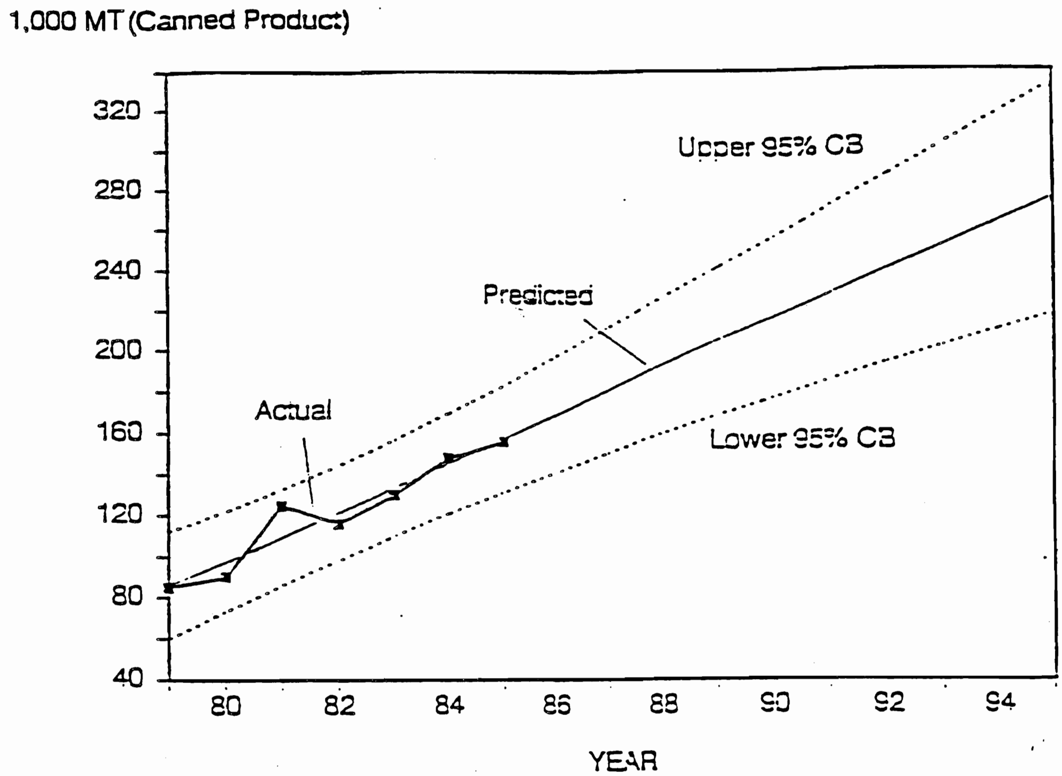

Figure 1.5. Actual and predicted canned tuna production by developing nations, 1979-1995.

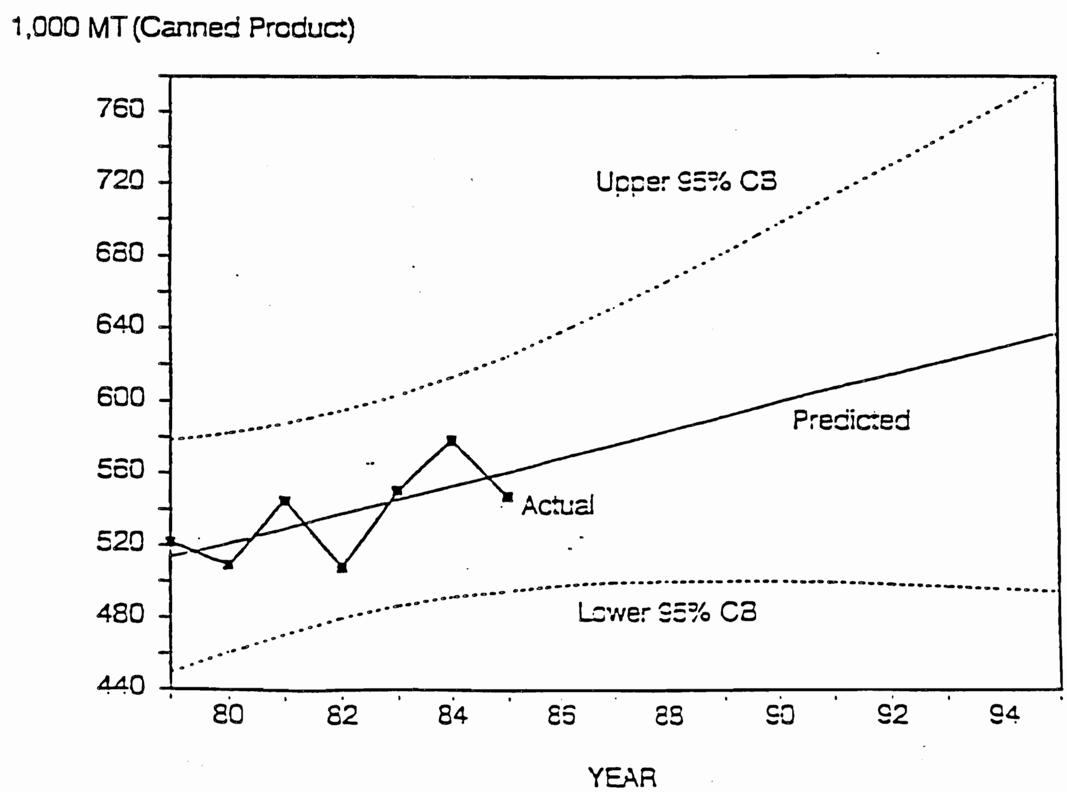

Figure 1.6. Actual and predicted canned tuna production by developed nations, 1979-1995.

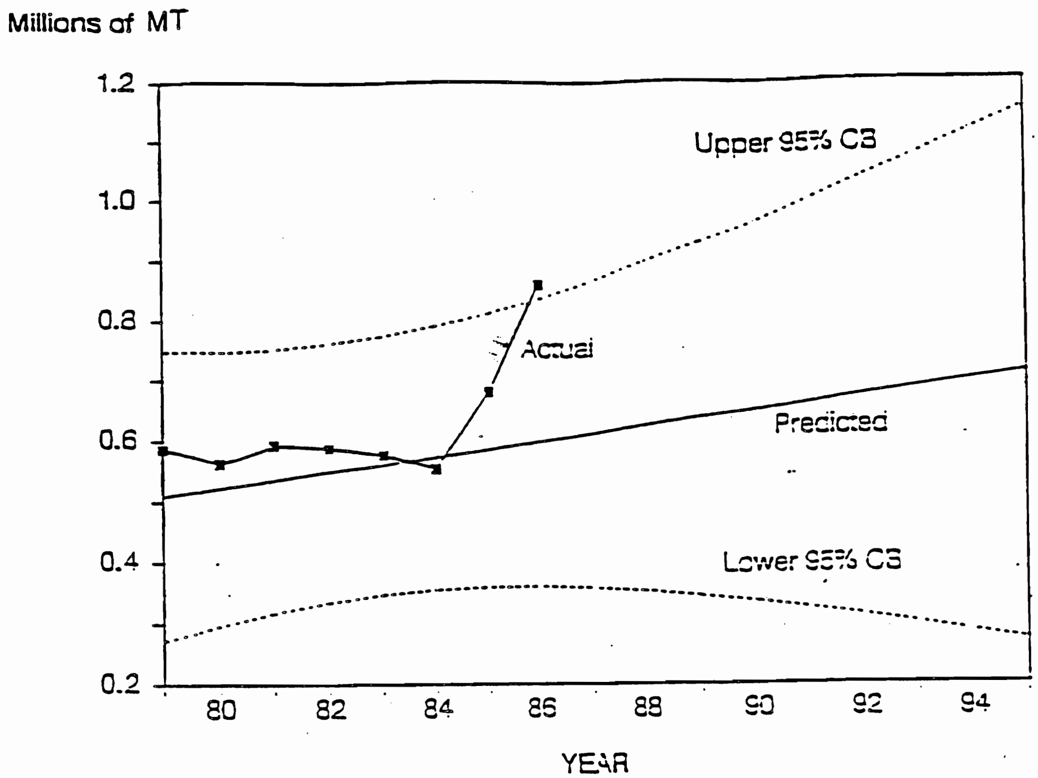

Figure 1.7. Actual and predicted global imports of fresh/frozen tuna and tuna-like species, 1979-1995.

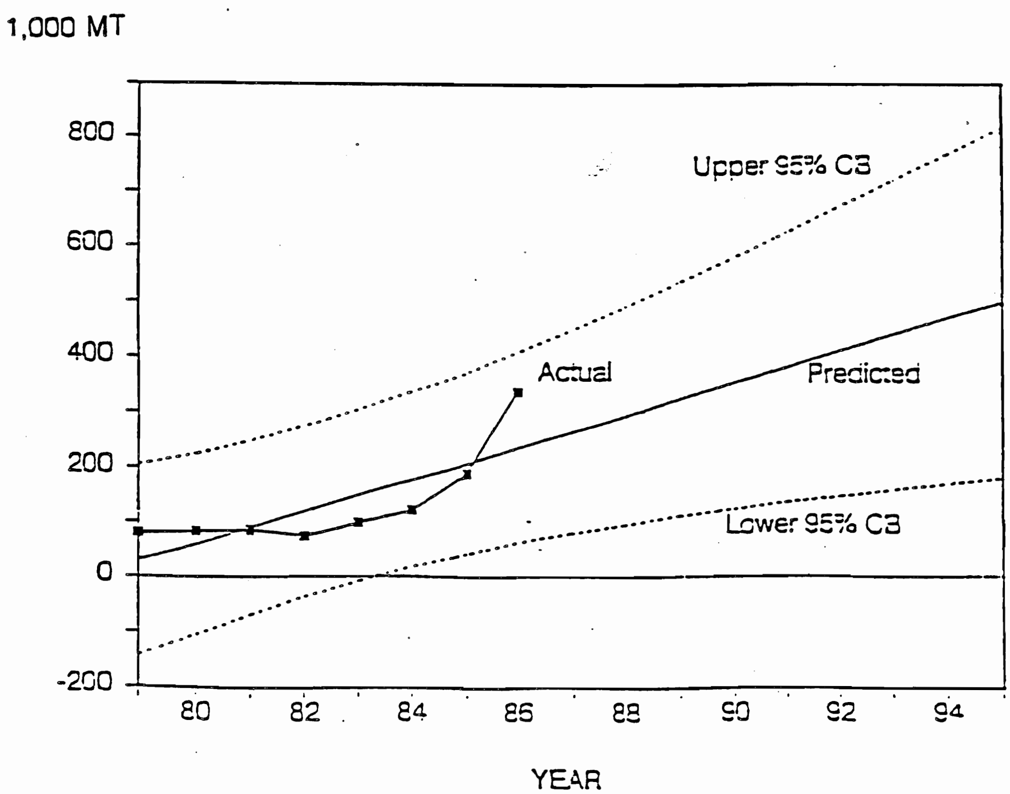

Figure 1.8. Actual and predicted imports of fresh/frozen tuna and tuna-like species by developing nations, 1979-1995.

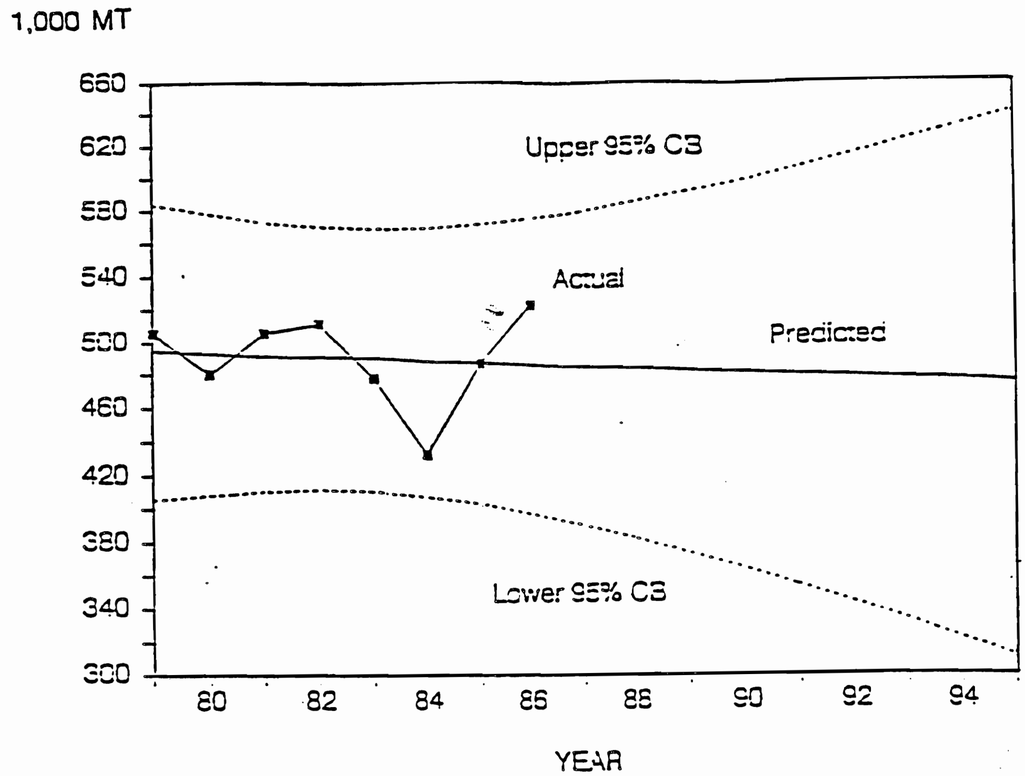

Figure 1.9. Actual and predicted imports of fresh/frozen tuna and tuna-like species by developed nations, 1979-1995.

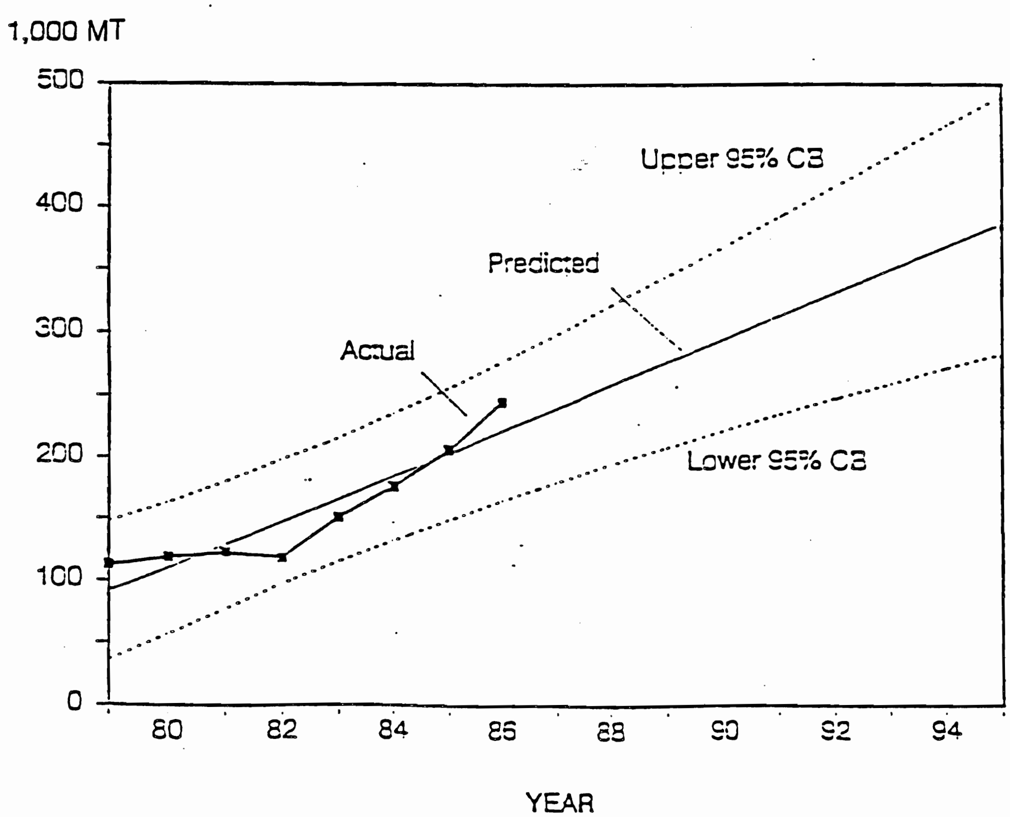

Figure 1.10. Actual and predicted global canned tuna imports, 1979-1995.

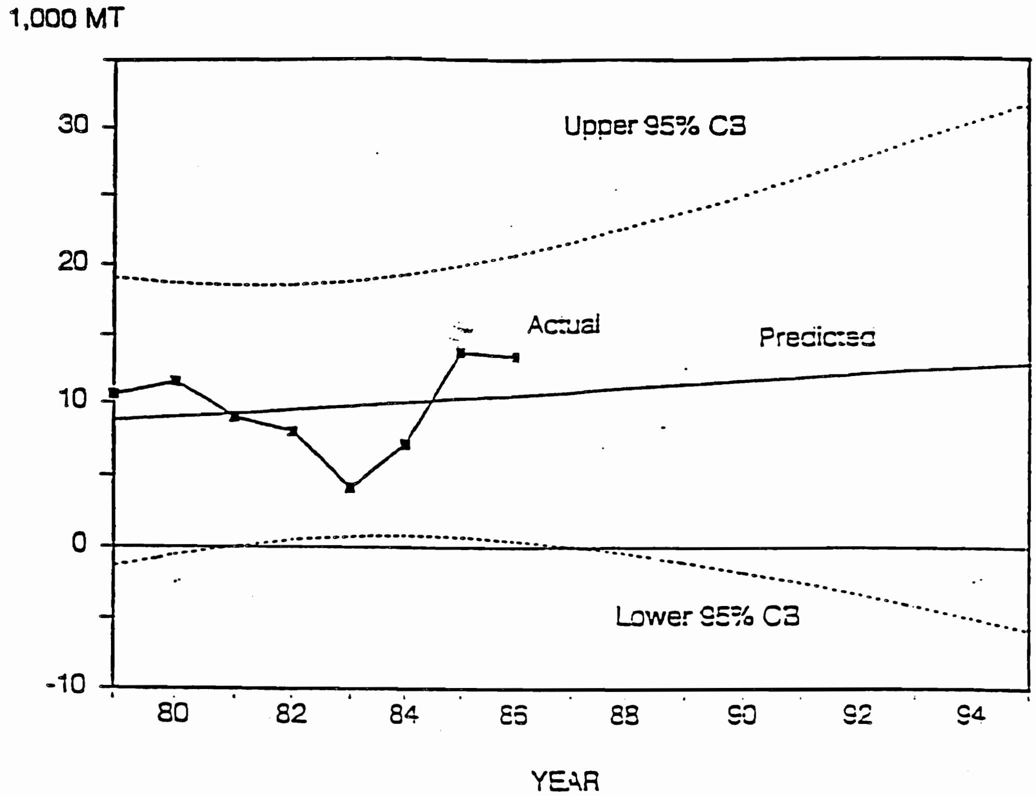

Figure 1.11. Actual and predicted imports of canned tuna by developing nations, 1969-1995.

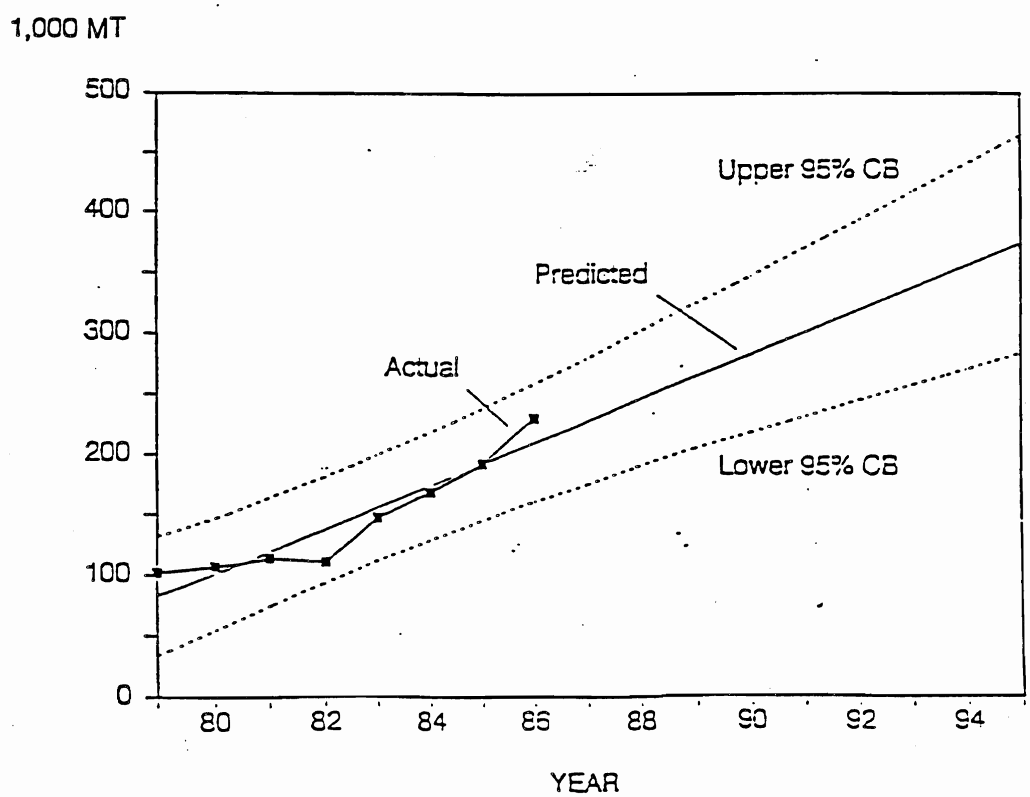

Figure 1.12. Actual and predicted imports of canned tuna by developed nations, 1979-1995.

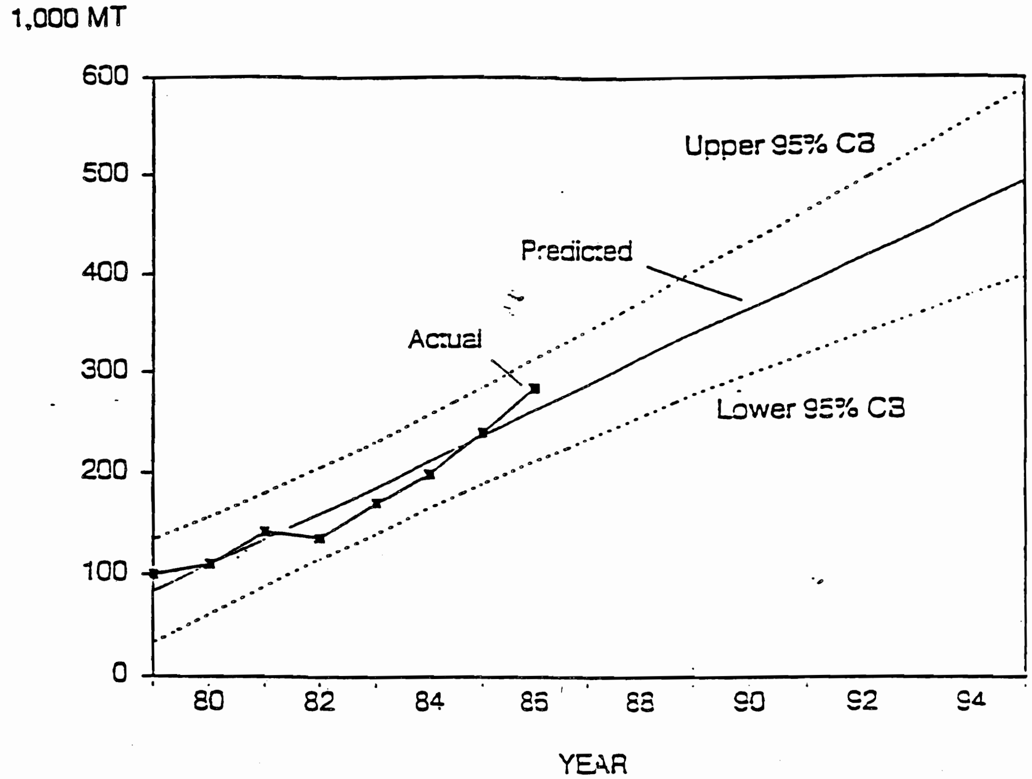

Figure 1.13. Actual and predicted global canned tuna exports, 1979-1995.

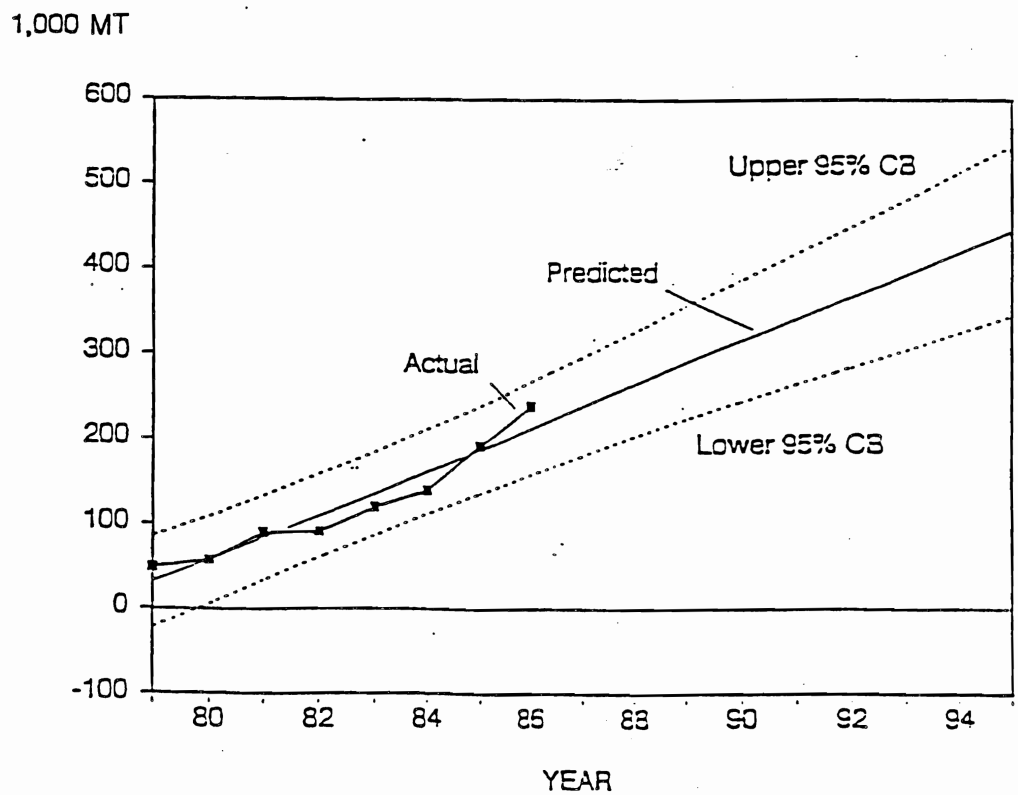

Figure 1.14. Actual and predicted canned tuna exports by developing nations, 1979-1995.

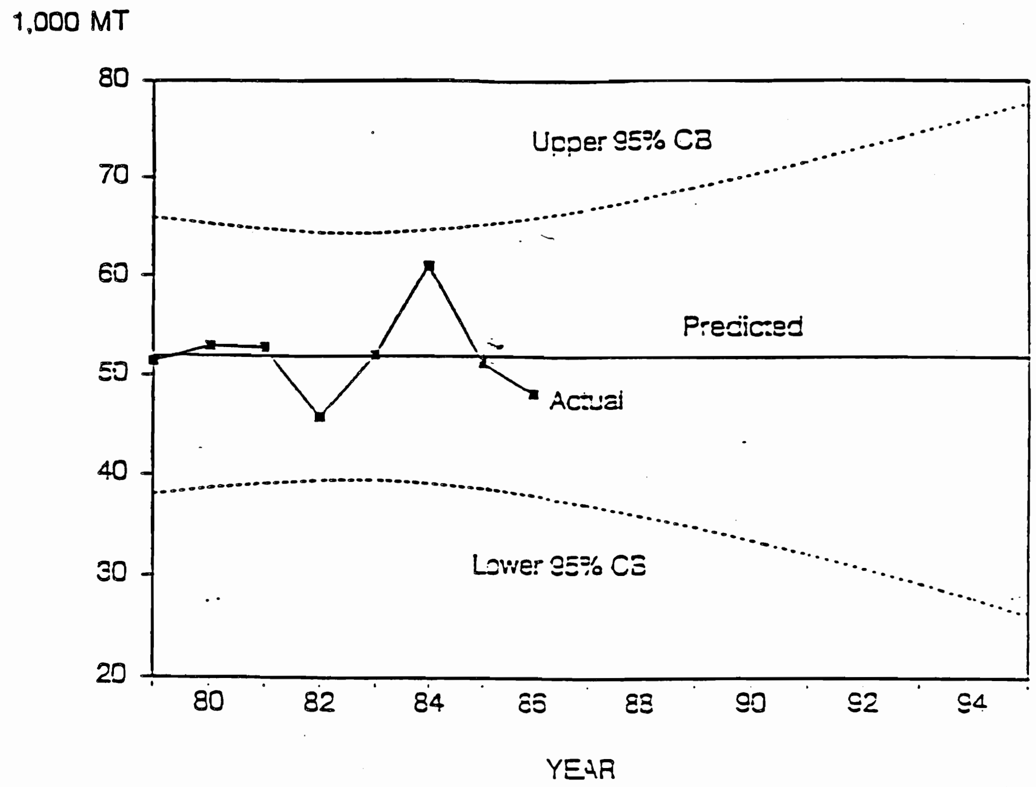

Figure 1.15. Actual and predicted canned tuna exports by developed nations, 1979-1995.

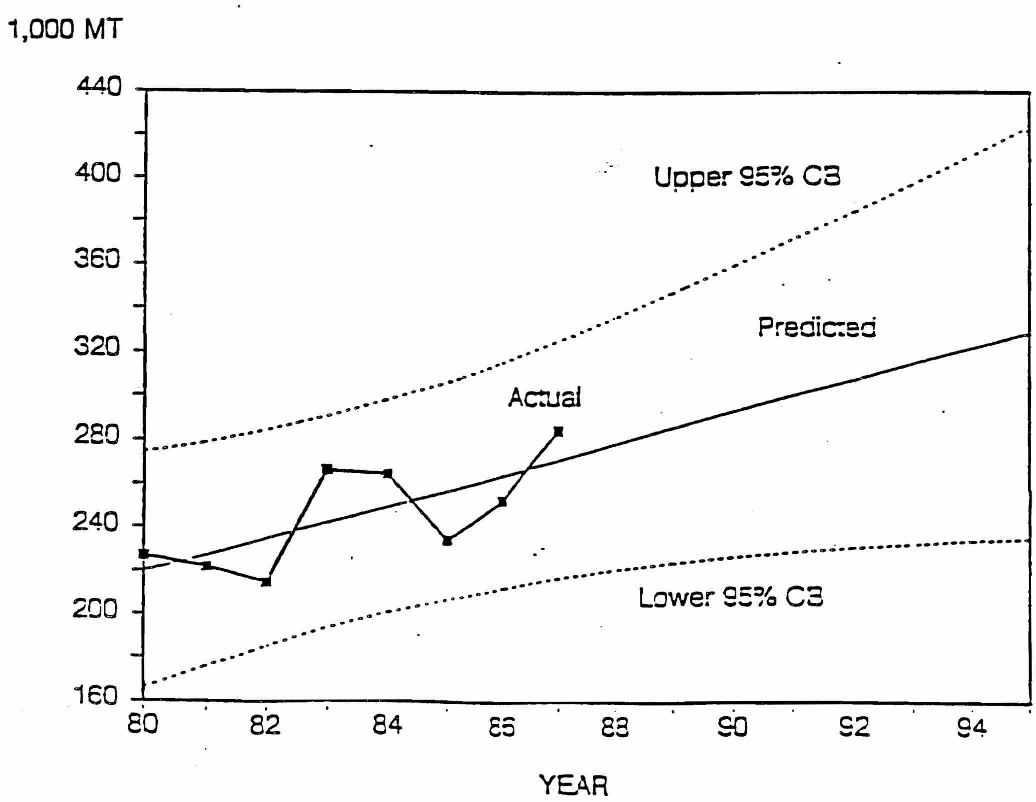

Figure 1.16. Actual and predicted U.S. tuna landings, 1980-1995.

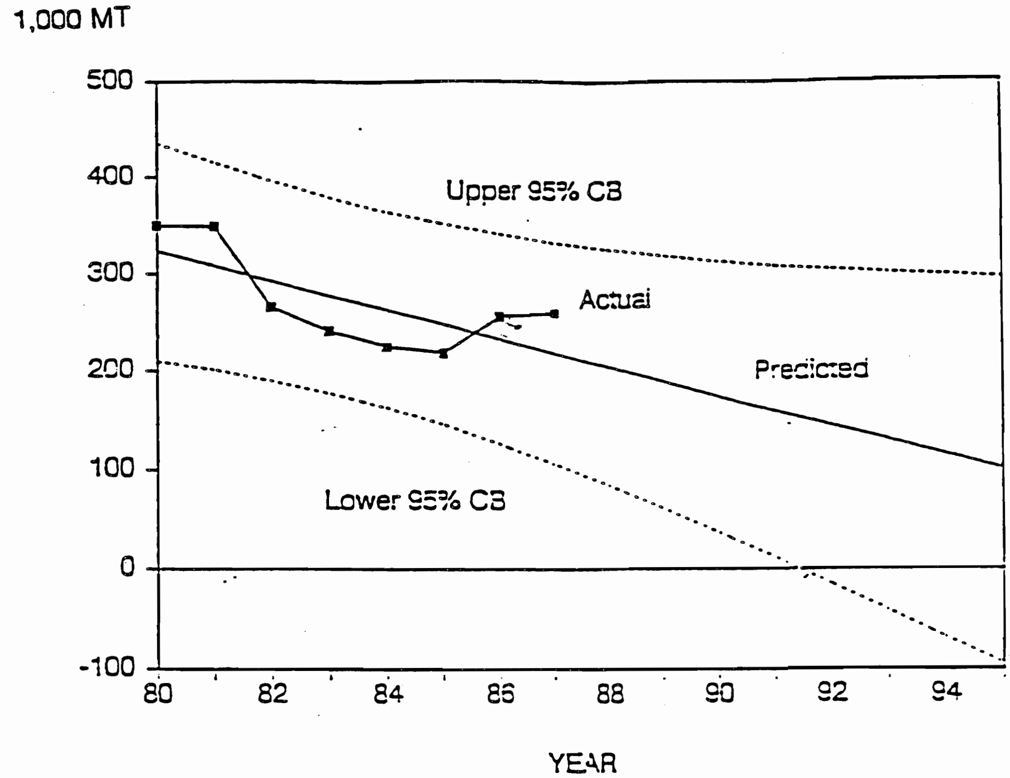

Figure 1.17. Actual and predicted U.S. tuna (all species) imports, 1980-1995.

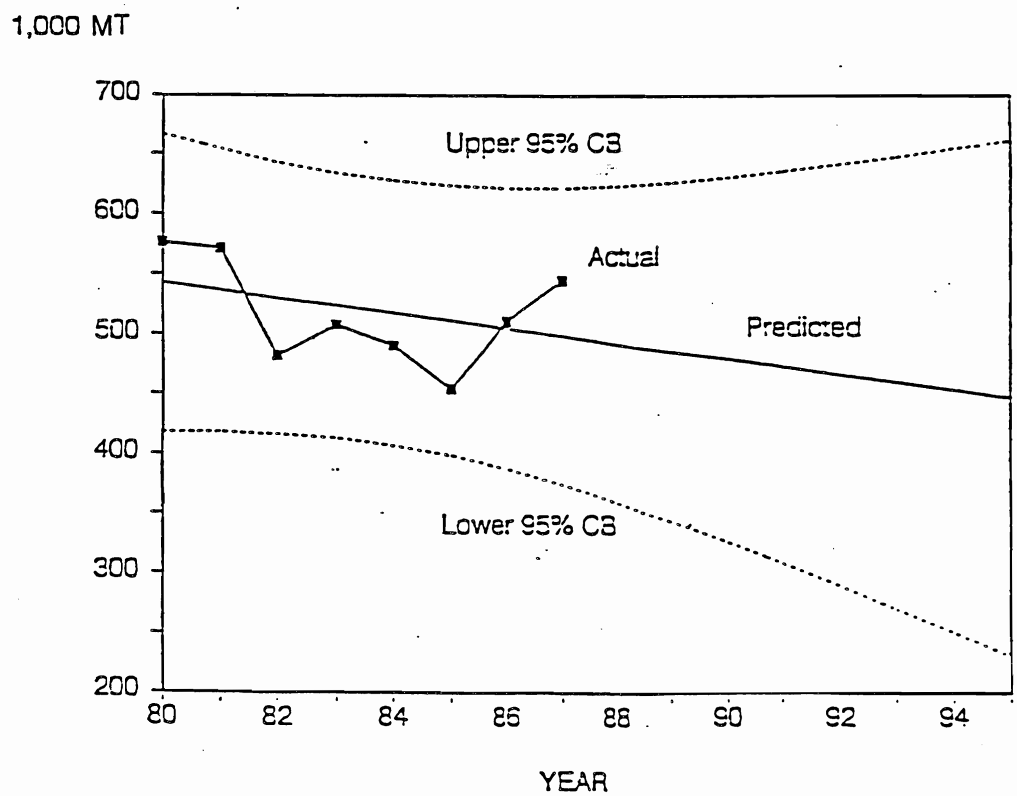

Figure 1.18. Actual and predicted U.S. total cannery inputs, 1980-1995.

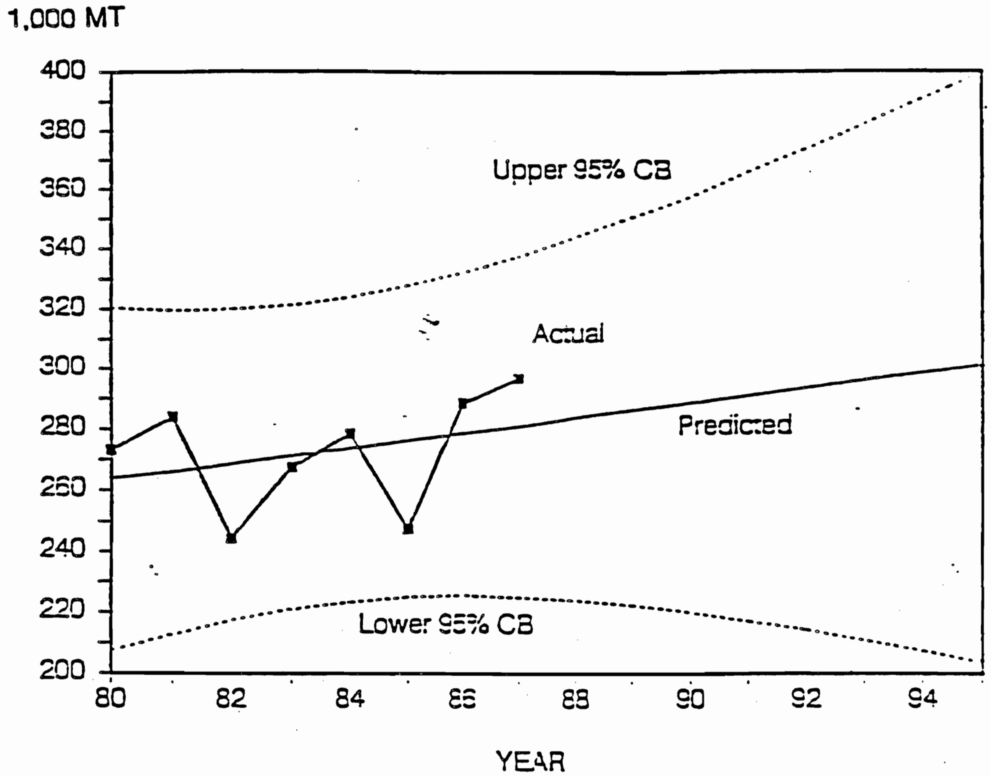

Figure 1.19. Actual and predicted U.S. canned tuna pack, 1980-1995.

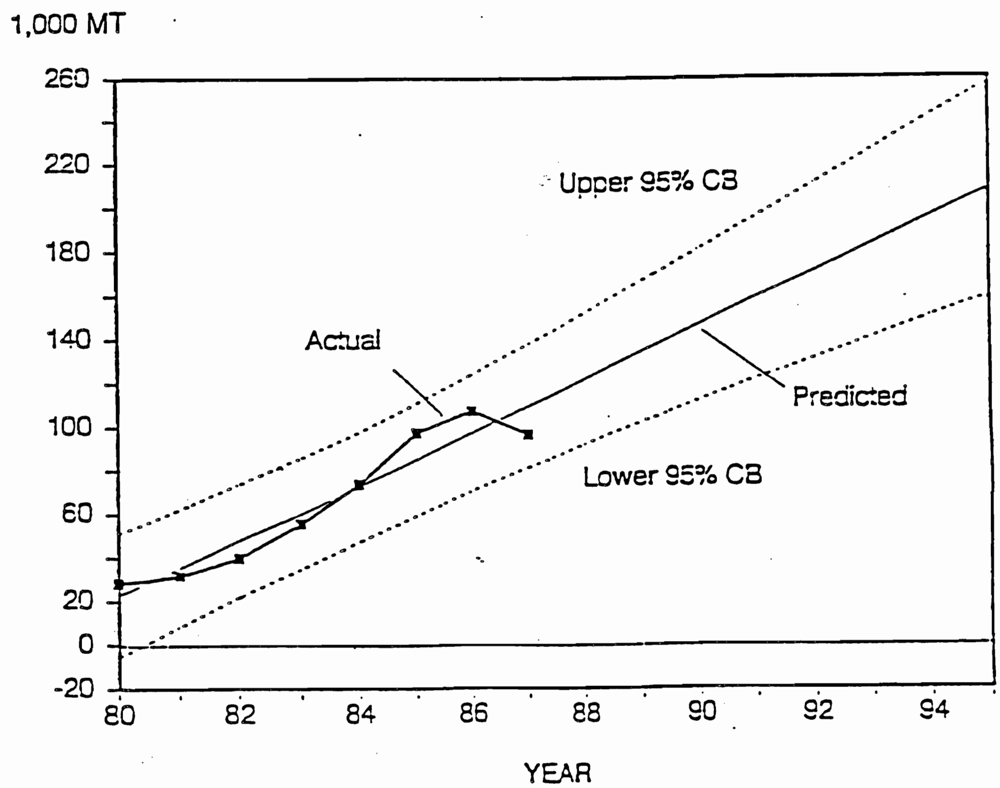

Figure 1.20. Actual and predicted U.S. canned tuna imports, 1980-1995.

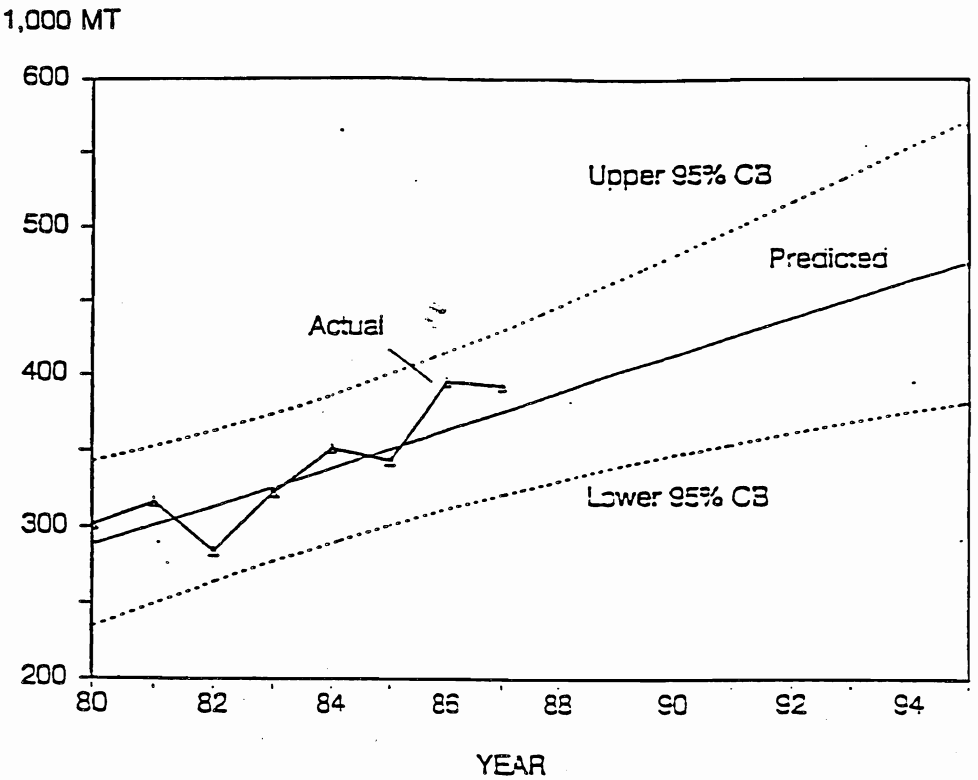

Figure 1.21. Actual and predicted U.S. canned tuna supply, 1980-1995.

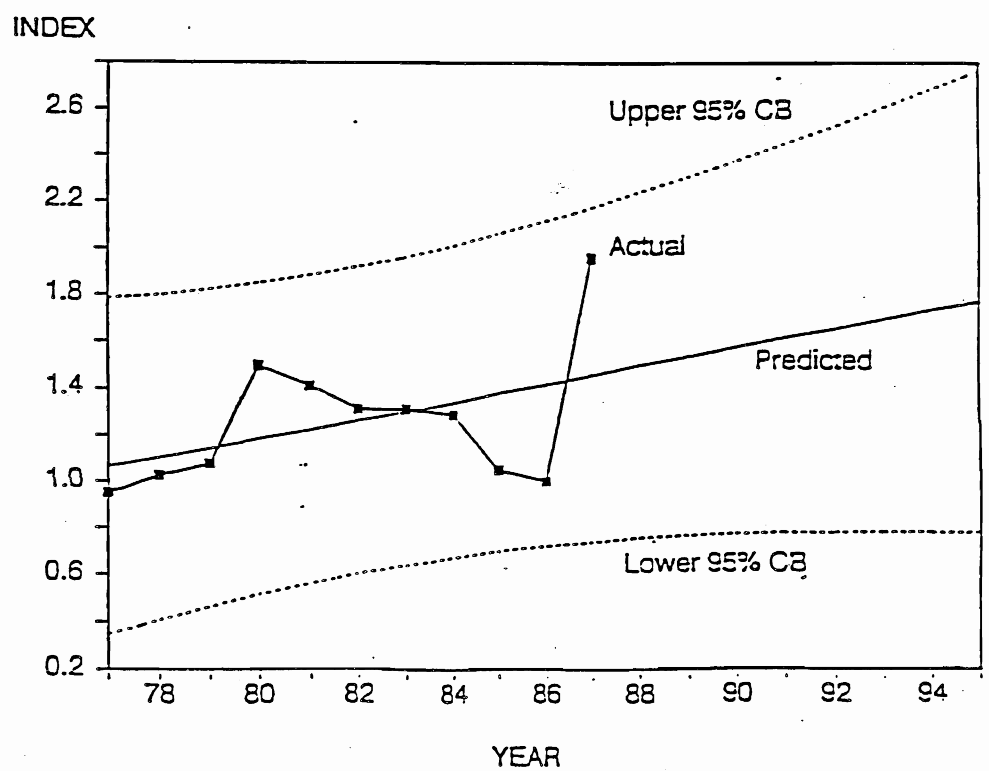

Figure 1.22. Actual and predicted movement of U.S. ex-vessel tuna price index (1986 = 1.00), 1977-1995.

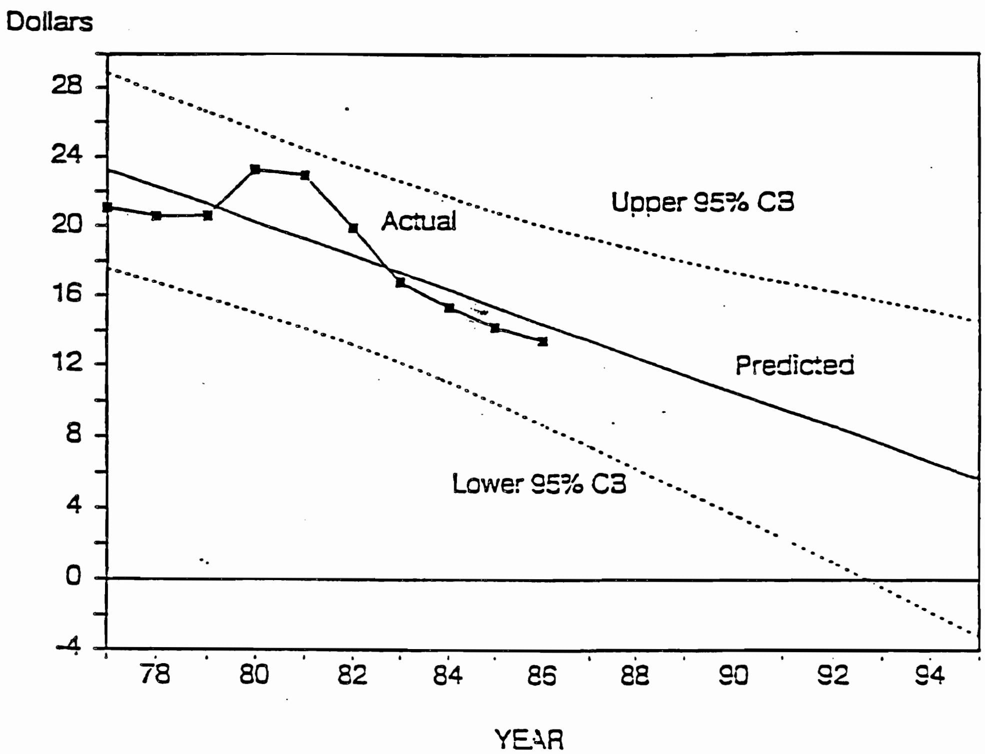

Figure 1.23. Actual and predicted U.S. canned tuna wholesale prices ($/std. case), 1977-1995.

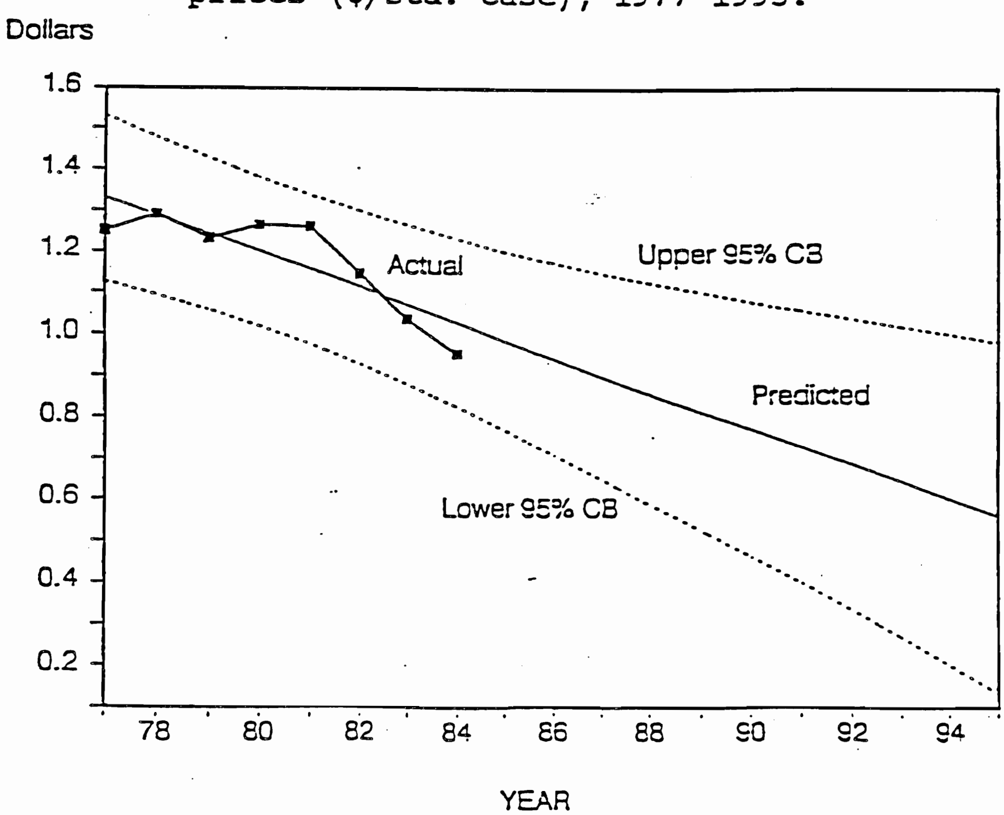

Figure 1.24. Actual and predicted U.S. retail canned tuna prices ($/lb), 1977-1995.

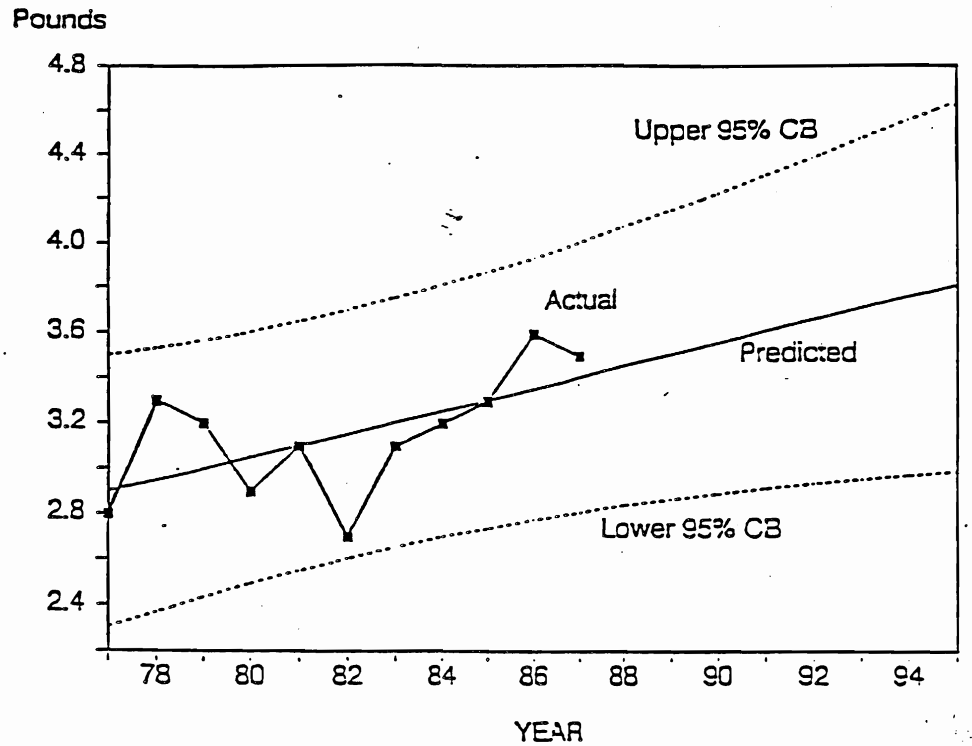

Figure 1.25. Actual and predicted U.S. civilian per capita consumption of canned tuna, 1977-1995.

Appendix 1.0. Linear trend equations for selected tuna trade variables (variable function of time).

DEPENDENT VARIABLE	CONSTANT	SLOPE[1]	R-SQD
Annual tuna and tuna-like species catches (all species):			
Developing Nations	1135.82	90.93* (4.60)	0.98
Developed Nations	1179.21	38.95* (9.81)	0.72
World Total	2312.32	130.01* (7.60)	0.98
Canned tuna processing:			
Developing Nations	73.71	11.93* (1.58)	0.92
Developed Nations	506.59	7.71 (3.91)	0.44
World Total	579.71	19.64* (5.02)	0.75
Annual fresh/frozen tuna and tuna-like species imports into major importing nations:			
Developing Nations	2.26	29.21* (9.17)	0.63
Developed Nations	495.96	-1.18 (4.73)	0.01
World Total	497.55	28.31 (12.63)	0.46
Annual canned tuna imports into major importing nations:			
Developing Nations	8.59	0.26 (0.54)	0.04
Developed Nations	64.70	18.19* (2.60)	0.89
World Total	73.27	18.45* (2.97)	0.87
Annual exports of canned tuna by major exporting countries:			
Developing Nations	5.74	25.82* (2.87)	0.93
Developed Nations	51.99	-0.001	0.00
World Total	57.98	25.71* (2.68)	0.94
U.S. canned tuna supply:			
Landings	212.76	7.31* (2.88)	0.52
Imports	337.97	-14.82 (5.96)	0.51

DEPENDENT VARIABLE	CONSTANT	SLOPE[1]	R-SQD
Total Cannery Inputs	549.03	-6.43 (5.51)	0.18
Domestic Production	261.39	2.52 (2.99)	0.11
Canned Imports	10.67	12.36* (1.49)	0.91
Total Supply	276.09	12.58* (2.41)	0.82
U.S. Ex-Vessel Price Index	1.03	0.04 (0.03)	0.20
U.S. Wholesale Price	24.20	-0.97* (0.23)	0.68
U.S. Retail Price	1.37	-0.04* (0.01)	0.73
U.S. Per Capita Consumption	2.85	0.05 (0.02)	0.37

[1] Standard errors in parentheses.

* coefficient significant at 0.05 level

2.0. TRENDS IN TUNA FISHERIES

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2.1. Introduction

The United States fisheries for tunas are primarily limited to four species -- yellowfin (*Thunnus albacares*), skipjack (*Katsuwonus pelamis*), albacore (*T. alalunga*) and northern bluefin (*T. thynnus*) -- which are frequently referred to as the principal tuna species along with southern bluefin tuna (*T. macoyii*) and bigeye tuna (*T. obesus*). The world catch[4] of these four species has more than doubled from 1970 to 1986, rising from less than 1 million metric tons (MT) in 1970 to over 2 million MT in 1986 (Table 2.1). The increased catch has been almost entirely due to increases in the yellowfin and skipjack fisheries. Both the albacore and northern bluefin catches rose somewhat during the mid 1970s; however, they have recently declined to their 1970 levels (Figure 2.1). In contrast, the U.S. catch of these four species has risen only 14%, from 214,000 MT in 1970 to 250,600 MT in 1986 (Table 2.2). This U.S. increase has been entirely due to increase in skipjack tuna; the yellowfin catch in 1986 was essentially the same as in 1970 and both the albacore and bluefin fisheries have suffered severe declines (Figure 2.2).

2.2. Yellowfin Tuna Fisheries

World yellowfin catches had a nearly continuous increase from 1970 to 1986; increasing at a rate of about 26,000 MT per year. Over the 1970 to 1986 period catches more than doubled in the Pacific, Atlantic and Indian Oceans (Figure 2.3). The catches of yellowfin by the U.S. amounted to 132,400 MT in 1970; they rose to a level of about 160,000 MT from 1972 to 1976, declined to a minimum of 100,200 MT in 1984 and then increased

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[4]Catch statistics in this chapter 2.0 are from FAO as of June 1988, and may be different from statistics reported in other chapters of this Tuna Management Information Document.

to 132,800 MT in 1986 (Figure 2.2). Yellowfin is economically the most important species in the U.S. tuna fisheries.

Yellowfin are primarily captured by two types of fishing gear, purse seine and longline. Traditionally, tuna purse seiners operated on the eastern boundaries of the oceans and longline vessels fished in the more central portions of the oceans; and these are the regions for which longer term data are available for fishing effort and catch/effort. However, more recently purse seine fisheries have developed on the western boundaries, e.g., western Pacific and Indian Oceans. A large proportion of the tuna purse seiners and longliners are very mobile vessels which may fish in one ocean in one year and another ocean in the next year; some even fish in more than one ocean in the same year.

In 1968, fishing effort of tuna purse seiners was about 7,500 fishing days in both the eastern Pacific and eastern Atlantic, and in both regions, effort increased rapidly during the 1970s (Figure 2.4). Effort reached a maximum of 35,474 fishing days in the eastern Pacific in 1979; then declined to about 17,000 fishing days in the mid 1980s. In the eastern Atlantic, maximum fishing effort (36,743 fishing days) occurred in 1982 and fell off rapidly after 1984 reaching a low of 11,742 fishing days in 1986.

In the eastern Pacific, the trend of catch per unit of effort (CPUE) of the purse seine fleet is opposite to that of fishing effort (Figure 2.4). The CPUE was above 12 MT per day fished in 1970 and it declined, during the period of increasing effort, to less than 6 MT per day fished in the late 1970s. Following the decrease in fishing effort, which occurred after 1979, CPUE increased, and by 1985 it again exceeded 12 MT per day fished. Catch per unit of effort in the eastern Atlantic was much lower (1.5 - 4.8 MT per day fished) and less variable than that in the eastern Pacific. However, the trends in the eastern Atlantic are similiar to those in the eastern Pacific in that CPUE declined during the rapid increase in fishing effort and then increased after the decline in fishing effort.

Fishing effort in the yellowfin longline fishery has increased nearly linear (Figure 2.5a). Total longline effort was dominated by effort in the Pacific; where longline effort rose from 75 million effective hooks (MEHs) in 1952 to a peak of 754 MEHs in 1980. In the Atlantic, fishing effort did not exceed 10 MEHs until 1958 and it reached 268 MEHs in 1983, the last year for which data are available. Longline effort in the Indian Ocean has had more inter-year variability than in the Pacific and Atlantic; effort exceeded 10 MEHs in 1953 and reached 156 MEHs in 1968. After 1968, effort in the Indian Ocean fluctuated considerably reaching a peak of 225 MEHs in 1982.

Catch per unit of effort in the longline fisheries has had downward trends in each ocean (Figure 2.5b). In the Pacific, CPUE did not exceed 0.5 MT per 1,000 effective hooks during the period of 1952-82 and there was a gradual downward trend over the entire period; CPUE has exceeded 0.2 MT per 1,000 hooks in only one year since 1972. In the Atlantic and Indian Oceans CPUE from the early 1950s to mid-1960s was much higher than in the Pacific; exceeding 2.0 MT per 1,000 hooks in some years. However, in both the Atlantic and Indian Oceans, CPUE declined to less than 0.5 MT per 1,000 hooks before total fishing effort reached 100 MEHs. In both regions CPUE continued to decline as effort increased and CPUE did not exceed 0.2 MT per 1,000 hooks in either ocean after 1979.

2.2.1. *Pacific Ocean*

Yellowfin catches in the Pacific rose from 260,600 MT in 1970 to 395,200 MT in 1976 and remained at about this level until 1984; catches then rose sharply reaching 523,800 MT in 1986 (Figure 2.3). The U.S. yellowfin catch from the Pacific was 125,400 MT in 1970; catches rose to a peak of 176,600 MT in 1976, declined to a low of 99,600 MT and then rose to 126,500 MT in 1986 (Table 2.4). Prior to 1980 there was no significant U.S. yellowfin fishery in the western Pacific; however, during the 1980s a U.S. fishery developed rapidly and catches reached a maximum of 51,100 MT in 1983.

In the early 1970s catches from the eastern Pacific dominated Pacific, and world yellowfin catches; comprising nearly half of the total. In the late 1970s and 1980s, catches in other regions increased and reduced the proportion of the catch which came from the eastern Pacific (i.e. from nearly half of the total catch in the early 1970s to about one third in 1986 (Table 2.3). Catches in the eastern Pacific increased somewhat from the early 1970s to the mid 1970s and then declined to a low of 124,600 MT in the El Niño year of 1983. Catches then rose to a peak of 280,200 MT in 1986. In the early 1970s most of the eastern Pacific catch was harvested by the U.S. fleet; however, in the 1980s there were significant catches by a number of other countries. In 1986, the U.S. and Mexico each took 32% of the catch, Venezuela took 10% and Japan and Ecuador each took 8% (Table 2.5.)

Although a small fleet of pole-and-line boats continues to operate in the eastern Pacific, most of the eastern Pacific catch is taken by purse seiners. The size of the international purse seine fleet grew dramatically during the 1970s, but then declined during the early 1980s. The decline was precipitated by the 1982-83 El Niño event, which caused catch rates for the target yellowfin tuna to fall off, prompting many U.S. purse seine vessels to move into the western Pacific. In recent years, ~~many~~ some of these vessels have returned to the eastern Pacific as yellowfin tuna catch rates there have increased. There were 206 vessels in the surface fishery of the eastern Pacific in 1987; all but 10 or 20 of these were purse seiners, the rest baitboats.

Catches from the western Pacific rose rapidly during the 1970s, exceeding the level from the eastern Pacific by the early 1980s. During 1980 to 1984, the western Pacific contributed the largest component to the world catch (Table 2.3). In 1986, the western Pacific fishery was divided among a number of nations; Japan took 35% of the catch, the Philippines took 24%, and the U.S and Indonesia each took 14% (Table 2.5).

The present U.S. purse seine fleet is distributed about equally between the eastern and western Pacific fishing grounds. In recent years, the fleet has been reduced, due to sinkings, economic attrition and changes in vessel registry. Along with this reduction in the number of vessels with U.S. flags, there has been a corresponding increase in vessels registered in Mexico, Venezuela and other countries. Most of the increase in the eastern Pacific yellowfin tuna catch during the 1983-86 period was due to fleet expansion by Mexico.

Since foreign tuna longliners no longer operate within the U.S. Exclusive Economic Zone (EEZ) around Hawaii, Guam, and American Samoa, the catch of yellowfin tuna in the Pacific EEZ of the U.S. is relatively small, on the order of 2,500 MT in 1987. Most of the Pacific Island EEZ catch of yellowfin is taken by trolling and handline fishing in Hawaiian waters. The troll fishery is important to the local recreational fishing community. Handline-caught yellofin and bigeye tuna supply the local fresh fish market, and are also exported to the mainland and Japan. Yellowfin and bigeye tuna are also important species taken by Hawaii's domestic tuna longline fishery which is rapidly expanding. These fish are sold locally and exported. The absence of foreign activity within the U.S. EEZ may continue to 1995, and the catch of yellowfin tuna by domestic hook-and-line vessels is likely to increase. Domestic vessels are also venturing more into central Pacific tuna areas outside the Hawaii EEZ. A shift of longline fishing effort to these waters may reduce the catch of yellowfin tuna within the U.S. EEZ.

The projected Pacific Ocean yellowfin tuna catch for 1995 is 400,000-430,000 MT, with more yield from the western than eastern Pacific. The U.S. share of this catch will likely decline as a result of flag changes and increasing competition from vessels of other nations.

2.2.2. *Atlantic Ocean*

The total catch of yellowfin from the Atlantic had an extended increase from 69,100 MT in 1970 to 169,800 MT in 1983; however, catches have declined somewhat since 1983 (Figure 2.3). The U.S. catches have been a minor component of the total Atlantic yellowfin catches exceeding 10,000 MT only in 1972 and 1975 (Table 2.4).

Most of the Atlantic catch of yellowfin tuna originates in the eastern Atlantic where catches rose from less than 60,000 MT in the early 1970s to nearly 140,000 MT in the early 1980s, but declined markedly after 1983 (Table 2.3). The surface fisheries, particularly the Spanish and French purse seine fleets, have been the major harvesters of yellowfin tuna since 1973. In the eastern Atlantic, the carrying capacity of the international baitboat fleet peaked in the late 1970s, and the purse seine fleet reached its zenith in 1983. The eastern Atlantic purse seine fleet declined in the mid-1980s, due largely to the movement of French and Spanish seiners to the Indian Ocean. The tuna longline fishery has also declined to about half its level of production in the early 1970's. In 1986, Spain took the majority of the total catch (64%); France took 8% and the rest of the catch was divided among a large number of countries (Table 2.5).

Until 1983, the U.S. Atlantic yellowfin fishery was dominated by catches from the eastern Atlantic (Table 2.4). The catch was quite variable during the 1970s and the maximum catch occurred in 1975 (13,700 MT). No U.S. vessels have operated there since 1982.

Total yellowfin catches from the western Atlantic remained between 10,000 to 15,000 MT during the period of 1970-81 and then rose sharply to a maximum of 53,333 MT in 1986 (Table 2.3). The expansion of the western Atlantic fishery after 1982 was primarily due to the growth of a purse seine fishery off Venezuela. During the same period, the longline catch of yellowfin tuna in this area was steady. The 1986 yellowfin catch in this region was dominated by Venezuela (62% of the catch); Mexico took 14% and the U.S took 11% of the the catch (Table 2.5).

There were small U.S. catches from the western Atlantic prior to 1985; in 1986, the catch reached a record high of 6,337 MT (Table 2.4). This increase was primarily due to the development of the U.S. Gulf of Mexico longline fishery, which is continuing to grow. Bigeye tuna is also taken by this fleet, but in small numbers (about 10% of the catch). Earlier U.S. catches were primarily by purse seiners.

The 1995 Atlantic yellowfin tuna catch is projected to be between 100,000 MT and 150,000 MT, depending on economic factors. It is unlikely that U.S. purse seiners will have a significant involvement.

2.2.3. *Indian Ocean*

In the 1970s, the catches from the Indian Ocean comprised a minor portion of the world's yellowfin catch. Catches were relatively stable until the mid 1980s when a rapid increase occurred. The most significant development was the 1982-86 emergence of the French and Spanish purse seine fisheries in the western Indian Ocean. The purse seiners moved into the Indian Ocean from the eastern Atlantic fishery and based their operations in the Seychelles, targeting stocks of skipjack and yellowfin tuna. Largely due to this expansion, the Indian Ocean yellowfin tuna catch grew from 48,300 MT in 1982 to 108,700 MT in 1986 (Figure 2.3). As of 1986 there were no U.S. vessels fishing tropical tunas in the Indian Ocean.

The purse seine fleet operating out of the Seychelles numbered only 7 vessels in 1983, but increased about 5-fold to number 38 vessels in 1985. The fleet is predominately French and Spanish, but also involves a few vessels registered in Ivory Coast, Mauritius, Panama, the United Kingdom, and the Soviet Union.

The catch of Indian Ocean yellowfin tuna by longliners has declined over the years. Korean and Japanese vessels account for most of the longline catch of yellowfin. Smaller amounts are taken by longliners registered in Taiwan. In the early 1980s, a few longliners from Kenya and the Soviet Union also fished in the Indian Ocean.

The Indian Ocean yellowfin tuna catch is expected to be about 120,000-150,000 MT in 1995, depending on market conditions. Most of this is likely to be taken by the international purse seine fleet, including vessels from countries not currently involved in the fishery.

2.3. Skipjack Tuna Fisheries

The skipjack fishery has had the largest increase in catches of any of the tuna fisheries. World catches rose from 392,700 MT in 1970 to 1,098,400 MT in 1986 (Table 2.6). Although the increase had more inter-year variability than with yellowfin catches, the trend was relatively constant over time with an average increase of about 44,000 MT per year (Figure 2.1). Catches from the Pacific have dominated the world's skipjack catch (Figure 2.6). The U.S. combined skipjack catch rose from 49,100 MT in 1970 to a peak of 146,600 MT in 1984, then fell to 107,700 MT in 1986 (Table 2.7).

2.3.1. *Pacific Ocean*

More than 50% of the world's annual skipjack catch (1970-86) has come from the western Pacific Ocean (Table 2.6). Catches in the western Pacific rose from 245,200 MT in 1970 to a peak of 775,500 MT in 1984. The U.S. fleet did not fish in the western Pacific prior to 1980; however, during 1982-86, the U.S. purse seine fleet expanded into the western Pacific to target skipjack in response to reduced catch rates for yellowfin tuna in the eastern Pacific. The U.S. skipjack catch in the western Pacific rose from 28,300 MT in 1982 to 114,300 MT in 1984; it was 98,000 MT in 1986. During 1982-86 most of the variation in western Pacific skipjack catch was due to fluctuation in the Japanese catch. Japan's catch ranged from 207,000 MT in 1985 to 435,900 MT in 1984. In the western Pacific, where skipjack tuna are targeted by various fleets of purse seiners and pole-and-line boats, most of the catch in 1986 was taken by Japan (53%), with smaller amounts reported by vessels from the U.S. (13%), Indonesia (12%), Philippines (11%) and other nations (11%) (Table 2.8).

In the eastern Pacific, skipjack are not consistently targeted by the purse seine fleets, and catches have been variable. Catches exceeded 100,000 MT from 1975 to 1982, and the peak catch of 164,100 MT occurred in 1985 (Table 2.6). The U.S. took more than 50% of the catch prior to 1982 (Table 2.7). In 1986, eastern Pacific skipjack catches were spread among a number of countries; Ecuador (35%), Japan (28%), Venezuela (13%), U.S. (10%), Mexico (6%) and other countries (8%) (Table 2.8).

In the U.S. Pacific EEZ, the skipjack catch is small. Almost all of it is accounted for by the Hawaii pole-and-line fleet, which took about 1,600 MT in 1987 and 1,800 MT in 1988. This is only one-third or one-fourth of the skipjack catch taken by the fleet during its heyday in the 1970s. The pole-and-line fleet has undergone a steady attrition during the last 20 years. Since the closing of the tuna cannery in Honolulu in 1984, catches have been constrained primarily by the limited local demand for fresh skipjack. Accordingly, fishing effort by the skipjack fleet has been voluntarily adjusted within season to avoid an oversupply on the local market.

The Pacific skipjack tuna catch in 1995 is projected to be about 800,000-1,000,000 MT, depending on market conditions. It is expected that most of this will continue to come from the western Pacific.

2.3.2. *Atlantic Ocean*

The Atlantic skipjack harvest rose from 44,500 MT in 1970 to 111,000 MT in 1974; catches were variable during the late 1970s and the peak catch (157,200 MT) occurred in 1982 (Figure 2.6). The Atlantic harvest has been dominated by catches from the eastern Atlantic; however, catches from the western Atlantic increased markedly during the 1980s. U.S. catches from the Atlantic exceeded 10,000 MT from 1971 to 1975, but have not been above 1,000 MT since 1981 (Table 2.7).

The eastern Atlantic skipjack catch has been extremely variable; catches rose from 42,000 MT in 1970 to over 100,000 MT in 1974 and 1977. Catches peaked at 121,500 MT in 1982, but have not exceeded 100,000 MT since 1983 (Table 2.6). The U.S. purse seine fleet was active in the eastern Atlantic during the early 1970s and its catch peaked at 18,100 MT in 1973. The fleet withdrew in 1982. The purse seine fleets of Spain and France, and pole-and-line vessels in Ghana have accounted for most of the skipjack tuna catch in the eastern Atlantic. The pole-and-line fisheries, first consisting of Japanese vessels and later dominated by Ghanaian vessels, have generally played a secondary role, except in 1979, when they took more skipjack than the purse seine fleets. In 1986, 46% of the catch was taken by Spain; Ghana took 31% and France took 6% (Table 2.8).

Skipjack catches in the western Atlantic did not exceed 10,000 MT until 1980; however, they have exceed 35,000 MT since 1982 (Table 2.6). In 1986, the pole-and-line fleet in Brazil took most of the skipjack tuna catch (55%), but a sizable portion (32%) was taken by the Venezuelan purse seine fishery that developed during the early 1980s (Table 2.8). The U.S. catch exceeded 1,000 MT only in 1981, 1985, and 1986 (Table 2.7).

Like the Atlantic Ocean yellowfin tuna catch, the Atlantic Ocean skipjack catch is likely to stabilize at a level between 150,000 mt and 200,000 mt by 1995. Little of this is apt to be taken by U.S. vessels.

2.3.3. *Indian Ocean*

During the 1970s, the Indian Ocean skipjack tuna catch remained between 30,000 and 41,000 MT; catches increased rapidly during the 1980s, particularly after 1983, reaching 155,300 MT in 1986. The expansion was primarily the result of growth in the purse seine fleets of France and Spain, which operated out of the Seychelles in the western Indian Ocean, and expansion of the Maldives pole-and-line fishery. Indian Ocean skipjack tuna in 1986 were primarily taken by French purse seiners (33%) and Spanish purse seiners (16%), and by the Maldives pole-and-line vessels (29%), Sri Lankan gillnets (9%), and Indonesian pole-and-line vessels (7%). The skipjack catch in the eastern Indian Ocean has been relatively minor; averaging less than 10% of the total Indian Ocean skipjack catch. The relatively small eastern Indian Ocean catch was taken almost entirely by Indonesia (Table 2.8).

The Indian Ocean skipjack catch is likely to continue to grow, but remain below 200,000 mt in 1995.

2.4. Albacore Tuna Fisheries

World albacore catches have been relatively constant since 1970 with catches varying between 168,000 and 230,000 MT (Figure 2.1). Regionally this stability has not been as evident. In the Pacific, catches exceeded 100,000 MT from 1971 to 1982, but have not achieved this level since; 1986 catches declined to a all-time low of 84,000 MT (Figure 2.7). Atlantic catches of albacore have averaged around 70,000 MT since 1970, although there has been a slight downward trend over the entire 1970-1986 period. Indian Ocean catches have been a minor component of the total albacore catch; however, their upward trend has partially offset the decline in the Pacific catches. It should be noted that albacore is one of the few important species for which the FAO shows a large catch labeled "Other Not Included Elsewhere" or ("Other"). This category is principally catches by Taiwan which was 34% of the total albacore catch in 1986.

2.4.1. *Pacific Ocean*

As noted above, total Pacific albacore catches have been quite variable (Figure 2.7). Traditionally, the Pacific albacore fishery has been dominated by the Japanese pole-and-line and longline fisheries in the north Pacific. However, during the 1980s, there has been a rapid increase in albacore catches by gillnet fleets from Japan, Taiwan and South Korea.

Catches in the north Pacific nearly doubled from 57,000 MT in 1970 to 101,000 MT in 1972, and they stayed for a time around the 100,000 MT level (Table 2.9). Since 1976, landings have decreased reaching a all-time low of 45,000 MT in 1986. In 1986, Japan took 88% of the north Pacific catch, and the U.S. took 11% of the total. Effort in the Japanese pole-and-line fishery in the northwestern Pacific has declined from over 16,000 vessel days in 1978 to less than 3,000 vessel days in 1986. In contrast, the longline fishing effort which occurs in the lower latitudes of the north and south Pacific has not declined as rapidly.

During the early 1970s, the United States troll fishery took the majority of the eastern Pacific albacore catch; however, the U.S. catch declined from 27,000 MT in 1972 to only 5,000 MT in 1986 (Table 2.10). Effort levels in the U.S. fishery declined from a peak of over 48,000 vessel days in 1972 to less than 6,000 in 1986.

Statistics on albacore catches (targeted and incidental) in the north Pacific drift gill-net fisheries are incomplete and undergoing revision. It is estimated that about 20,000 MT of albacore are taken annually by the various drift gillnet fisheries.

The south Pacific catch of albacore has fluctuated in a narrow range. With the exception of several years, landings have fluctuated around 30,000 MT, reaching a peak of 39,000 MT in 1977 and 1986 (Table 2.9). Almost all of the catch has been by longliners. The 1986 catch was predominately Korean (47%); Japan took 16%;, while other countries, primarily Taiwan, took 36% (Table 2.11). Since 1986, troll fisheries by vessels from the U.S., Canada, New Zealand and some other South Pacific island nations have rapidly expanded, as have drift gillnet fisheries by Japan and Taiwan. Catches by the driftnet fleet are estimated to have been between 25,000 and 50,000 MT in 1989 while the expanded troll fisheries caught about 10,000 MT.

2.4.2. *Atlantic Ocean*

Albacore landings in the Atlantic have remained relatively stable varying from a high of 85,297 MT in 1972 to a low of 58,371 MT in 1984 (Figure 2.9). Over 60% of the Atlantic catch is from the north Atlantic, and the catch in 1986 was principally by Spain (63%) (Table 2.11). In the south Atlantic, catches varied from a high of 35,000 MT in 1972 to a low of 17,000 MT in 1983 (Table 2.9). Taiwan took the largest component of the south Atlantic catch in 1986 (80%); and 15% was taken by South Africa (Table 2.11). There is no significant U.S. fishery for albacore in the Atlantic Ocean; only 46 MT were taken in 1986.

2.4.3. *Indian Ocean*

The Indian Ocean albacore catches have recently risen sharply. During the 1970s, catches varied between 5,000 and 16,000 MT; however, during the 1980s, catches have not been below 11,000 MT and in 1986 the catch rose to 35,000 MT (Figure 2.7).

Catches in the western Indian Ocean have been dominated by distant-water fisheries of Asian nations. In 1986, the catches in the Indian Ocean were dominated by Taiwan (93%); Japan took 6% of the catch (Table 2.11). The use of drift gillnets for albacore in the Indian Ocean by Taiwan began in about 1984, and expanded rapidly to become the dominant gear for albacore by 1986.

2.5. Northern Bluefin Tuna Fisheries

The total world catch of northern bluefin tuna has been reasonably constant since 1970; varying between about 30,000 and 50,000 MT. However, the catch has not exceeded 40,000 MT since 1982 (Table 2.3). Catches from the Pacific and the Atlantic (including the Mediterranean) have both varied around 20,000 MT since 1970 (Figure 2.8).

2.5.1. *Pacific Ocean*

Catches in the Pacific were stable until 1982, followed by a sharp drop to a all-time low of 8,000 MT in 1984 (Table 2.12). Recovery followed, but catches have not yet risen to historical highs (Figure 2.8). In 1986, Japan dominated the Pacific fishery taking 60% of the catch, mostly off Japan. The United States has historically dominated the bluefin fishery in the eastern Pacific, but U.S. catches amounted to only 30% of the total Pacific catch in 1986 (Table 2.14). The U.S. fishery has traditionally been carried out by purse seine vessels which normally fish for other species and switch to bluefin tuna only when they are seasonally available off southern and Baja California.

2.5.2. *Atlantic Ocean*

Catches in the Atlantic (including the Mediterranean) have had two peaks (1976 and 1984) when catches approached 30,000 MT (Figure 2.8). The western Atlantic catch exceeded 5,000 MT from 1976 to 1981, but has recently declined sharply, largely because of a catch quota instituted by ICCAT, reaching a low of 1,000 MT in 1986 (Table 2.12). The U.S. Atlantic fishery is confined to the western Atlantic and has traditionally taken slightly less than half the total catches from this region. The U.S. catch declined from a high of 2,900 MT in 1970 to a low of 289 MT in 1986 (Table 2.13). In 1986, the Atlantic fishery was dominated by Japan (62%), and the U.S. catch amounted to only 26% of the total catch (Table 2.14).

Eastern Atlantic catches have more than doubled from just over 10,000 MT in the early 1970s to over 20,000 MT since 1981 (Table 2.12). In 1986, the major nations in the fishery were Italy (45%), France (18%), Spain (15%) and Japan (5%) (Table 2.14).

2.6. Trends in Catches

In 1976, the United States enacted the Magnuson Fisheries Conservation and Management Act (MFCMA). Under the provisions of the MFCMA, tunas were considered to be highly migratory species and were specifically excluded from domestic management. Instead, the Act called for international agreements for the conservation and management of highly migratory species. To evaluate the changes in the world and U.S. tuna fisheries since enactment of the MFCMA, the average catch in the three years prior to enactment (1973-75) was compared with the average catch of the three most recent years for which complete data are available (1984-86) (Tables 2.15, 2.16).

2.6.1. *World Tuna Catches*

World catches of the four species (yellowfin, skipjack, albacore, and northern bluefin) averaged 1,328,000 MT in the 3 years before enactment of the MFCMA and rose to 1,976,000 MT in 1984-86; an increase of 49%. This increase was dominated by the 74% increase in skipjack catches; skipjack catches rose by 63% in the Pacific, 51% in the Atlantic and 260% in the Indian Ocean (Table 2.15). Yellowfin catches also had large increases worldwide (47%); rising 34% in the Pacific, 32% in the Atlantic and 267% in the Indian Ocean.

In contrast, world bluefin catches had almost no change (+1%) and world albacore catches fell by 12%. Declines were the worst in the Pacific where bluefin catches fell by 30% and albacore catches fell by 27%. In the Atlantic, bluefin catches rose by 26%, although this increase was entirely in the eastern Atlantic, and albacore catches declined by 4%. In the Indian Ocean, northern bluefin do not normally occur; albacore has been exploited there since the 1950's with wide variability in catches. The change in albacore catches from 1973-75 to 1984-86 is an increase of 96%.

2.6.2. *United States Tuna Catches*

The harvest of tunas by the U.S. averaged 249,000 MT in 1973-75 and it was the same in 1984-86. The only component of the U.S. catch that increased between the two periods was the Pacific skipjack catch, which was up by 142% (Table 2.16). All other components suffered severe declines; bluefin (-62%), albacore (-59%), and yellowfin (-23%) catches fell in the Pacific, and bluefin (-43%), yellowfin (-41%), and skipjack (-91%) catches had sharp reductions in the Atlantic.

2.7. Summary of tuna fisheries

A summary of principal characteristics of fisheries for tunas in 1986 is presented in Table 2.17. Catch statistics are from FAO and fisheries of interest to the U.S. are emphasized. The summary shows that the U.S. took about 17% of the world catch of yellowfin tuna, 10% of the skipjack tuna, 3% of the albacore, and 18% of the bluefin tuna in 1986. The U.S. is clearly not the dominant producer in most fisheries, except in the eastern tropical Pacific fishery for yellowfin tuna.

Table 2.1. World tuna catch (metric tons) by species and year.

	Yellowfin	Skipjack	Albacore	Bluefin	Total
1970	363734	392647	169576	36414	962371
1971	316416	461597	205615	43495	1027123
1972	417186	463027	226547	32887	1139647
1973	454031	566340	225561	30765	1276697
1974	481764	675025	221129	37435	1415353
1975	511405	569164	168246	42351	1291166
1976	544571	687774	230449	44501	1507295
1977	552356	660567	186886	42927	1442736
1978	543157	826356	225044	39466	1634023
1979	555812	740068	193175	40325	1529380
1980	545172	807206	193040	35991	1581409
1981	603524	762324	183778	46307	1595933
1982	586062	802103	203765	48534	1640464
1983	606512	938103	169685	39022	1753322
1984	626304	1111838	170110	35878	1944130
1985	721572	934496	182913	38284	1877265
1986	781858	1098363	185979	37552	2103752

Table 2.2. U.S. tuna catch (metric tons) by species and year.

	Yellowfin	Skipjack	Albacore	Bluefin	Total
1970	132400	49100	25500	7000	214000
1971	89200	90900	22600	10400	213100
1972	159900	40500	27300	13500	241200
1973	159800	47400	18100	10500	235800
1974	155340	65615	24964	6540	252459
1975	155279	71686	22217	9641	258823
1976	178335	92669	18633	10363	300000
1977	129904	59455	14375	7697	211431
1978	119718	108155	16922	6210	251005
1979	122023	81257	6993	6757	217030
1980	105061	106600	7214	3663	222538
1981	113277	90860	13306	2165	219608
1982	101549	85912	6953	2947	197361
1983	109655	142086	10513	1978	264232
1984	100239	146599	13711	1820	262369
1985	125017	95701	8205	4462	233385
1986	132797	107712	5251	4848	250608

Table 2.3. World yellowfin tuna catch (metric tons) by ocean area.

	Pacific		Atlantic		Indian		Total	
	West	East	West	East	West	East		
1970	86937	173700	11892	57205	25000	9000	363734	
1971	89710	125100	14779	55417	25982	5428	316416	
1972	105952	192900	14828	73182	25901	4423	417186	
1973	136481	198300	14437	79065	22456	3292	454031	
1974	140174	205046	14049	94198	24258	4039	481764	
1975	139230	219728	11396	112661	21864	6526	511405	
1976	145666	249505	11913	107397	22185	7905	544571	
1977	175772	198007	10868	116186	39871	11652	552356	
1978	193216	180805	10678	113775	32049	12634	543157	
1979	188254	207053	10089	113434	24041	12941	555812	
1980	211170	174213	10423	115302	21610	12454	545172	
1981	220595	195516	11507	139441	27791	8674	603524	
1982	211595	162516	24927	138733	40711	7580	586062	
1983	251232	124574	44415	125378	48790	12123	606512	
1984	246990	161101 65%	38795	85570	85540	8308	626304	616,031
1985	225106	238270 64%	41171	116625	88601	11799	721572	713,293
1986	243622	280183 67%	53333	96040	95387	13293	781858	790,246

1987 (73% ~~85%~~) (15%) (12%) 822,773
88 602543 580,019 (65%) 128,236 160,695 (18%) 888,950
89 596865 (66%) 156,441 (17%) 152,187 (17%) 905,493

Table 2.4. U.S. yellowfin tuna catch (metric tons) by ocean area.

	Pacific		Atlantic		Indian		Total
	West	East	West	East	West	East	
1970	0	125400	0	7000	0	0	132400
1971	0	85000	0	4200	0	0	89200
1972	0	148300	0	11600	0	0	159900
1973	0	157000	0	2800	0	0	159800
1974	0	150361	0	4979	0	0	155340
1975	0	141567	0	13712	0	0	155279
1976	0	176556	5	1774	0	0	178335
1977	0	124693	0	5211	0	0	129904
1978	0	116109	10	3599	0	0	119718
1979	0	120513	0	1510	0	0	122023
1980	1059	102652	466	884	0	0	105061
1981	12871	98313	409	1684	0	0	113277
1982	14835	85913	165	636	0	0	101549
1983	51066	58297	292	0	0	0	109655
1984	41455	58127	657	0	0	0	100239
1985	28798	90632	5587	0	0	0	125017
1986	36520	89940	6337	0	0	0	132797

Table 2.5. Yellowfin tuna catch (metric tons) by country and ocean area for 1986.

	Pacific West	Pacific East	Atlantic West	Atlantic East	Indian West	Indian East	Total
USA	36520	89940	6337	0	0	0	132797
Japan	86452	21273	2172	3495	8399	2783	124574
Mexico	0	90777	7500	0	0	0	98277
Spain	0	0	0	62092	17532	0	79624
Venezuela	0	30300	33308	0	0	0	63608
Philippines	59510	0	0	0	0	0	59510
France	0	0	0	8082	32889	0	40971
Indonesia	34238	0	0	0	0	3270	37508
Korea	3587	9620	1007	811	14062	829	29916
Others	17972	882	614	114	0	5238	24820
Ecuador	0	21957	0	0	0	0	21957
World	243622	280183	53333	96040	95387	13293	781858

Table 2.6. World skipjack tuna catch (metric tons) by ocean area.

	Pacific West	Pacific East	Atlantic West	Atlantic East	Indian West	Indian East	Total
1970	245176	61510	2476	41985	39200	2300	392647
1971	244209	106110	2673	67491	38681	2433	461597
1972	311957	40410	2801	72160	31869	3830	463027
1973	410765	47110	3134	71217	30012	4102	566340
1974	446304	78153	3844	107221	34909	4594	675025
1975	358343	111147	4407	60102	30593	4572	569164
1976	425587	149501	5085	68989	32630	5982	687774
1977	419394	101006	6654	103219	26172	4122	660567
1978	547689	148025	6641	93540	25329	5132	826356
1979	494222	125381	5810	80726	27318	6611	740068
1980	517250	137667	13385	93024	37771	8109	807206
1981	436109	149816	24895	105648	39146	6710	762324
1982	467230	124991	35715	121517	40753	11897	802103
1983	664853	71390	36409	102655	49681	13115	938103
1984	775512	99024	39073	96250	91409	10570	1111838
1985	517685	164122	41000	76746	124547	10396	934496
1986	735073	80723	39892	87412	143662	11601	1098363

Table 2.7. U.S. skipjack tuna catch (metric tons) by ocean area.

	Pacific		Atlantic		Indian		Total
	West	East	West	East	West	East	
1970	0	40000	0	9100	0	0	49100
1971	0	77100	200	13600	0	0	90900
1972	0	28100	0	12400	0	0	40500
1973	0	29200	100	18100	0	0	47400
1974	0	52335	0	13280	0	0	65615
1975	0	61128	2	10556	0	0	71686
1976	0	91041	0	1628	0	0	92669
1977	0	54031	19	5405	0	0	59455
1978	0	105902	63	2190	0	0	108155
1979	0	79711	292	1254	0	0	81257
1980	9918	94259	657	1766	0	0	106600
1981	17213	69527	1410	2710	0	0	90860
1982	28286	56955	646	25	0	0	85912
1983	104352	37124	591	19	0	0	142086
1984	114278	32001	320	0	0	0	146599
1985	85674	8139	1888	0	0	0	95701
1986	97986	8354	1372	0	0	0	107712

Table 2.8. Skipjack tuna catch (metric tons) by country and ocean area for 1986.

	Pacific		Atlantic		Indian		Total
	West	East	West	East	West	East	
Japan	389207	22551	0	0	564	3	412325
USA	97986	8354	1372	0	0	0	107712
Indonesia	87545	0	0	0	0	10955	98500
Philippines	77031	0	0	0	0	0	77031
Spain	0	0	0	40629	24877	0	65506
France	0	0	0	4910	51755	0	56665
Maldive Is.	0	0	0	0	45445	0	45445
Solomon Is.	38247	0	0	0	0	0	38247
Ecuador	0	28230	0	0	0	0	28230
Ghana	0	0	0	26878	0	0	26878
Korea	25573	3	7	4	0	0	25587
Venezuela	0	10370	12578	0	0	0	22948
Brazil	0	0	21824	0	0	0	21824
World	735073	80723	39892	87412	143662	11601	1098363

Table 2.9. World albacore tuna catch (metric tons) by ocean area.

	Pacific North	Pacific South	Atlantic North	Atlantic South	Indian Total	Total
1970	56881	28160	46632	24403	13500	169576
1971	83414	32313	57840	25648	6400	205615
1972	101287	33041	50566	34731	6922	226547
1973	100274	35654	47192	28869	13572	225561
1974	103669	29700	52513	20283	14964	221129
1975	77801	25513	41490	18081	5361	168246
1976	119454	27214	57619	19992	6170	230449
1977	62784	39177	52983	22229	9713	186886
1978	99263	36797	48565	23766	16653	225044
1979	74365	28777	50357	23465	16211	193175
1980	82675	37279	38335	23114	11637	193040
1981	73158	37862	34300	25225	13233	183778
1982	71545	34566	42344	32105	23205	203765
1983	57983	26163	51249	17110	17180	169685
1984	71740	24880	39997	18374	15119	170110
1985	60378	31830	40589	33714	16402	182913
1986	44608	39418	34871	32101	34981	185979

Table 2.10. U.S. albacore tuna catch (metric tons) by ocean area.

	Pacific North	Pacific South	Atlantic North	Atlantic South	Indian	Total
1970	25500	0	0	0	0	25500
1971	22600	0	0	0	0	22600
1972	27300	0	0	0	0	27300
1973	18100	0	0	0	0	18100
1974	24964	0	0	0	0	24964
1975	22217	0	0	0	0	22217
1976	18633	0	0	0	0	18633
1977	14373	0	2	0	0	14375
1978	16922	0	0	0	0	16922
1979	6993	0	0	0	0	6993
1980	7196	0	18	0	0	7214
1981	13252	0	54	0	0	13306
1982	6877	0	76	0	0	6953
1983	10491	0	22	0	0	10513
1984	13687	0	24	0	0	13711
1985	8189	0	16	0	0	8205
1986	5109	96	46	0	0	5251

Table 2.11. Albacore tuna catch (metric tons) by country and ocean area for 1986.

	Pacific North	Pacific South	Atlantic North	Atlantic South	Indian Total	Total
Other	179	14240	11758	25688	32530	84395
Japan	39320	6427	731	1149	2250	49877
Spain	0	0	21963	180	0	22143
Korea	0	18655	373	321	201	19550
USA	5109	96	46	0	0	5251
S. Africa	0	0	0	4763	0	4763
World	44608	39418	34871	32101	34981	185979

Table 2.12. World northern bluefin tuna catch (metric tons) by ocean area.

	Pacific West	Pacific East	Atlantic West	Atlantic East	Total
1970	15200	6200	4644	10370	36414
1971	14803	10000	5011	13681	43495
1972	5421	13500	2684	11282	32887
1973	4849	11600	3622	10694	30765
1974	10622	5692	3195	17926	37435
1975	7127	9678	4140	21406	42351
1976	5372	10831	5535	22763	44501
1977	8701	8906	6549	18771	42927
1978	13773	5562	5483	14648	39466
1979	17416	5560	5259	12090	40325
1980	14348	2846	5822	12975	35991
1981	25298	2110	5669	13230	46307
1982	22550	3062	1261	21661	48534
1983	14617	915	2526	20964	39022
1984	6653	1396	2316	25513	35878
1985	7442	4264	2586	23992	38284
1986	9487	5562	1131	21372	37552

Table 2.13. U.S. northern bluefin tuna catch (metric tons) by ocean area.

	Pacific West	Pacific East	Atlantic West	Atlantic East	Total
1970	0	4100	2900	0	7000
1971	0	8000	2400	0	10400
1972	0	11500	2000	0	13500
1973	0	9100	1400	0	10500
1974	0	5451	1089	0	6540
1975	0	7424	2217	0	9641
1976	0	8525	1838	0	10363
1977	0	5888	1809	0	7697
1978	0	4671	1539	0	6210
1979	0	5555	1202	0	6757
1980	0	2276	1387	0	3663
1981	0	876	1289	0	2165
1982	0	2419	523	5	2947
1983	7	760	1211	0	1978
1984	0	683	1137	0	1820
1985	0	3205	1257	0	4462
1986	0	4559	289	0	4848

Table 2.14. Northern bluefin tuna catch (metric tons) by country and ocean area for 1986.

	Pacific West	Pacific East	Atlantic West	Atlantic East	Total
Other	474	1000	137	3681	5292
Japan	9013	3	705	997	10718
Italy	0	0	0	9600	9600
USA	0	4559	289	0	4848
Spain	0	0	0	3256	3256
France	0	0	0	3838	3838
Total	9487	5562	1131	21372	37552

Table 2.15. Mean world catch (metric tons) by ocean for 1973-75 and 1984-86.

	Pacific 73-75	Pacific 84-86	Atlantic 73-75	Atlantic 84-86	Indian 73-75	Indian 84-86	Total 73-75	Total 84-86
<u>Catch</u>								
Bluefin	16523	11521	20328	25637	0	80	36850	37238
Albacore	124204	91062	69476	66549	11299	22167	204979	179778
Yellowfin	346320	465091	108602	143845	27478	100976	482400	709911
Skipjack	483941	790713	83308	126791	36261	130728	603510	1048232
<u>Percent Change</u>								
Bluefin	-30%		+26%				+1%	
Albacore	-27%		- 4%		+ 96%		-12%	
Yellowfin	+34%		+32%		+267%		+47%	
Skipjack	+63%		+51%		+260%		+74%	

Table 2.16. Mean U.S. catch (metric tons) by ocean for 1973-75 and 1984-86.

	Pacific 73-75	Pacific 84-86	Atlantic 73-75	Atlantic 84-86	Indian 73-75	Indian 84-86	Total 73-75	Total 84-86
<u>Catch</u>								
Bluefin	7325	2816	1569	894	0	0	8894	3710
Albacore	21760	9027	0	29	0	0	21760	9056
Yellowfin	149643	115157	7164	4194	0	0	156806	119351
Skipjack	47554	115477	14013	1193	0	0	61567	116671
<u>Percent Change</u>								
Bluefin	-62%		-43%				-58%	
Albacore	-59%						-58%	
Yellowfin	-23%		-41%				-24%	
Skipjack	+42%		-91%				+89%	

Table 2.17. Summary of 1986 catches by fisheries of interest to the U.S.

Fishery	World Catch (x 10^3 MT)	World Dominant Gear	World Dominant Producer	U.S. Catch (x 10^3 MT)	U.S. Dominant Gear
Yellowfin Tuna					
Eastern Pacific	280	Purse seine	Mexico/U.S.	90	Purse seine
Western Pacific	244	Purse seine	Japan	36	Purse seine
Eastern Atlantic	96	Purse seine	Spain	-	-
Western Atlantic	53	Purse seine	Venezuela	6	Longline
Eastern Indian O.	13	Longline	Indonesia	-	-
Western Indian O.	95	Purse seine	France	-	-
Skipjack Tuna					
Eastern Pacific	81	Purse seine	Ecuador	8	Purse seine
Western Pacific	735	Purse seine	Japan	98	Purse seine
Eastern Atlantic	87	Purse seine	Spain	-	-
Western Atlantic	40	Pole-and-line	Brazil	>1	Purse seine
Eastern Indian O.	11	Pole-and-line	Indonesia	-	-
Western Indian O.	144	Purse seine	France	-	-
Albacore					
North Pacific	46	Pole-and-line	Japan	5	Troll
South Pacific	40	Longline	Korea	0.1	Troll
North Atlantic	40	Longline	Taiwan	0.2	Longline
South Atlantic	28	Longline	Taiwan	-	-
Indian Ocean	28	Gillnet	Taiwan	-	-
Bluefin Tuna					
Pacific	15	Purse seine	Japan	5.1	Purse seine
Eastern Atlantic	17	Purse seine	France/Italy	-	-
Western Atlantic	2	Longline	Japan	1.1	Purse seine

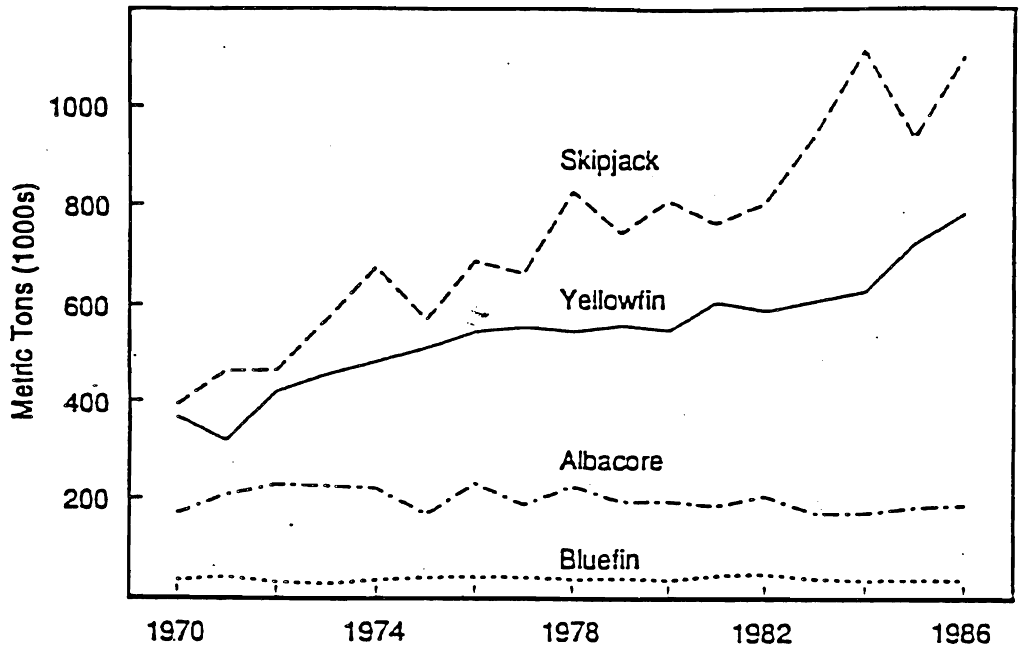

Figure 2.1. Annual world tuna catch by species.

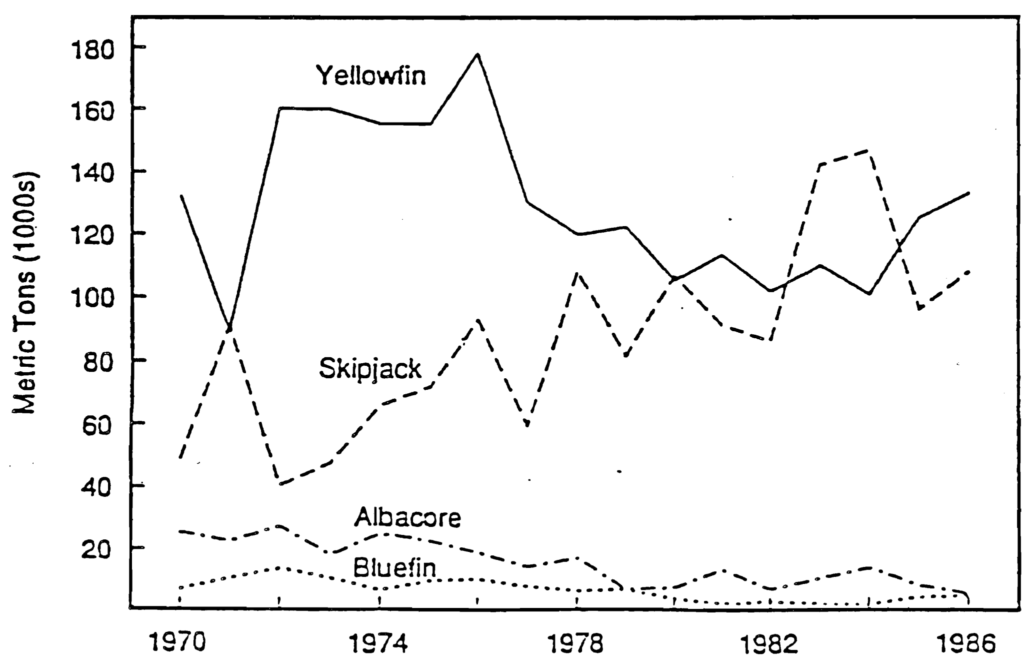

Figure 2.2 Annual U.S. tuna catch by species.

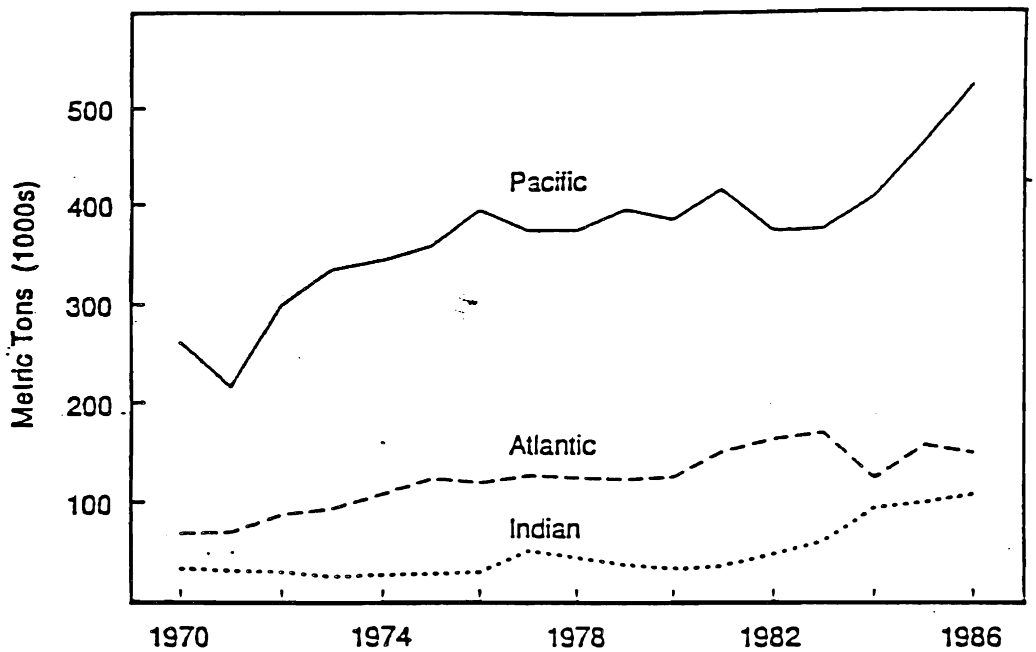

Figure 2.3. World yellowfin tuna catch by ocean.

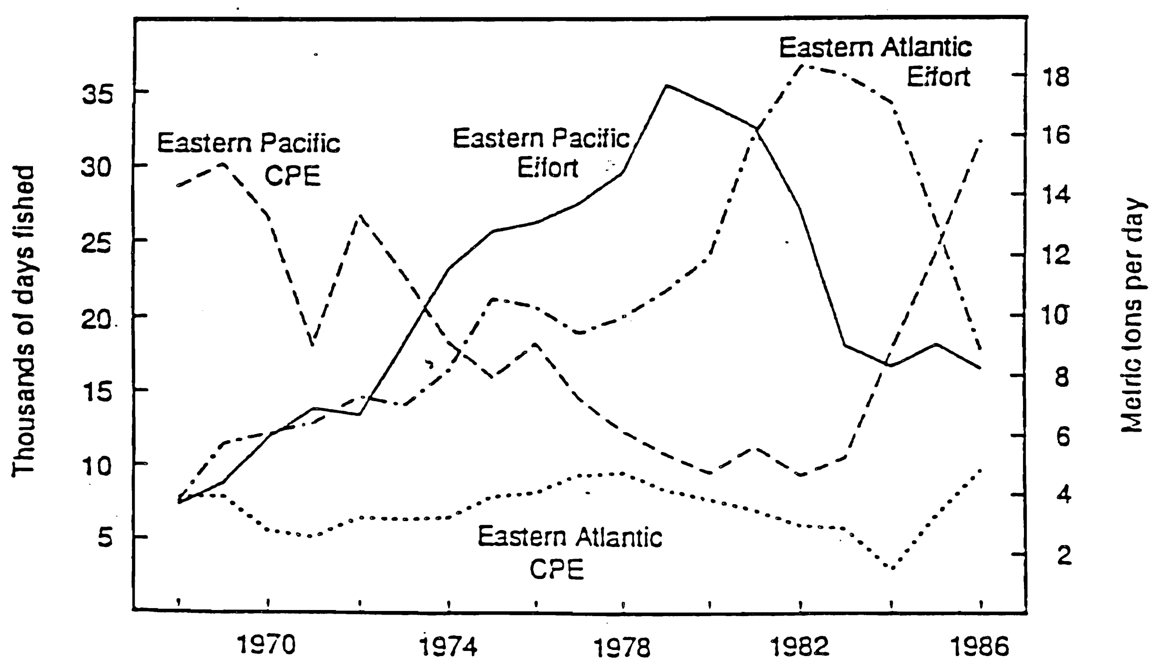

Figure 2.4. Purse seine effort and catch per effort (CPUE) for yellowfin tuna.

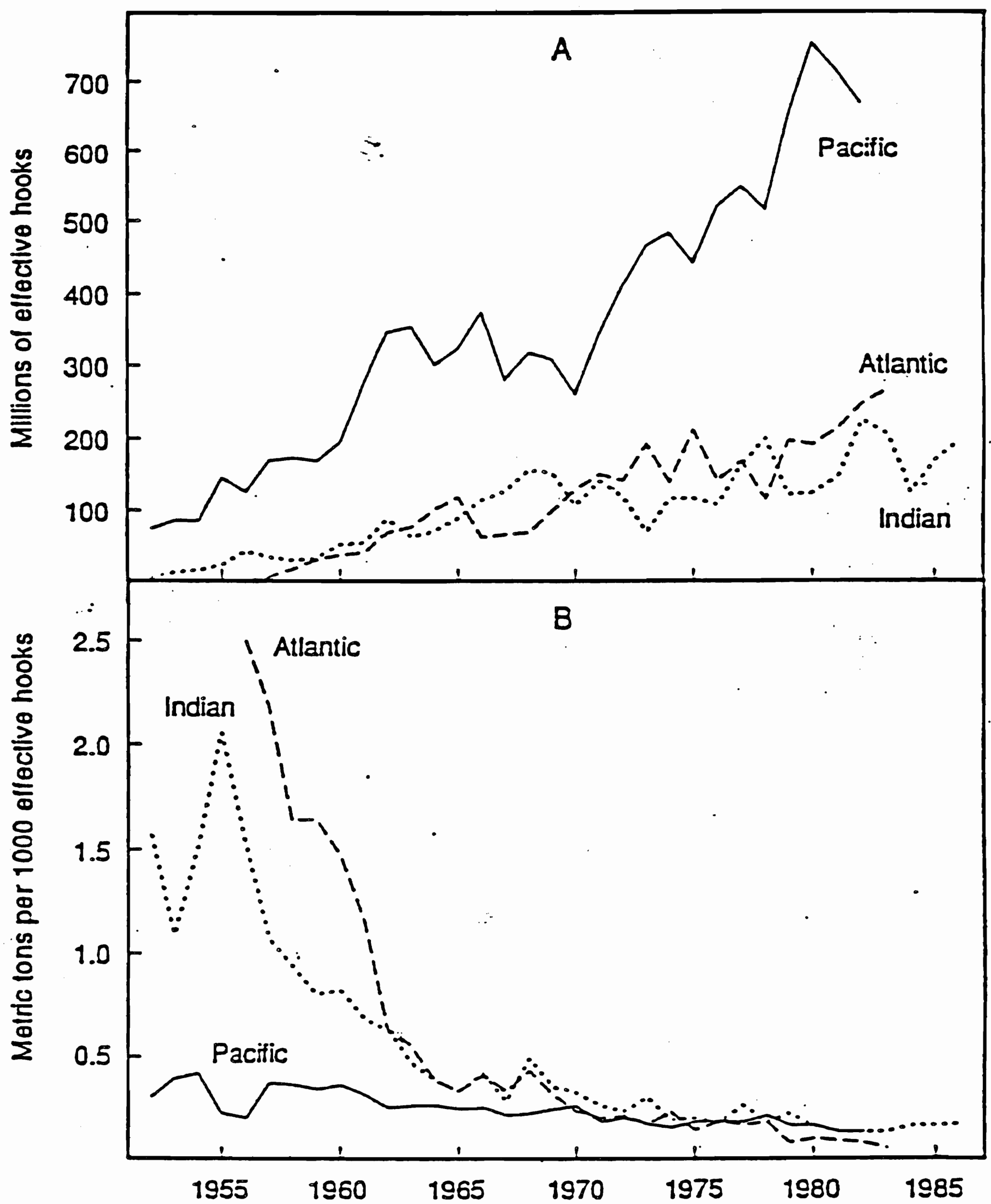

Figure 2.5. Yellowfin tuna longline effective effort (A) and catch per effort (B) by ocean.

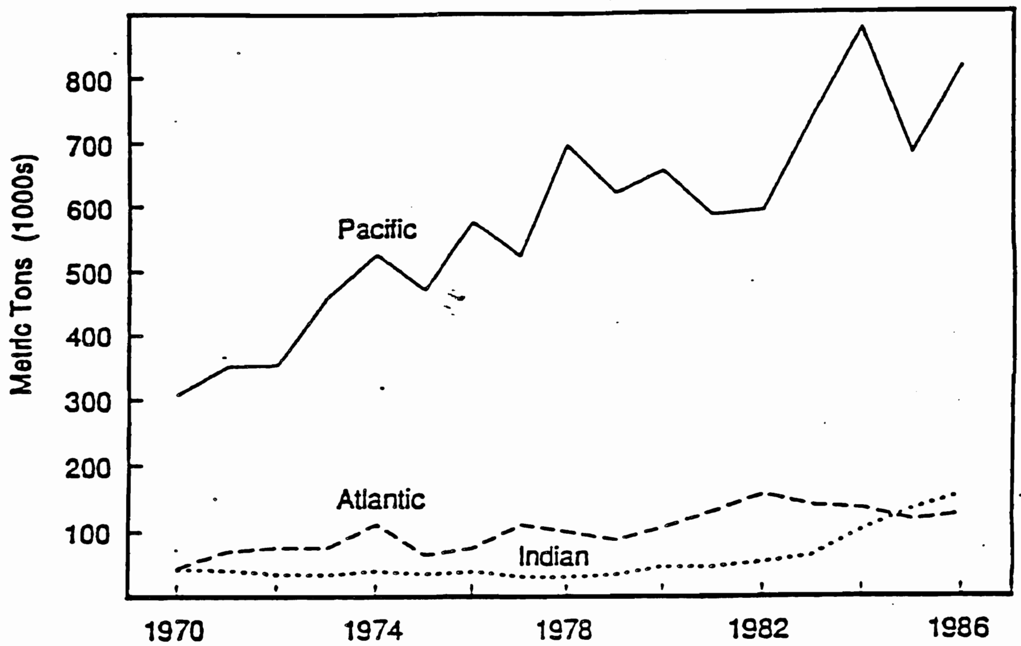

Figure 2.6. World skipjack tuna catch by ocean.

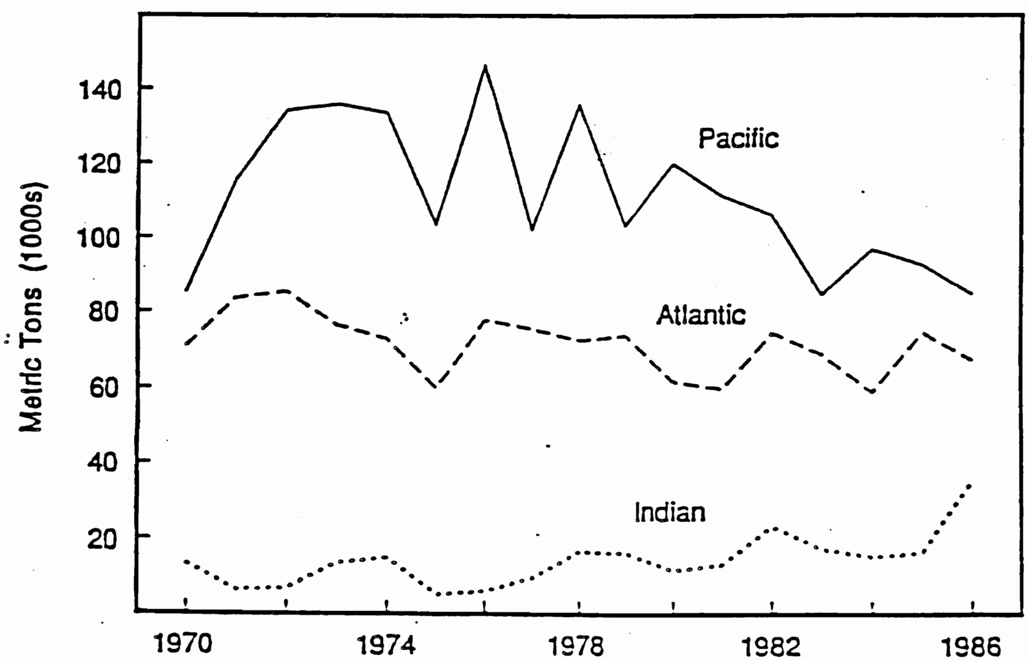

Figure 2.7. World albacore tuna catch by ocean.

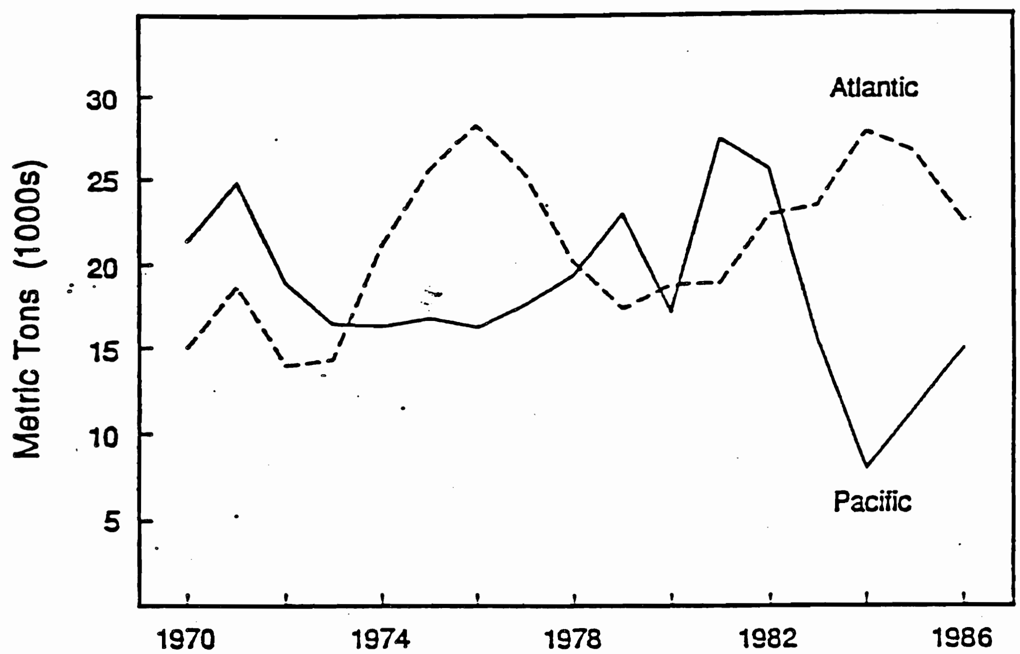

Figure 2.8. World northern bluefin tuna catch by ocean.

3.0. TRENDS IN TUNA STOCK ABUNDANCE

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3.1. Introduction

Tuna resources of interest to the U.S. and other countries are found in the tropical and temperate waters of the Atlantic, Indian and Pacific oceans and their adjacent seas; e.g., Caribbean, Mediterranean, Arabian, and South China Seas. The total catch[5] from all stocks was over 2.7 million metric tons (MT) in 1986 (3.4 million MT, including billfishes and other tuna-like species). The U.S. share was 263,000 MT, but the U.S. used more than 600,000 MT (22%), primarily for canning. The U.S. consumption was even higher (30%) for the three principal species: yellowfin, skipjack, and albacore, consumed in the U.S.

Yellowfin tuna (*Thunnus albacares*), skipjack tuna (*Katsuwonus pelamis*) and bigeye tuna (*T. obesus*) are found largely in tropical waters (Figure 3.1 - 3.3). Albacore (*T. alalunga*) and bluefin tuna, both southern (*T. maccoyii*) and northern (*T. thynnus*), are found in temperate waters (Figures 3.4 and 3.5). The temperate species are more far-ranging than the tropical species. These five species are referred to as the principal tuna species because catches are traded internationally for the canned-tuna and fresh-fish markets. Other tuna species, such as blackfin tuna (*T. atlanticus*), longtail tuna (*T. tonggol*), kawakawa (*Euthynnus affinus*), black skipjack (*E. lineatus*), Atlantic black skipjack (*E. alletteratus*), frigate tuna (*Auxis thazard*), are referred to as small tunas, species that principally inhabit coastal waters and which are primarily traded in local, fresh-fish markets. Recently, more of the blackfin tuna, longtail tuna and kawakawa catches have been entering the canning market.

In this section, trends in tuna stock abundance for the principal tuna species are reviewed in detail and a summary of the condition of the small tuna stocks is presented.

3.2. Yellowfin Tuna

One species of yellowfin tuna is recognized worldwide. This species is found in tropical waters and is separated into stocks for convenience in monitoring the condition of the population and for management of the fisheries.

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[5]Catch statistics in this chapter 3.0 are from stock assessment reports, and may be different from statistics reported in other chapters of this Tuna Management Information Document.

3.2.1. *Pacific Ocean*

The yellowfin tuna population of the Pacific Ocean is generally considered to be composed of two stocks, an eastern tropical Pacific stock, east of about 150° W long. and a western, or central-western Pacific stock, west of 150° W long. The real stock structure is probably much more complex than this with many more stocks, especially small, local ones around islands and in the southeast Asia region. For this report, however, we use the conventional east and west stock hypothesis.

3.2.1.1. Eastern stock

In the eastern tropical Pacific (ETP) there is a large yellowfin tuna stock that supports a major fishery, primarily comprised of purse seiners, that targets yellowfin tuna as the primary species and skipjack tuna as the secondary species (295,000 MT yellowfin and 85,000 MT of skipjack in 1988). In the 1970s, the yellowfin stock was intentionally overfished to determine the precise level of maximum sustainable yield (MSY). The experiment showed that the MSY for the stock is about 175,000-185,000 MT with the fishing effort pattern used in the experiment, and that catches over this amount result in reduced stock size and are non-sustainable.

In the ETP environmental conditions can significantly affect availablity of the stock to fishermen. This was demonstrated in 1982 and 1983 when the largest El Niño event of this century occurred in the Pacific. This event created anomalous oceanographic conditions that dispersed yellowfin tuna and made them less available to fishermen. Catches decreased sharply to only 70,000 MT in 1983 as fishermen found it difficult to locate fishable concentrations. They abandoned the ETP for more productive areas in the central-western Pacific, where skipjack tuna is readily available. With this reduced fishing, the yellowfin stock increased in biomass from growth and recruitment of new individuals.

With environmental conditions returning to normal in 1984, fishermen returned to fish the ETP again. The yellowfin stock was then at a very high level. Unprecedented high catches of 277,000 MT in 1987 and 295,000 MT in 1988 were made, owing largely to fishermen concentrating on taking the larger fish that had accumulated during the previous years of reduced fishing.

This situation is not expected to continue in the future. The stock is expected to quickly settle to a pre-El Niño level of recruitment and biomass structure. Fishing effort will increase and be increasingly directed at schools containing smaller yellowfin tuna. The net result will be lower yields and a smaller stock. We speculate that future yields will be much less than those of 1987 and 1988. By 1995, yields could be in the 150,000 MT to 180,000 MT range, which should be sufficient to maintain a healthy stock.

3.2.1.2. Western stock

In the western Pacific, developments in the late 1970s and early 1980s significantly increased the catch of yellowfin tuna from that region. Developments such as expanded coastal fishing by southeast Asian countries and increased purse seine fishing by distant-water nations doubled the catch from 105,000 MT in 1976 to 213,000 MT in 1986.

In 1976, longline gear took about 50% of the total catch, and purse seine gear less than 5%. By 1986, the take by longline gear decreased to 20% and purse seine gear take increased to 40% of total catch. In other words, development of the surface fishery was the principal contributor to the increase in catch. This fishery targets skipjack tuna as the primary species and yellowfin tuna as a secondary species.

A precise MSY for the western stock of yellowfin tuna is not available, although some analysts have suggested a range of 200,000 to 210,000 MT annually, which is about the current level of catches. We speculate that there is still scope for increased yield from the stock(s). Probably the greatest latent potential is in deep-water areas of southeast Asia where pockets of large yellowfin tuna may be available.

Another latent potential could be realized from reducing the large catches of small, juvenile yellowfin tuna that are currently being taken (both landed and discarded at sea) in association with logs, flotsam and floating aggregation devices (FADs or "payaos"). By allowing the juveniles to survive and be caught at a larger size, the yield could be increased substantially and the spawning stock replenished.

Assuming no changes in the catching of juveniles, we speculate that the western stock could sustain catches of as high as 250,000 MT. The catch should reach this level by 1995.

3.2.2. *Atlantic Ocean*

The Atlantic yellowfin tuna population is thought to consist of two stocks: one in the east (east of 30° W long.) and one in the west (west of 30° W long.). The eastern stock has been intensively exploited. Its center of abundance is in the Gulf of Guinea. The western stock has not been as intensively exploited, and because it does not have a particular center of abundance, may be composed of several smaller stock units, or a small stock with immigration from the eastern stock. For our purposes, we use the convention of two separate stocks.

3.2.2.1. Eastern stock

The fishery exploiting the eastern Atlantic stock of yellowfin tuna is primarily a surface fishery which has gone through phases of rapid expansion, intense fishing, shrinking and finally building again to a moderate level. This fishery targets yellowfin tuna as the primary species and skipjack tuna as the secondary species.

Intense fishing in the late 1970s through 1982 produced the peak catch of 135,000 MT (in 1982) for the fishery and depressed the stock. Unusual oceanographic conditions, similar to the Pacific El Niñ o, struck the eastern tropical Atlantic in 1983, dispersing the fish and making fishing difficult. Fishing effort was reduced and diverted mostly to the Indian Ocean. The catch decreased markedly to 75,000 MT in 1984 and the stock recovered. Since then, oceanographic conditions have returned to normal and fishing effort has built back up, although still lower by about 40% than its peak in 1982. Catches have also increased, reaching 101,000 MT in 1987.

The MSY for the eastern stock is believed to be about 117,000 to 123,000 MT. If the current moderate level of fishing is maintained, annual catches in excess of 100,000 MT, approaching 125,000 MT are sustainable through 1995. However, if effort builds back up to the level in 1982, catches will increase temporarily and could fall to below 100,000 MT by 1995.

3.2.2.2. Western stock

The western Alantic stock of yellowfin tuna has not had a history of intense exploitation, so the level of MSY for this stock is unknown. In the early 1960s, catches as high as 29,600 MT were recorded annually, taken mainly by longline gear. Since then longline effort decreased substantially, then increased again beginning in 1984 with the emergence of the U.S. and Mexican fleets. Surface fisheries also developed off Brazil and Venezuela. For the future, through 1995, catches of yellowfin from the western stock are expected to be in the 20,000-30,000 range.

This stock appears to have a much lower yield potential than the eastern stock. Concentrates of fish for large-scale exploitation are not widely prevalent in the region. Large-sized fish are scattered, but readily available to longline gear, and intense fishing could result in high yields for a period, followed by local depletion.

3.2.3. *Indian Ocean*

The yellowfin tuna population of the Indian Ocean has not been intensively exploited throughout its range, so its stock structure and yield potential are largely unknown. Currently, only the western part of the range, i.e., the area centered off the Seychelles, supports an intense surface fishery. In the rest of the range, fishing has largely been with artisanal or small-scale gears and longlines.

The surface fishery in the western Indian Ocean is dominated by purse seiners that target yellowfin tuna in an area bound by about 10° N to 10° S lat. and west of 70° E long. during roughly January to May, and in some years to as late as July. This fishery also takes skipjack tuna as a secondary species. During the rest of the year, fishing shifts south to the Mozambique Channel and targets on skipjack. The current annual catch for this fishery is about 60,000 MT of yellowfin tuna and 100,000 MT of skipjack tuna.

A longline fishery operates throughout the tropical region of the Indian Ocean in search of yellowfin tuna and other large-sized tunas. The yellowfin tuna catch for this fishery has recently increased to a level comparably to that of the 1970s, after experiencing a low-period in the intervening years. The catch in 1986 was 36,000 MT owing to improved efficiency in the major longline fleets.

Artisanal or small-scale fisheries are locally concentrated and target on pelagic species, with yellowfin tuna being one of several species often caught. Significant amounts of yellowfin tuna are taken by the fisheries of Indonesia, Maldives, Pakistan, and Sri Lanka. The total catch is about 18,000-20,000 MT per year.

The yellowfin tuna population of the Indian Ocean has largely been treated as a single stock in assessment studies. However, there is not enough information to confirm this hypothesis. From biological information on yellowfin tuna of other oceans, we speculate that the stock(s) in the Indian Ocean can support sustained catches greater than current levels, such as 114,000 MT in 1986. Total catch could exceed 125,000 MT of yellowfin tuna by 1995 with increased fishing, particularly increased longlining and handlines and development of surface fisheries in the Bay of Bengal, in areas off southwest Indonesia and other locations.

3.3. Skipjack Tuna

One species of skipjack tuna is recognized world-wide. Within each ocean, however, the skipjack population is assumed to be a separate unit, each consisting of probably one or more stocks. It is often taken in mixed catches with small yellowfin tuna by surface fisheries.

3.3.1. *Pacific Ocean*

The stock structure of skipjack tuna in the Pacific Ocean is unclear althought it is recognized that fish at the extremes of the distributional range do not freely mix or interbreed. For convenience, the Pacific population has been divided into two, one stock distributed east of about 160° W long. and another located to the west of that boundary.

3.3.1.1. Eastern stock

To the east of 160 W long. is the eastern tropical Pacific stock that is exploited principally by the ETP fishery. Skipjack tuna catches by this fishery are affected largely by the availability of yellowfin tuna -- yellowfin is a preferred species for this fishery because of its higher value. Consequently, yearly catches have varied -- 50,000 MT level in the early 1970s, rising to 111,000 MT in 1975, fluctuating within a 101,000 to 150,000 MT range through 1982 before declining. The catch in 1986 was 81,000 MT.

There have been several estimates of potential yield for this ETP skipjack stock. They range from 140,000 to 1.2 million MT. The high end of this range is probably unattainable in the ETP because the stock moves out of the region, and is available only at a mean size of 40-50 cm. Highest yield per recruit from the stock is obtained at size of entry into the fishery of 35 cm and with very high fishing effort. Fishing effort in excess of levels so far recorded in the fishery will be required for maximizing yield per recruit from this stock.

We speculate that as a result of heavy fishing on the yellowfin tuna stock, the yellowfin tuna stock will decline and force the vessels to divert their effort onto pure skipjack schools as well as mixed schools that contain small-sized tunas including skipjack.

This shift will result in increased skipjack catches from the eastern stock. By 1995, catches should be at historical high levels (~ 150,000 MT).

3.3.1.2. Western stock

Skipjack tuna is the target species for the surface fishery in the western Pacific. The catch from the western stock, west of 160° W long., has been gradually increasing since 1970 when it was 245,000 MT. In 1986 the catch was 735,000 MT.

This stock is estimated to be large, 2.5 to 3.7 million tons, with high monthly turn-over rate that produce a potential yield of 6 to 7 million tons per year. We speculate that by 1995, the yield from this stock will be not much different than the current catch, primarily because the island nations in the region will continue to maintain strict limits on fishing by large vessels in their EEZs. Also, concerns for overfishing of the western Pacific yellowfin tuna stock will restrict growth of the surface fishery, which targets both yellowfin and skipjack.

3.3.2. *Atlantic Ocean*

Skipjack tuna is found in a continuous band across the Atlantic Ocean and with centers of concentration near the continents. The entire Atlantic population has, therefore, been treated as a single stock, but the fisheries have been treated as separate eastern and western units. For convenience, we use this latter format and assume two stocks in the Atlantic.

3.3.2.1. Eastern stock

There is no MSY estimate for the eastern stock, which has a center of concentration in the Gulf of Guinea. This stock is believed to be in good condition and able to yield in excess of the peak 1982 catch of 120,000 MT. The stock biomass is large, and the stock characteristics favor high productivity: skipjack grow rapidly, become sexually mature at a young age, and adults spawn over a large area year-round. These characteristics allow for rapid turn-over of the stock and large potential yields. We speculate that by 1995 the catch will be well above the 89,000 MT taken in 1986, and will approach 120,000 MT. The stock will not be adversely affected by this high catch.

3.3.2.2. Western stock

There is likewise no MSY estimate for the western Atlantic stock. This stock is widely dispersed and yields so far have been much less than from the eastern stock. Large commercial concentrations occur off southern Brazil and off Venezuela. Peak total catch from this stock was 40,000 MT in 1985. In 1986, the catch was 18,000 MT. This stock is in good condition and underexploited. Yields in excess of 50,000 MT per year are possible without damage to the stock.

3.3.3. *Indian Ocean*

The stock structure of skipjack tuna in the Indian Ocean is unknown, although skipjack is found over a broad area of the ocean and has been exploited for years by many artisanal fisheries. The annual catch in the late 1970s averaged about 30,000 MT to 35,000 MT.

With the development of the purse seine fishery in the western Indian Ocean, the catch increased markedly. This fishery contributed 800 MT in 1982, increasing to 67,000 MT in 1986 or 48% of the total ocean-wide skipjack catch of 140,000 MT. There is no estimate of yield potential for the stock(s). The potential, however, is probably high and well above the current catch. We speculate that in the coming years, the catch will increase and may even reach 200,000 MT by 1995 if there is substantial increase in fishing effort and changes in the distribution of that effort. The stock should be able to sustain this level of catch.

3.4. Bigeye Tuna

Bigeye tuna is largely taken by longline gear at a large size for the high-value "sashimi" market of Japan, although recently the use of deeper purse seine nets and fishing on logs during twilight hours have increased the catch of small bigeye tuna by purse seines.

The stock structure of bigeye tuna is unknown. Because they are found in a continuous east-west band across the oceans, each ocean is assumed to have a single stock. The stock structure is probably much more complex, with multiple stocks in each ocean.

3.4.1. *Pacific Ocean*

The Pacific-wide stock of bigeye tuna has historically yielded a maximum catch of about 150,000 MT taken in 1963. Currently, the catch is at 120,000 MT. Some analysts believe that a 150,000 MT yield is in excess of the MSY for the stock. However, the evidence is based on data when fishing was largely with longline gear. Experience from the Atlantic Ocean indicates that the yield can be much higher with a combination surface and longline fishery. The true yield potential for the Pacific stock is thus unknown, but is probably higher than 150,000 MT.

We speculate that because of continued strong demand for bigeye tuna in the sashimi market, high fishing effort will continue into 1995 and longline catches will be in excess of 120,000 MT annually. An additional 10,000 MT is expected to be taken by the surface fisheries as part of the incidental catch taken while fishing for yellowfin and skipjack. The stock should be able to sustain this level of catch.

3.4.2 *Atlantic Ocean*

A surface and a longline fishery in the Atlantic take bigeye tuna, but only the longline fishery actually targets on this species. The annual catch peaked at 74,000 MT in

1985, and fell to 47,000 MT in 1987 largely because of reduced longline effort. Increased cost of longline operations in the Atlantic was largely the reason for the Asian longline fleets reducing their fishing effort.

The MSY for the Atlantic-wide stock is 67,000 to 138,000 MT, which is greater than the current catch. We expect catches through 1995 to increase to about 60,000-70,000 MT.

3.4.3. *Indian Ocean*

Virtually all bigeye tuna from the Indian Ocean are taken by longliners who target specifically on this species. Catches rose from about 20,000 MT in 1965 to a peak of 56,000 MT in 1978 then decreased to 43,000 MT in 1986.

The MSY for the stock has been estimated to be 35,000 to 42,000 MT; however, this is based on longline fishery data and would be higher if a surface fishery develops. We speculate that the catch will increase in the coming years and be in excess of 40,000 MT by 1995. The stock should continue to be in good condition.

3.5. Albacore

One species of albacore is found in the world's oceans. Interchange of fish between oceans, e.g., Indian Ocean and south Atlantic Ocean, is believed to be small, so separate populations are considered for each ocean. Within the Atlantic and Pacific Oceans, each population is believed to consist of two stocks, one in the northern hemisphere and another in the southern hemisphere. In the Indian Ocean the population is considered a single unit stock.

3.5.1. *Pacific Ocean*

3.5.1.1. Northern stock

The MSY for the north Pacific albacore stock is 84,000 to 133,000 MT. The catch for the fishery has been falling since 1976 from a peak of 124,000 MT to 46,000 MT in 1987. Trends in catch rates for the different components of the fishery have all been downward and in 1989, there were signs of unusually low recruitment to the traditional pole-and-line, troll and longline fisheries. There is speculation that the stock is experiencing low recruitment caused by the growing drift gillnet fisheries which remove large amounts of small fish that normally would increase in size and be recruited to the traditional albacore fisheries.

Research is underway to determine the cause(s) for the decrease in albacore catches; nonetheless, the future is not bright. We speculate that catches will continue to decrease through at least 1991. Without a period of good recruitment and/or reduced fishing mortality, the stock will not have the opportunity to rebuild, and record low catches will continue into 1995.

3.5.1.2. Southern Stock

There is no MSY estimate for the south Pacific albacore stock as a whole, although estimates of 33,000 to 35,000 MT per year have been reported for the traditional longline fishery operating in the presence of a negligible surface fishery. These estimates refer to only the segment of the stock exploited by longline gear and not to the entire stock.

Up to 1987, the longline fishery landed virtually all the albacore from the south Pacific, producing a steady catch of about 30,000 MT annually. The surface fishery was small and confined to the coast of New Zealand, and exploratory gillnet fishing by Japanese vessels in the Tasman Sea and adjacent areas. In 1987, the surface fishery began expanding with long-range vessels to include the subtropical convergence zone. In 1989, the surface fishery accounted for more than 50% of the total catch, which was 61,000 to 90,000 MT. Marked growth of drift gillnet fleets of Japan and Taiwan accounted for this rapid increase in catch.

The drift gillnets take small fish as well as cause mortality from dropout and from injury. Actual fishing mortality is probably much larger than indicated by landing statistics.

We speculate that the stock could sustain an annual catch of 60,000 MT with the current fishing pattern and if there were negligible losses from dropouts. If drift gillnet fishing is banned completely from the region, as currently anticipated by the South Pacific nations, we expect the total catch of the remaining surface fishery to decrease sharply and then increase to about 45,000 MT by 1995. If fishing continues as is, the catch is expected to remain in the 61,000 to 90,000 MT range through 1995.

3.5.2. *Atlantic Ocean*

3.5.2.1. Northern Stock

The International Commission for the Conservation of Atlantic Tunas (ICCAT) gives MSY estimates for the north Atlantic albacore stock of 48,000 MT to 70,000 MT. The catch has averaged 40,000 MT during the 1980s, down from an average of 50,000 MT in the 1970s and 54,000 MT in the 1960s. Catch rates for most of the components of the fishery have been declining, and more efficient fishing gears, drift gillnets and pair trawls, have recently been introduced into the fishery to increase catches. Nonetheless, ICCAT has determined that the stock is in good condition. We suspect that ICCAT's assessment might be in error and the stock is at best fully exploited. Hence, future yields from this stock are expected to continue at low levels, although there may be small temporary increases as the more efficient gears compensate for lower catches by the more traditional gears. However, eventually yield will decrease and even dip below 35,000 MT by 1995 as stock condition deteriorates further.

3.5.2.2. Southern stock

The MSY for the south Atlantic stock is 24,000 to 29,000 MT. The catch from this stock has fluctuated within the range of 13,000 to 29,000 MT in the 1980s with no particular trend. This fishery is unusual in that it is with longlines only and takes a wide range of fish sizes. The peak catch was in 1972 at 33,000 MT. The stock is believed to be in good condition and able to sustain the current level of catch. We speculate that catches will remain within the 24,000 to 29,000 MT range through 1995, if exploitation continues with longlines only.

3.5.3. *Indian Ocean*

The peak catch for the Indian Ocean albacore fishery was about 27,000 MT in 1974 followed by a sharp decline to 10,000 MT in 1975. Thereafter, it fluctuated upward reaching a high of 26,000 MT in 1986. More than 50% of the catch in 1986 was from a gillnet fishery that started in 1984. Previous to 1986, virtually all the catch was taken with longlines. The estimate of MSY for this stock is 16,000 to 20,000 MT based on longline data only. As with the MSY for the south Pacific albacore stock, this estimate appears to be inappropriate for the new combination fishery of gillnet and longline.

Because the Indian Ocean gillnet fishery is taking relatively large albacore 70 to 90 cm long, and displacing the longline catch, the stock is probably able to sustain the current or a slightly higher level of catch without difficulty. We speculate that barring a successful international effort to ban drift gillnets from the Indian Ocean, the catch will continue at the current level, and the stock should be able to support it.

3.6. Bluefin tuna

There are two species of bluefin tuna: northern bluefin tuna and southern bluefin tuna. The north bluefin tuna occurs only in the Pacific and Atlantic Oceans with one stock in the Pacific and two in the Atlantic. The southern bluefin tuna occurs in the southern waters of the three oceans - Atlantic, Indian and Pacific, and is a single stock.

3.6.1. *Atlantic and Pacific Oceans*

Bluefin tuna, particularly large individuals, commands an exceptionally high price in the Japanese "sashimi" market. Demand is high for this luxury item, and supplies from throughout the world enter this market. Virtually the entire global catch of bluefin tuna is traded in this market.

Northern bluefin tuna is found principally in the northern hemispheres of the Atlantic and Pacific Oceans, generally north of 20° S lat. In the Pacific Ocean there is only one stock which has its center of abundance off Japan and spawns in the Philippine Sea. This stock produced record catches of 39,000 MT in 1956 and 1966. Since 1966, catches have been lower - about 15,000 MT in 1986. We speculate that continued removal of large amounts of small bluefin tuna by the Japanese coastal line and net fisheries, will keep this stock below optimum. Catches will fluctuate and slip below 15,000 MT by 1995.

Two stocks of northern bluefin tuna are recognized in the Atlantic Ocean. The western stock spawns in the Gulf of Mexico and the eastern stock spawns in the

Mediterranean Sea. The catches from the western stock have been regulated since 1982 with an ICCAT ad hoc country quota totaling 2,660 MT (1,387 MT U.S., 700 MT Japan, 573 MT Canada), whereas there is no limitation on catches from the eastern stock.

The western stock is currently only a fraction of its former size when 19,000 MT were taken in 1963. Despite the strict annual quota, the stock continues to decline, albeit at a slower rate than before, owing to low recruitment and fishing mortality concentrated on principally adult fish. As long as the total quota remains as high as it is, and recruitment remains low, the stock will not recover, but, in fact, be at risk of slipping to lower levels. Catches are predicted to dip below 2,600 MT by 1995, and the stock will decrease in abundance.

The eastern stock is also low in abundance. Catches were in the 20,000 MT to 30,000 MT range during the 1950s. They declined and then increased to about the 20,000 MT in the late 1970s and early 1980s as the biomass of juveniles was heavily exploited in the Mediterranean Sea. Although the fisheries are not regulated by an ICCAT catch quota, they are subject to an ICCAT regulation that limits fishing mortality. However, this regulation is largely not adhered to owing to inadequate enforcement. In 1987, the catch was at a near record low of 11,000 MT. We speculate that the stock will continue to be depressed owing to excessive removals. Catches in the future will be low and possibly dip below 11,000 MT by 1995.

3.6.2. *Indian Ocean*

The southern bluefin tuna is found in the southern oceans of the Atlantic, Pacific, and Indian Oceans, generally south of 20°S lat. Only one stock is recognized, which spawns and has its center of abundance in the Indian Ocean off Australia. This stock produced a catch as high as 81,200 MT in 1961. Excessive fishing, however, has caused the stock to decline to low levels. Australia, Japan and New Zealand have established country quotas, which totalled 15,500 MT for 1989, in an attempt to arrest the decline.

Because small fish continue to be taken under the existing quotas and analyses indicate that smaller quotas are required to rehabilitate the stock, we are not confident that this stock will be restored with the current management measures. We therefore speculate that the stock will continue to decline owing to excessive removals. The catch will initially remain at the quota, but with time, will decrease below 15,500 MT by 1995.

3.7. Small tunas

"Small tunas" is a general term used to include other-than-principal tuna species that are taken in tuna fisheries. The condition of the stocks of small tunas are not well known because catches are principally made by artisanal and small-scale fishermen and go unreported or underreported to authorities. Reported annual catches by FAO are at the 50,000 MT level for the Atlantic, 70,000 MT level for the Indian Ocean and 230,000 MT level for the Pacific Ocean. These statistics are probably underestimates owing to primarily unreported catches. For the southeast Asia region alone, studies indicate that the actual small tuna landing is several orders larger than indicated by FAO statistics.

The stocks mainly inhabit coastal waters and are vulnerable to heavy and sustained exploitation as well as depletion from habitat degradation resulting from coastal developments. Some stocks are believed to be already depleted, such as in the Philippines and Thailand, while others are underexploited. We speculate that the total yield could reach 500,000 MT or more by 1995, although stocks near major fishing centers will tend to be overfished.

3.8. Summary of stock condition

Summarized in Table 3.1 are statistics on exploitation level and stock condition for the principal tuna species. Catch statistics are from stock assessment reports. The statistics indicate that overall, the tropical tuna stocks are in good condition with several having considerably more scope for higher yields with increased exploitation. The temperate tuna stocks, on the other hand, are in poor condition and most will not improve as long as heavy exploitation continues.

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Table 3.1. Summary of statistics on explotation level and stock condition.

Stock	MSY ($x10^3$ MT)	1986 catch ($x10^3$ MT)	Maximum Catch ($x10^3$ MT) and Year	Stock Condition	Projected 1995 Yield ($x10^3$ MT)	U.S. Interest Harvesting	U.S. Interest Import
Yellowfin Tuna							
Eastern Pacific	175-185	268	295 (1988)	Good	150-180	X	X
Western Pacific	200-210	213	213 (1986)	Good	250	X	-
Eastern Atlantic	117-123	109	135 (1982)	Good	125	-	X
Western Atlantic	?	46	46 (1986)	Good	20-30	X	-
Indian Ocean	?	114	114 (1986)	Good	125	-	-
Skipjack Tuna							
Eastern Pacific	140-1200	81	170 (1978)	Good	150	X	X
Western Pacific	6000-7000	735	776 (1984)	Good	740	X	X
Eastern Atlantic	?	89	120 (1982)	Good	120	-	X
Western Atlantic	?	18	40 (1985)	Good	50	-	X
Indian Ocean	?	114	140 (1986)	Good	200	-	X
Bigeye Tuna							
Pacific	150[1]	120	150 (1963)	Good	130	-	-
Atlantic	67- 138	61	74 (1985)	Good	60-70	-	-
Indian Ocean	35- 42[1]	43	56 (1978)	Good	>40	-	-
Albacore							
North Pacific	84- 133	46	124 (1976)	Poor	>46	X	X
South Pacific	35[1]	39	60 (1989)	?	60	X	X
North Atlantic	48 70	40	64 (1964)	Poor	>35	-	X
South Atlantic	24- 29[1]	28	34 (1972)	Good	24-29	-	X
Indian Ocean	16- 20[1]	26	27 (1974)	Good	26	-	X
Bluefin tuna							
Pacific	?	15	39 (1956)	?	>15	X	-
Western Atlantic	?	2	19 (1964)	Poor	> 2	X	-
Eastern Atlantic	?	17	27 (1962)	Poor	>11	-	-
Indian Ocean	?	30	81 (1961)	Poor	>16	-	-
Total (million MT)		2.3	2.8		2.4-2.5		

[1] Longline fishery only; probably higher with combination longline and surface fisheries.

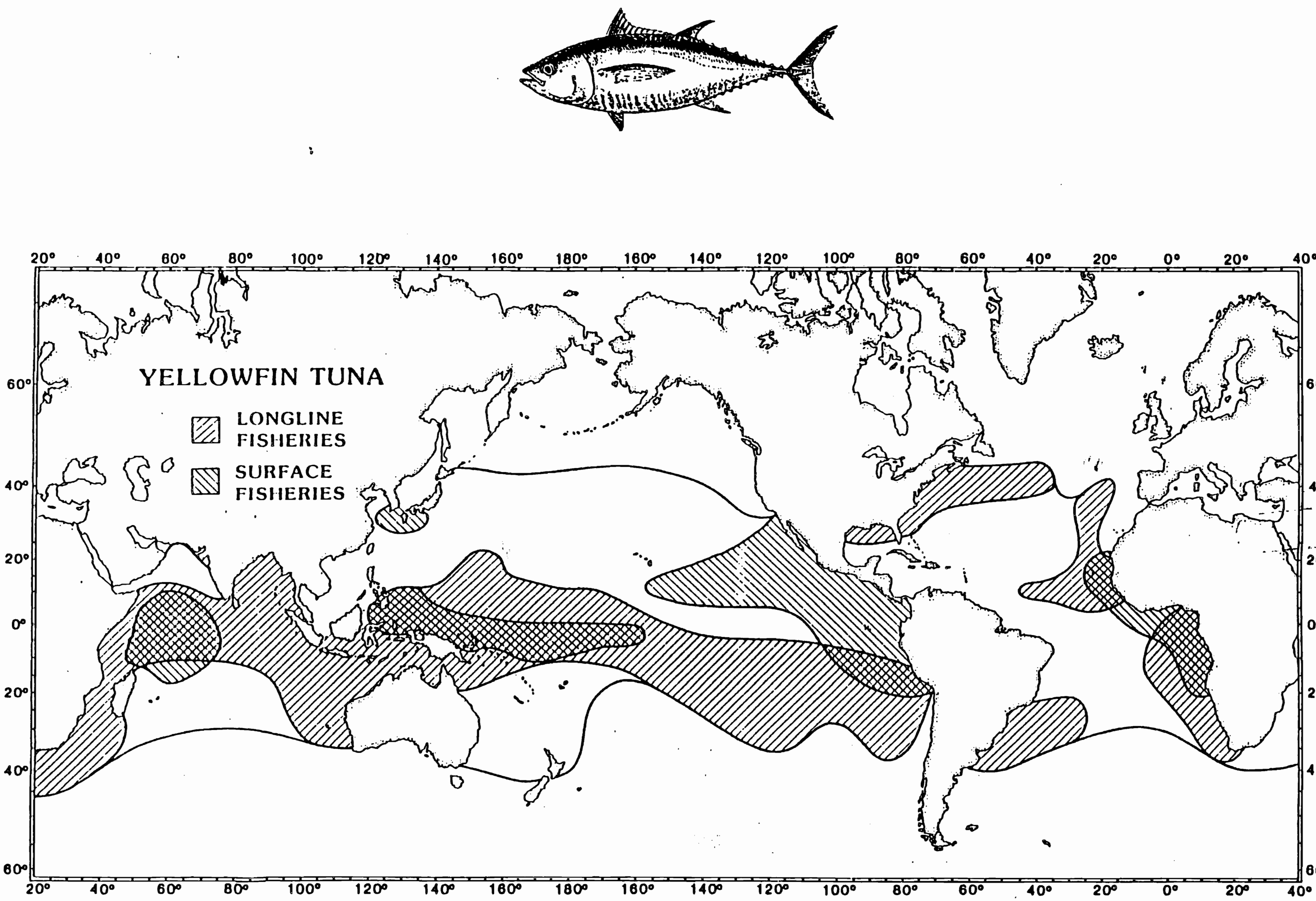
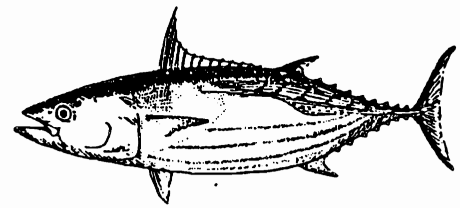


Figure 3.1. North-south habitat range and distribution of fisheries for yellowfin tuna.



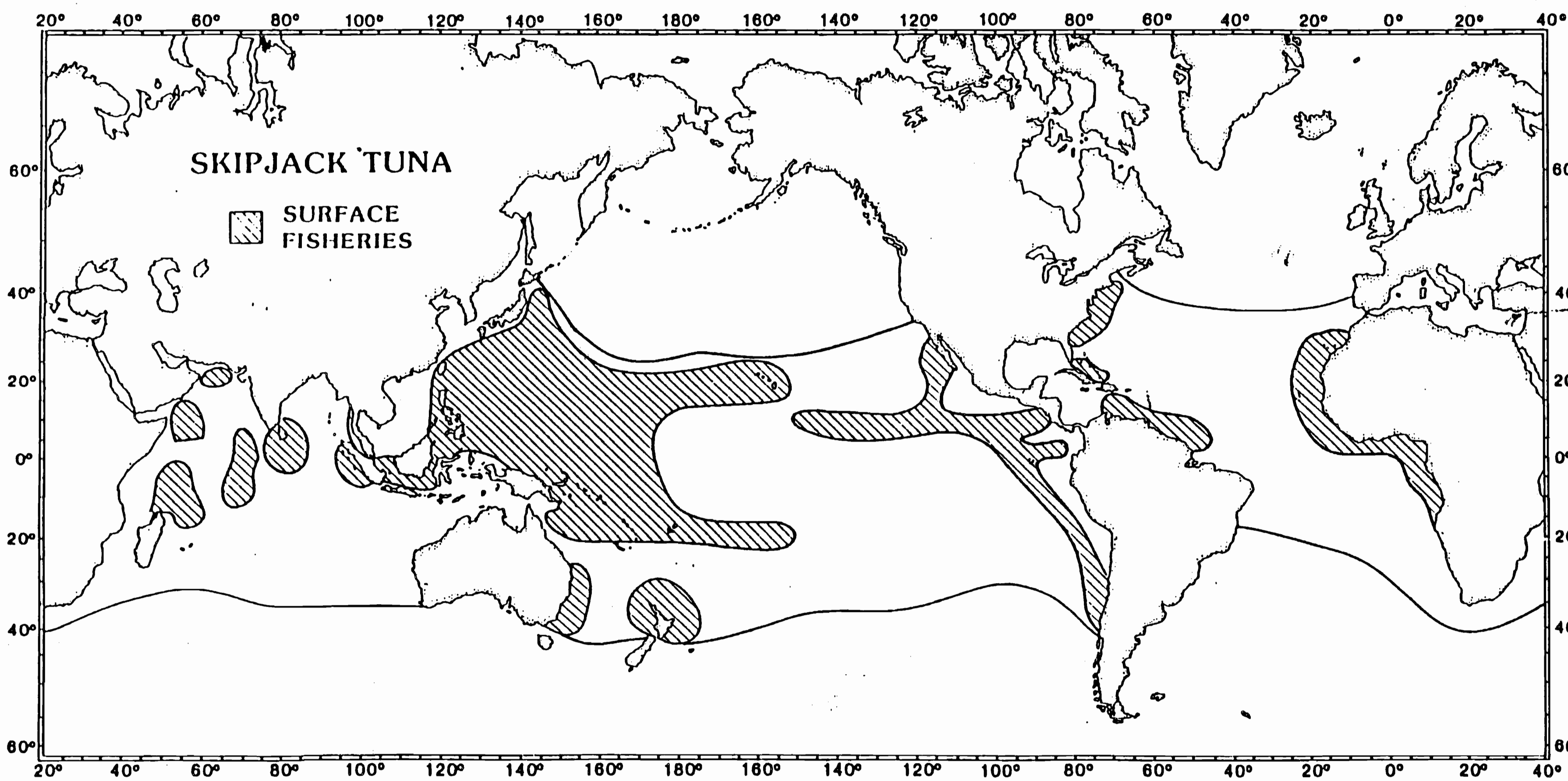
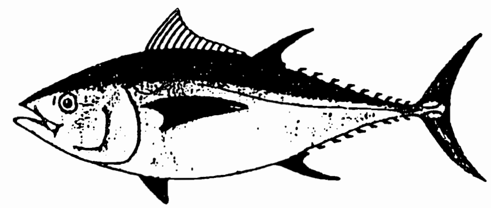


Figure 3.2. North-south habitat range and distribution of fisheries for skipjack tuna.



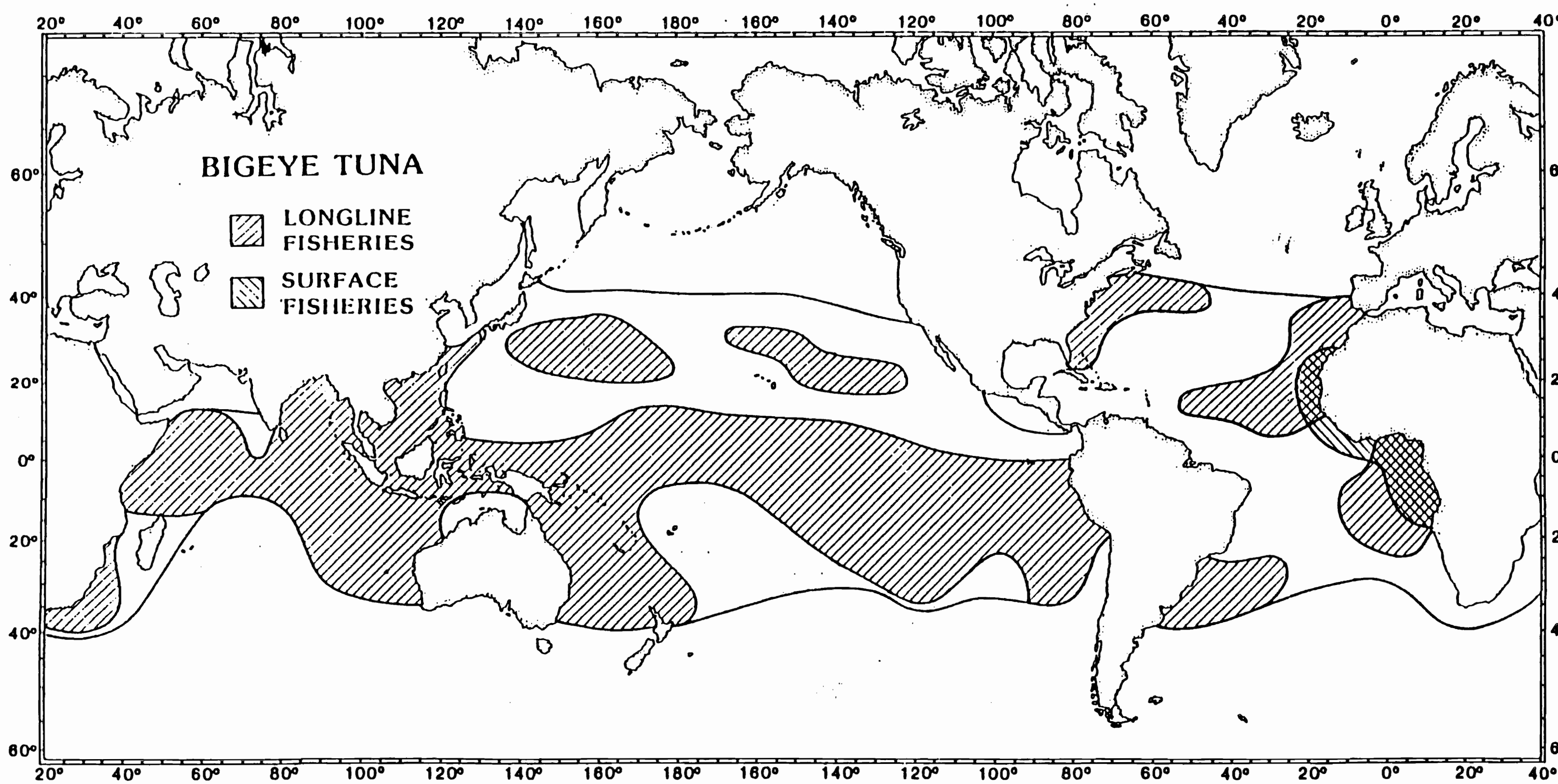
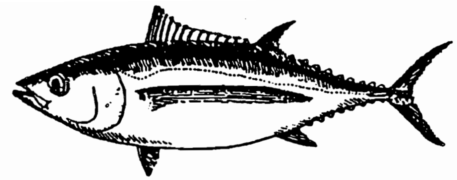


Figure 3.3. North-south habitat range and distribution of fisheries for bigeye tuna.



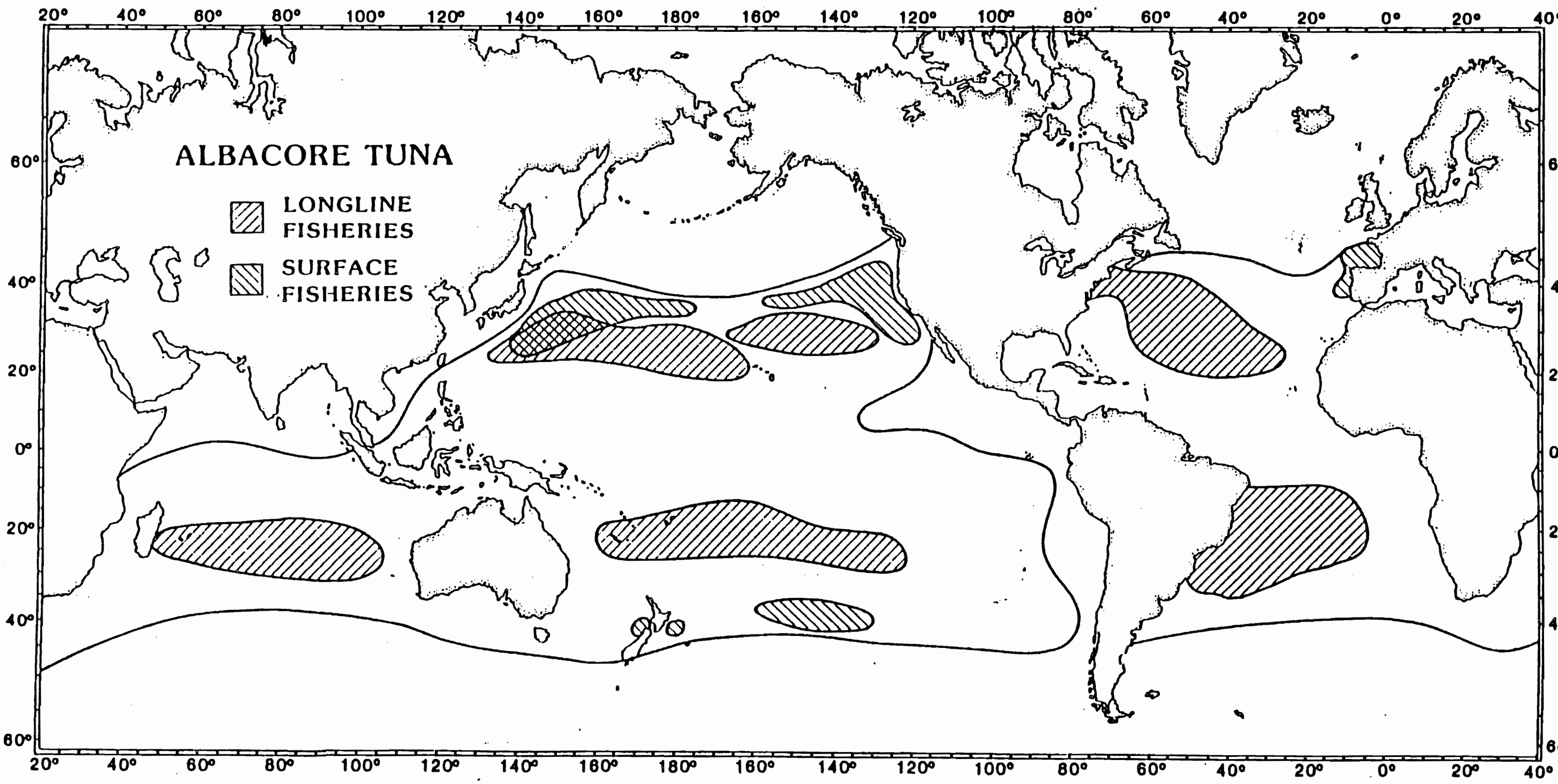
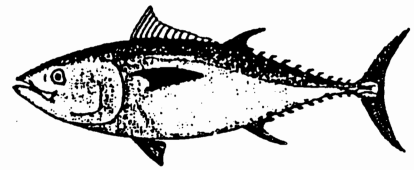


Figure 3.4. North-south habitat range and distribution of fisheries for albacore.



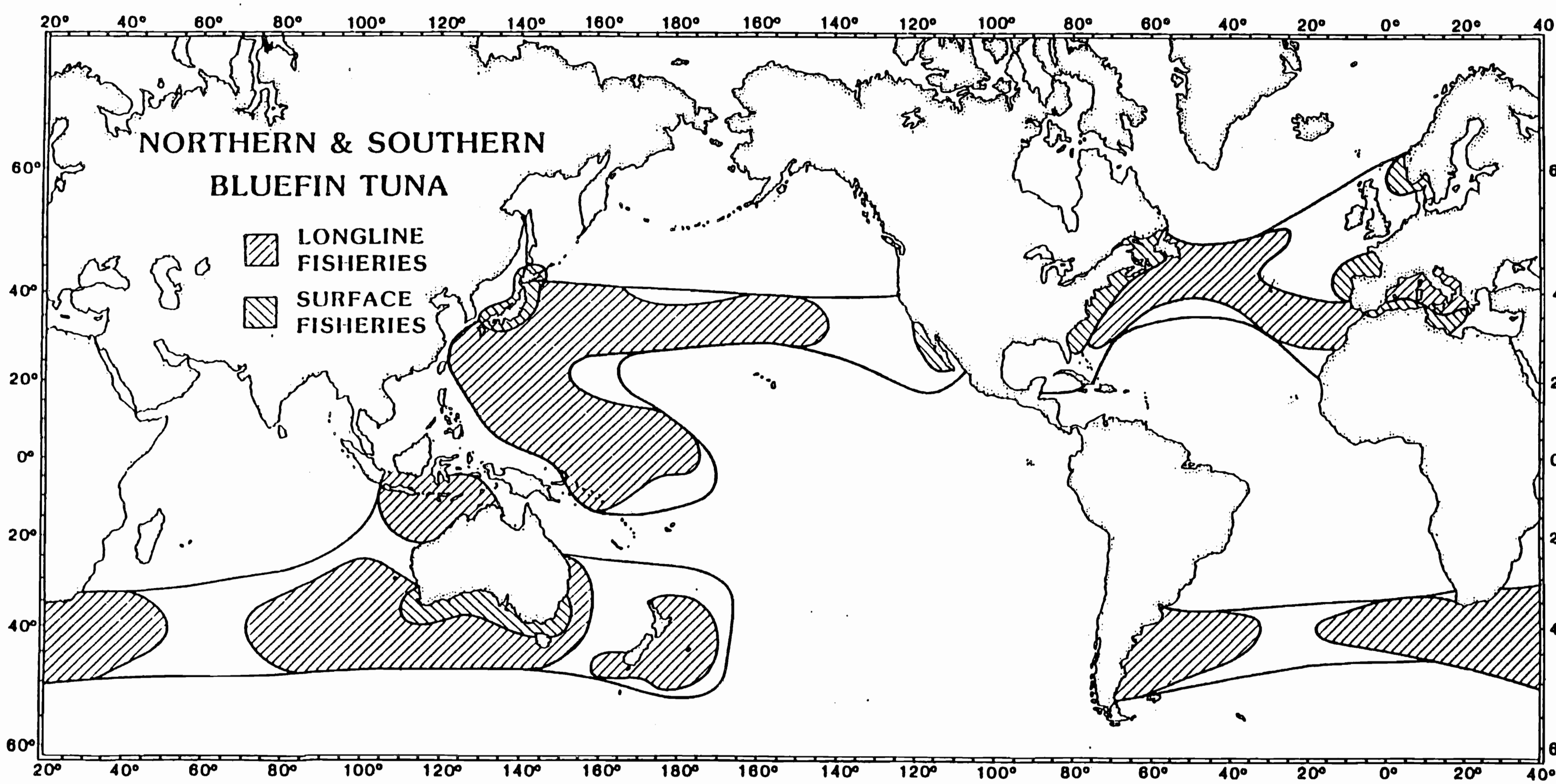


Figure 3.5. North-south habitat range and distribution of fisheries for northern and southern bluefin tunas.

4.0 TRENDS IN TUNA MANAGEMENT AND RESEARCH ARRANGEMENTS

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4.1. Introduction

A variety of tuna management and research arrangements are in use. They range from informal arrangements to formal arrangements by private and government organizations. In this section, only multi-national formal tuna arrangements involving the U.S. government are reviewed. They include the Inter-American Tropical Tuna Commission (IATTC: formed in 1949), the International Commission for the Conservation of Atlantic Tunas (ICCAT: 1966), the South Pacific Commission (SPC: 1947), the Indian Ocean Fishery Commission (IOFC: 1968) and the South Pacific Tuna Treaty (SPTT: 1988). This review focuses on function and effectiveness of the arrangements, and concludes with an analysis of trends.

4.2. Management Arrangements

The U.S. is signature to several international fisheries conventions, or treaties, but only three are for tuna management. They are the Inter-American Tropical Tuna Convention, International Convention for the Conservation of Atlantic Tunas, and the South Pacific Tuna Treaty.

Since about the late 1940s, the U.S. has maintained a consistent tuna management policy. The policy, simply stated, is that tunas can only be effectively managed on an international basis that includes the entire geographic range of the stock and all major fishing nations that fish the stock. A cornerstone of this policy is the principle that tunas are migratory, travelling over vast ocean regions during their lifetime, and are fished by highly mobile fleets that operate in and well-beyond the jurisdictional boundaries of coastal states. Consequently, the only completely effective way to control or manage fishing mortality for conservation purposes is through cooperation of all major fleets fishing on the stock. Armed with this policy, the U.S. organized international management conventions for tunas in selected regions where it had an interest as a distant-water fishing nation. The first application of this policy was off Central America and South America where the U.S. fleet developed a fishery for yellowfin and skipjack tunas.

4.2.1. *Inter-American Tropical Tuna Convention*

A convention was concluded in 1949 that established the Inter-American Tropical Tuna Commission with jurisdiction over tuna stocks in the eastern tropical Pacific Ocean. This convention codified the U.S. principle concerning migratory tunas, and promoted management through consensus of member nations fishing on the stocks. It established and provided authority for a permanent international staff of scientists to conduct biological studies on the stocks, tuna baitfishes and effects of fishing, and to recommend conservation measures when necessary, so that the stocks could be maintained at levels which would support maximum sustainable catches. It also established a management decision body, Commission, that is made up of member nation representatives, who adopt policies and make decisions based on recommendations from the IATTC staff. Management recommendations are executed by the individual member nations through national authorities.

Between 1970 and 1987, 2.9 million metric tons (MT) of tuna were caught by the U.S. fleet from the IATTC-juridictional region of which about 80% was yellowfin tuna. In the early years, U.S. fishermen accounted for more than 70% of the total eastern tropical Pacific tuna catch. But several factors, including the rejection of the U.S. principle by the coastal states, particularly Mexico and Costa Rica, and extension of exclusive economic zones (EEZ) by many Latin American coastal states, restricted U.S. access to the more productive, inshore fishing areas of the region in the late 1970s and 1980s. The U.S. portion, hence, decreased to about 40% in 1987 (Figure 4.1). Most of this decrease was in the share of yellowfin tuna, which is of higher value and preferred over skipjack tuna (Figure 4.2). The U.S. loss was a gain for fleets of coastal states, such as Mexico and Ecuador, as they assumed exclusive access to the productive fishing areas in their EEZs.

The IATTC recommends management actions to the member countries (currently Costa Rica, Japan, France, Nicaragua, Panama and the U.S.) and relies on members to implement and enforce the actions under national regulations. So far, the IATTC has recommended catch quotas for yellowfin tuna, and has implemented a quota-management system for each of the years from 1966 to 1980. The annual quota started at 71,900 MT for 1966 and gradually increased to 190,500 MT for 1979.

Beginning in 1969, the IATTC undertook an experiment to overexploit the yellowfin tuna stock for determining the precise maximum sustainable yield (MSY). The experiment was designed to last three years, but continued until 1980. By about 1974, the results were clear and the objective of the experiment had apparently been met. However, the "experiment" continued presumably because termination would have required the fishing nations to reduce fishing capacity.

The IATTC experiment allowed all fleets to expand while postponing the issue of equitable allocation of the MSY among participants. Under the experiment, the quota was large enough to accommodate special allocations, adjusted annually, for exclusive use by certain coastal nations (e.g., Mexico and Costa Rica) to operate at full capacity and grow, and also allowed the large U.S. fleet to operate at near full capacity. Furthermore, the efficient U.S. fleet was restrained through U.S. regulations and stringent enforcement measures that allowed the less efficient foreign fleets to compete.

By the mid-1970's, as signs of overfishing became acute, i.e., the catch rate plummeted and fish became scarcer, strains in this arrangement became evident. Mexico and Costa Rica pressured for higher special allocations to continue full operations of their fleets as well as to sustain their plans for building additional vessels. The U.S. objected to these demands because the higher allocations would have reduced fishing opportunities for the U.S. fleet which was already suffering and encourage expansion of fishing capacity which was already excessive. In 1979, Mexico and in 1980, Costa Rica opted to terminate their membership in the IATTC rather than to be constrained by the IATTC rules. They also closed their EEZs to fishing by large foreign tuna vessels and continued expanding their fleets.

Since 1979, IATTC management role has been suspended because IATTC's actions are ineffective without the participation of non-member countries with major fishing fleets (such as Mexico). The research role, however, has continued. There have been ongoing efforts to bring the major non-members back into the IATTC and there has been recent success with Costa Rica rejoining in 1989. Efforts are also underway to develop a new management organization to succeed or replace the IATTC, including a proposal to expand the Permanent Commission for the Exploitation and Conservation of the Maritime Resources of the South Pacific or to use the framework of OLDEPESCA (a Latin American fisheries development organization). Proposals so far do not have full support of all nations with a stake in the resource and most have restricted membership to only resource-adjacent countries.

4.2.2 *International Convention for the Conservation of Atlantic Tunas*

The U.S. was also instrumental in organizing the International Convention for the Conservation of Atlantic Tunas of 1966. This convention is broader in scope than the IATTC convention. It includes tuna-like species (billfishes, small tunas, and some *mackerels*) as well as tunas, covers fisheries throughout the entire Atlantic Ocean and adjacent seas, and contains provisions for international enforcement of regulations.

Access to tuna stocks off Africa was apparently on the minds of many ICCAT convention supporters in the 1960s. After the convention was signed, U.S. purse seiners began fishing off Africa in a serious way. From 1967 until 1982, they landed 193,200 MT of skipjack and yellowfin tuna, or 8% of the total catch of these species from that region. At the end of 1981, the U.S. fleet withdrew from the fishery owing to factors such as increased competition from French and Spanish seiners, high cost of operations and political unrest in the region. Since then, the U.S. distant-water tuna vessels have not fished the Atlantic in significant numbers.

In the 1980s, the U.S. coastal fleet began large-scale fishing along the Atlantic seaboard, from Massachusetts to the Gulf of Mexico, for yellowfin and bigeye tunas for the fresh tuna markets. Catches in 1988 were 9,400 MT of yellowfin tuna and 700 MT of bigeye tuna. Most of the fish are large and taken with longlines or handlines that also fish for swordfish in the U.S. EEZ. Catches are increasing, but yields will most likely not match those of major tropical tuna fisheries such as in the eastern tropical Pacific or elsewhere.

Like the IATTC, ICCAT has a Commission composed of member representatives (Angola, Benin, Brazil, Canada, Cape Verde, Cuba, Equatorial Guinea, France, Gabon, Ghana, Code d'Ivoire, Japan, Korea, Morocco, Portugal, Senegal, Sã o Tome and Principe, South Africa, Spain, Uruguay, U.S.A, U.S.S.R., Venezuela), who adopt management recommendations and rely on the member countries to promulgate regulations to carry out the recommendations. So far, ICCAT has recommended minimum size regulations for yellowfin (in 1973), bigeye (1980) and bluefin tunas (1975), a catch quota for the western bluefin tuna fishery (starting in 1982), and a fishing mortality limit for the eastern bluefin tuna fishery (1975).

None of these ICCAT management measures, except one, have been strictly enforced. The bluefin tuna quota for the western stock is the exception. In 1982, a bluefin tuna catch quota of 1,160 MT was put into effect for the western Atlantic and called a "scientific monitoring" quota. This quota was increased to 2,660 MT for 1983, and has remained at this level since then. Three member countries (Canada, Japan and the U.S.) share and enforce the quota on an ad hoc basis, even though ICCAT's charter does not allow for country allocations. Because the quota has been larger than the rejuvenating capacity of the stock, and fully subscribed each year, the stock has continued to decline.

This and other ICCAT management measures have not necessarily been instituted with the explicit ICCAT conservation goal in mind, i.e. "...maintain the populations... at levels which will permit the maximum sustainable catch." They were implemented primarily to accommodate political pressures and secondarily, with the hope that they contribute to conservation of the stocks. Consequently, it is not surprising that declining stock abundance trends continued despite the implementation of ICCAT management measures.

4.2.3. *South Pacific Tuna Treaty*

In 1976, the U.S. passed the Magnuson Fishery Conservation and Management Act which extended jurisdiction over living marine resources within 200 mi of the U.S. coast, but left the highly migratory tunas exempt from this Act and subject to management only through international arrangements. Soon after, in 1982, the United Nations (U.N.) reached agreement on a new Convention for the Law of the Sea (CLOS) that assigned sovereign rights over living and non-living resources within the exclusive economic zone to coastal states, but mandated that coastal states cooperate in managing tunas and highly migratory species through international arrangements.

Most coastal states adopted the CLOS, so in the late 1970s and early 1980s, the U.S. principle regarding management of tunas lost currency within the EEZs. Under the U.N. law, coastal states can claim jurisdiction over the tuna resources in their EEZs as well as pursue arrangements for international management. International arrangements are not defined, so they can take the form of cooperation among states within a region where the stocks occur to manage the resource with the exclusion of distant-water fishing nations.

An example of such an arrangement is the Forum Fisheries Agency (FFA), an organization of 16 south Pacific island countries (Australia, Belau, Cook Is., Federated States of Micronesia, Fiji, Kiribati, Marshall Is., Nauru, New Zealand, Niue, Papua New Guinea, Solomon Is., Tonga, Tuvalu, Vanuatu, Western Samoa). The FFA is a cartel that has claimed jurisdiction over the tuna resources in the south Pacific. In 1987, it successfully negotiated a 5-year tuna treaty with the U.S. (the South Pacific Tuna Treaty). The 5-year treaty provides access for U.S. purse seine vessels to fish the skipjack, yellowfin and bigeye tuna stocks throughout their south Pacific range for a fee of $60 million ($50M from government and $10M from industry). The treaty, went into force in June 1988. This event has been interpreted by some as a shift in U.S. policy and an implicit admission that the island countries have jurisdictional claim over the tuna resources in their EEZs.

Serious U.S. interest in fishing the stocks of the western Pacific region began to emerge around 1975, when the eastern tropical Pacific stocks showed signs of being overexploited, and the U.S. fleet required an alternative to remain economically viable. Methods to successfully fish in that region were slow in developing. Nonetheless, by 1980, new, promising purse seining methods were being perfected that could sustain a fishery. This spurred a build-up of U.S. presence in that region. The catch, which is predominantly skipjack tuna, was about 33,000 MT in 1981. It increased to 134,000 MT in 1986. From 1981 to 1987, the U.S. removed more than 668,000 MT of tuna from the western Pacific. Currently, about 50% of the U.S. domestic production is from that region (Figure 4.3) and most of the catch is skipjack tuna (69%) made within the EEZs of the island nations.

The South Pacific Tuna Treaty is a fee-based access agreement, so it is unlike earlier U.S. tuna treaties which were for resource conservation and free access. Terms of the treaty are largely determined by the South Pacific countries, or resource owner. The U.S. pays a fee for resource extraction privileges on an annual basis for 5 years. Because the agreement does not guarantee access after 5 years, and is not an exclusive privilege (monopoly), the burden for conservation is on the South Pacific countries, and the U.S. purse seine fleet focuses on maximizing production within the terms of the treaty. This arrangement is a delicate one that appears to be working for now. However, difficulties will arise when competition for the privilege increases and limits are required on harvest levels.

4.3. Research Arrangements

Four international organizations, IATTC, ICCAT, SPC and Indo-Pacific Tuna Development and Management Programme (IPTP) are actively involved with research of tunas. They are quite different in structure and provisions for providing research results to sponsors. The IATTC and the SPC have in-house research staffs that are funded to conduct research and are responsible to their commissions; hence, findings are reported to the commissions. Of these two organizations, the IATTC is older and by virtue of having a management-advice giving role for a fishery of significant importance to the U.S., has a focused mission, is funded adequately, and is relatively free from having to respond to the day-to-day needs of member countries. In contrast, the SPC's tuna research program is a more recent effort. The staff is smaller, funding has fluctuated, and the mission is evolving. The research is not tied into a fishery management body, so the research tends to serve the needs of individual island countries.

ICCAT does not have a research staff. ICCAT has a permanent staff (Secretariat) with administrative responsibilities, which include processing and maintaining a statistical data base, assisting members in designing national data collection systems, and supporting stock assessment activities of the Commission's Standing Committee on Science and Statistics (SCRS). The SCRS, which is composed of scientists of member countries, is the research arm of ICCAT. Members perform required research with funds from their agencies and outside the ICCAT budget. The committee reviews results submitted by members and non-members, and provides scientific advice to the Commission on status of stocks and management of the fisheries.

IPTP has a structure akin to ICCAT's. It has a program office, i.e., Secretariat, with a small technical staff devoted to maintaining a statistical data base, providing technical assistance on fishery data gathering, and promoting coordinated research on tunas by the developing countries of the Indian Ocean and southeast Asia.

4.3.1. *Inter-American Tropical Tuna Commission*

The principal duties of the IATTC are (1) to study the biology of the tropical tunas, tuna baitfish, and other kinds of fish, and since 1976, marine mammals taken by tuna vessels, and the effects of fishing and natural factors upon them, and (2) to recommend appropriate conservation measures, when necessary, so that these stocks of fish can be maintained at levels which will afford the maximum sustained catches.

The IATTC carries out an extensive research program using a permanent, internationally-recruited staff of approximately 40 scientists and technicians, working out of several offices in the eastern tropical Pacific region as well as in California and Puerto Rico. The annual budget is $3.5M, with the U.S. providing about 79%. A large share of this budget is spent on administration and collection of fishery statistics from the international fleet, particularly for monitoring of tuna catches and dolphin mortality. Findings of the staff are published, largely in internal documents, and used for developing management recommendations. The staff's recommendations are submitted to the Commission for decision.

4.3.2. *International Commission for the Conservation of Atlantic Tunas*

ICCAT coordinates research conducted by member country scientists, emphasizing research on the condition of the Atlantic stocks for management advice. ICCAT does not have a permanent research staff, only a Secretariat in Madrid, Spain, of approximately 15 persons and with an annual budget of about $900,000; the U.S. contributes about $93,000. The Secretariat coordinates exchange of research information and fishery data, and organizes an annual peer review of research findings and assessments of the condition of stocks by the Commission's scientific committee (SCRS). Research is left largely for member countries to finance and execute. Findings are published primarily in national scientific journals, but may appear in informal ICCAT publications as well. The SCRS is the exclusive source of scientific information for the Commission.

Progress in research is slow with this ICCAT arrangement as compared to IATTC, which has a permanent staff and adequate funding. Funding and staffing of research projects is dependent on individual member countries, many of whom do not have funds and expertise to execute the types of research required for complex management decisions. Most invest their meager research funds into collecting fishery statistics, a requirement of member countries.

4.3.3. *South Pacific Commission*

The SPC is a consultative and advisory body to the governments of the South Pacific region in fisheries matters as well as socio-economic and other natural resources matters of the region. It carries out tuna research with a staff of the Tuna and Billfish Assessment Programme (TBAP), formerly the Skipjack Survey and Assessment Programme, in Noumea, New Caledonia and an annual budget of up to about $1.1M. The staff consists of approximately 8 scientists and technicians. Current donors to the SPC programs include Australia, France, New Zealand, the United Kingdom and the U.S., former administrative governments of the Pacific Islands and the European Economic Community.

TBAP projects are of two basic types: (1) collection, processing and dissemination of tuna and tuna fishery data, and (2) research. Research projects currently emphasize assessment of fishery interactions through tagging and fishery data analysis. Findings are published primarily in internal SPC documents and are used to provide advice to individual south Pacific countries. Recently, the TBAP has worked closely with the FFA on tuna fisheries issues. Although there is no formal arrangement between the SPC and FFA for this relationship, a close working relationship has developed owing to all members of the FFA belonging to the SPC. Hence, the TBAP serves as a convenient tuna research arm without additional cost to the FFA countries.

SPC tuna research is conducted by an in-house staff similar to the IATTC structure, so theoretically, research projects can be well focused and managed to provide timely information. However, unlike the IATTC, the SPC's TBAP does not report directly to a management body, and the staff is on two - to three-year contract assignment; hence, it has fewer requirements for focusing projects to meet management needs or to build long-term continuity in staff expertise. Furthermore, many of the research questions for fisheries management issues in the South Pacific such as stock boundaries, optimum yield, and stock condition are intractable without a large, long-term research effort. This is costly and the SPC donor countries have been reluctant to support such efforts.

4.3.4. *Indo-Pacific Tuna Development and Management Programme*

In 1982, FAO organized the IPTP program with funds from the U.N. Development Program (UNDP), and later with contributions from the Japanese government as well.

IPTP has since served as the lead organization for coordinating the collection and compilation of tuna fisheries statistics from the Indian Ocean and southeast Asia and for sponsoring tuna tagging projects. It also sponsors biannual consultations of expert scientists to review scientific information, and to assess the condition of the stocks in the Indian Ocean. The results are used as advice to the IOFC and other FAO-associated bodies about stock condition, and tuna fishery developments. The IPTP has an annual budget of about $1.1M (about $700,000 from UNDP, and $400,000 from Japan) which supports a small permanent staff in Colombo, Sri Lanka which consists of a program leader, 4 biologists and several support personnel; and several field offices in Southeast Asia, as well as support for tuna tagging projects.

IPTP's research effort is primarily in supporting collection of fisheries statistics, and tagging experiments for investigating fishery interactions. Findings of the program are published in informal IPTP publications.

4.4. Trends in arrangements

In the 1960s and earlier, the popular view was that international arrangements were the only completely effective way to manage tuna fisheries and to conduct research on the highly migratory tunas. The standard models of such arrangements were the IATTC, ICCAT and FAO-associated bodies. These arrangements allowed virtually all interested parties, both resource-adjacent countries and distant-water fishing countries, to join and have open and free access to the resource and share in the research findings. Members contributed to the data pool, paid for a wide-range of research projects according to level of commercial benefits derived from the resource, and shared in the information pool. The economic rewards, however, were not shared equally, but accrued to those that were efficient in exploiting the resource, i.e., primarily the distant-water fishing nations. The arrangements also had rules, e.g., consensus and objection procedures, and goals that maintained status quo and encouraged efficiency in harvesting. This, for the most part, allowed the distant-water fishing countries with their efficient fishing technology to dominate the fisheries, retain the competitive edge in fishing, and control the arrangements.

Perhaps, largely because of such weaknesses, the popularity of such international arrangements waned. In their place, coastal state jurisdiction and regional arrangements came into favor with emergence of the CLOS and the 200-mile EEZ concept and the recognition by resource-adjacent nations that they were entitled to benefits from the resource. Unlike older international arrangements, the newer regional arrangements do not allow open membership and free access by all fishing nations. Instead, membership is limited to resource-adjacent countries only, and the arrangements are designed to maximize benefits for the member countries. The South Pacific Tuna Treaty is a good example of this new arrangement.

Regional arrangements seem to be well-suited for areas where coastal nations control most of the geographic range inhabited by the resource, or control most of the geographic area where the resource is available for efficient harvesting. The members must be in harmony with the organization's objectives and must not be in competition among themselves for harvesting the resource. In other words, they must be unbiased in selecting the best option for maximizing the collective benefits.

The current trend is definitely towards coastal state jurisdiction of tunas, and regional arrangements for managing fishing and the resource. As long as the members of such arrangements do not develop large harvesting capability, regional arrangements should be successful. Uncoordinated investment in harvesting capability by the member countries could easily create large national fleets that outstrip yields from national EEZs. The formulas for distributing benefits among the members could then become complicated and difficult to administer.

The trend is also towards reduced emphasis on arrangements that include both management and research. Formal management-research arrangements currently in existence were established well before the 1970s, and no new effective ones have been formed since then. The best working arrangement is the IATTC with a scientific staff that is somewhat protected from day-to-day contact with and possible influence by the sponsors. However, with controversial management issues, this breaks down, and the staff is less successful in remaining detached and able to concentrate solely on the scientific mission.

An example of this is the IATTC's recent involvement in dolphin research in the eastern tropical Pacific. The IATTC's research has long been clearly focused to primarily maximize long-term yield of yellowfin tuna to the fishermen. More recently, it has been broadened to include minimizing incidental fishing mortality on the dolphin stocks to satisfy U.S. public concerns. Because maximum yield of yellowfin tuna is obtained with capture of the large yellowfin that make up dolphin-tuna aggregations, the IATTC has long encouraged fishing on such aggregations although this results in dolphin kills of over 100,000 animals annually. The U.S., which provides a large share of the IATTC research budget, is currently strongly in favor of reducing dolphin kills to a low level, even at the expense of yellowfin yield. This goal is at odds with the IATTC staff's approach and management recommendations.

Other arrangements, such as the ICCAT, SPC and IPTP have tuna research responsibilities, but are less effective in carrying them out. Scientists involved in the research are also not as well protected from day-to-day influences of sponsors as is the IATTC staff. These arrangements suffer from poor funding and focus. They largely depend on national research agendas to either augment or satisfy entire research needs and for political support in securing funding. Political considerations also enter into the development of their research plans. Occasionally, political considerations nullify otherwise sound scientific objectives, or approaches and prevent studies from meeting their objectives. As a result, comprehensive research to resolve management issues, for preventing potential fisheries crisis or for expanding the scientific information base, is frequently compromised or is not undertaken.

Despite these flaws, a positive feature of the ICCAT, SPC and IPTP is their system of peer review of research results. Unlike the IATTC, these organizations have established a peer review system to review available scientific information, share individual national results, build common understanding and coordination among the national scientists, and to encourage development of scientific capabilities of junior participants. The system varies in form, but typically involves a committee of scientists meeting annually to review research results and to share information.

All current research arrangements have become heavily invested in collecting and processing fishery statistics, and in emphasizing analysis of the statistics for management advice. Basic research that does not have immediate applicability does not receive the attention it deserves, so the pool of knowledge for informed future management decision grows very slowly. The situation will continue or even worsen in the future as coastal states gain more control over the resource, and with it, the responsibility for conservation and research. Distant-water fishing nations, who historically supported basic research, will reduce their support, except as required for stocks in their own EEZs. The trend, thus, is a shift in responsibility for research toward the coastal states.

4.5. Summary of tuna management and research arrangements

In general, the international management arrangements (Table 4.1) have, for the most part, failed to meet their conservation objective of maintaining stocks at levels allowing maximum sustainable yields because of structural defects, particularly the absence of central authority to control and manage fishing effort. Research arrangements have, in many cases, failed to provide precise and timely advice for management decision making, because of poor funding and/or political interference.

The trend is towards coastal state jurisdiction and regional management arrangements, with membership limited to coastal states. The objective is to maximize benefits to the members. Formal research arrangements will be fewer and largely ineffective as funding responsibility shifts from the developed nations to the developing nations, or resource owners. A larger share of the research funding will be used for collection and processing of fishery statistics rather than on research required to expand the pool of biological knowledge for informed management decision.

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Table 4.1. Summary of existing international or regional management and research arrangements for tuna stocks. Year of formation is shown in parentheses.

Stock	International/Regional[1] Research organization	Management organization
Yellowfin tuna		
Eastern Pacific	IATTC (1949)	IATTC
Western Pacific	SPC (1947)	SPTT (1988)
Eastern Atlantic	ICCAT (1966)	ICCAT
Western Atlantic	ICCAT	ICCAT
Indian Ocean	IPTP/IOFC (1982)	None
Skipjack tuna		
Eastern Pacific	IATTC	IATTC
Western Pacific	SPC	SPTT
Eastern Atlantic	ICCAT	ICCAT
Western Atlantic	ICCAT	ICCAT
Indian Ocean	IPTP/IOFC	None
Bigeye tuna		
Pacific	None	None
Atlantic	ICCAT	ICCAT
Indian Ocean	IPTP/IOFC	None
Albacore		
North Pacific	None	None
South Pacific	None	SPTT
North Atlantic	ICCAT	ICCAT
South Atlantic	ICCAT	ICCAT
Indian Ocean	IPTP/IOFC	None
Bluefin tuna		
Pacific	None	None
Western Atlantic	ICCAT	ICCAT
Eastern Atlantic	ICCAT	ICCAT
Indian Ocean	AJN[2]	AJN[2]

[1] IATTC - Inter-American Tropical Tuna Commission; ICCAT - International Commission for the Conservation of Atlantic Tunas; IOFC - Indian Ocean Fishries Commission; IPTP - Indo-Pacific Tuna Development and Management Programme; SPC - South Pacific Commission; AJN - Australia-Japan-New Zealand.

[2] An informal organization with three members: Australia, Japan, and New Zealand is being established. Language for a formal treaty is being developed.

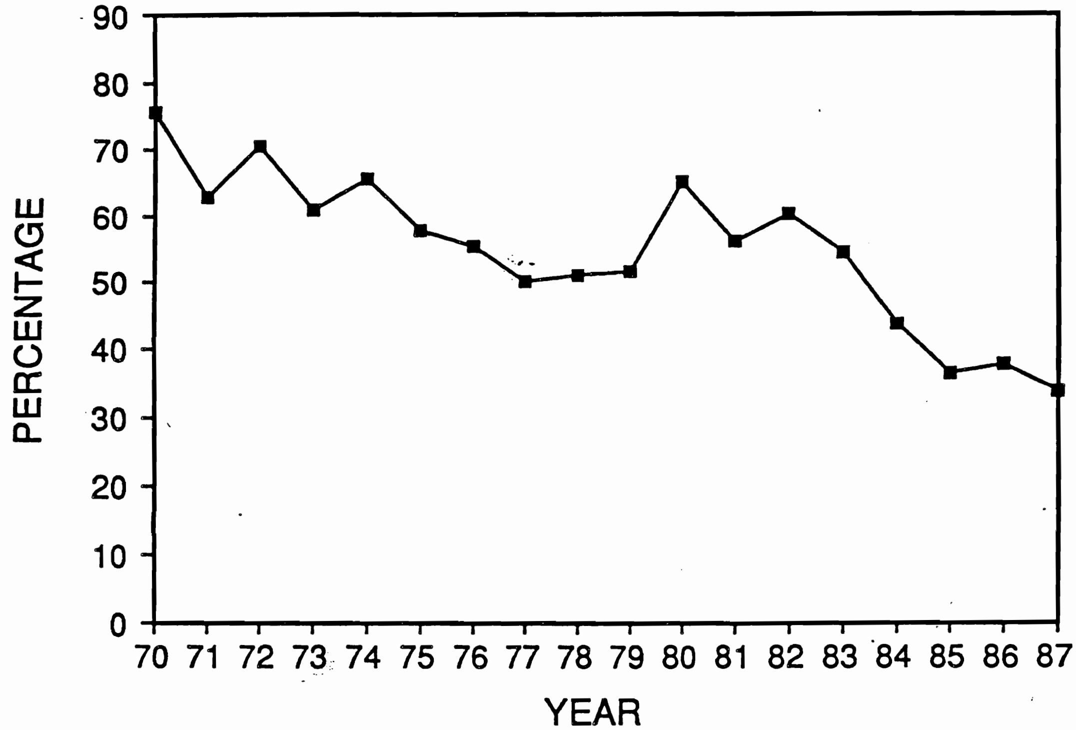

Figure 4.1. Percentage of total eastern tropical Pacific catch of all tuna species taken by the U.S. fleet.

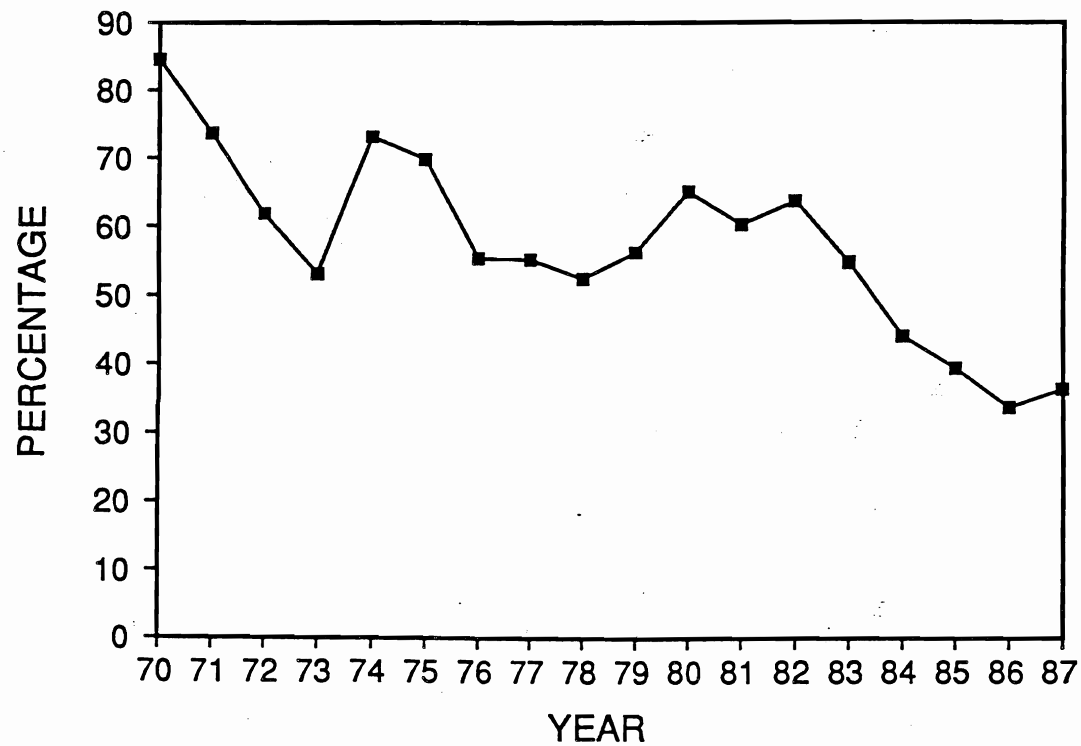

Figure 4.2. Percentage of total eastern tropical Pacific catch of yellowfin tuna taken by the U.S. fleet.

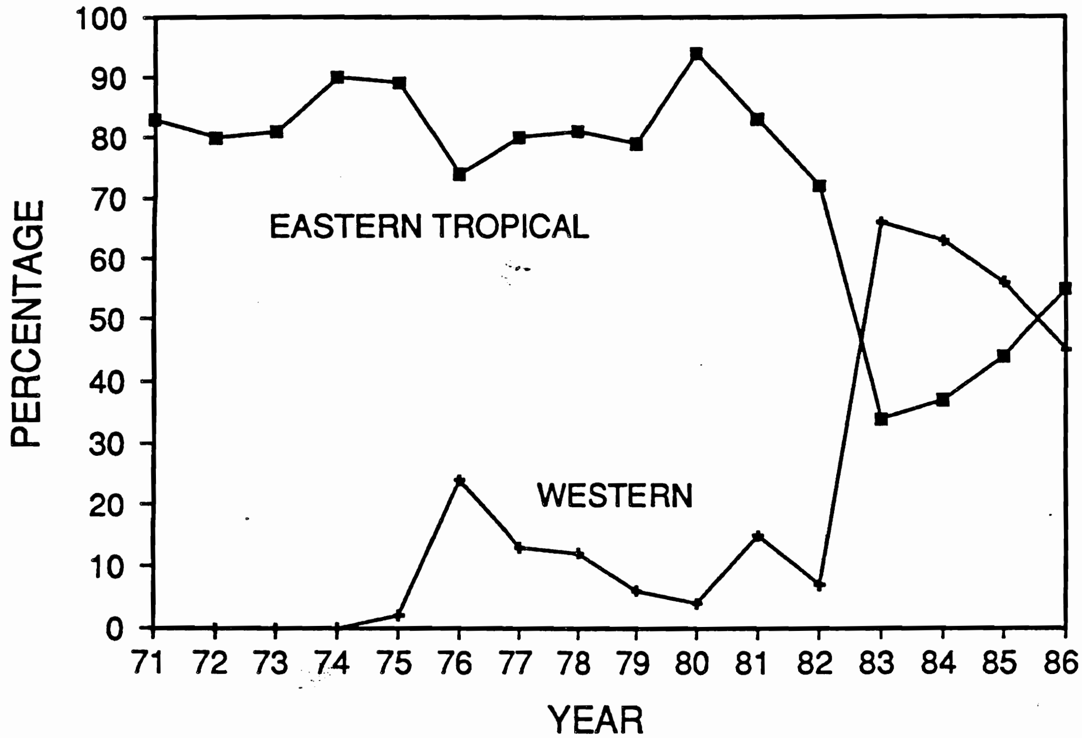

Figure 4.3. Percentage of U.S. Pacific tuna catch taken in the eastern and western regions.