Draft Report[1]

North Pacific Albacore 'White Paper'

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North Pacific Albacore White Paper

1. Purpose

The purpose of this 'White Paper' is to provide the Pacific Fishery Management Council (PFMC) with information that may assist it in initiating deliberations for initiating a framework process to maintain or limit fishing effort by the West Coast albacore fishery. The document includes a summary of management measures that are in place for the fishery and an analysis of management options that could be considered for maintaining or reducing effort in the fishery. Information is also presented regarding the albacore resource and the fisheries operating on it. An outcome of the analysis of management options is that it later may serve as the basis of the National Environmental Policy Act (NEPA) process and thus serve as the building blocks that could be formulated into a range of rational management options for the U.S. West Coast albacore fishery.

2. Background Information

The North Pacific albacore resource is distributed in ocean areas that encompass multiple zones of national jurisdiction, as well as the high seas, and are exploited by fisheries of many Nations. As such, international agreement is necessary to conserve North Pacific albacore tuna stocks and to ensure the viability of the fisheries. Article 64 of the United Nations Law of the Sea Convention mandates States to cooperate directly or through appropriate international organizations to ensure the conservation of tunas. International management of the North Pacific albacore tuna resource and fisheries operating on it are shared under the auspices of the Inter American Tropical Tuna Commission (IATTC) and the Western and Central Pacific Fisheries Commission (WCPFC). The Commissions formulate overarching resolutions based on recommendations from scientific committees or staff. Member states negotiate agreements on management mechanisms and once agreed upon, the actual implementation is left to the individual member and cooperating countries.

The PFMC has the lead to adopt management actions regarding the U.S. West Coast albacore fishery. Stock assessments indicate that presently the North Pacific albacore tuna resource is not overexploited. However, the assessment concludes that fishing effort may be above levels that are not sustainable in the long term. The status of the stocks and evidence supporting the need to cap fishing effort on the North Pacific resource are presented in Section 7 of this document.

In 2005 the IATTC and the WCPFC adopted resolutions, which have been continued through the present time, for conservation of North Pacific albacore based on concerns that recent fishing effort may be above levels that are sustainable in the long term. Resolutions adopted by both Commissions call upon their members and cooperating parties to take necessary measures to ensure that the level of fishing effort by their vessels fishing for North Pacific albacore is not increased beyond current levels, and to report all catches of North Pacific albacore to the Commissions at 6-month intervals. The WCPFC resolution requires that fishing effort be reported by gear type annually

"… in terms of the most relevant measures for a given gear type, including at a minimum for all gear types, the number of vessel-days fished."

In response to the IATTC and WCPFC resolutions, the PFMC tasked its Highly Migratory Species Management Team (HMSMT) to examine recent levels of U.S. albacore fishing effort on North Pacific albacore in order to establish the current effort level and enable decision makers to meet the requirements of the IATTC and WCPFC resolutions. Scientists of NOAA Fisheries' Southwest Fisheries Science Center (SWFSC), working in cooperation with the Council's HMSMT and HMS Advisory Subpanel (HMSAS), compiled fishery statistics and analyzed trends in North Pacific albacore catch and effort for U.S. commercial fisheries. The analyses included information for the West Coast troll/bait fishery and the Hawaii-based longline fishery, which catches albacore incidentally. The findings of the analyses, which are discussed in Section 6.1.2 of this document, are contained in a report issued in May 2007, *Characterization of Recent U.S. North Pacific Albacore Commercial Fishing Effort.*

In summary, the intent of this 'White Paper' is to provide the PFMC with information that may assist it in deliberations regarding the initiation of a framework process to maintain or limit fishing effort by the West Coast albacore fishery.

3. <u>Management Measures Presently in Place on the U.S. West Coast Fishery</u>

The U.S. West Coast albacore fishery, which is one of the few remaining open access fisheries on the West Coast, is managed under the PFMC HMS Fishery Management Plan (HMS FMP). The management measures presently in place on the fishery, which apply to vessels fishing for albacore in the EEZ off the West Coast as well as when fishing on the high seas and landing their catch in West Coast states, include the following:

- A Pacific HMS fishing permit with an endorsement for a specific gear and other accompanying provisions, is required by all commercial and recreational charter fishing vessels fishing for albacore. Permits are issued to the owner of a specific vessel for a 2-year term and are renewable.
- All Pacific HMS permit holders must maintain and submit to NMFS a daily logbook of catch and effort and catch disposition.
- The HMS FMP prohibits all pelagic longline fishing within the West Coast EEZ as well as shallow-set longline fishing in the adjacent high seas areas.
- All U.S. fishing vessels operating in HMS fisheries may be required to carry a NMFS certified observer on board to collect scientific data when directed to do so by the NMFS Regional Administrator.
- A control date of March 9. 2000 has been established.
- A U.S./Canada Albacore Tuna Treaty that allows, with conditions, fishing vessels of both countries to fish for North Pacific albacore in the respective EEZ waters outside 12 miles of the other county and to access certain ports to obtain supplies and services and to land their catch (see Section 3.1.1 of this document)
- The recreational fishery is managed by daily bag limits of 10 albacore per angler south and 25 albacore per angler north of Point Conception, CA.

- The State of California has a 7 pound minimum size limit for albacore on the books, which was decreased from 9 pounds in 1957. The size limit was apparently put in place for processing efficiency.

3.1 U.S. /Canada Albacore Tuna Treaty

The U.S./Canada Albacore Treaty was initially put into effect in 1981, amended in 2002, and codified by law in April 2004. U.S. and Canadian delegations met in 2008 to re-negotiate future and specific aspects of the Treaty

3.1.1 Provisions of the Treaty

The Treaty allows, with conditions, fishing vessels of both countries to fish for North Pacific albacore in the respective EEZ waters outside 12 miles of the other county and to access certain ports to obtain supplies and services and to land their catch. U. S. vessels have access to British Columbia ports in Coal Harbor, Port Hardy, Prince Rupert, Victoria, Vancouver, and Ucluelet. Canadian vessels have access to ports in: Bellingham and Westport, Washington; Astoria, Newport, and Coos Bay, Oregon; and Eureka, California. The Treaty also establishes regulations regarding vessel marking, record keeping, and reporting requirements when operating in each other country's waters; and calls for exchange of fisheries data between the governments of the two Nations. In addition, the Treaty provides for agreed fishing limits on reciprocal fishing access. Negotiations conducted in 2008 for a new 3-year fishing regime included limiting the number of Canadian vessels to 110, none of which can be pole-and-line vessels and the number of U.S. vessels fishing in Canada to remain within historical levels; defining the vessel access period as starting June 15 and ending October 31; and that and that either country may terminate the new regime in the event that international or domestic management measure are adopted.

3.1.2 Amount of U.S. and Canadian Albacore Caught in Each Others EEZ

The percentage of U.S. catch caught in Canada's EEZ during 2004 – 2008 ranged from one to four percent. However, in earlier years when the availability of albacore was high in 'northern' waters and there was a much larger U.S. pole-and-line albacore fleet, the U.S. catch in the Canadian EEZ was considerably more, up to 30 percent and higher. The distribution of U.S. albacore catch and effort is shown in Figure 1 and the monthly use by U.S. and Canadian vessels in each other's EEZ is given in Table 1. The annual total of Canadian albacore catch and total amount caught in the U.S. EEZ, and the values of the catch in Canadian dollars are given in Figures 2a and 2b, respectively. There has been a large increase in the Canadian total catch of albacore, as well as the amount caught in U.S. EEZ waters beginning in the late 1990s. During 2003 to 2007 Canadian catch made in the U.S. EEZ ranged from 1,725 to 3,891 mt. or approximately 60 to 80 percent of the total Canadian annual catch. The value in Canadian dollars during this period ranged from approximately C$3.65 million to C$13.65 million. In addition to the apparent benefit to U.S. coastal processors of albacore landed by Canadian fishermen in west coast ports, the Canadian stopovers may also benefit local communities through expenditures for fuel and supplies while they are in port. A Canadian government survey that sampled a subsection of their fishermen that fished in the U.S. EEZ during 2002 – 2007 estimated that approximately $700K to $800K in expenditures were made annually by Canadian fishermen while in U.S. ports. No information was available on the amounts of expenditures by U.S. fishers during stopovers in Canadian ports.

4. Potential Management Options For Consideration

Fisheries management options are broadly classified as 1) output controls which control the catch through, for example, TACs; 2) input controls which regulate the extent and kind of effort that is prosecuted; examples are gear restrictions, minimum sizes and area restrictions; and 3) the access programs in which particular entities are allowed to fish. If fishing mortality needs to be limited, then ultimately some form of input and/or output controls will be needed in conjunction with access decisions on who can fish. The discussion (below) of potential management options for the U.S. West Coast albacore fishery centers around decisions about access programs: Limited Access Privilege Programs (LAPP); limited entry; and open access. Then options for input/output controls are discussed in the context of access..

4.1 Open Access

Most U.S. fisheries were managed under open access until the end of the 20th century. Under this system of management, lucrative fisheries have often become over-capitalized resulting in excess capacity and over-exploitation of the resource. At some point to halt the over-exploitation, an authority often would establish input and/or output controls on the fishery, e.g., vessel size, limit number days fished, catch limits, restrictions to fishing effort, limit the characteristics (normally size or breeding status) of individual fish that may be taken legally or other similar options. In many cases input controls by themselves eventually have proved to be ineffective due to the development of technological changes to overcome them. Conversely output controls are often not effective due to poor governance structures, imperfect implementation and enforcement and by choosing too risky TAC levels. However, there are many cases where TACs combined with input controls have been effective. For example TACs, country-specific allocations, a minimum size and seasonal closures of small-fish areas were used to recover the over-exploited swordfish stock in the North Atlantic

4.1.1 Possible Input and/or Output Controls Applied to an Open Access the U.S. West Coast Albacore Fishery

Some possible specific input and/or output controls for consideration for application to the U.S. West Coast albacore fishery and the pros and cons of each are summarized in Table 2. The implications of this approach are the last open access fishery on the West Coast would not be closed to new entrants. If management action is required, many fishers and others in the albacore fishing industry, including some recreational albacore fishing charter vessels, favor some sort of unspecified input and/or output controls to other management options that limit their participation.

There a number of disadvantages to using input and/or output options to limit or maintain fishing effort in the U.S. West Coast albacore fishery, including:

- Catch limits, trip limits, or reducing the amount of gear that may be fished would at least initially result in a reduction of effective fishing effort, but would create serious disruptions to the fishery resulting in severe economic inefficiencies.

- Limiting the amount of gear fished, e.g., the number of jigs that could be trolled or poles that could be fished likely could not be enforced unless there is100 percent observer coverage.
- Evaluating the effectiveness of limiting the amount of gear that could be fished would be problematical since fishers normally only 'pull' and land albacore caught on short lines when fishing activity and catches are very high.
- Establishing a total allowable catch (TAC) is strongly opposed by many U.S. fishers and fish buyers, but supported by a few fishers.
- The highly migratory nature of the species and the high inter-and intra-annual variability in its seasonal distribution and availability in waters off the west coast of North America would generally contribute to reducing the effectiveness of utilizing input or output controls.
- Closed areas would be very tricky to establish and almost impossible to enforce due to the large swings in inter- and intra-annual variability of albacore distribution, availability, and vulnerability to capture, all of which are markedly influenced by spatial and temporal variability in ocean conditions.
- Establishing a minimum fish size (age) limit where only mature fish could be landed would not work because the fishery is based exclusively on pre-adult 2, 3, and 4 year-old fish.
- Allowing only male albacore to be landed is not feasible because dissection is required to distinguish the gender of albacore.
- Technological changes most often overcome the effectiveness of input and/or output controls in controlling fishing effort.

4.2 Rights-Based Management Programs
Rights-based management programs include Limited Access (LA) and Limited Access Privilege Programs (LAPPs) for managing fisheries resources.

4.2.1 Limited Access (LA) Programs
Limited access (LA) programs are commonly used to regulate entry into a fishery in order to promote the conservation and sustained management of the stock, and maintain or enhance the economic health and stability of the fishing industry. They are a simple rights-based input controls, which provided the rights are guaranteed for a long time, give those with the right an interest in conservation, but on its own does not promote economic rationalization (Allen et al in press). The effectiveness of LA's for holding harvest at safe levels depends on a multitude of factors including the number of permits relative to safe harvest limits, the types of other management controls that are put in place, and on the potential for input substitution in the fishing process. Also, limited entry or limited access simply limits entry, but does not limit use or catch, nor does it take into account technological changes in fishing.

4.2.1.2 Applying Limited Access to the U.S. West Coast Albacore Fishery
There are a number of advantages to adopting a limited access or limited entry fishery regulatory measure for managing the U.S. West Coast albacore fishery.
- Would allow the Council to act in a precautionary manner by developing a framework process to maintain or limit fishing effort at the present time and avoid the risks of having to do so if the fishery is determined to be *overfished* in about 2015 as is indicated will happen

by stock assessment results if effort is not capped.

- Would provide both short-term and long-term benefits to the fishery in maintaining its viability.
- Initiating a LA program at the present time would likey not eliminate U.S. vessels in the fishery, since the number of U.S. vessels active in the fishery has been relatively stable during the recent 5 or more years.
- LA program would contribute towards preserving the health of the North Pacific albacore resource. The full effect of which requires that all Nations harvesting North Pacific albacore stock(s) keep fishing effort in check. According to WCPFC International Scientific Committee (ISC) documents, Japanese longline and baitboat fleets that target albacore are subject to strict capacity and other controls, and North Pacific albacore catch by these fleets is declining. Taiwan is constraining North Pacific albacore fishing effort to 2004 levels and the Canadian troll fleet has decreased. Korea reports that it is no longer targeting North Pacific albacore, but some albacore catches are made incidental to longline fishing for tropical tunas in the North Pacific.
- Undertaking the option before there is a possible 'emergency situation would likely allow increased opportunities for fishers and other stakeholders to play more active roles in the formulation a LA program.
- A control date of March 9, 2000 is in place for the fishery, which may or may not be considered final in regard to the adoption of a LA.
- A program likely can be set up to allow permit transfers.
- It may be possible to structure a LA process that could accommodate the vessels from other West Coast fisheries that have a history of entering the albacore fishery when there are limited opportunities in their respective fisheries.
- Setting up a LA program for the U.S. albacore fishery conceptually could be relatively straight forward since it is a single species fishery.
- Costs to plan and implement a LA program would likely be relatively low.
- Would ensure that the U.S. meets its responsibilities related to North Pacific albacore regarding U.N. Article 64.
- Adopting a LA program for the albacore fishery would also establish an assemblage of participants for future management measures should they be needed, possibly including stronger forms of rights-based management.

There are a number of actions that the Council could take leading to the adoption of a LA program for the U.S. West Coast albacore fishery. These are listed, with pros and cons, in Table 3.

There are several disadvantages for adopting a limited entry or limited access fishery management program for the U.S. West Coast fishery at this time.

- The last open access fishery on the West Coast would be closed needlessly if the scientific warnings are wrong that the fishery will become *overfished* in about 2015 if effort is not capped.
- Concerns exists that the U.S. albacore fishery would be at a disadvantage if the U.S. takes action to cap fishing effort and other Nations do not.
- Possible complications could arise related to vessels that may move in and out of the albacore fishery from other West Coast fisheries, e.g., Dungeness crab, salmon and/or

groundfish fisheries, in years when conditions in these fisheries are unfavorable.
- There could be complications regarding the U.S./Canada Albacore Tuna Treaty.

4.2.2 Limited Access Privilege Programs

Limited Access Privilege programs (LAPPs) are market-based or rights-based fishery management programs whereby an individual fisherman, community, or other entity is granted the privilege to catch a specified portion of the Total Allowable Catch (TAC) of a fishery stock. Originally LAPPs were referred to as Individual Fishing Quotas (IFQs) or Individual Transferable Quotas (ITQs) where an individual fisher is granted a specified portion of the TAC, where the ITQ could be transferred to another user. Over time the concept of IFQs and ITQs has been expanded and is referred to as a LAPP in the amended Magnusson-Stevens Act (MSA) (Public Law 109-479). MSA specifies mandatory conditions and other provisions for designing LAPP fishery management programs. MSA also is clear that any LAPP is only a permit to harvest and does not confer any right to compensation and that there are no rights, title, or interest in any fish until it is harvested. LAPPs are generally designed by Fishery Management Councils, while NMFS implements and monitors them. The NMFS/Office of Policy has issued a comprehensive publication, *The Design and Use of Limited Access Privilege Programs* (Anderson and Holliday eds. 2007), to assist Regional Councils and NOAA NMFS in the design and implementation of LAPPs. This publication also includes summary information on ten current LAPPs in the U.S.

A LAPP type rights-based fisheries management program is believed by Joseph (2003) and Allen et al (in press) to be the most viable solution available for the international management of global tuna stocks to address the problems of excess capacity and over-exploitation. Allen et al. (in press) state that *"…Unlimited entry into tuna fisheries must now change. Failing this, the inevitable outcome will be overexploitation of the world's tuna stocks. Rights-based management, (*the concept upon which LAPPs are based) *wherein catches are allocated to participants and fleets are limited in numbers, can bring this change and provide incentives to fishers to maintain fleets at optimal levels. To accomplish this requires a change in mind set and political will of many nations whose citizens participate in world tuna fisheries, both on the high seas and in coastal zones.*"

New Zealand introduced the first major ITQ program in1986. Other foreign countries with ITQ or LAPP-like management programs include Australia, Canada, Iceland, Italy, the Netherlands, and South Africa. Although this is not a comprehensive list of all non-US ITQ programs, it indicates that ITQ management is widely used internationally. Some foreign countries, e.g., New Zealand and Australia, may apply more restrictive criteria for deciding if an ITQ or LAPP-like program is an appropriate measure for managing a fishery, including: 1) the sustainability of the overall catch, 2) adverse harvest effects on the aquatic environment or the sustainability of other species and/or biological diversity, and 3) issues of allocation between commercial and non-commercial users or inefficient utilization or under utilization of catches. Whereas, usually the only criterion for deciding if a LAPP is an appropriate measure for managing a fishery in the U.S. is if there is a concern of overexploitation of the fishery and that it is *overfished*.

Relatively early in the period when the U.S. began using ITQs for managing fisheries, the National Council for Science and the Environment conducted a thorough review of the measure for managing U.S. fisheries (Buck, 1995). A summary of Pros and Cons of ITQ programs taken from Buck's (1995) review is given in Table 4; the Pros and Cons from Buck also generally apply to LAPPs. Information in Table 4 indicates that LAPPs provide an option in fisheries management that can promote conservation of stocks, improve market conditions, promote safety in the fishing fleet, slow or eliminate the 'race to fish' and minimize overcapitalization. However, there can also be many disadvantages to the programs and they are not ideal, appropriate, or desired for every fishery or region

4.2.2.1 Examples of Management Programs of Foreign Albacore and Other Tuna Fisheries Using LAPP-like and Other Measures

A summary table prepared by staff at the NMFS SWR Division of Sustainable Fisheries that lists several foreign countries using LAPP-like and other management strategies for albacore and other HMS fisheries is given in the *Appendix* (*Table A-1).* Most of the fisheries listed in *Table A-1* are longline fisheries that target southern bluefin tuna or swordfish (e.g., Australia SBT, WTBF, and ETBF; and New Zealand southern bluefin, bigeye tuna, and swordfish) and make incidental catches of albacore and other large pelagic species

The New Zealand albacore troll fishery has been considered in two consultations for introduction into the Quota Management System (an ITQ-based system used in New Zealand fishery management) and failed both times when stakeholders expressed strong opinions both for and against the proposal. In considering the information presented on albacore and the submissions received during both consultations, the Minister of Fisheries was not satisfied that the requirements to introduce albacore into the QMS were met, namely that the fishery has sustainability or utilization issues. However, since QMS is the preferred long term management regime for albacore it will be reconsidered for introduction when and if there is new information (New Zealand Minister of Fisheries. Albacore Tuna (ALB)- Initial Position paper – October 1, 2007). It is likely that the inclusion of albacore, as well as skipjack tuna, in the QMS will be incorporated in the development of fisheries plans for these species in 2009 (Personal communication cited in *Table A.1).*

The South Atlantic albacore stock, which is considered *not overfished* and *no overfishing* is occurring, and the North Atlantic albacore stock, which is considered *overfished* with *overfishing* going on, are subject to ICCAT international management. ICAAT has adopted TACs for the albacore stocks in both regions and assigned specific country quotas. In the Indian Ocean the status of the albacore resource is unknown due to a lack of data to conduct a stock assessment. However because of concerns about the status of the albacore stock, the Indian Ocean Tuna Commission (IOTC), which has international management authority, has adopted a conservation measure to limit fishing effort of the stock. In response to this, the European Union has established limitations of fishing capacity for Community vessels fishing for albacore on the Indian Ocean high seas where the IOTC has international management authority (Official Journal of the European Union, 2008. Council Regulation No. 1222/2008 regarding management measures adopted by the Indian Ocean Tuna Commission).

4.2.2.2 Applying a LAPP Program to the U.S. West Coast Albacore Fishery

A LAPP program could be carefully planned and implemented for the U.S. West Coast albacore fishery. There are advantages to taking this action including:

- Fishing effort by the U.S. fleet could be maintained or limited,
- It may allow fishers and others in the industry to make better long-range business decisions thereby enhancing the viability of the industry.
- Very significantly, it could further promote the conservation of the North Pacific albacore resource.
- Some albacore fishers favor a IFQ form of management for the fishery.

Anderson and Holliday (2007) are careful to point out that a LAPP for managing fisheries is not ideal, appropriate, or desired for every fishery or region. At this point in time, there are several reasons why this seems to be true for the U.S. West Coast albacore tuna fishery.

- It is questionable whether the fishery meets a primary criterion for LAPPs management, namely that the stock is overexploited. Stock assessment of the North Pacific albacore (addressed in Section 7 of this document) clearly indicates that the resource is *not overfished.* But, when considering all of the fisheries that are harvesting North Pacific albacore, *overfishing* maybe going on and there is real concern that the resource may become *overfished* by about 2015 if present fishing effort by all Nations is not capped. Regarding the U.S. West Coast Fishery it is important to note that in 2007 a segment of the fishery, the American Albacore Fishing Association, was the first tuna fishery in the world to receive Marine Stewardship (MSC) eco-certification. A similar application to the MSC in 2009 by the Western Fishboat Owners Association (another segment of the fishery) is nearing completion of the eco-certification process.
- It appears that currently there are compelling needs for adopting a LAPP for managing the fishery.
    - ✓ The fishery is executed in a sustainable manner. (albacore are caught one at a time on hooks attached to individual lines or poles, it has virtually no bycatch issues, and virtually no interactions with protected species).
    - ✓ It has negligible environmental impacts (gear is minimal and loss almost never occurs, fishing takes place on or very near the sea surface and there is no contact with the ocean bottom).
    - ✓ There are no product utilization issues (the whole fish is retained and is almost entirely used for human and pet food and other products, e.g., fish oil and meal).
- A large number of albacore fishers strongly reject the idea of IFQs.
- There are high costs to design, implement, and operate a LAPP (GAO, 2005); there is a mandated cap of 3 percent of the ex-vessel value of the fish harvested for recovery costs to fund program management (data collection and analysis) and enforcement associated with LAPPs.
- Adopting a LAPP at this time appears to be excessive to the present need for the Council to have a mechanism in place to maintain or limit fishing effort in the U.S. West Coast albacore fishery

4.3 'No Action' Scenario

The 'no action scenario' would make no changes in the present status of the U.S. West Coast albacore fishery as an open access fishery. Advantages to retaining this option include:

- No costs required to retain present open access.
- Option favored some segments of the U.S. albacore fishing industry.
- Would avoid possible complications regarding the U.S./Canada Albacore Tuna Treaty.
- Would avoid complications related to vessels from other West Coast fisheries that to 'come and go' to and from the albacore fishery when there are unfavorable conditions in their respective fisheries.

Disadvantages to retaining the open access of the fishery include:

- Council would continue to lack a mechanism or adequate controls to address maintaining or reducing fishing effort in the U.S. West Coast albacore fishery.
- If West Coast albacore fishery increases and the Council has no mechanism to regulate it, the U.S. may possibly be in violation of its responsibilities related to Article 64 of the United Nations Law of the Sea Convention that mandates States cooperate directly or through appropriate international organizations to ensure the conservation of tunas.
- The opportunity would lost to use 'good sense' to initiate actions for the adoption of a framework process for the authority to maintain or limit fishing effort of the West Coast albacore fishery before there is a crisis and emergency action may be required.
- The opportunity would be lost to heed the argument put forth by Allen et al (in press) who stated that "… *Allowing the resources to be treated as common property, open access, or controlled open access fisheries, has led to excess fishing capacity, which has led to overexploitation"… "It has been shown that such excess capacity exists in all oceans and so long as the concept of open access and common property management prevails, this problem of overcapacity will not be corrected."*

4.4 Summary of Management Options

To reiterate, access decisions are made to define who gets to fish, whereas input/output controls determine how much fishing or how much catch. If spawning stock declines below reference points the fishery will be classified as overfished and actions will be required to ameliorate this situation by implementing input and/or output controls. Similarly, if the rate of fishing is too high (which will lead to SSB declining to an overfished state) then the fishery is classified as undergoing overfishing and again this is ameliorated by I/O controls. If I/O controls are needed to limit mortality then there will be impact on fishers. If they did not, then the controls would not be effective in addressing the stock's status. However, choosing the proper access process can help in addressing those impacts and to assure those impacts are not protracted.

In the case of a fishery under the auspices of international management regimes such as the albacore fishery the process is the same with the addition of country allocations. For example, an overall TAC is chosen based upon stock status. This TAC is then partitioned into country allocations. Then it is the country's responsibility to implement measures to assure that their fishers stay within that allocation. This process occurs regularly in ICCAT, IATTC, SBT and other RFMOs (international commissions). In some cases individual countries choose to implement these through input controls, in some cases output controls; and all use various access programs (several mentioned above). In some cases enforcement is a country responsibility, but in others joint enforcement arrangements are made through the RFMO. Additionally, most of the RFMO have formal compliance committees to deal with monitoring. The country decisions are geared to the particular needs of the country's fisheries. However, if a country allocation of a TAC is needed it is important for the nation to have processes in place to implement the needed actions.

5. Description of the North Pacific Albacore Resource

This segment of the 'White Paper' includes a description of the North Pacific albacore resource including its life history, biology, stock structure, and habitat and ecosystem. A review of information on the stock structure of albacore entering West Coast waters is provided in *Appendix A-2.*

5.1 Distribution, Life History, Biology, and Ecology

Albacore is a highly migratory tuna found in all of the global oceans and Mediterranean Sea; about 40% of its total biomass is in the North Pacific, 27% in the South Pacific, 25% in the Atlantic, 8% in the Indian and <1% in the Mediterranean. Albacore mature at a relatively early age of approximately 5 or 6 years (Ueyanagi 1957, Otsu and Uchida 1963) and have a moderate lifespan to about 10 to 12 years. The species is highly fecund with 0.8 to 2.6 million eggs per spawning (Ueyanagi 1957; Otsu and Uchida 1959). Spawning occurs generally throughout much of the year, with a peak usually in summer months in the central and western North Pacific (Otsu and Uchida 1959) and in the winter months in eastern Pacific off Mexico (Wetherall et al 1987). Spawning in the North Pacific takes place in subtropical waters between about 10^{o}N to 25^{o}N latitudes in the western Pacific (Ueyanagi 1957), in the vicinity of the Hawaiian Islands (Brock 1943, Otsu and Uchida 1959; Yoshida 1968;), and to a lesser degree in the eastern Pacific off Guadalupe Island, Mexico (Scofield 1914, Anon. 1953, and Clemens 1961). Growth rates are moderate (Otsu 1960, Nose et al, 1957, Clemens 1961, Yabuta and Yukinawa 1963, and Laurs and Wetherall 1981). Estimates of the fork lengths at first birthday have been estimated to range from about 38 cm (Laurs et al 1985) to 45 cm (Clemens 1961), and the fork length at sexual maturity at approximately 90 cm or somewhat less (Otsu and Uchida 1959).

Albacore, like other tunas, have a number of physiological and morphological specializations that adapt them to a fast, continuous swimming lifestyle in the pelagic open ocean environment. They must swim constantly to overcome their negative buoyancy and to continuously force water over their gills to maintain respiration (Brill and Bushnell 2001). They are endothermic as the result of a countercurrent *rete mirable* heat exchanger system (Carey and Teal 1966 Graham and Dickson 1981, and Graham and Dickson 2001), which enables them to maintain internal core body temperatures up to 10^{o} C warmer than ambient ocean water temperatures (Graham and Dickson 2001). Temperatures lower than 10^{o}C disrupt albacore physiological processes and may lead to fatality (Graham and Laurs 1982).
Albacore metabolic rates are 2 to10 times higher than most other bony fishes (Graham and Laurs 1982). As a likely consequence, albacore are restricted to waters with dissolved oxygen saturations greater than 60 percent (Cech et al 1985). Albacore are also different from most other teleosts in having a high blood volume (Laurs et al 1981), high cardiac performance (Breisch et al 1983), specialized hemoglobin-oxygen dissociation characteristics (Cech et al

1984), and other cardiac and vascular system distinctions that adapt them (Lai et al 1987, White et al 1988; and Graham et al 1989) for fast swimming (Dotson 1976, Magnuson1978). In addition, albacore have very large eyes for detecting prey and specialized fins and body form to reduce drag.

5.2 Habitat and Ecosystem

The habitat of albacore generally is open ocean pelagic waters, mostly in the vicinity of oceanic fronts. The horizontal dimension of albacore habitat in the North Pacific is linked to oceanic frontal structure associated with the Kuroshio Current, the Kuroshio Current Extension Waters, the North Pacific Transition Zone and the Subtropical Convergence Zone (NPTZ), and the California Current System. Oceanic frontal structure greatly influences the distribution, relative abundance, and availability of albacore, as well as the location of migration routes and rates, and their vulnerability to capture. Sub-adult albacore make trans-Pacific migrations associated with the NPTZ (Laurs and Lynn 1977) and have been linked with various regional or mesoscale features of the North Pacific Ocean (Laurs and Lynn 1977, Polovina et al 2001, Broder et al in prep). They move along oceanic thermal fronts as they migrate and form transient aggregations or patches in areas of local enrichment favorable for foraging (Laurs 1983; Laurs et al 1984, Laurs and Lynn 1977, 1991, Laurs et al 1977, Polovina et al 2001, Zainuddin et al 2006). The vertical distribution and albacore habitat is related to the configuration and depth of ocean vertical thermal structure and is mostly in waters located in or near the thermocline (Laurs 1982 and Koin in prep). The vertical distribution of pre-adult albacore is shallower than that of adult sexually mature albacore. As a consequence, pre-adult albacore are targeted by surface troll and pole-and-line fisheries in temperate zone waters of the North Pacific by the Japanese fishery in the western Pacific and the U.S. and Canadian fisheries in the eastern Pacific. Most albacore caught by trolling and pole-and-line fishing are from waters that have sea surface temperatures between 15^{o}- 19.5^{o}C (Clemens, 1961, Flittner 1963, and many others).

Adult albacore are targeted by the Asian longline fisheries and are caught incidentally by the Hawaii-based longline fishery in the subtropical and tropical zones of the North Pacific. In coastal waters off the coast of North America, sea surface temperature, coastal upwelling, the Columbia River plume, and other oceanic frontal features, which play roles in the aggregations and behavior of prey species, all influence distribution, availability and catchability of albacore (Pearcy and Mueller 1970; Pearcy 1973, Laurs and Fiedler, 1984, and others). Albacore are opportunistic carnivores that occupy relatively high trophic levels. Their diet is made up of a variety of pelagic and mesopelagic species including small fishes, cephalopods, and crustaceans (Iverson 1962, Iverson 1971, Bernard et al 1985, Watanabe et al 2004, Glaser 2008; and others). Little is known about what animals prey on pre-adult and adult albacore, but predators on them are believed to be large marine mammals, sharks, and billfish. Young albacore have been found in stomachs of large tunas and other large fishes (Yabe et al 1958 and Yoshida 1965).

Albacore distribution and availability is known to fluctuate extensively over a range of spatial and temporal scales, which appear to be related to ocean-atmosphere interactions, oceanic tele-connections, and large-scale climatic variability. Clark et al 1975 found that the distribution of albacore tuna along the west coast of North America and the growth of conifers in western North America are linked by large scale atmospheric flow patterns, which are influenced by air-sea interaction processes over the eastern North Pacific. Although the albacore and conifer ecosystems respond to their respective environments during different times of the year, there is strong evidence that they are reacting to the same climatic fluctuations that are responsible for major north-south shifts in North Pacific albacore availability along the coast of North America (Laurs 1974, Clark et al 1975). Modeling climate-related variability of tuna populations from a coupled ocean-biogeochemical-populations dynamics model, Lehodey et al (2003) demonstrated that El Nino conditions have negative effects on albacore recruitment in the western South Pacific. Similar El Nino effects are being examined and expected regarding recruitment of North Pacific albacore. Albacore provide a good example of Hallett et al, 2004 conclusion that large-scale indices are often better predictors of ecological processes and population fluctuations than local climate.

5.3 Stock Structure

In the Pacific Ocean there are believed to be separate and distinct stocks of albacore in the northern and southern hemispheres (Ueyanagi 1960; Nakamura 1969; Lewis 1990; IATTC 2006; and others). There appear to be two subgroups of albacore in the North Pacific Ocean. (Laurs and Lynn 1991). The fish of the northern subgroup occur mostly north of 40°N when they are in the eastern Pacific Ocean. There is considerable exchange of fish of this subgroup between the troll fishery of the eastern Pacific Ocean and the pole-and-line and longline fisheries of the western Pacific Ocean. The fish of the southern subgroup occur mostly south of 40°N in the eastern Pacific, and relatively few of them are caught in the western Pacific. Fish that were tagged in eastern Pacific offshore waters and recaptured in the West Coast exhibited different movements, depending on the latitude of release. Most of the recaptures of those released north of 35°N were made north of 40°N, whereas, most of the recaptures of those released south of 35°N were made south of 40°N. The stock structure of North Pacific albacore is not fully understood and is a priority need for further research, perhaps, using modern genetic approaches, e.g., microsatellite DNA genetic methods which was recently successful in differentiating separate albacore stocks in the western and eastern South Pacific (Takagi et al, 2007). A review of information regarding the stock structures of albacore entering the U.S. West Coast albacore fishery is provided in *A-2*.

6. Fisheries Operating on North Pacific Albacore

As noted earlier, North Pacific albacore are targeted or caught incidentally by numerous fleets from a number of Nations. These include the Japanese and Taiwanese pelagic longline fisheries that target albacore and the Korean longline fishery that catch albacore incidentally in the western and central North Pacific; the U.S. Hawaiian longline and hand-line fisheries that catch albacore incidentally in the central North Pacific; the Japanese pole-and-line fishery carried out in the western North Pacific; the U.S. troll and limited pole-and-line fishery executed in the eastern North Pacific mostly along the U.S. West Coast; the Canadian troll fishery conducted by and large in the U.S. EEZ ; and the U.S. recreational hook and line fishery that traditionally takes place mostly off southern California and to a lesser degree along the entire U.S. west coast. Several other countries also have minor fisheries with various fishing gears that incidentally catch North Pacific albacore. Asian drift-gillnet fisheries targeted and caught substantial amounts of albacore across much of the North Pacific mostly during the mid-1970s and 1980s. However, drift gillnet fishing was halted by U.N. action in 1992. Although the magnitude is difficult to estimate, some IUU drift gillnet fishing apparently continues to take place in the North Pacific, which likely catches some albacore, but accurate amounts are unknown.

For the most part, only basic fishery data are available for most of the fisheries catching albacore in the early years. However, in recent years the data provided by countries have been improved and expanded to include: catches and number of vessels, summarized catch and effort, and size composition of the catch. Information on the annual amounts of catch taken by country for 1952 – 2007 is given in Table 5 and Figure 3, respectively.

The record high total catch of North Pacific albacore for all nations combined was 125,433 mt in1999 and the record low catch was 37,325 mt in 1991 (ISC 2008). During the 5 year period 2003 - 2007, the total catch ranged from 62,722 mt to 92,647 mt and averaged 78,730 mt. Fisheries based in Japan accounted for 66.6 percent of the total harvest, followed by fisheries in the U.S. 15.9 percent, Chinese-Taipei 8.4 percent, Canada 6.3 percent and all other countries 2.8 percent.

Annual North Pacific albacore catch by gear type is shown in Figure 4. The average percentages of the catch by gear type were: pelagic longline 37.5 percent, pole-and-line 36.8 percent, troll 20.2 percent, and all other gears including the U.S. recreational hook and line 5.5 percent.

6.1 History of the U.S. West Coast Albacore Fishery

For a number of years before about 1900, albacore were considered a 'nuisance fish' that took fishing lures being trolled for blue fin tuna (Clemens 1961). The U.S. west coast fishery began in the early 1900's when fishers commenced targeting on seasonally migrating albacore in near-shore ocean waters off southern California to meet the needs of a tuna cannery established there. In 1903, an experimental pack of 700 cases of albacore led to the development of the U.S. tuna canning industry. The troll fishery for albacore gradually spread northwards, but was restricted to waters off California until the late 1930's, when it extended to coastal waters off the states of Oregon and Washington, and eventually to off British Columbia, Canada. From its beginning until the late 1970's, the troll fishery usually began operating in early July, when migrating albacore approach the west coast of North America, and was primarily conducted within a couple hundred miles of the coast. From 1961 through 1979, approximately 99 percent of the reported U.S. catches of North Pacific albacore were made within 200 miles of the North American coast, with 84 percent off the U.S. coast and 9 percent and 7 percent in the jurisdictional waters of Mexico and Canada, respectively. From the late 1970's until about 2000, U.S. albacore fishers with larger vessels began troll fishing in the early spring months on the high seas. Some of these vessels operated as far west as the International Dateline and beyond, to extend the fishing season by intercepting albacore migrating towards the coast of North America locating high catch rate areas. However, during the recent about five or so years, the fishery has operated mostly within a few hundred miles of the coast, apparently because of high fuel and insurance costs and uncertain market conditions.

The history of the U.S. pole-and-line fishery for albacore differs somewhat from that of the troll fishery, and is linked to the U.S. tropical tuna fishery for yellowfin, bigeye, and skipjack tunas. The pole-and-line method of catching albacore, which is also referred to as bait-boat or live-bait fishing, also began in the early 1900's with vessels operating within a one-day run from port to provide product for the tuna cannery located in southern California. A poor catch of albacore in 1918 forced pole-and-line boats to shift to fishing for tropical yellowfin and skipjack to fill the cannery's demand for tuna. In subsequent years, even though the availability of albacore may have been high, the amount of pole-and-line effort expended for albacore was thereafter greatly influenced by events in the tropical tuna fishery. Nevertheless, in some years up to 40 percent of the annual catch of albacore on the west coast was caught by pole-and-line vessels. In the late 1980s, U.S. pole-and-line vessels were prevented from catching bait, which is used to fish for tropical tunas, in the Mexican EEZ. Consequently, most of the pole-and-line vessels were soon sold to other countries or converted to albacore troll fishing. From the late 1980s through about 2000 there were only very small amounts of albacore caught by U.S. pole-and-line fishing. However, resurgence in U.S. pole-and-line fishing began in about 2003, and up to about 15 – 20 or so vessels presently use this fishing method in the U.S. fleet. The frequency of records for troll and pole-and-line gear types in the NMFS SWFSC west coast albacore logbook database for the years 1961 – 2006, provides a timeline showing a rough approximation of the relative amounts of U.S. albacore troll and pole-and-line fishing, Figure 5 (from Barr 2009).

Traditionally, over 90 percent of the albacore catch taken by the U.S. West Coast fishery has been purchased by major U.S. processors for canning and marketed as premium 'white meat' tuna. However, in recent years the large U.S. processers have purchased only about 10 percent of the catch. As a consequence, fishers have developed alternative markets. An increasing amount of the catch is being marketed in the fresh and fresh-frozen trade, canned by small 'boutique processers, and exported to Europe (WFOA Website).

A review of fishing methods and equipment used in the U.S. albacore fleet is given in Doston 1980. Although the basic gear and methods of fishing have changed little, many albacore fishing vessels today are outfitted with an array of sophisticated electronic equipment e.g., satellite navigation, advanced communications equipment, various types of acoustic sounders and fish-finders, computers, ocean sensors, etc. Many fishers use information derived from satellite ocean remote sensing to guide fishing operations.

6.2 Trends in U.S. Albacore Fishing Effort

In the 1940's there were about 500 vessels in the U.S. west coast albacore fleet. A high of about 3,000 vessels was reached in 1950; the number dropped to about 1,000 by 1960, climbed to approximately 2,100 during the 1970's and dropped to fewer than 500 boasts in the late 1980's (Laurs and Dotson 1992). Characterization of recent U.S. North Pacific albacore commercial fishing effort was recently examined in response to a Council request to the HMS MT. The report and analyses were prepared by NOAA NMFS Southwest Fisheries Science Center and the PFMC HMSMT (PMFC 2007); this work was carried out under the leadership of Suzy Kohin at the SWFSC. Table 6 shows the number of troll and pole-and-line vessels, number of vessel days of fishing effort, and landings for the years 1996 – 2005. During this 10 year period:

- Number of vessels ranged from 549 in 2005 to 1,121 in 1997, and averaged 750.
- Number of vessel-days ranged from 21,445 in 1998 to 45,572 in 1997, and averaged 29,630..
- Landings ranged from 9,122 mt in 2005 to 16,938 mt in 1996, and averaged 12,347 mt.

A histogram plot of the number of U.S. West Coast albacore troll and pole-and-line vessels by year (Figure 6a) shows that except for a peak of 1,121 in 1997, in the number of vessels in the fleet has been more-or-less constant, but with steady slight declines during the 1998 through 2000 and 2003 through 2005. Histograms of the number of vessel-days of fishing effort and landings are shown in Figure 6b. Except for a peak in 1997 (when there was a peak in the number of vessels), the amount of effort (number of vessels-days) was somewhat variable, but a little bit higher in the first five years of data than the last five. It's interesting to note that during the last three years of data used in the analysis (2003 – 2005), while the number of vessels decreased somewhat, the number of vessel-days of effort increased very slightly. There appears to be little relationship between the number of vessel-days and landings (Figure 7).

The mean number of effort-days and amount of catch by gear type for all U.S. commercial fisheries landing North Pacific albacore, including incidental catches of albacore by the Hawaii longline fleet, during the period 1996 – 2005 are shown in Table 7, which shows that:

- Number of effort days and amount of catch for troll and pole-and-line fleet were 29,630 days and 12,347 mt, respectively,
- For the Hawaii-based longline were 2,486 days and 1,048 mt, respectively, and
- For all other gears were 920 days and 106 mt, respectively.

The bulk of the catch, 90.4 percent, was harvested by the troll/pole-and-line fleet, 6.8 percent by the Hawaii-based longline fishery in the central Pacific, and 2.8 percent by other commercial gears, e.g., California gillnet fishery, purse seiners, Hawaii handline fishing, etc. (Table 8).

7 North Pacific Albacore Stock Assessment

North Pacific Albacore stock assessments have been conducted by the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC) and its predecessor, the North Pacific Albacore Workshop for the last several decades. The most recent assessment was conducted in December of 2006 (Stocker 2006). The ISC charge is to provide scientific advice for management of North Pacific albacore through assessments and the associated activities of collating and maintaining international data bases, coordinating biological research (including the setting of research priorities) and facilitating the development of assessment methods. Because of the ISC and its predecessor's long history of scientific activity in regards to North Pacific albacore, it remains the principal scientific body providing input to both the WCPFC and the IATTC.

7.1 Assessment Methods

The current assessment is based upon Virtual Population Analysis (VPA) methods in which catch, catch-at-age, and indices of abundance (standardized catch-per-effort data, CPUE) are statistically fit by a backward projection model. The methodology is well-known and used in many assessment arenas. Assumptions of the method are also well-known, as are the ramifications of deviations from those assumptions. The major assumptions of VPA are that catch-at-age are estimated without error and are complete, i.e. that catches-at-age are available from all fishing sectors, and that the standardized catch-per-effort indices are proportional to the abundance of the age-groups that are selected by the gear from which the CPUE is derived.

During the most recent assessment, alternative modeling approaches were explored, most notably Stock Synthesis Version 2 (SS2). In addition to utilizing CPUE data, the SS2 approach uses statistical forward projection methods in which catch-at-age can be measured with error and data need not complete for all sectors. Conversely, this method requires explicit modeling of the stock-recruitment relationship and of the age or size selectivity by the fisheries. The ISC is likely to move toward using SS2 more prominently in its next assessment in 2010 (ISC 2008). Presumably, this method would allow utilization of tagging data more directly in the analysis, as well. This would allow spatial dynamics and spatial management to be explored. However, model development issues preclude this from being implemented within the next assessment cycle.

<u>7.1.2 Indices of Abundance</u>

The CPUE indices of abundance evaluated in the assessment included longline indices, troll indices and pole and line indices from Japanese, US and Taiwanese fisheries. General linear modeling methods were used for standardization in which spatial, seasonal and other effects were examined to determine if their impact on the index was likely related to abundance or to other extraneous factors.

<u>7.2 Assessment Results</u>

Trends in spawning stock biomass (SSB) and fishing mortality rate are shown in Figures 8a and 8b, respectively. Pertinent conclusions from Stocker (2006) were: *"… although current SSB reached a historically high level in 2006 (roughly 153,000 mt), projected levels of SSB are forecasted to decline to the long-term average (approximately 100,000 mt) observed over the modeled time period (1966-05), i.e., the stock is predicted to decline to the equilibrium level of roughly 92,000 mt by 2015. Further, the ISC-ALBWG strongly recommended that all countries support precautionary-based fishing practices (e.g., limits on current levels of fishing effort) at this time, given the following:*

> *(1) the current level of fishing mortality (i.e., spawning potential ratio of F17) is high relative to commonly used reference points and often associated with overfishing thresholds in various fisheries world-wide;*
> *(2) a retrospective analysis indicated a noticeable trend of over-estimation of stock biomass over the last two assessment cycles;*
> *(3) the considerable decline in total (North Pacific Ocean) catch over the course of the last two years, particularly in 2005, when the total harvest (roughly, 62,000 mt) was the lowest recorded since the early 1990s."*

<u>7.3 Biological Reference Points</u>

Biological reference points are the standards by which status of a stock is measured. Typically there are two such standards in fisheries assessment and fisheries management: 1) a measure of fishing mortality rate (*F*) which should not be exceeded and 2) a minimum level of SSB. The former defines the metric of overfishing and the latter defines the level at which the stock is considered overfished. Formal criteria for these measures have yet to be adopted by the WCPFC and the IATTC. However, proposals for doing this have been introduced at the WCPFC. In the interim the ISC has begun to explore options for doing this (Stocker 2006, ISC 2008). In particular, the the 2006 assessment report (Stocker 2006) noted that *" a fishing mortality-based reference point ($F_{SSB\text{-}Min}$) designed to ensure that SSB in future years remains within the range of the historical 'observed' SSB was introduced at an earlier ISC Plenary Meeting conducted in 2005. Even though the ISC forum has not yet determined which reference points are appropriate for North Pacific albacore (or other highly migratory stocks), preliminary discussions within the ISC Plenary forum in 2005 regarding candidate SSB-based 'thresholds' to consider, including: minimum 'observed', lower 10th percentile, lower 25th percentile, and median. In this context, at the 95% probability of success, all of the thresholds (lower 10th percentile, lower 25th percentile, and median) would require reductions in future F from the current estimated level (F=0.75); noting that the future F=0.64 associated with the minimum 'observed' SSB target is roughly equal to the current rate. However, this minimum SSB value occurred at the beginning of the overall, estimated time series and necessarily reflects additional uncertainty. Thus, the ISC-ALBWG felt that the thresholds based on the lower 10th percentile, lower 25th percentile, and median represented more robust and ultimately, precautionary thresholds that should be considered."*

Subsequently, biological reference points based upon proxies of the fishing mortality rate at maximum sustainable yield (MSY) were explored (ISC 2008). The proxies ranged from $F_{20\%SPR}$ to $F_{40\%SPR}$. Note that an F_{SPR} proxy for MSY is not necessarily the most appropriate choice for a management limit. However, the results are consistent with previous assessment results that the North Pacific albacore stock is experiencing fishing mortality rates that are near full exploitation.

7.4 Implications of Assessment Results for Management

In response to North Pacific albacore assessments, limits on any further increases in fishing effort have been established by the WCPFC and the IATTC. Should more rigorous measures be needed to control albacore fishing effort, then this implies that mechanisms for international and thus, spatial control might be needed.

8. Economic Research and Bio-Economic Modeling

Economic research has centered on measuring the annual rate of increase in technical change for the US and Canadian surface hook and line fleet over the period 1981-2006 (Squires and Vestergaard 2009). The empirical analysis employs the catch and days fished data used in the international stock assessments by the population biologists of the fishery's representative countries (McDaniel, Crone, and Dorval 2006). These catch and days fished data are for all landings by all vessels. Vessel numbers for the U.S. over 1981-2066 were obtained from the PacFIN Research Data Base and for Canada over 1995-2006 were obtained from the Department of Fisheries and Oceans. Econometric estimation of a Schaefer type production function allowed for technical change and technical inefficiency, specified fishing effort as a composite of days fished and vessel numbers, and employed stock estimates from the international stock assessments (Section 7). (The details can be found in Squires and Vestergaard 2009.) The estimated annual rate of technical change was about 3.5 percent. Ultimately, this rate is a residual value, but a confident estimate of annual technical change of at least 2 percent and up to 3.5

percent is warranted.

The annual rate of technical progress is due not to changes in the gear per se, but is due to increased understanding of ocean conditions allowing forecasting of fish locations through temperature sensing devices reinforced by satellites, improvements in interpretation, and GPS, all of which give information about the overall distribution of albacore, dramatically reduces searching, and eases finding schools below the surface. Improved communications and computer technology onboard albacore fishing vessels, as well as shore-based, allow sharing of information among members of code groups, reducing search time, and increasing catch rates. Acoustic devices, such as sounders, are also increasingly sophisticated. The fishing gear itself has remained relatively static. Improved weather forecasts extend the end of the fishing season.

The effect of relatively high rates of fishing power or increase in technology are to undermine the effectiveness of input controls and shift the management focus to an output or catch orientation. A major advantage of a rights-based LAPP management program is that the fishery manager does not have to explicitly account for the growth in technology (although it needs to be incorporated into population assessments). Instead, the market for catch shares accounts for the lowering of fishing costs and increasing catch rates.

Preliminary bio-economic modeling accounting for technical progress and in a surplus production framework demonstrated the importance of accounting for technical change on the optimum resource stock (Squjres and Vestergaard 2009). The empirical results are too preliminary to provide reliable estimates for management purposes, but do illustrate the long-term effects of the steady march of technology on estimates of resource stocks and their optimum use. Not accounting for technical change clearly leads to inappropriate management measures.

TABLES

Table 1. Distribution of vessel months used by U.S. and Canadian fleets for 2008.
Source NMFS/SWRO

Monthly Vessel Month Utilization

2008							
	June	July	August	September	October	November	Total
US	0	0	24	34	11	4	73
Canada	6	79	110	107	53	4	359

Table 2. Pros and cons of input and/or output controls applied to U.S. West Coast albacore fleet.

CONTROL	PROS	CONS
Establish catch or trip limits; establish TAC	Reduce amount of effective fishing effort and catches of albacore	Likely result in severe economic efficiencies for albacore fleet
Establish size/age limits restricted to larger/older albacore	Increase yield per recruit; greatly reduce catches	Eliminate most of the U.S. albacore fishery which is based on pre-adult 2, 3, and 4 year old fish
Retain only male albacore	Greatly increase abundance of spawning females	Gender is disguisable only by dissection
Establish closed areas	Reduce amount of effective fishing effort if selected correctly	Very difficult to determine because albacore availability, distribution, and vulnerability to capture are markedly affected by changing ocean conditions; difficult to enforce
Limit number of lines or poles fished	Reduce amount of fishing effort	Probably not possible to enforce; during very active catching usually only jigs with short lines are pulled
General use of input and/or output controls	**Reduce amount of fishing effort and catches of albacore**	Fishers likely would develop technological changes to overcome controls which could have the effect of increasing effort even though nominal effort may remain constant
General use of input and/or output controls	**Reduce amount of fishing effort and catches of albacore**	Highly migratory behavior and variable seasonal distribution and availability of albacore in West Coast waters would greatly reduce effectiveness of input and/or output controls

Table 3. Pros and cons of actions for adopting a Limited Entry program for the U.S. West Coast albacore fishery.

ACTION	***PRO***	***CON***
Remove from control date database vessels that have made less than some minimum albacore landing since establishment of control date.	Improve accuracy of control date database.	Vessels with albacore landings below some minimum amount not eligible for LA permit.
Add to control date database vessels that landed more than some minimum amount of albacore since establishment of control date.	Improve accuracy of control date database; makes vessels that made landings after control date established eligible for LA permit,	No obvious con.
Establish moratorium on the issuance of new HMS permits for albacore for 5 years.	Improve accuracy of HMS albacore permit database; no new fishing effort increases.	Eliminate new entries into albacore fishery.
Impose performance criteria for renewal of HMS albacore permit e.g., minimum amount albacore landed.	Improve accuracy of HMS albacore permit database.	No obvious con.
Remove vessels from HMS albacore permit database that have made less than some minimum landing of albacore.	Improve accuracy of HMS albacore permit database.	Vessels with albacore landings below some minimum amount not eligible for LA permit
Adopt Limited Entry program for U.S. West Coast albacore fishery.	Maintain industry viability and preserve health of North Pacific albacore resource.	Eliminate last open access West Coast fishery; possibly eliminate opportunities for some crab, salmon and other vessels to fish for albacore when those seasons are poor; put U.S. at possible disadvantage if other Nations keep open access; cause controversy with Canada over their albacore catches made under Treaty in U.S. EEZ.

Table 4. Pros and cons of ITQ programs for managing fisheries (taken from Buck 1995 report, National Council for Science and the Environment).

PROS	CONS
Reduce overcapitalization.	Can increase incentive for fishermen to file false catch reports and 'high-grade'.
Promote conservation of stocks.	Possible for processors or wholesalers to obtain effective monopoly control over landings.
Improve market conditions.	Discourage new entrants into a fishery because of capital investment required to purchase or lease shares.
Promote safety in the fishing fleet .	High costs to set and enforce
Slow or eliminate 'race to fish'.	Equity of current approaches to initial allocation of ITQ shares questioned for their creation of wealth and windfall profits and their exclusion of processors and crew .
	Can cause substantial unemployment and socio-economic dislocation in coastal communities.
	Administrative processes for implementing ITQ plan can be as long as 5 years or more, this leads to creates the impression that inadequate consideration has been given to "current" fishery participants and can contribute to public opposition.

Table 5. North Pacific albacore catches (mt) by country and fisheries, 1952 – 2007.

	Canada	Japan	Korea	Mexico	Taiwan	US	Others	Total
1952	71	68,865	0	0	0	25,262	0	94,198
1953	5	60,868	0	0	0	15,934	0	76,807
1954	0	49,088	0	0	0	12,406	0	61,494
1955	0	40,657	0	0	0	13,850	0	54,507
1956	17	57,208	0	0	0	19,239	0	76,464
1957	8	70,787	0	0	0	21,473	0	92,268
1958	74	40,739	0	0	0	14,910	0	55,723
1959	212	30,121	0	0	0	20,995	0	51,328
1960	5	42,737	0	0	0	20,661	0	63,403
1961	4	36,351	0	41	0	16,253	41	52,690
1962	1	24,737	0	0	0	22,526	0	47,264
1963	5	40,161	0	31	0	28,740	31	68,968
1964	3	39,763	0	0	0	22,627	0	62,393
1965	15	55,324	0	0	0	17,693	0	73,032
1966	44	48,576	0	0	0	17,530	0	66,150
1967	161	59,959	0	0	330	22,646	0	83,096
1968	1,028	41,934	0	0	216	26,302	0	69,480
1969	1,365	51,374	0	0	65	22,195	0	74,999
1970	390	41,319	0	0	34	26,279	0	68,022
1971	1,746	65,691	0	0	20	23,783	0	91,240
1972	3,921	74,513	0	100	187	27,995	100	106,816
1973	1,400	87,449	0	0	0	17,987	0	106,836
1974	1,331	88,237	0	1	486	25,058	1	115,114
1975	111	63,023	2,463	1	1,240	22,858	1	89,697
1976	278	103,612	859	41	686	19,345	41	124,862
1977	53	49,342	792	3	572	12,040	3	62,805
1978	23	80,122	228	1	6	18,442	1	98,823
1979	521	62,984	259	1	81	7,158	1	71,005

Table 5 (cont.). North Pacific albacore catches (mt) by country and fisheries, 1952 – 2007.

	Canada	Japan	Korea	Mexico	Taiwan	US	Others	Total
1980	212	65,925	603	31	249	8,106	31	75,157
1981	200	56,611	475	8	143	13,605	8	71,050
1982	104	59,893	500	0	38	7,417	0	67,952
1983	225	43,515	687	0	8	10,059	0	54,494
1984	50	53,952	652	107	0	15,491	107	70,359
1985	56	48,107	867	14	0	9,124	14	58,182
1986	30	39,005	967	3	0	5,391	3	45,399
1987	104	41,842	1,366	7	2,514	3,160	7	49,000
1988	155	31,363	1,425	15	7,389	5,232	15	45,594
1989	140	32,084	1,173	2	8,390	2,386	2	44,177
1990	302	32,629	1,022	2	16,705	3,038	2	53,700
1991	139	30,594	855	2	3,410	2,323	2	37,325
1992	363	41,289	286	10	7,866	5,034	10	54,858
1993	494	46,806	32	11	5	6,788	11	54,147
1994	1,998	59,077	45	6	83	11,969	164	73,342
1995	1,763	52,452	440	5	4,280	9,339	142	68,421
1996	3,316	54,394	333	21	7,596	18,517	2,261	86,438
1997	2,168	74,324	319	53	9,119	17,192	3,281	106,456
1998	4,177	61,776	288	8	8,617	17,020	6,165	98,051
1999	2,734	91,912	107	57	8,186	15,812	6,625	125,433
2000	4,531	54,887	414	103	8,842	12,634	4,247	85,658
2001	5,248	59,851	82	22	8,684	14,618	1,620	90,125
2002	5,379	76,655	113	28	7,965	13,918	855	104,913
2003	6,861	58,849	144	28	7,166	17,044	2,555	92,647
2004	7,856	57,713	68	104	4,985	15,512	2,631	88,869
2005	4,829	38,682	520	0	4,472	10,692	2,527	61,722
2006	5,819	38,948	520	109	4,317	13,266	2,636	65,615
2007	6,112	65,273	520	40	4,317	5,969	2,567	84,798

Table 6. U.S. albacore troll and bait-boat fleet: No. vessels, vessel-days, and landings, 1996 – 2005.

U.S. Albacore Troll/Baitboat Fleet: No. Vessels, Vessel-Days, and Landings 1996 - 2005

Year	No. Vessels	Vessel-Days	Landings (MT)
1996	640	32,717	16,938
1997	1,121	45,572	14,252
1998	755	21,445	14,410
1999	705	34,643	10,060
2000	649	37,331	9,645
2001	870	26,566	11,210
2002	641	25350	10,387
2003	836	23,442	14,102
2004	734	23,979	13,346
2005	549	25,252	9,122
Average	750	29,630	12,347

Table 7. Mean number effort-days and landings (mt) of North Pacific albacore made by U.S. commercial fishing vessels by gear type.

1996 – 2005 Mean Effort-Days and Amount Catch by Gear Type for U.S. Commercial Fisheries Landing Albacore

Gear Type	Effort Days	Amount Catch (MT)
Troll/Bait-boat	29,630	12,347
Hawaii Longline	2,486	1,048
Other Gears (Gillnet, HI Handline, Purse Seine, etc.)	920	106

Table 8. Average relative proportional of total U.S. commercial landings by fishery.

Average Relative Proportion Total U.S. Commercial Albacore Landings by Fishery 1996 - 2005

Fishery	Percent
Troll/Baitboat	90.4
HI Longline	6.8
Other Gears	2.8

FIGURES

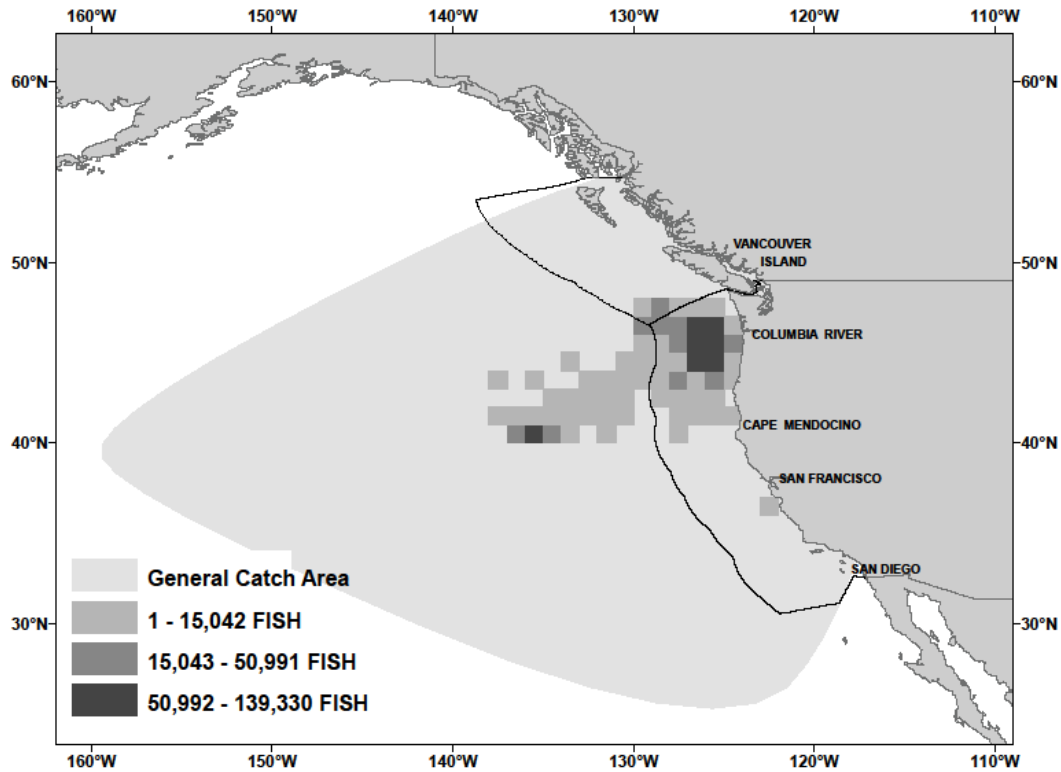


Figure 1. Distribution of albacore catch and effort by U.S. West Coast Fishery, 2008.

Figure 2a. Annual Canadian total albacore catch and catch made in US EEZ.

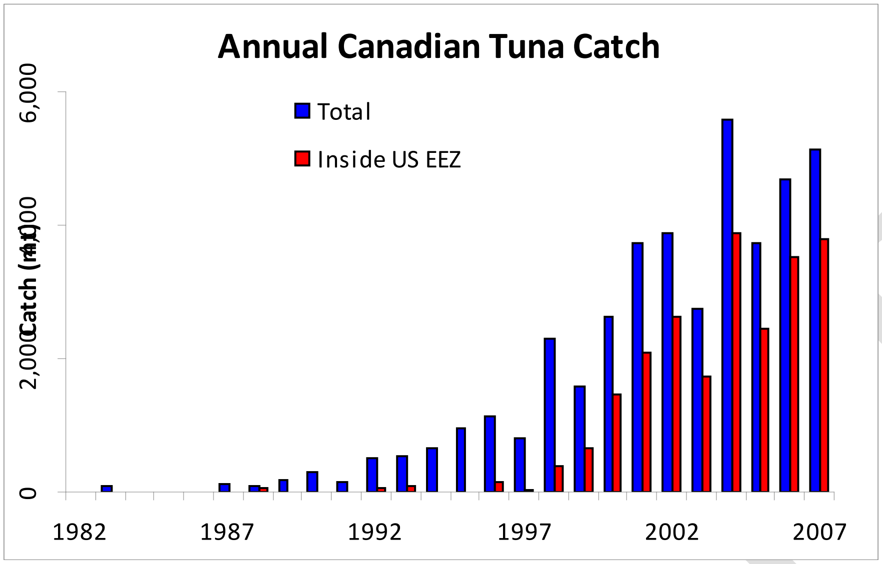


Figure 2b. Values of annual Canadian total albacore catch and catch made in U.S. EEZ.

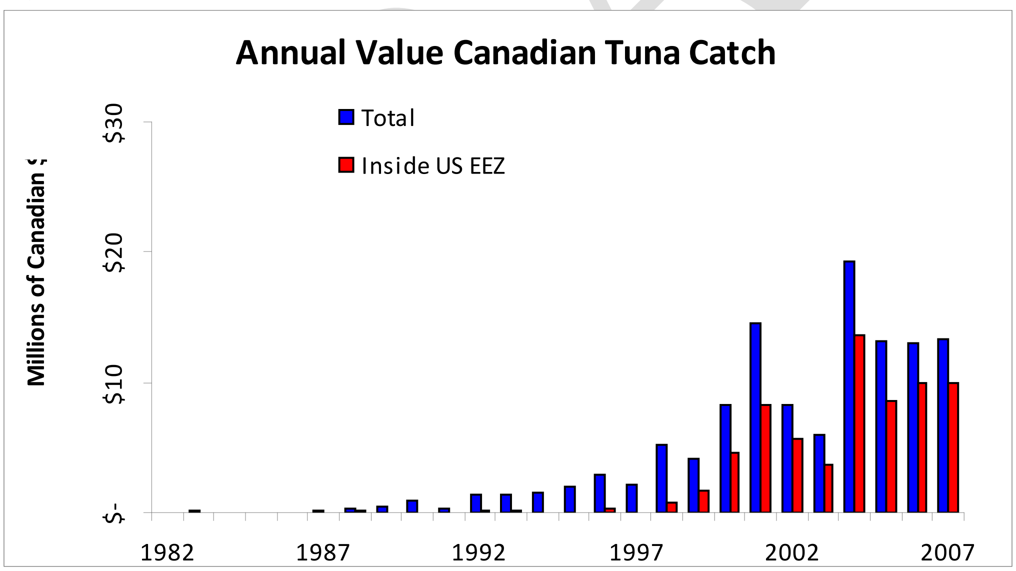


Figure 3. Total annual North Pacific albacore catch by country.

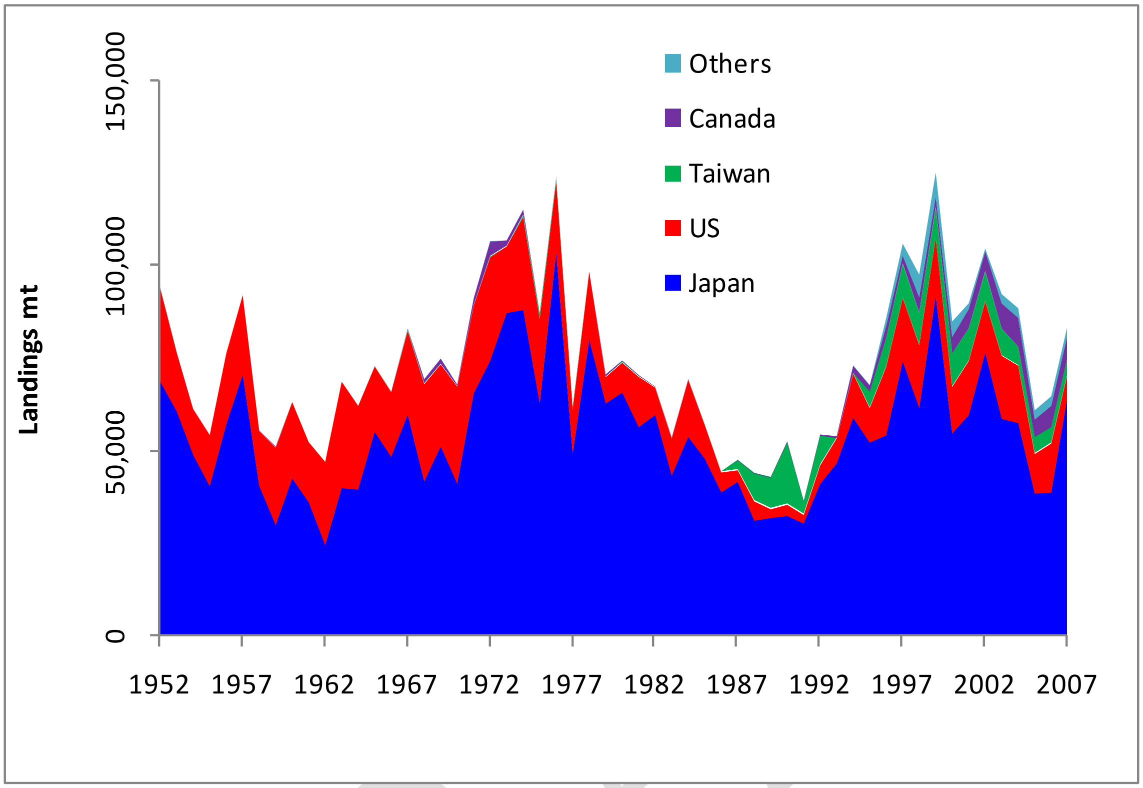
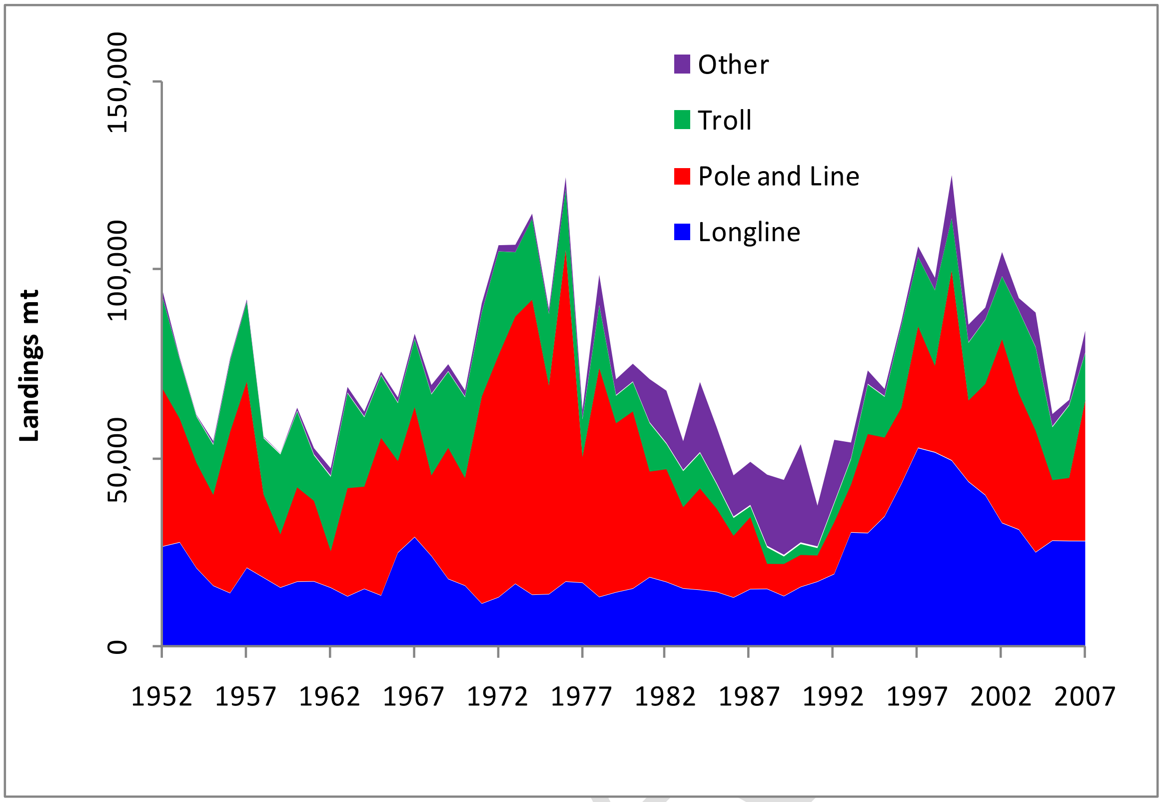


Figure 4. North Pacific albacore catch by gear type.



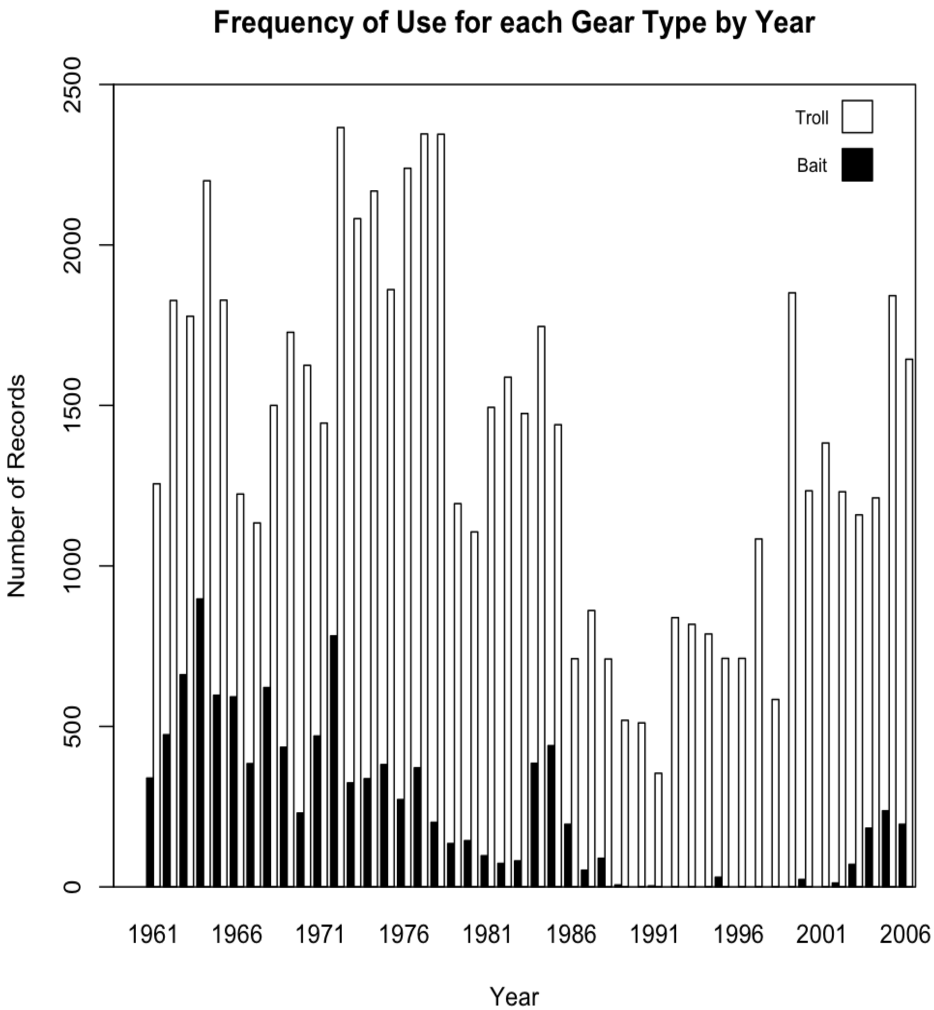


Figure 5. Relative proportion of troll and baitboat vessels in U.S. West Coast Fishery. Estimated from frequency of logbook records, 1961 – 2006. From Barr (2009).

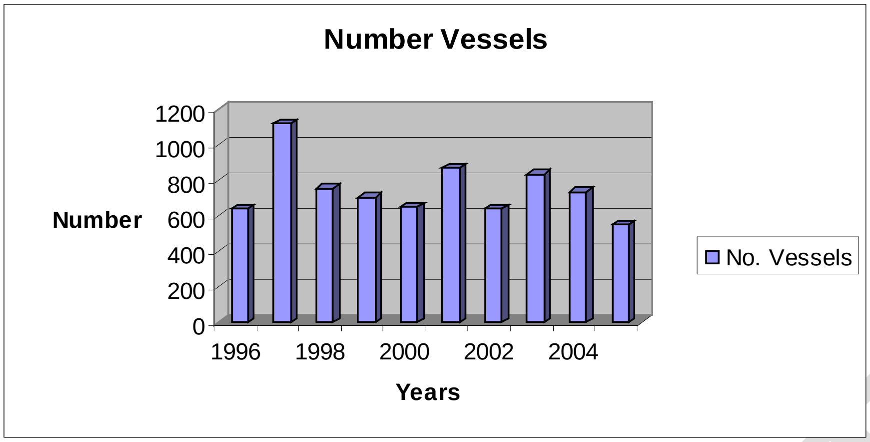


Figure 6a. Number of albacore troll and pole-and-line vessels, 1996 – 2005.

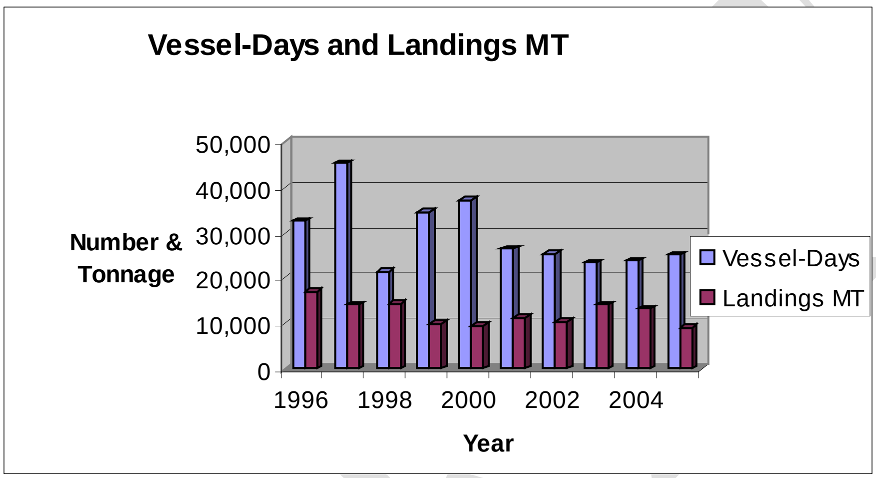


Figure 6b. Number of albacore vessel-days and tonnage, 1996-2005.

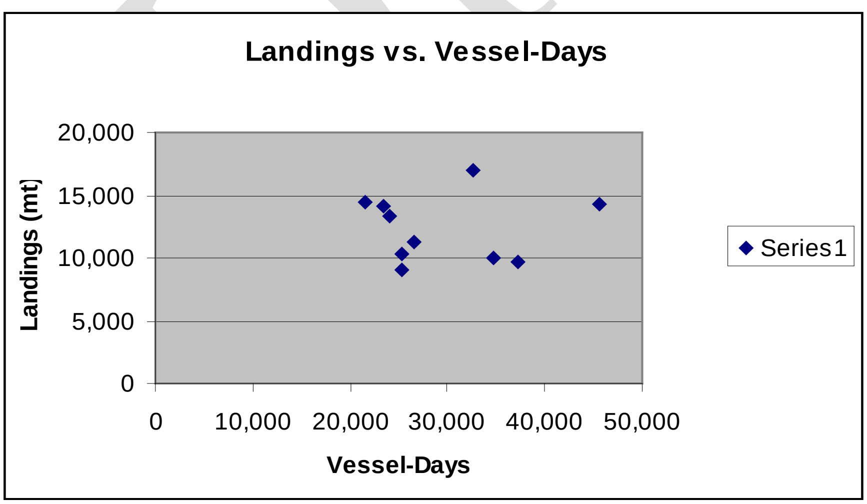


Figure 7. Annual albacore landings vs. vessel-days, 1996 – 2005.

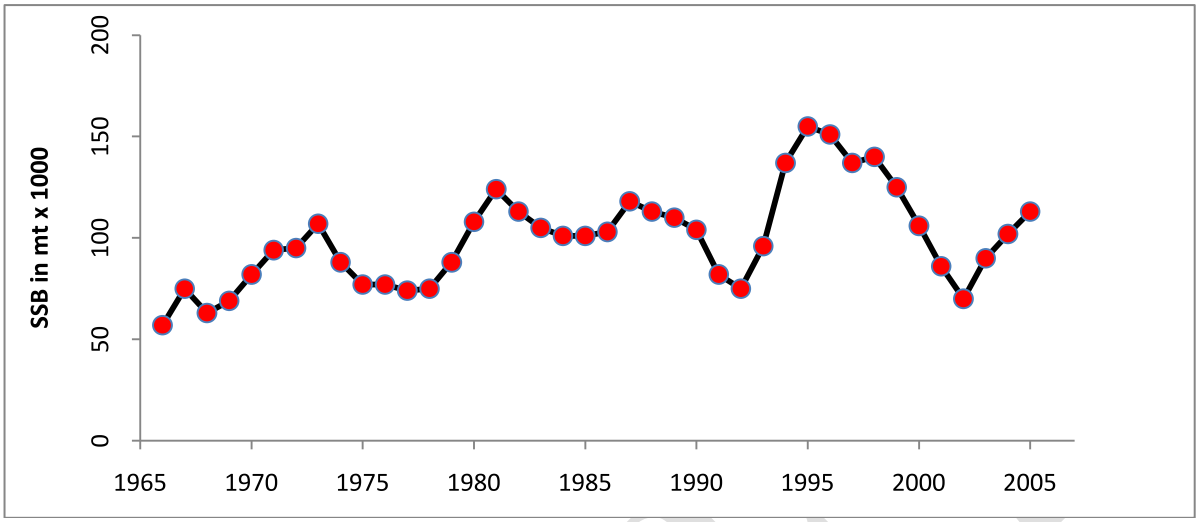


Figure 8a. North Pacific albacore spawning stock biomass.

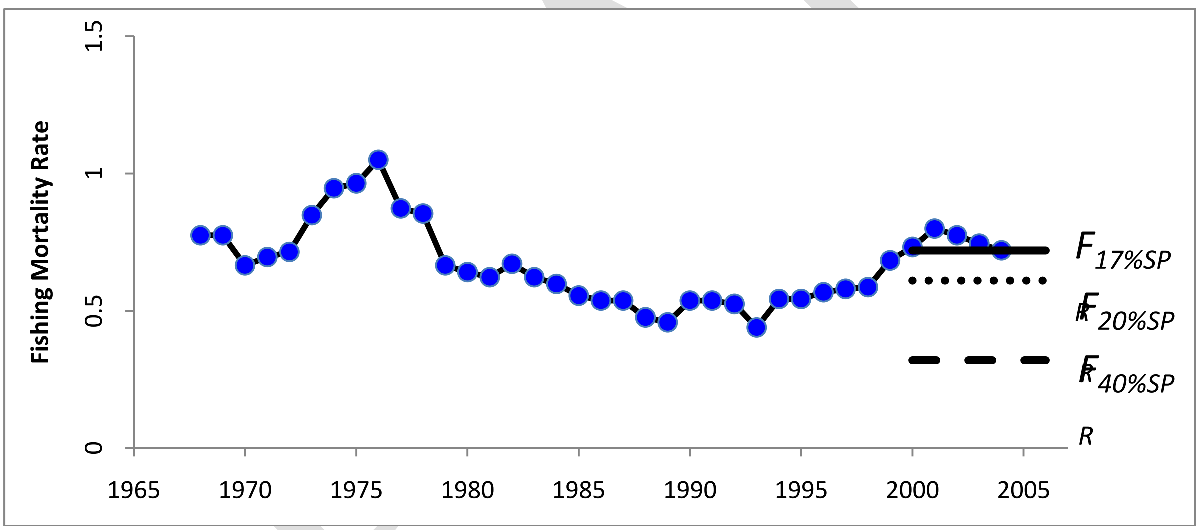


Figure 8b. North Pacific albacore fishing mortality rate.

APPENDIX

A.1 Management Programs Being Used in Foreign Albacore and Other HMS Fisheries

Country	Species	Management Plan	Determination	Website
Australia (SBT)	• Southern bluefin tuna	Output controls comprising Individual Transferable Quotas (ITQs). National catch allocations for member countries were determined and set by the CCSBT at its October 2004 meeting. Australia received a national allocation of 5,265 tonnes and AFMA subsequently set the Australian TAC at this level for the 2004-2005 season.	Under the *Southern Bluefin Tuna Management Plan 1995* (the Plan) AFMA must calculate the interim live weight value and the actual live weight value of each Statutory Fishing Right. These values are worked out on the basis of Australia's national catch allocation or provisional national catch allocation, which are determined in accordance with the Plan.	http://www.afma.gov.au/fisheries/tuna/sbt/default.htm
Australia (WTBF)	• Broadbill swordfish • Yellowfin tuna • Bigeye tuna • Albacore tuna	Input control management regime, based on limited entry – ITQs for key species to be implemented under the management plan – expected to occur in early 2007. *Note: I don't see anything more recent than 2005.*	Note: e-mailed contact on 1/5/08 to find out more information.	http://www.afma.gov.au/fisheries/tuna/wtbf/default.htm
Australia (ETBF)	• Yellowfin tuna • bigeye tuna • albacore tuna • broadbill swordfish • Striped Marlin	Under the new Management Plan, input controls, in the form of restrictions on the number of hooks that can be used, are the primary management tool. These controls can be complemented by a range of other tools, including (but not limited to) spatial management and trip limits on certain species.	• Yellowfin tuna: Not overfished, but subject to overfishing. • bigeye tuna: Not overfished, but subject to overfishing. • albacore tuna: not overfished or subject to overfishing" • broadbill swordfish: stock status is uncertain • Striped Marlin: stock status is uncertain Swordfish and albacore fishes are controlled by TACs. The introduction of transferable effort units or catch quotas for the fishery are currently under review by AFMA.	http://www.afma.gov.au/fisheries/tuna/etbf/default.htm http://www.abare.gov.au/publications_html/fisheries/fisheries_08/fisheries_08.html
New Zealand	• Bigeye tuna • Pacific Bluefin tuna • Southern Bluefin tuna • Swordfish	The Quota Management System (QMS) was introduced because it was seen as the best way to: • prevent overfishing, which had reached critical levels in some inshore fisheries; • improve the economic	In the QMS, commercial fishing rights are allocated as individual transferable quota. The main characteristics of quota are: • it is owned by an individual or company (or any other legal entity); • only New Zealanders can own quota for our fisheries; • the right is not created for a fixed term – it is	http://www.fish.govt.nz/en-nz/Publications/Historical+Documents/HMS/Proposed+Management+Framework+for+Tunas+and+Other+Highly+Migra

A.1 Management Programs Being Used in Foreign Albacore and Other HMS Fisheries (Cont.)

		efficiency of the fishing industry; and • continue the development of our deepwater fisheries. (see events leading to the QMS)	perpetual; • it secures a fixed percentage of the available resource; • it is fully transferable and divisible; and it is a valuable asset that enables owners to borrow against the quota.	tory+Species.htm?WBCMODE=PresentationUnpublished++&MSHiC=65001&L=10&W=albacore++quota%20&Pre=%3Cspan%20class%3d'SearchHighlight'%3E&Post=%3C/span%3E
New Zealand	• Yellowfin tuna • Albacore • Skipjack	QMS -- Proposed Management Framework for Highly Migratory Species	"These proposals were declined and albacore and skipjack remain non-quota species. Future consideration of their inclusion in the QMS will be incorporated in the development of fisheries plans for these species during 2009[6]" It was concluded that there was **no sustainability risk to albacore** within New Zealand's exclusive economic zone[7]	
France	• South Atlantic Albacore	The South Atlantic albacore is the subject of an ICCAT regulation imposing a TAC and France was assigned a specific quota from the Community quota. The Indian Ocean albacore is not so far the subject of specific regulations, but a restriction of the fishing capacity in terms of number of vessels targeting albacore and swordfish should be adopted this year.		http://ec.europa.eu/fisheries/fleet/index.cfm?method=FM_Reporting.Annual Report
France	• Temperate Tuna	Temperate tuna (albacore): These vessels are declared on the ICCAT list of vessels authorized to fish for tuna restrictions are imposed on the activities of theses vessels by a quota from a larger Community quota, out of a TAC fixed by the ICCAT and on the fishing effort (restriction to 151 vessels) in accordance with ICCAT.		http://ec.europa.eu/fisheries/fleet/index.cfm?method=FM_Reporting.Annual Report

[6] Personal communication with Arthur Hore from the New Zealand Minisrty of Fisheries, January 13, 2009.
[7] The New Zealand Ministry of Fisheries. "Albacore Tuna (ALB) – Initial Position paper." October 1, 2007. para. 4.

A-2. Stock Structure of Albacore Entering West Coast Fisheries

The stock structure of North Pacific albacore that enter the fisheries off the coast of North America has been based historically on locations of spawning, tagging results, or fishery-related biological information. Scofield (1914 and 1914a) reported the discovery of albacore spawning in the area near Guadalupe Island, Baja Mexico and for about five decades it was surmised that albacore spawned in subtropical waters off Mexico and seasonally migrated along the coast to enter the surface fishery along the west coast of California. Tagging studies conducted in the 1950's showed that North Pacific albacore, particularly sub-adults, undertake trans-Pacific migrations (Clemens 1961, Clemens and Craig 1965, Otsu and Uchida 1959, and others). This led to the belief that there is one stock of albacore in the North Pacific (Otsu and Uchida 1959; Clemens 1961; Otsu and Uchida 1963; Clemens and Craig 1965). However there is a large body of evidence summarized in the section that follows, which indicate that albacore entering the U.S. west coast fishery are not a homogeneous stock, but rather are heterogeneous.

A-2.1 Morphometrics

An early preliminary morphometric investigation of albacore caught off Japan, Hawaii, and southern California concluded that albacore caught off California and off Japan are probably distinct and non-intermingling (Godsil 1948). Japanese albacore were characterized by a relatively shorter head and caudal region and longer abdominal or central trunk than specimens from off California. Hawaiian albacore appeared to resemble the Japanese more than California specimens, but there were insufficient Hawaiian samples to justify conclusions. Schaefer (1952) pointed out that there are shortcomings to defining albacore stock structure using morphometric data. However, the validity of findings using this approach is strengthened when considering the scientific evidence provided by other diverse studies.

A-2.2 Size Composition

Brock (1943) suggested that the North American coastal albacore fishery was comprised of two separate and independent groups of fish. He based this premise on the finding that size compositions of albacore landed in Los Angeles, which were caught off southern California, had larger modal peaks than albacore landed in Astoria, Oregon, which were caught off the Pacific Northwest (Brock, 1943). Similar findings where the size compositions of fish caught in coastal waters from the 'southern' and 'northern' areas have different modal peaks have been reported by other investigators, e.g., Laurs and Lynn 1977, Laurs and Wetherall 1981, Wetherall, et al 1987, and recently by Barr who is investigating the variability in the seasonal migration and size composition of albacore in the U.S. coastal fishery. Barr is using logbook records and size composition data provided courtesy of the NMFS/SWFSC from the albacore fishery database for the years 1961 – 2006 found similar findings.

A-2.3 Navy Vessel Offshore Albacore Surveys

Based on data from a Navy picket vessel survey data of albacore in waters extending several hundreds of miles off the North American coast, Flittner (1963) postulated that albacore congregate offshore and then split into two migratory components: early arrivals proceed to southern fishery areas off southern and central California and late arrivals turn northward to the coast off Oregon and Washington.

A-2.4 Artificial Radionuclide Concentration in Albacore Livers

Pearcy and Osterberg (1968) found that off Oregon and Washington that levels, as well as specific activities, of the artificial radionuclide Zn-65 in albacore livers sampled increased markedly during summer months. Association of albacore with the effluent of the Columbia River accounted for this enhancement. Zn-65 concentrations of albacore from southern and Baja California were about 10% of those off Oregon and Washington with no seasonal trends evident. Pearcy and Osterberg stated …*"We have no evidence either for immigration of Zn-65 tagged albacore into the southern California fishery or for immigration of southern albacore, with low Zn-65 content, into the northern fishery during one season."*

A.2.5 NMFS/American Fishermen Research Foundation Tagging Studies

Results from tagging studies reported by Laurs and Nishimoto 1979 and summarized in Table 4 in Laurs and Lynn 1991, suggest that at least two subgroups of albacore enter the fishery along the west coast of North America: a 'southern' subgroup south of about 40^{o}N and a 'northern' subgroup north of that latitude. The two subgroups have different migratory patterns, with 'northern' fish making migrations between the eastern and western North Pacific and the 'southern' fish making migrations between the eastern and central North Pacific. There was very little exchange of tagged fish between north and south of 40^{o}N, with less than 1% of fish tagged north of 40^{o}N being recovered south, and vice-versa. About 5% of fished tagged north or south 40^{o}N and recovered after being at liberty one year to three years, were recovered in the opposite area. In previous albacore tagging studies conducted by California Fish and Game during the 1950s, no albacore tagged off Baja or southern California were recovered off Oregon or Washington (Clemens 1961).

A.2.6 Growth Rates

Laurs and Wetherall 1981 found that albacore tagged and released south of 40^{o}N had significantly higher growth rates than albacore tagged north of 40^{o}N. They proposed that the differences in growth rates between the two subgroups likely explain the dissimilarity in the modal peaks of their respective size compositions. They postulated that the slower growth rates of the 'northern' subgroup result from their high energy requirements for the very long migrations across the North Pacific and that less energy may be available for somatic growth, than for the 'southern' subgroup, which undergo much shorter migrations.

A-2.7 Birth-date Distributions

Wetherall et al 1987 estimated birth-date distributions for the 'north' and 'south' albacore by using tag release and return statistics, and growth models computed from the tag data. Each of 521 albacore provided two estimates of its birth date, one based on release length and date and another on corresponding recapture statistics. The findings suggest that the 'north' fish are born primarily during the April-October period, with a peak in July; whereas, the 'south' albacore appear to be born mostly during the November-June period, with a peak in February.

A-2.8 Migration Patterns by Age at Release

Wetherall et al 1987 noted that the general variation in tag return patterns between albacore tagged inshore of 145°W in the 'north' and 'south' zones provide interesting results when analyzed by age group. Most of the albacore in the 60 – 70 cm range at time of tagging were made in subsequent years in the area of release. Recaptures from fish in the 70 – 80 cm range and the 80 – 90 cm range when tagged were made in increasingly higher proportion away from their area of release, with a greater percentage coming from the central and western Pacific fisheries. However, albacore in the largest size class and tagged in the 'north' area of the eastern Pacific had a much greater rate of recapture in the western Pacific than their 'south' counterparts. The latter were still recaptured mainly in the region where they were released, or offshore east of the Dateline. This apparent difference in migration behavior of the larger albacore is particularly interesting because these are mature fish. This difference suggests the possibility of separate spawning areas.

A-2.9 Fisheries and Stock Structure

The tagging data demonstrate that the two proposed subgroups are for the most part harvested by different fisheries. Fish north 40°N, which make trans-Pacific migrations between eastern and western North Pacific, are harvested by the U.S. troll/pole-and-line fishery north of 40°N and the Japanese baitboat and Asian longline fisheries west of the Dateline. Whereas, fish south 40°N, which make migrations between the eastern and central North Pacific, are fished on by the U.S. troll/pole-and-line fishery south of 40°N and the Asian and Hawaii longline fisheries east of the Dateline.

A-2.10 Length of Fishing Season and Catch Rates

Preliminary findings made by Barr (in prep.) show that the 1) distribution and spatial range of the fishery oscillates between the north and south areas over periods lasting about a decade or more; 2) average season length in northern area is 96 days and in the southern area is 146 days; 3) average annual catch per day (CPUE) is 77.6 and 48.2 fish/day north and south of 40°N, respectively; and 4) the average CPUE during peak months of the fishing season is higher in the northern area than in the southern area Figure 2). The results are compatible with the proposed stock heterogeneity of albacore entering the coastal waters of North America.

A-2.11 Research Needed

Information gathered from a broad range of sources indicates that a better understanding of the possibility of stock heterogeneity of North Pacific albacore may be needed to effectively manage the resource. Appropriate genetic studies are required to further investigate the likelihood that two subgroups of albacore enter the U.S. albacore fishery. In addition, stock assessments of North Pacific albacore, which have assumed a single stock, need to be evaluated regarding the likelihood of albacore stock heterogeneity. It may be found that it is necessary to structure management actions for specific fisheries and/or segments of fisheries.

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