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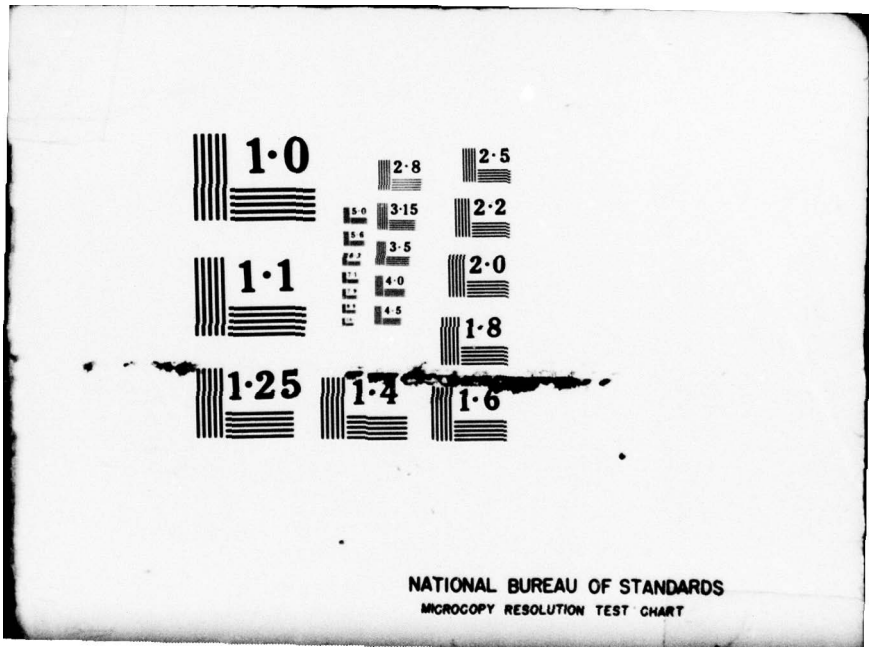
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THESIS

THE DEVELOPMENT OF AN
OPTIMUM MANAGEMENT PLAN FOR THE
SABLEFISH FISHERY OF THE
CALIFORNIA, OREGON AND WASHINGTON COAST

by

Stephen John Wehner

June 1978

Thesis Advisor: P.M. Carrick

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) (6) The Development of an Optimum Management Plan for the Sablefish Fishery of the California, Oregon and Washington Coast		5. TYPE OF REPORT & PERIOD COVERED (9) Master's Thesis; June 1978
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) (10) Stephen John Wehner		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Postgraduate School Monterey, California 93940		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Postgraduate School Monterey, California 93940		(11) 12. REPORT DATE June 1978 13. NUMBER OF PAGES 94
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) (12) 94 p.		15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Sablefish Fishery
Fishing Conservation and Management Act of 1976
Fishing Conservation Zone
Governing International Fishery Agreement (GIFA) (Cont'd)

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Public Law 94-265, the Fishery Conservation and Management Act of 1976, generated requirements for the optimal management of fishery resources of the United States. This thesis examines, from the perspective of a government regulatory agency, the Coast Guard, the management problem facing the Pacific Regional Council in developing a management plan for the sablefish fishery of the California, Oregon and Washington

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(20. ABSTRACT Continued)

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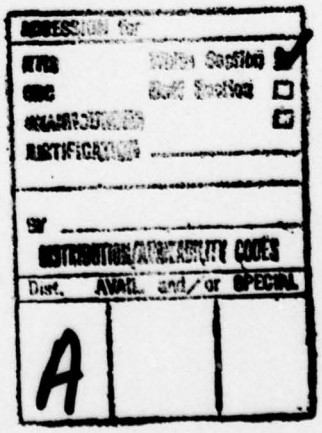
(19. KEY WORDS Continued)

Total Allowance Catch (TAC)
Optimum Yield
Maximum Sustainable Yield (MSY)
Blackcod
Butterfish
Externalities
Maximum Economic Yield (MEY)
Maximum Social Yield
Economic Profit



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The Development of an Optimum Management Plan for the Sablefish Fishery of the California, Oregon and Washington Coast

by

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Lieutenant, United States Coast Guard
B.S., University of California at Irvine, 1969

Submitted in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE IN MANAGEMENT

from the

NAVAL POSTGRADUATE SCHOOL

June 1978

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ABSTRACT

Public Law 94-265, the Fishery Conservation and Management Act of 1976, generated requirements for the optimal management of fishery resources of the United States. This thesis examines, from the perspective of a government regulatory agency, the Coast Guard, the management problem facing the Pacific Regional Council in developing a management plan for the sablefish fishery of the California, Oregon and Washington coast. Economic and biological considerations, which make government regulation an apparently desirable social alternative, are reviewed. A review and examination is made of the Act, the preliminary management plan, the sablefish fishery itself, including markets, the Coast Guard relationship to the enforcement of the plan, and the current status of the Councils plan development. Alternatives are developed and critiqued with an orientation towards optimal management of the fishery and indications as to the requisite Coast Guard involvement for enforcement. Conclusions and recommendations are included.

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I. INTRODUCTION

A. THESIS OBJECTIVES

This thesis will examine, from the perspective of a government regulatory agency, the Coast Guard, the management problem facing the Pacific Regional Council in developing a management plan for the sablefish fishery of the California, Oregon, and Washington coast. The primary intent will be in general, to review the economic and biological considerations which make government regulation an apparently desirable social alternative. This will require a review of the administrative mechanisms developed per the Fishery Conservation and Management Act of 1976, Public Law 94-265; an examination of the preliminary management plan for the sablefish, as prepared by the Department of Commerce; an examination of the sablefish fishery itself, including domestic and foreign operations and domestic and foreign markets; an examination of the Coast Guard relationship to the enforcement of the sablefish management plan; and a review of the current status of the Pacific Regional Council's management plan for the sablefish fishery, which is in the process of being developed. The alternatives developed by this thesis are oriented towards optimal management of the fishery with indications as to the requisite Coast Guard involvement for enforcement.

B. WHY THE SABLEFISH FISHERY

The sablefish fishery and its management has been selected for examination because it is a relatively small and simple fishery and yet has a multi-national interest. Fishery efforts for sablefish are primarily targeted solely at sablefish rather than at multi-species targets. By limiting the study to the sablefish fishery of California, Oregon, and Washington, the geographic area involved lends itself to relatively simple division for analysis and management if deemed necessary. Additionally, the market demand for sablefish and sablefish products has, both domestically and abroad, been expanding with concomitant increases in price. Finally, development of an optimal management plan for a less complex fishery may provide some insight and methods of analysis that would prove useful in developing optimal plans for more complex fisheries.

II. FISHERY CONSERVATION AND MANAGEMENT ACT OF 1976, PL 94-265

The contents of this chapter have been extracted from PL 94-265. They have been edited and rephrased to facilitate presentation. This material is considered necessary as background and for development of the rest of the thesis.

A. CONGRESSIONAL ACTION

Congress, responding to strong pressure from conservation groups, the U.S. fishing industry and various other interest groups, and to a lack of action on the part of the United Nations conference on the Law of the Sea, acted to unilaterally establish a 200 mile fishery zone for the United States. The Fishery Conservation and Management Act of 1976, Public Law 94-265, was signed into law on April 13, 1976.

Congress based their actions on their findings that:

1.) The fish off the coasts of the United States constitute a valuable and renewable natural resource that contributes to the food supply, economy, and health of the Nation and also provides recreational opportunities.

2.) Increased fishing pressure coupled with inadequate fishery conservation and management practices and controls has resulted in certain stocks of fish having been overfished to the point where their survival is threatened and other stocks of fish have been so substantially reduced that they could become similarly threatened.

3.) Commercial and recreational fishing constitutes a major source of employment and contributes significantly to the economy of the Nation. Many coastal areas are dependent upon fishing and related activities and their economies have been badly damaged by the overfishing of fishery resources at an ever increasing rate. Massive foreign fishing fleets in waters adjacent to such coastal areas have contributed to the damage, interfered with domestic fishing efforts and caused destruction of the fishing gear of United States fishermen.

4.) International fishery agreements have not been effective in preventing or terminating the overfishing of these valuable fishery resources. There is danger that irreversible effects from overfishing will take place before an effective international agreement on fishery management jurisdiction can be negotiated, signed, ratified and implemented.

5.) Fishery resources are finite but renewable and thus if placed under sound management before overfishing has caused irreversible effects, the fisheries can be conserved and maintained so as to provide optimum yields on a continuing basis.

6.) A national program for the conservation and management of the fishery resources of the United States is necessary to prevent overfishing, to rebuild overfished stocks, to insure conservation, and to realize the full potential of the Nation's fishery resources.

7.) A national program for the development of fisheries which are underutilized or not utilized is necessary to assure that our citizens benefit from the employment, food supply, and revenues which could be generated thereby.

B. FISHERY CONSERVATION ZONE

Congress, through the Fishery Conservation and Management Act of 1976, established the Fishery Conservation Zone as a zone, contiguous to the territorial sea, with an outer boundary being a line drawn in such a manner that each point on it is 200 nautical miles from the baseline from which the territorial sea is measured. The Act claims exclusive fishery management authority over all fish within this zone. Additionally, it claims exclusive fishery management authority over all anadromous (fish which spawn in fresh or estuarine waters of the United States) species throughout their range, except within the fishery conservation zone of another nation recognized by the United States and over all Continental Shelf fishery resources (Appendix A) that extend beyond the zone.

However, the Act does exclude the United States from exclusive management authority over species of tuna which are deemed to be "highly migratory". The logic behind this exclusion is undoubtedly influenced by the United States tuna industry which does not want to recognize the 200 mile fishery conservation zones' of other nations' jurisdiction over tuna.

C. FOREIGN FISHING

The Act authorizes foreign fishing within the fishery conservation zone, or for anadromous species or Continental Shelf fishery resources beyond the zone only if all of the following criteria are met:

I. A Governing International Fishery Agreement (GIFA) is negotiated between the United States and the foreign nation. The GIFA constitutes a binding commitment on the part of the foreign nation and its fishing vessels to comply with the following terms and conditions:

A.) The foreign nation and its fishing vessel operators must abide by the regulations prescribed by the Act and the applicable fishery management plans implemented pursuant to the Act.

B.) The GIFA requires the operators of the foreign fishing vessels to permit boardings, searches and inspections at any time, by an officer authorized under the Act. This officer with reasonable cause as a result of the search or inspection may make arrests for violations and seize the vessel. He is also authorized to examine and make notations on the vessel's fishing permit.

C.) It requires that the permit issued, pursuant to the Act, to each vessel, be prominently displayed in the wheelhouse.

D.) It requires, if the Secretary of Transportation so determines, that transponders or other appropriate position fixing and identification equipment be installed and maintained in working order on each vessel.

E.) It requires that duly authorized United States observers be permitted on board any such vessel and that the United States be reimbursed for the cost of such observers.

F.) Fees required pursuant to the Act must be paid in advance.

G.) Agents, who are authorized to receive and respond to any legal process issued in the United States with respect to the owners or operators, must be appointed and maintained.

H.) It requires responsibility be assumed, in accordance with any requirements prescribed by the Secretary of Commerce, for the reimbursement of United States citizens for any loss of, or damage to their fishing vessels, fishing gear, or catch which is caused by any fishing vessel of that nation.

I.) It requires compliance with any other monitoring, compliance, or enforcement requirement relative to fishery conservation or management that may be included in the agreement.

J.) It prohibits the foreign nation and the owners or operators of all the fishing vessels of the nation, in any year, from exceeding that nation's allocation of the total allowable level of foreign fishing.

II. There is an allowable level of foreign fishing only when the total harvest of United States vessels is less than the optimum yield of that fishery. An allocation of this

allowable level is made by the Secretary of State in cooperation with the Secretary of Commerce. In making such a determination they consider:

A.) the extent to which the fishing vessels of the foreign nation have traditionally engaged in fishing in the fishery;

B.) the cooperation with the United States and substantial contributions made to fishery research and the identification of fishery resources;

C.) the cooperation with the United States in enforcement and with respect to the conservation of the fishery resources; and

D.) such other matters as the Secretary of State in cooperation with the Secretary of Commerce deems appropriate.

III. Foreign fishing will be authorized only if the foreign nation satisfies the Secretary of Commerce and the Secretary of State that it extends substantially the same fishing privileges to fishing vessels of the United States, if any, as the United States extends to it's vessels.

Briefly stated the Act requires that the governing international fishery agreements (GIFAs) referred to above are 1.) negotiated by the Secretary of State, 2.) transmitted to both Houses of Congress by the President, and 3.) either approved or disapproved by both Houses of Congress after a 60 day minimum time period.

The Act requires that no foreign fishing vessel shall engage in fishing within the fishery conservation zone, or for anadromous species or Continental Shelf fishery resources beyond the zone, unless it has on board and prominently displayed in the wheelhouse, a valid permit. An application for this permit is to be made annually, by the foreign nation to the Secretary of State, for each vessel that it wishes to engage in the fishery. The Secretary of State publishes the permit application in the Federal Register. The Secretary of State transmits the application to the Secretary of Commerce with his comments and recommendations. He transmits a copy of the application to the appropriate Regional Council, to the Secretary of Transportation, and to the Committee on Merchant Marine and Fisheries of the House of Representatives and to the Committees on Commerce and Foreign Relations of the Senate.

Within 45 days of receipt, the Regional Council prepares and submits to the Secretary of Commerce its written recommendations including any restrictions. The Regional Council is to consider the comments of any interested parties which have been submitted to them.

The Secretary of Commerce, after consulting with the Secretaries of State and Transportation and after considering the Regional Council's comments, makes the determination whether the application is approved or not.

If the application is approved, a copy of the approval is transmitted to the Secretary of State for transmittal

to the foreign nation; the Secretary of Transportation; the appropriate Regional Council; and the House Committee on Merchant Marine and Fisheries and the Senate Committees on Commerce and Foreign Relations.

If the application is disapproved the Secretary of Commerce promptly informs the Secretary of State of the disapproval and his reasons therefore. The Secretary of State, in turn, notifies the foreign nation of the disapproval and the reasons. The foreign nation, after taking into consideration the reasons for disapproval, may submit a revised application.

The Act provides that reasonable fees shall be paid to the Secretary of Commerce by the owner or operators of any foreign fishing vessel for the issue of a permit. The Secretary of Commerce in consultation with the Secretary of State establishes and publishes the fee schedule. In determining the level of the fees, the Secretary of Commerce may take into account the cost of carrying out the provisions of the Act with respect to foreign fishing including but not limited to, the cost of fishery conservation and management, fisheries research, administration and enforcement.

D. NATIONAL STANDARDS FOR FISHERY CONSERVATION AND MANAGEMENT

Congress, through the Act established the following national standards for fishery conservation and management:

1.) Conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimum yield for each fishery.

2.) Conservation and management measures shall be based upon the best scientific information available.

3.) To the extent practicable, an individual stock of fish shall be managed as a unit throughout its range, and interrelated stocks of fish shall be managed as a unit or in close coordination.

4.) Conservation and management measures shall not discriminate between residents of different states. If it becomes necessary to allocate or assign fishing privileges among various United States fishermen, such allocations shall be fair and equitable to all such fishermen; reasonably calculated to promote conservation; and carried out in such a manner that no particular individual, corporation or other entity acquires an excessive share of such privileges.

5.) Conservation and management measures shall, where practicable, promote efficiency in the utilization of fishery resources, except that no such measure shall have economic allocation as its sole purpose.

6.) Conservation and management measures shall take into account and allow for variations among and contingencies in fisheries, fishery resources, and catches.

7.) Conservation and management measures shall, where practicable, minimize costs and avoid unnecessary duplication.

Based on these national standards the Secretary of Commerce is to establish guidelines to assist the Regional Councils in the development of fishery management plans.

E. REGIONAL FISHERY MANAGEMENT COUNCILS

To insure that fishery management plans are sensitive to local situations and problem areas, the Act required the establishment of eight Regional Fishery Management Councils as follows:

1.) The New England Fishery Management Council which consists of the States of Maine, New Hampshire, Massachusetts, Rhode Island, and Connecticut and has authority over the fisheries in the Atlantic Ocean seaward of these States.

2.) The Mid-Atlantic Fishery Management Council which consists of the States of New York, New Jersey, Delaware, Pennsylvania, Maryland, and Virginia and has authority over the fisheries in the Atlantic Ocean seaward of these states.

3.) The South Atlantic Fishery Management Council which consists of the states of North Carolina, South Carolina, Georgia, and Florida and has authority over the fisheries in the Atlantic Ocean seward of these states.

4.) The Caribbean Fishery Management Council which consists of the Virgin Islands and the Commonwealth of Puerto Rico and has authority over the fisheries in the Caribbean Sea and Atlantic Ocean seaward of these states.

5.) The Gulf of Mexico Fishery Management Council which consists of the states of Texas, Louisiana, Mississippi, Alabama, and Florida and has authority over the fisheries in the Gulf of Mexico seaward of these states.

6.) The Pacific Fishery Management Council which consists of the states of California, Oregon, Washington, and Idaho

and has authority over the fisheries in the Pacific Ocean seaward of these states.

7.) The North Pacific Fishery Management Council which consists of the states of Alaska, Washington, and Oregon and has authority over the fisheries in the Arctic Ocean, Bering Sea, and Pacific Ocean seaward of Alaska.

8.) The Western Pacific Fishery Management Council which consists of the state of Hawaii, American Samoa, and Guam and has authority over the fisheries in the Pacific Ocean seaward of these states.

The voting members of each Council are the principal state official with marine fishery management responsibility and expertise in each constituent state as designated by the Governor of the State; the regional director of the National Marine Fisheries Service for the geographic area concerned; and the Council members appointed by the Secretary of Commerce from lists of qualified individuals submitted by the Governor of each applicable constituent State.

The nonvoting members of each Council are the regional or area director of the United States Fish and Wildlife Service for the geographic area concerned; the Coast Guard District Commander as designated by the Commandant of the Coast Guard; the executive director of the Marine Fisheries Commission for the geographical area concerned; and a representative of the State Department designated for the purpose by the Secretary of State.

Each Council is charged with the responsibility to:

1.) prepare and submit to the Secretary of Commerce a fishery management plan with respect to each fishery within its geographical area of authority and such amendments to each plan as necessary over time;

2.) prepare comments on any application for foreign fishing transmitted to it by the Secretary of State;

3.) conduct public hearings at appropriate times and in appropriate locations in the geographical area concerned so as to allow all interested persons an opportunity to be heard in the development of fishery management plans and amendments to such plans, and with respect to the administration and implementation of the provisions of the Act itself;

4.) submit to the Secretary of Commerce an annual report on the Council's activities during the year, periodic reports as deemed necessary by the Council and any other relevant report which may be requested by the Secretary of Commerce;

5.) review on a continuing basis and review as appropriate the assessments and specifications made with respect to the optimum yield from, and total allowable level of foreign fishing in, each fishery within its geographical area of authority; and

6.) conduct any other activities which may be required or are deemed appropriate or necessary.

The fishery management plans prepared by the Councils must have the following required provisions:

1.) They must be consistent with the national standards, the other provisions of the Act and any other applicable law.

2.) They must contain a description of the fishery including the number of vessels involved, the type and quantity of gear used, the species of fish involved and their location, the cost likely to be incurred in management, actual and potential revenues from the fishery, any recreational interests in the fishery, and the nature and extent of foreign fishing and Indian treaty fishing rights if any.

3.) They must assess and specify the present and probable future condition of, and the maximum sustainable yield and optimum yield from, the fishery, and include a summary of the information utilized in making such specifications.

4.) They must assess and specify the capacity and the extent to which fishing vessels of the United States, on an annual basis, will harvest the optimum yield as well as the portion of the optimum yield remaining which can be made available for foreign fishing.

5.) They must specify the pertinent data which are to be submitted to the Secretary of Commerce.

Additionally the Act provides the Councils with the discretionary authority to include the following in the management plan:

1.) They may require a permit to be obtained from and fees to be paid to the Secretary of Commerce with respect

to any fishing vessel of the United States fishing or wishing to fish, in the fishery conservation zone, or for anadromous species or Continental Shelf fishery resources beyond the zone.

2.) They may designate zones where and periods when, fishing shall be limited, or shall not be permitted, or shall be permitted only by specified types of fishing vessels or with specified types and quantities of fishing gear.

3.) If necessary and appropriate for the conservation and management of the fishery, they may establish specified limitations on the catch of fish, based on area, species, size, number, weight, sex, incidental catch, total biomass, or any other factor deemed appropriate.

4.) They may prohibit, limit, condition, or require the use of specified types and quantities of fishing gear, fishing vessels, or equipment for such vessels, including devices which may be required to facilitate enforcement of the Act.

5.) They may, as long as they are consistent with the provisions of the Act, incorporate the relevant fishing conservation and management measures of the coastal state nearest to the fishery.

6.) They may establish a system for limiting access to the fishery in order to achieve optimum yield, however they must take into account:

A.) present participation in the fishery,

B.) historical fishing practices in, and dependence on, the fishery,

C.) the economics of the fishery,

D.) the capability of fishing vessels used in the fishery to engage in other fisheries,

E.) the cultural and social framework relevant to the fishery, and

F.) any other relevant considerations.

7.) They may prescribe such other measures, requirements, or conditions and restrictions which are determined to be necessary and appropriate for the conservation and management of the fishery.

Following the development of the plan or an amendment to an existing plan by the Council, it must be submitted to the Secretary of Commerce for approval. The Secretary has 60 days within which he must either approve the plan, partially disapprove it, or totally disapprove it. If partially disapproved, the Secretary returns it to the Council with an explanation of objections. The Council then must satisfy the objections and resubmit the plan within 45 days. In making his approval or disapproval decision the Secretary of Commerce must consult with the Secretary of State concerning foreign fishing matters and the Secretary of Transportation concerning matters dealing with Coast Guard enforcement at sea.

Upon approval, the Secretary of Commerce publishes the plan in the Federal Register. Interested persons then have 45 days within which to submit in writing, data, views, or comments on the plan. The Secretary may hold a hearing if he deems it necessary on the plan. To the extent practicable, the plan, following any hearings and the 45 day period, will be put into effect in a manner which does not disrupt the regular fishing season.

F. ENFORCEMENT

The provisions of the Act and pursuant to it the Regional Council management plans will be enforced by the Secretary of Commerce and the Secretary of Transportation through the National Marine Fisheries Service and the Coast Guard. However, the enforcement section of the Act allows the Secretaries to, by agreement, on a reimbursable basis or otherwise, utilize the personnel, services, equipment, including aircraft and vessels, and facilities of any other Federal agency, including all elements of the Department of Defense, and of any state agency in the performance of enforcement duties.

Authorized enforcement officers may:

1.) arrest any person, if he has reasonable cause to believe that such person has committed an act prohibited by the Act;

2.) board and search or inspect, any fishing vessel which is subject to the provisions of the Act;

3.) seize any fishing vessel, together with its fishing gear, furniture, appurtenances, stores and cargo, which is used or employed in, or with respect to which it reasonably appears that such vessel was used or employed in, the violation of any provision of the Act;

4.) seize any fish, wherever found, taken or retained in violation of any provision of the Act; and

5.) seize any other evidence related to any violation of any provision of the Act.

The enforcement officer may execute any warrant or other process issued by any court of competent jurisdiction as well as exercise any other lawful authority.

If an authorized enforcement officer finds that a fishing vessel is operating in violation or has been operated in violation of the Act, he may in lieu of the above, issue a citation to the owner or operator of the vessel. If a permit has been issued, the officer shall note the issuance of the citation on the permit. The Secretary of Commerce is to maintain a record of all citations issued pursuant to the Act.

G. PRELIMINARY MANAGEMENT PLAN

The development of the various management plans by the Regional Councils can take several months or even years, consequently the Act requires that the Secretary of Commerce develop a preliminary management plan for each fishery to fill the void between the enactment of the Act, 1 March 1977,

and the approval of the Regional Council prepared plans. These preliminary management plans are generally broad in scope and not particular in detail. They have been published in the Federal Register and thus provide initial guidelines for management and enforcement.

H. INTENT OF CONGRESS

From the Act, it can be concluded that the stated intent of Congress charges the Secretary of Commerce, through the Regional Councils, for the development of management plans, and the Coast Guard and National Marine Fisheries Service for the enforcement of these plans, to optimally manage the fishery resources of the United States for the benefit of the nation. It is not simply, as some would have it, to exclude foreign fishing if domestic fishing efforts are capable of completely handling the harvest. Therefore, it follows, that management plans prepared subordinate to the Act, are required to govern the fishing activity of U.S. fishermen as well as foreign fishermen.

To this point in time, the U.S. fishing industry has come under relatively little regulation as compared with other industries. What regulation there has been, is primarily limited to a few species of fish, such as halibut and salmon.

It is true in our society, that demands for government of a public nature have been increasing. Along with the growth in management requirements and the production of increased services, the regulatory functions of government have expanded quite rapidly.

III. THE SABLEFISH FISHERY

A. DISTRIBUTION AND LIFE HISTORY

The geographic distribution of the sablefish, or commonly, blackcod, Anoplopoma fimbria, ranges from northern Mexico northward along the entire Pacific Coast of the United States and Canada to Alaska, westward along the Aleutian Island chain and the Continental edge in the Bering Sea to the coast of Siberia and down to the northeastern coast of Japan. Sablefish occupy a wide range of depths with the pelagic eggs and larvae in surface waters, juveniles in surface and inshore waters to a depth of approximately 150 meters and adults from 150 meters down to over 1200 meters.

Although tagging studies conducted by Japan, the United States, and the Republic of Korea (Sasaki et. al, 1975) indicate that some sablefish conduct extensive migrations within the range, Low [1976] reported that the inter-area exchange of sablefish is slow and that the majority of these fish are apparently localized and do not migrate long distances. Low et. al [1976] reported that there is an interchange of fish between the inshore and offshore regions. Juvenile fish are found in the shallower waters along the coast, and as they mature and grow larger, they migrate into the deeper waters offshore. The adults tend to stay in the deeper waters, from 150 meters down, year round, with spawn and larvae carried inshore, and along the Pacific Coast, southward by surface currents.

Sablefish are known to live in excess of 20 years of age, however, the exploited biomass primarily consists of fish 3 to 8 years of age [Low et al 1976]. Generally the size of the fish in pounds is approximately equal to its age. Thus a 7 lb. fish is likely to be 7 years of age.

It takes approximately 5 to 7 years for sablefish to achieve sexual maturity [Edson 1954, Philips 1954, Pruter 1954]. Spawning takes place once a year during the winter in waters 250-750 meters deep [Thompson 1941, Bell and Gharrett 1945, Kodolov 1968]. Small females may produce around 100,000 ova and larger females over 1 million ova [Philips 1954]. The ova, after being spawned, rise to the surface where they develop into larvae and eventually into fry [Low et al 1976]. It is during this stage that predation is the greatest, with many fish feeding on the sablefish larvae and fry. Additionally, several parasites and diseases affect the sablefish population.

Still much remains to be learned of the life history, behavior and community ecology of the sablefish. Very little is known of its relationships with other commercially harvested species such as halibut, hake, flounders, rockfish, and cod.

B. DESCRIPTION OF THE FISHERY

Sablefish have been fished for by U.S. and Canadian fishermen for nearly a century as a target fish when halibut was not in season. The Pacific Coast sablefish resource has

been fished heavily only since the early 1960's when Japan entered the fishery soon followed by the Soviet Union, Republic of Korea, Republic of China, Poland, German Democratic Republic, Federal Republic of Germany and Bulgaria.

In 1976, the fishery off California, Oregon, and Washington found the Republic of Korea and the Republic of China in a directed fishery for sablefish and the Soviet Union, Japan, Poland, Bulgaria, and the German Democratic Republic in an incidental fishery through their trawlers directed for hake. These vessels ranged from approximately San Luis Obispo, California as a southern limit for the Koreans, to the Canadian border on the northern limit.

United States fishermen utilize two distinct methods of harvesting sablefish. The trawl fishery is basically a bottom dragging operation that targets on several bottom dwelling species including sablefish. Small domestic trawlers operate out of just about every small port along the coast. In the past, some have considered sablefish as a rough fish and discarded it because the market was so poor for it. The longline or trap fishery is a static gear setting operation. It tends to be located only out of certain ports along the coast, probably more a function of an established market than of where the fish are located. In recent years there has been a general increase in the domestic sablefish fishery effort, with a particularly large increase off California. A factor in the recent increase in domestic fishing was the refinement of a sablefish trap which greatly improved the harvesting process.

C. VESSELS AND GEAR

The fishing vessels of the sablefish fishery off the Pacific Coast generally fall into three types:

1.) The large foreign stern trawlers with gross tonnages up to 5000 metric tons and a capability to electronically locate and monitor schools of fish; pull huge trawl nets through the water, maneuvering the mouth of the nets up or down to follow the schools of fish; completely process with automated machinery, the fish into frozen filets and the wastes into oil and meal; hold up to 900 tons of processed fish in massive freezer holds; and remain at sea for months at a time. These vessels normally do not target on sablefish but catch them incidentally to other directed fisheries.

2.) The foreign longline-trap combination vessels with gross tonnages up to 500 metric tons and a capability to set several longlines with a total of hundreds of hooks or set several hundred traps; electronically locate concentrations of fish; completely process either manually or in some cases with automated machinery, the fish into frozen filets; hold up to 100 tons of processed fish in freezer holds; and remain at sea for months at a time. These vessels target on sablefish and may operate in small fleets to facilitate location and harvest of fish concentrations.

3.) The domestic trawl or longline-trap combination vessels are small with gross tonnages up to 50 metric tons. Domestic vessels have varying capabilities. They generally can set fewer longlines or traps than foreign counterparts.

Their electronic gear is generally much more limited in capability than the foreign vessels. If any processing is done on board it is all manual and consists only of heading and gutting. Generally fish are iced down although some vessels do have freezer compartments. The method of operation is to chill the fish to preserve it until it can be delivered to the processing facility ashore. Those vessels rigged for trawls are much more limited by depth and use much smaller nets in comparison to the foreign trawlers. The domestic vessels have limited holds and generally small crews.

The nature of the domestic fishery is such that fishing trips range from day trips to no more than a few weeks. They very often operate singly and at times jealously guard discoveries.

The development of the sablefish trap has probably been the greatest single contributor to the recent growth of the domestic sablefish fishery. In California for example, the trap catch went from less than 4% of the total landings in 1971 to more than 58% in 1974. The trap tends to be species specific, attracting and capturing only sablefish. The fish captured are of high quality and tend to be larger in size, perhaps due to either the failure to attract or the ease of escape for smaller fish. The trap has several other advantages including greater safety for the operator and ease of operation.

Sablefish taken by trap or longline generally command a higher price per pound than those taken by trawl because they are larger sized and generally in better condition.

D. FOREIGN FISHERY IMPACT ON DOMESTIC FISHERY

The primary impact of unregulated foreign or U.S. fishery operations on the sablefish fishery of the California to Washington coast is resource depletion through direct competition for stocks of sablefish. This competition in 1976 was especially acute with the Republic of Korea vessels along the entire coast. They often fished in the exact same areas as the U.S. fishermen, thus harvesting from the exact same stock of fish. The incidental catch by foreign trawl fisheries, though small, also impacts on the availability of stock for the domestic fishery. The foreign trawl operations are very often in close proximity to domestic operations.

The next greatest impact of foreign fishery operations on the domestic fishery is in the area of gear conflicts. A gear conflict would be defined as the fishing operation of one vessel interfering with, damaging, or destroying the fishing gear of another vessel. The primary cause of gear conflicts on the Pacific Coast are foreign trawling activities which run over, snag or destroy U.S. fishermen's longlines or trap sets. The trawler or the trawl itself either cuts off or destroys the end marker floats making it impossible to retrieve the gear or by snagging the float lines and dragging them off for some distance making them extremely difficult if not impossible to relocate. The blame, if any,

cannot be placed solely on the foreign vessels however, for the end markers or floats are often very difficult to see and thus avoid. Many a domestic fisherman has been unable to relocate his own sets due to slight navigational errors in position fixing or due to severe weather which can also destroy or relocate the markers.

Gear conflicts are very difficult to prove unless they are actually witnessed. Transiting commercial vessels can destroy the end markers. Unscrupulous domestic fishermen can steal them for the catch or for even the gear in more brazen cases. Nevertheless, the gear lost is often very expensive running in cases to the thousands of dollars, consequently gear conflict charges are often very emotion packed. The foreign nations will at times agree to settle the claim even without proof to avoid running the risk of jeopardizing their fishing opportunities.

To help alleviate the gear conflict problem a joint effort was developed whereby U.S. fishermen would report their gear set positions to the Coast Guard or the National Marine Fisheries Service, who in turn would advise the foreign fishing fleets of their position. The foreign fleet expedition commanders would in turn advise all of their vessels, directing them to remain clear of the reported positions. Many problems arose, however. In particular, U.S. fishermen would advise of sets but not of hauls, thus foreign vessel charts soon became cluttered with gear positions where in fact there was no gear. Additionally, U.S. fishermen would

often report positions that were slightly off, perhaps to protect "secret grounds" from fellow U.S. fishermen. Still other U.S. fishermen simply elected not to use the system at all.

A second method to avoid gear conflicts, among other purposes, was the establishment of no-trawling pot sanctuaries in certain limited areas. These were areas where, by bilateral agreements with the foreign nations involved prior to 1977 and by the preliminary management plan since then, foreign trawling was prohibited in order to protect pot (trap) - longline gear. This method of course, was successful only if the U.S. fisherman set his gear in the sanctuary areas.

E. SABELFISH PRODUCTS

Domestically caught sablefish are primarily used for human consumption with only 3% used as industrial products or animal food [Low et al 1976]. Smoked sablefish has been the primary product produced from the domestic sablefish harvest. Only the larger fish are used for smoking, however, because of the shrinkage which results from the smoking process. Sablefish are also pickled or salted, again, the demand is for the larger fish so that sufficient cuts of flesh are available for processing. The smaller fish are generally prepared as fresh or frozen steaks or filets. These smaller fish are often marketed as butterfish [Frey 1971]. The butterfish filet has become increasingly in demand in

the U.S. market [Low et al 1976] as an alternative to more expensive species of fish, and other protein sources.

Foreign caught sablefish are primarily marketed as filets and steaks, with only a small percentage pickled or salted. Japan is a major consumer of sablefish. The Koreans have indicated that the major portion of their catch has been marketed in Japan. Although little is known for sure, it is believed that the Soviets, Poles, and other Eastern European nations primarily use sablefish for human consumption [Low et al 1976].

F. PRIOR REGULATION

The sablefish fishery has had very little restriction placed upon it over the years.

In 1937 an incidental catch regulation for Pacific halibut was imposed by the International Fisheries Commission, which indirectly affected the sablefish fishery. For each pound of halibut sold, the fisherman must sell 7 pounds of other species not including salmon or tuna [Crutchfield and Zellner 1962]. This regulation was removed in 1966.

In 1955, Washington adopted a minimum size regulation in response to industry concern over the capture of small sablefish by trawls and its potential impact on the conditions of sablefish stocks. This regulation was removed in 1971.

In 1956, Washington adopted a closed season between November 1 and December 31, however this was lifted in 1958

following the Pacific Marine Fisheries Commission recommendation that it be abolished [DiDonato 1970].

In 1975 and 1976 through bilateral agreements with Japan, the Soviet Union and Poland in the form of direct and indirect catch quotas, vessel and gear limitations and area-time closures, some control of foreign fishing was affected. However, no agreements were reached with the Republic of Korea and their fisheries expanded in number of vessels and areas fished during this time period. It is interesting to note that several of these Korean vessels were registered in Panama, flew the Panamanian flag, but had Korean crews.

G. PRELIMINARY MANAGEMENT PLAN FOR THE SABLEFISH FISHERY

In February of 1977, pursuant to the requirements of Public Law 94-265, the Fishery Conservation and Management Act of 1976, the Secretary of Commerce published in the Federal Register a preliminary fishery management plan for the sablefish fishery of the Eastern Bering Sea, and the Northeastern Pacific Ocean. This plan became effective with the effective date of the Act, 1 March 1977. The sablefish fishery of California, Oregon, and Washington, is subordinate to this plan until it is amended or a new plan is developed by the Pacific Regional Council.

The preliminary management plan, in defining the status of the sablefish stock of the California-Washington region, defined the sablefish abundance as "stable and high". This

determination was made based on 1974 catch levels. This was prior to the major Korean sablefish fishery expansion. Because of the stable and high status, the plan deemed that no reduction in 1974 catch levels was necessary. The preliminary plan defined the annual total allowable catch (TAC) for the California-Washington as 7000 metric tons. The U.S. catch in 1974 was estimated to be at least 6100 metric tons.

In defining the total allowable level of foreign fishing, the plan explains that subsequent to the Republic of Korea expansion in the sablefish fishery in 1974, U.S. sablefish fishermen off Washington and Oregon have reported poorer catch rates and a greater loss of gear due to foreign fishing activities as opposed to earlier years. The plan goes on to state, "Because of declining catch rates in the Washington-California area and the adverse economic impact foreign fisheries have created on U.S. sablefish fishermen, compounded with the growing importance of sablefish to the U.S. consumer and the domestic production potential to catch all of the 7000 mt of sablefish equilibrium yield, there should be no foreign fisheries for sablefish off Washington-California."

As it has been published, the plan is very general. It defines the total allowable catch as 7000 mt, indicates that the U.S. sablefish fishermen are capable of harvesting the entire TAC, and that therefore, there should be no

foreign fishery allowed. It places no limits or requirements on the U.S. fishermen.

The 7000 mt TAC figure apparently assumes that the heavy Korean fishing pressure from 1974 to 1976 had no significant effect on the sablefish stock, so that 1974 catch figures are still valid in defining the TAC.

H. ADDITIONAL OBSERVATIONS

Based on personal observation and discussion with fishermen, fish brokers and buyers, National Marine Fisheries Service personnel, state fish and game personnel, and staff members of the Regional Council, the following observations are made concerning the sablefish fishery of the California, Oregon and Washington coast.

Although the sablefish population ranges along the entire coast with good population density, as revealed by various population studies, the U.S. fishing pressure tends to be concentrated in small, limited geographic areas, which appear to be more a function of traditional fishing grounds, homeport, or specific market location rather than apparent fish density. The motivation to remain on traditional grounds appears to be very strong. This is particularly evident in the Monterey Bay area, where, according to a California Department of Fish and Game official, the fishing pressure has increased significantly in recent years with a resultant decrease in catch per unit effort and a decrease in average fish size. The fishermen appear hesitant to

venture outside their traditional grounds in spite of the poor returns. Yet, just south of the Monterey Bay area, in 1976 the Koreans were observed taking substantial catches of large fish. The explanation as to why the fishermen do not venture further away appears to be a sociological one. The Monterey Bay sablefish fisherman, for the most part is a holdover or a decendent of the formerly great sardine fishery of Monterey Bay. They have strong family ties in Monterey and wish to be home every night if possible. Thus they "day trip", that is, they go no farther than they can successfully transit to, fish, and return from in one day.

This contrasts with some of the Fort Bragg fishermen, who generally tend to set their sablefish gear in a location that is adjacent to or enroute to albacore or salmon grounds. They set their gear, go off to fish in the other fishery, returning in a few days to retrieve their gear.

In neither case above does the location of the best sablefish grounds appear to be a primary determinant of the fishing site.

There is a marked difference in the price paid to the fishermen for sablefish along the coast. In a recent, informal telephone survey, prices for large (over 7 pound headed and gutted) sablefish ranged from 30¢ per pound to 90¢ per pound. Generally, the prices appeared to be higher in Washington and Oregon than they did in California. The explanation for this is not clear since the market is

international in scope. In both areas there appears to be growing foreign buying pressure on the market. Additionally, in both areas there has been a recent increase in the demand for "butterfish", the small sablefish. Perhaps a nationally organized selling market does not function well because the catch sizes are so small and locally landed.

Related to the above observation, there is every indication that the market for sablefish, both small and large, is about to expand much more quickly than it has in the past. The small "butterfish", are being discovered as an economical alternative to other higher priced, species of fish. Fish consumption generally, is growing, as consumers discover fish to be an economical, nutritional, low cholesterol, protein source alternative. This market expansion is most notable in the fresh or frozen filets of the smaller fish. However, processed fish are also gaining in popularity.

There are indications that ever increasing numbers of foreign buyers will be entering the market place. This is already very much the case in the salmon and crab markets. Several Alaskan crab canneries process crab solely for a Japanese market. To be economical, foreign buyers must enter the market with orders for large quantities of fish. With the traditionally inelastic supply of fish, these large purchases could result in large, rapid price increases.

Finally, with respect to the management plan itself, the Regional Council has assigned to its "ground fish" committee the responsibility of preparing the draft of a

management plan for the sablefish fishery. It is to be incorporated in the larger plan which is also to include plans for other ground fish species, some of which include hake, rockcod, ocean perch and the bottom fish such as sole but not including halibut. The upshot of this is that this plan, because of all the species in it, will take a considerable amount of time to prepare and be approved. It is particularly complicated by the fact that this large plan will include hake. The hake is the primary target fish of the large foreign fishing fleets. Thus, it would be expected that the other species in the plan would appear less significant in comparison and perhaps receive less attention and effort. In any case, the best estimate of when the plan could be completed at the earliest is sometime in late 1980 or early 1981.

IV. ECONOMIC THEORY

Since economics is, among other things, the science of studying the allocation of scarce resources so as to maximize the benefit or value to society, it is desirable to spend some time analyzing the economics of the sablefish fishery. The basic resources to be allocated, for which economic theory is concerned, are capital or money, labor, and, of course, the sablefish population. These resources are the factor inputs of the sablefish fishing industry. The factor input, sablefish, presents unique economic issues because the fish population is a renewable resource. The benefits received by society from the sablefish fishing industry include profits and a high protein source, both of which are easily quantified, and such difficult to quantify benefits as job satisfaction, security, and recreation.

Thus, from an economic perspective, the task facing the Regional Council is to develop a mangement plan which will control the amounts and mix of these input resources in such a manner as to maximize the present value of their future output benefits to society.

A. COMPETITIVE INDUSTRY

Micro-economic theory tells us that there are three basic industry types; 1) Perfect competitors, 2) Pure monopolies, and 3) Oligopolies. No one industry precisely fit any one industry type however, some industries are actually at points midway between the basic types.

Perfect competition is characterized by; 1) The elements in the industry each act as price takers. Through their actions they can control neither the price of inputs nor the price of outputs. 2) The products of the industry are homogeneous, that is, the product of one element in the industry is the same as the product of any other element. 3) All resources are perfectly mobile in and out of the industry, including free entry and exit of elements. 4) Consumers of the products produced, as well as the producers themselves, have perfect and complete knowledge of the market, that is, they know prices and costs of inputs and outputs.

A pure monopoly is characterized by there being no other producers or rivals. They are price makers in that the price they set is the only price available to the consumers.

An oligopoly is characterized by there being some competition but not enough to eliminate the impact of any one producer on the market. The actions of any one element affect the rival elements. Because they are sensitive to each other and yet each has the ability to affect market price, there is considerable second guessing and tactical maneuvering of the elements in an oligopoly.

The sablefish fishery, as do most other fisheries, appear to best fit in the competitive industry type. Sablefish fishermen are price takers in that they individually do not dictate or control the price they pay for their

inputs or they receive for their outputs. Harvested sablefish are a homogeneous product in that the catch of one fisherman is no different and thus commands the same market price as any other. Fishermen are free to enter or exit the industry. Currently there are no restrictions on entry or migration from one area to another. Start-up costs, of course, are high, but that does not preclude entry or exit. Knowledge of prices and costs, though not perfect, are public and available to both producers and consumers.

Since the sablefish fishery appears to fit the competitive industry type best, the various micro-economic models which pertain to the competitive industries would also reasonably pertain to the sablefish fishery.

B. OPEN ACCESS EQUILIBRIUM

The operation of the freely competitive individual fisherman and of the open access sablefish fishing industry as a whole is depicted in Figure 1. The left-hand side depicts the individual fisherman and the right the industry. The MC curve represents the individual fisherman's marginal cost curve as a function of the quantity harvested, q. The AC curve represents his average cost curve as a function of q. The D curve represents market demand as a function of the total industry catch, Q. The S_p and S_s curves represent industry supply curves as a function of Q. Specifically, the S_p curve is the private cost curve, which represents the sum of all the individual fishermen's marginal private

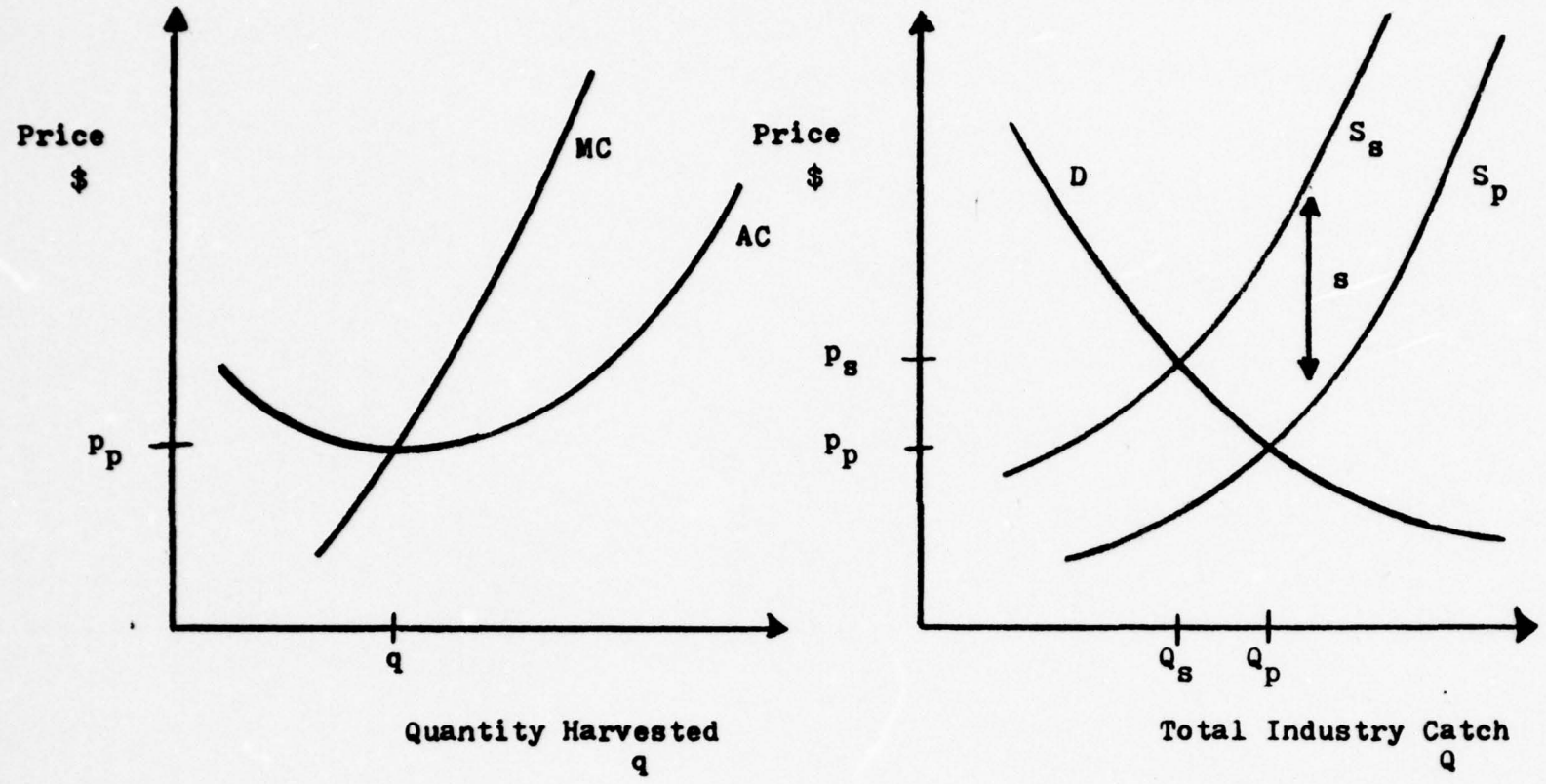

Price
$
MC
AC
p_p
q
Quantity Harvested
q
Individual Fisherman
Price
$
D
S_s
S_p
s
p_s
p_p
Q_s
Q_p
Total Industry Catch
Q
Industry

Figure 1

costs. The S_s curve is the social cost curve, which represents the S_p curve with the addition of additional social costs as represented by s in Figure 1.

The intersection of the S_p supply curve and the demand curve D, is the point of market equilibrium, where Q_p is the quantity of sablefish harvested by the industry and p_p is the prevailing market price. This long run, open access equilibrium is achieved in the following means. First, individual fishermen will initially adjust their efforts so as to equate their marginal costs to the price of fish, p_p. Only those fishermen will remain in the fishery whose MC = p_p is equal to or greater than their average cost. The other fishermen would be operating at a loss and would eventually depart the fishery. Finally, in the long run, fishing efforts will have been adjusted so that each fisherman is operating at the level where long run average cost is at a minimum and it equals the MC = p_p. At this long run, open access equilibrium, fishermen are motivated to remain in the fishery as long as their average revenues, which equals price, p_p, times quantity, q, are equal to or greater than their average costs.

By operating at the minimum of his average costs, the individual fisherman is operating at his most efficient level, producing sablefish for the market at the least possible costs.

C. EXTERNALITIES

According to Hyman [1973], an externality exists when the production or consumption activities of one economic unit affect the productivity or well being of another economic unit and no compensation is paid for the externally generated benefits or costs. When these costs are imposed on a large number of people they are called social costs. Traditional examples of such externalities are the various forms of environmental pollution.

These externalities result in the market failing to give proper signals concerning the true scarcity or valuation of resources. In order to internalize these externalities, that is force the producers to recognize the social costs, government intervention is often required. Again, the environmental pollution legislation and controls provide an example.

The open access exploitation of a common property resource, such as sablefish, involves externalities. An example of an externality in the fishery is the operations of one individual imposes costs on the other individuals because he reduces the fish stock by his harvest, and thereby increases unit costs for all the individuals in the fishery.

A precise determination of these costs, such that they can be assessed, is extremely difficult. However, in general, if the social costs, as represented by s in Figure 1, are added to the private costs, they result in a new supply curve as represented by S_s. The new intersection point of this

supply curve, S_s, with the demand curve, D, yields a quantity Q_s for the industry, which reflects the total private and social costs of harvesting the fish. It also establishes a new prevailing market price p_s. From this new price the individual fisherman will establish a new set of operating curves, which will include his accounting and assessment for all or part of the social costs, and which will result in a new long run equilibrium and new levels of individual efforts. Exactly how the individual fisherman's curves will change depends on how completely the social costs are internalized to them, the producers.

The existence of externalities in the sablefish fishery, and the need for their internalization, is justification for some form of government regulation of the fishery.

D. OPTIMAL INDUSTRY OUTPUT

Since the unregulated, open access fishery fails to internalize its externalities, and thus produces something other than an optimal production output, it is desirable to determine an optimal level of output. Anderson [1977], Christy [1977], Clark [1976], Gordon [1954], and Schaefer [1957], as well as others, have developed methods which can be used to attempt to determine an optimal level of output.

The open access model ignores the fact that as the total quantity harvested increases, there are fewer fish remaining which are available to be caught. Over time, as the resource is depleted, marginal social and private costs will increase

as more effort is expended to harvest from a less dense and smaller population. Additionally, as greater numbers of fish are harvested, fewer remain to reproduce, which slows the population replenishment rate.

Thus the quantity of fish caught is actually a function of both the total amount of effort expended to catch fish and the size of the fish population at the time. The size of the population is a function of the previous efforts expended to catch fish and the population growth rate. Over a period of time, at a constant effort level, the fish population will reach some equilibrium size. This will be true up to some maximum effort level beyond which the fish population cannot sustain itself. From this fact can be produced the sustainable yield curve shown in Figure 2.

For any level of effort E_0 through E* there is a corresponding equilibrium catch level for which the fish population can sustain itself. The maximum catch level, F_M, at effort level E_{MSY} defines the maximum sustainable yield, the MSY, as referred to earlier. Increasing effort below the E_{MSY} effort level will increase the sustainable yield, while increasing effort beyond the E_{MSY} level will decrease sustainable yield, until, at effort level E* sustainable yield is zero.

By slightly modifying a technique demonstrated by Anderson [1977], the sustainable yield curve can be converted to a long run total revenue curve, Figure 3. This

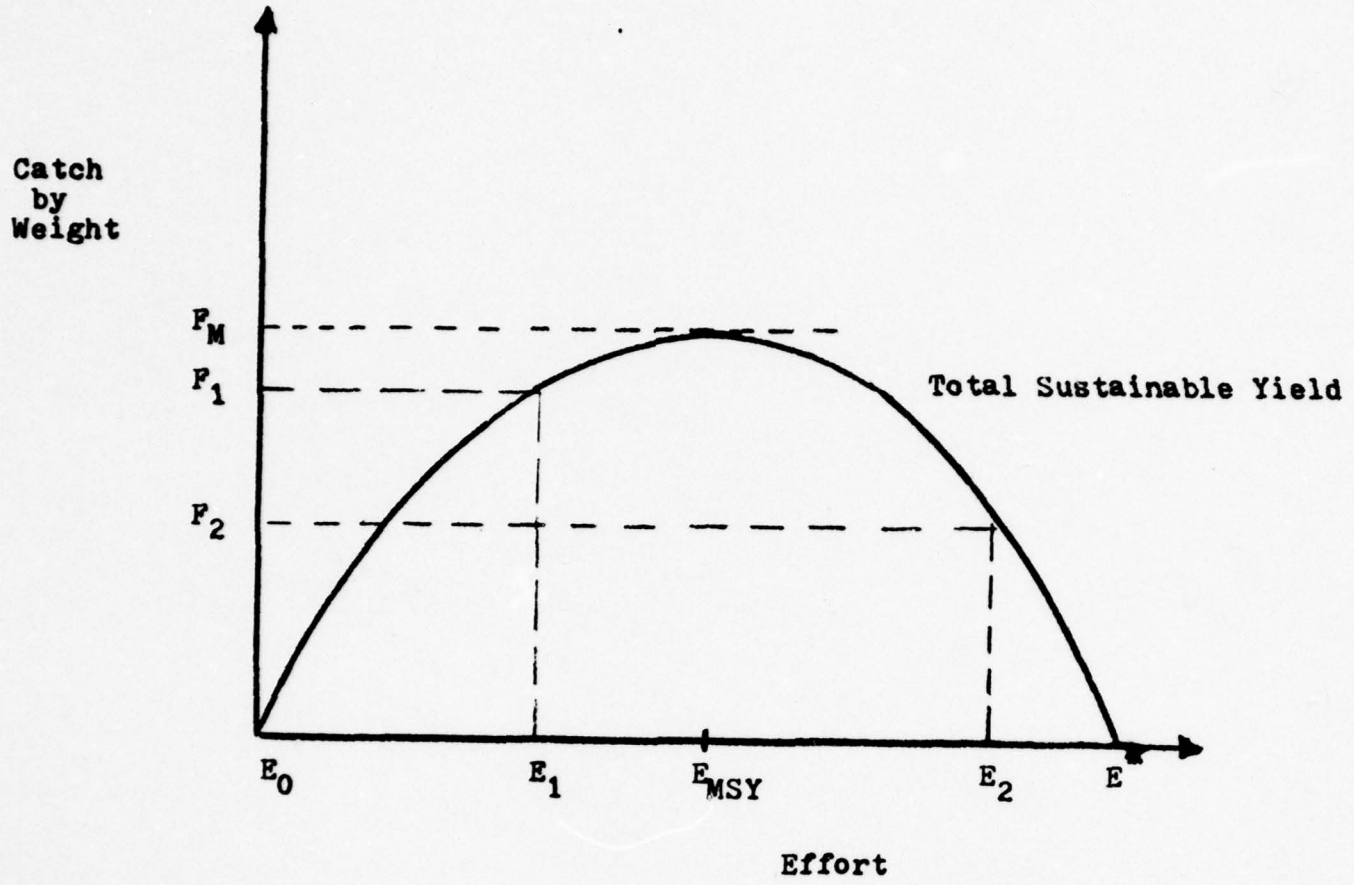
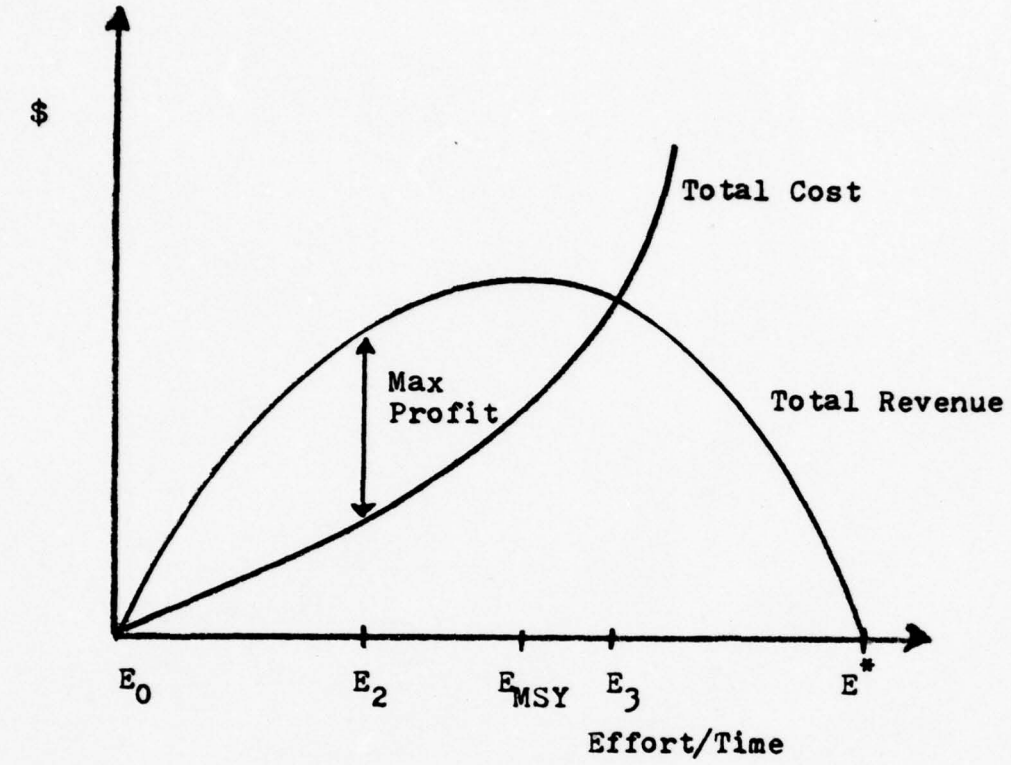

Catch
by
Weight
F_M
F_1
F_2
Total Sustainable Yield
E_0
E_1
E_{MSY}
E_2
E
Effort

Figure 2


$
Total Cost
Max
Profit
Total Revenue
E_0
E_2
E_{MSY}
E_3
E^*
Effort/Time

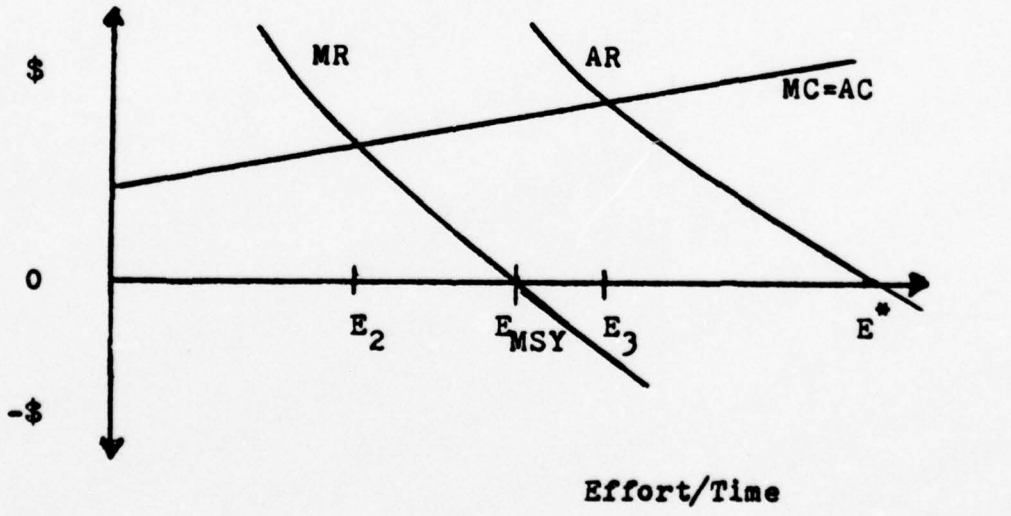

$
MR
AR
MC=AC
0
E_2
E_{MSY}
E_3
E^*
-$
Effort/Time

Figure 3

conversion is based on the assumption that the price of fish remains constant and the cost of effort rises at an ever increasing rate. The total cost curve is one of increasing slope as costs of effort rise. The marginal revenue curve, MR_E, shows the change in revenue resulting from a change in the production of effort, and is downward sloping because the marginal catch per unit of effort decreases with increased fishing intensity. The average revenue curve, AR_E, shows revenue per unit at each level of effort, and is downward sloping because average catch per unit of effort also declines with increased fishing intensity.

From Figure 3 it can be observed that the maximum profit, which is the difference between total cost and total revenue, is achieved at fishing effort E_2. This difference between the total cost and total revenue curves is called economic rent or economic profit. Traditionally, in economics, the level of production which produces the maximum economic profit, is predicted to be the level at which a monopolist or sole owner of the resource would operate in order to realize the maximum profits. Anderson [1977] has interpreted this effort level, which produces the maximum economic profit, E_2, to be the point of maximum economic yield, MEY. He contends that this level of effort should be the optimal allocation of effort to the fishery since the value to society of the last unit of fish caught, the marginal revenue, just balances the cost of providing it, the marginal cost. The value to society, he contends, is not in the fact that

profit is maximized to the fishery as a whole, but rather that society's inputs are not being used to exploit the fishery if they can be used more advantageously elsewhere.

As the optimal effort level it would produce the optimal fishery output of fish. Thus, this effort level should be the management objective for the fishery, the result of the applied regulations.

Referring to Figure 3, it can be seen that the effort level which produces the maximum economic yield may be less than, equal to, or greater than the effort level which produces the maximum sustainable, E_{MSY}, depending on the shape of the total revenue and total cost curves.

Referring again to Figure 3, it can be demonstrated that in an unregulated, open access fishery, fishing effort will increase through new entry and expansion of effort until an equilibrium, referred to as a bionomic equilibrium by Gordon [1954], is reached at E_3, the point where total cost just equals total revenue. This is the same open access equilibrium produced in Figure 1.

Anderson concludes that the reason there is a difference between the equilibrium level of effort at E_3 and the optimal allocation (for society) of effort at E_2 is the fact that in an unregulated fishery no one entity owns the fish stock and can not therefore restrict others from harvesting. Rather, fish can be harvested as fishermen please, and since they are rational individuals, they will fish as long as revenues exceed costs.

The above models represent static portrayals of the fishery. In fact, Anderson describes the maximum economic yield, MEY, as being a static maximum economic yield. He indicates, and Clark [1976] more thoroughly develops, the concept of a dynamic maximum economic yield, which primarily includes the concept of time discounting. Time discounting is essentially the application of an interest rate, often referred to as the social discount rate, to monies and resources. In an overly simplified explanation, it means that the same dollar received or paid today is worth more than if it were received or paid at a later date.

At a discount rate of zero, there is no change in value over time. Clark has demonstrated that the dynamic economic yield is the same as the static economic yield. At the other extreme, with an infinite discount rate, the maximum dynamic economic yield is the same as the open access, unregulated equilibrium point. Clark concludes that the optimal fishery effort level thus lies between these two extremes as a function of the existing discount rate. This value reflects the compromise between the desire for current versus future revenues. Through a series of equations, which are not presented here, Clark is able to calculate a precise, dynamic, optimal level.

The above models can be made more representative of the real world by the addition of anticipated changes in the market demand as the tastes of consumers, prices of related

goods, and total income and income distribution of society change.

Technological improvements and changes in demand for the inputs of the capital and labor used in the fishery will affect the models.

All of these additional considerations can be added to the basic economic models, each changing the curves in some comparatively small manner. However, the bottom line remains, there is some effort level at which there is a maximum economic profit available. This point represents the optimal amount of effort, and its resultant harvest, which is at the least cost to society. This value is optimal, not because it maximizes profit to the fishery, but because it guarantees that society's resources are being allocated so as to maximize the social welfare. Furthermore, due to the lack of central ownership of the fish population, the effort level in an unregulated fishery at which the fishermen will elect to fish, is something greater than the effort level producing the maximum economic profit. The yield produced at this unregulated level is sub-optimal, not only because the profit of the fishery is less, but because society is not making the best uses of its resources, including the fishery, to maximize its welfare.

E. MAXIMUM SOCIAL YIELD

By going through the modeling analysis above, an effort level which produces the maximum economic yield, MEY, can

be determined. It guarantees that the net contribution of the fishery to the economy as a whole is maximized through economic efficiency. However, as Anderson [1977] points out, economic efficiency is not the sole goal of society. Some of the other goals of society which impact on a management plan for the sablefish fishery include; 1) income redistribution, 2) maintenance of balance of payments equilibrium, 3) reduction in overall unemployment, and 4) provision of recreation activities. In some instances, striving for economic efficiency may well assist in the achieving of these other goals, while in other situations, the striving for economic efficiency may well be acting contrary to the objectives of the other goals. Therefore, in the situations where the economic efficiency goals run contrary to another goal of society, some form of compromise must be reached. The level of effort which coincides with this compromise, Anderson defines as producing the maximum social yield, MScY.

Economic logic can be used to determine specifically the effort level which will produce the MScY. To do so requires a quantification of the other goals into a dollar value. This may prove politically difficult, but is logically feasible. The effort level of MScY is then the level at which benefits of the other goals gained as quantified, equals the loss in economic profits incurred by the movement away from the level producing the MEY, which was required to obtain the other goals.

F. ECONOMICS OF REGULATIONS

The arguments developed in this section are primarily the same as those developed by Lee Anderson in chapter 5 of his book The Economics of Fisheries Management.

Be it to achieve maximum economic yield or maximum social yield, the problem that must be faced in developing a management plan is how to change the amount of fishing effort from the present, unregulated levels to the desired levels. Before any regulation is proposed however, it must be demonstrated that the improvements in yield offset the costs of obtaining them. These costs include the costs of management, related research, and enforcement.

Fishing effort is a function of four primary variables; 1) the number of fishing boats used in the fishery, 2) the boats' individual harvesting power, 3) the spatial distribution of the boats, and 4) the total time spent fishing. In order to affect effort levels, one or more of these variables must be changed.

The primary regulatory methods used are, 1) area closures, 2) season closures, 3) maximum harvest quotas, 4) limitations on the number of boats in the fishery, 5) gear restrictions, 6) taxes, and 7) licenses. Each of these methods reduces effort levels by affecting one or more of the variables of effort.

The first five of these methods of regulation function by forcing some form of inefficiency on the fisherman. The

remaining two can be implemented in such a manner that they do not reduce the fisherman's efficiency.

1. Area Closures

Area closures restrict access to certain areas thus requiring a greater expenditure of inputs on the part of the fisherman to reach and return from open areas in which he can fish.

2. Season Closures

Season closures limit the duration of use of capital equipment to some fraction of the year. Additionally it requires a more intense and thus more costly usage of equipment and other input factors during open seasons in order to produce efforts beyond the point where the time limit becomes binding.

3. Maximum Harvest Quotas

Maximum harvest quotas prohibit further fishing once a specified catch has been harvested. The effect on the individual fisherman is to motivate him to increase his fishing power, with concomitant increase in input costs, so as to obtain a larger individual share of the quota. Once quotas are achieved, capital equipment again lies idle.

4. Limitations On The Number Of Boats

Limitations on the number of boats in the fishery will, in the short run, reduce effort because it is not possible to produce as much per period with the existing boats. However, with no other restriction, the existing boats will be motivated, at some increase in costs, to

modify their boats to increase their productive capability and thus producing a greater, less efficient effort level. To be an effective regulatory method, the number of boats in the fishery would have to be periodically reduced.

5. Gear Restrictions

Gear restrictions, which are the most direct form of forced inefficiency, specifically retard fishing power. These restrictions have the effect of forcing the fishermen to use more costly methods to effect the same amount of effort than would be used in an unregulated fishery.

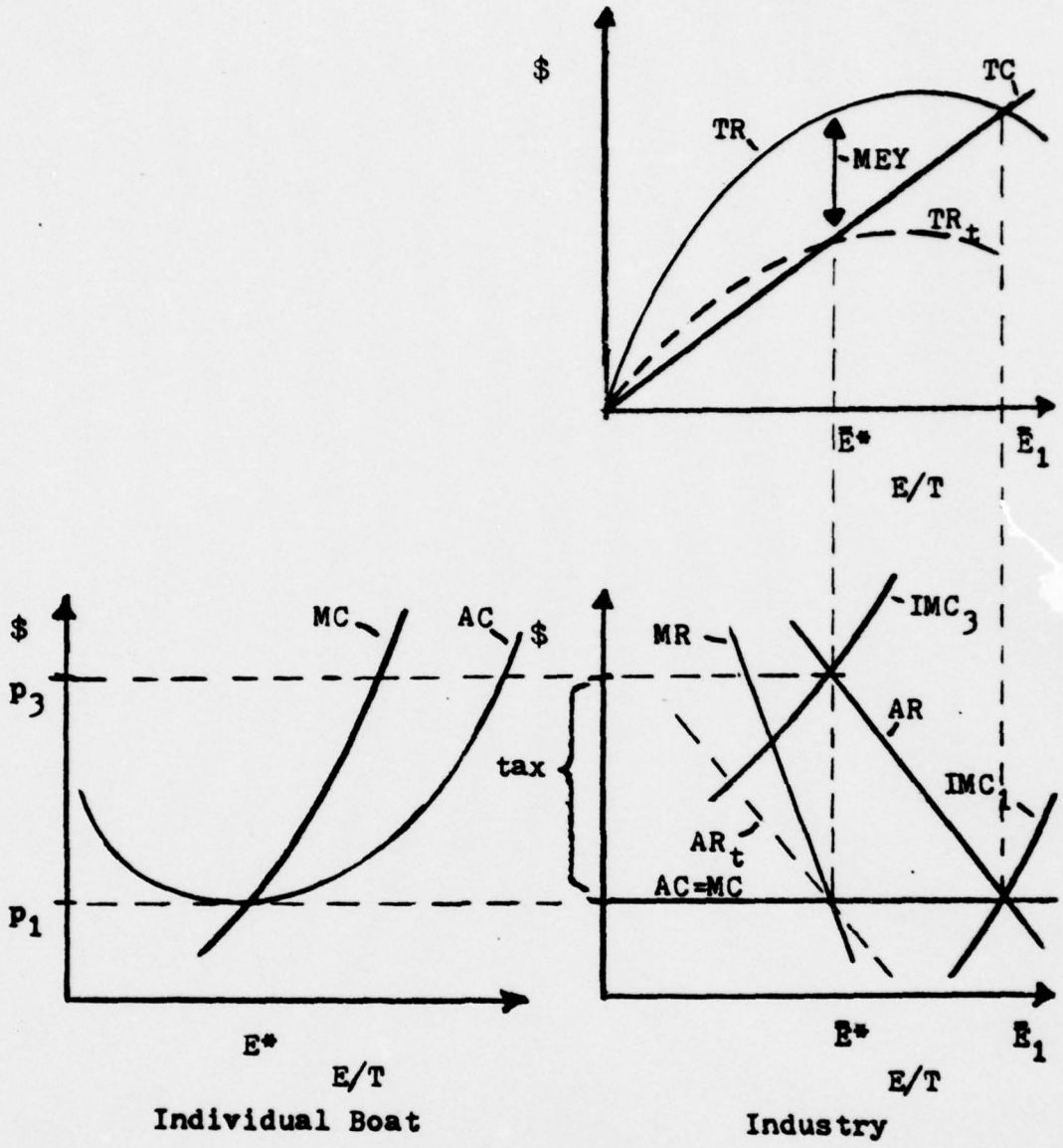
The effect of regulation by forced inefficiency is a reduction of efforts toward the desired levels, but at the expense of increased unit costs to the individual fishermen. Improvements are made from the unregulated fishery levels. However, the costs of inefficiencies prevent social welfare from being maximized as compared to regulatory methods which do not regulate by forced inefficiency.

6. Taxes

Taxes, on the other hand, as a regulatory device, do not affect the efficiency of effort. Their impact falls upon the results of the total effort, rather than the individual variables of effort. A properly designed tax would reflect the difference between the average and marginal revenues, for the fishery as a whole, as measured at the MEY effort level. This effectively lowers the fisherman's average revenue down to his marginal revenue for the

optimal effort level at MEY. The effect of such a tax is to force some fishermen, the least efficient, who cannot afford the increased total costs produced by the tax, out of the fishery. The remaining fishermen, now producing at the desired effort level, are motivated to remain at this effort level because it is still their minimum average cost value. The reduced effort, of course, reduces supply so that the market price rises to a value which exactly offsets the tax. Figure 4 is a graphic representation of this process under an assumption of constant cost of industry supply. The bottom line of such a tax as a method of regulation is that the cost of producing effort has not changed and yet the effort level has dropped to that which is desired. The economic profit which exists at this desired effort level is taken by the tax collector, that is, the government, who, as the representative of the people, is the "owner" of the fishery. The individual return to the fisherman, in the long run, is exactly the same as it was before regulation. However, when the assumption of constant cost is dropped the tax will cause some distortion in production methods.

The most practical means of levying this tax, since effort levels are difficult to conveniently quantify, is to place a unit tax on the fish harvested, the end product. The amount of tax, again for simplicity assuming constant costs, should be the difference in price per unit of fish, at the desired level and the existing level as determined from the market demand curve.



p_1 - net return to fisherman, p_3 - price to the consumer

E_1 - open access equilibrium, each boat producing it's E*

E^* - open access equilibrium, with tax, each boat producing E^*

$p_3 - p_1$ = tax per unit of fish

$E_1 - E^*$ = reduction in total industry effort

AR_t = AR less the tax

Figure 4

7. Licenses

Licenses, if properly designed, also do not affect efficiency of effort. In contrast to the other regulatory methods, which operate by pressuring the inefficient fisherman to leave the fishery "voluntarily", a licensing program specifically excludes fishermen, beyond those licensed. Because of this fact, this distributional problem becomes the primary management concern.

Economically, licensing differs from taxation only in the distribution of the economic profit. Under taxation, this profit goes to the government. Under a licensing program, it goes to the fishermen holding the licenses less any fees paid to obtain the license. As far as resource allocation is concerned, it does not matter who receives this profit, for in either case, resources are properly allocated to the fishery.

Licensing, as regulation, works by granting to a certain fisherman, the right to harvest a specific amount of fish. Those who are granted licenses, are motivated to seek the maximum economic yield effort level in order to maximize their profits. Thus, they operate at the level which produces the greatest efficiency, and therefore, with the least cost to society. The end result is that social welfare is maximized.

The number of licenses to be issued is such that the optimal number of boats, each operating at minimal average

cost of effort, are allowed to fish. If licenses are not permanent, they should be at least of long enough life to enable fishermen to make reasonable capital equipment investment decisions.

Anderson proposes two methods of license distribution which appear to be practical. The first is a grandfather system with a government buy-back plan, in which all those presently in the fishery are granted a license. The licenses would be freely transferable. When the effort levels rose above those desired, the government could buy back a certain number of licenses to reduce the effort level to that desired. A fisherman would be willing to sell if the offered purchase price equalled or exceeded his anticipated discounted income stream from continued fishing. Since the licenses would be transferable, new entrants could successfully enter the fishery with sufficient money to buy a license from a present holder.

The second license distribution alternative proposed by Anderson is a sale of licenses at auction. Present fishermen would be in a favored position in the bidding because of their existing equipment, skill and preparation. As in the above alternative, a sale of a greater number of licenses, with a buy-back plan would ease the problem of resource transfer in and out of the fishery, given a desire to either raise or lower the effort levels. This plan would return most of the economic profit to the government through

the bid revenues. The total amount bid would approach the maximum economic profit of the fishery.

The properly designed licensing system will allow the proper amount of fish to be harvested with the least cost in terms of resources foregone. Each fisherman will operate as inexpensively as possible and in the long run will be motivated to substitute new and more efficient equipment and methods as old gear wears out. With the auction alternative, the most efficient fishermen will be able to bid higher than less efficient competitors and will thus obtain the licenses.

G. ECONOMIC CONCLUSIONS

As Huppert [1977] points out, the received body of theory in fishery economics emphasizes the importance of free access to fisheries as a source of social welfare loss. Fishermen, privately maximizing their own profits, fail to respond to the social costs of depleting the resource, and as a group, will deplete the fish stock until the average cost of production rises to equal the market price of fish. Huppert goes on to say that the ideal economic solution to this externality problem requires that the investment of capital and labor in the fishery be prevented beyond the point where incremental costs are justified by marginal social returns. Christy [1977] has calculated an estimate of the economic yield lost through free access competition in the U.S. fisheries, in total, at $300 million annually.

Government intervention, therefore, through some form of regulation, would appear necessary in order to internalize this externality.

From an economic perspective, the primary factor to be considered when designing any form of regulation is the cost of instituting and enforcing it. The benefits, to the national economy as a whole, must outweigh the costs of obtaining them. One of the most significant costs is going to be in the acquisition of adequate data to determine proper levels of regulation. Due to the dynamic nature of the fishery and its market, data must be continually updated and the regulations flexible enough, to allow proper adjustments to be made. The ultimate goal of the regulations should continue to be to maximize the social welfare by harvesting the optimal amount of fish, obtained at the least cost production methods.

Economic reasoning is but one tool available to the Regional Councils to assist them in developing a management plan for the sablefish. By its nature it transcends emotions and politics which can otherwise cloud and confuse the management problem. However, in itself, economic reasoning is not the sole method of solution.

V. ALTERNATIVES

The following regulatory alternatives are completely original. The economic validity of taxation and licensing, as regulatory methods, is based primarily on the work of Lee Anderson [1977].

A. THE PROBLEM

The problem facing the Regional Councils is one of designing an optimal management plan for the sablefish fishery. The regional nature of the Council provides them much local insight into the management problem, but, at the same time, subjects them to the strong localized political pressure of special interests.

The plan must meet the requirements of the Act, and yet it must be flexible enough to accommodate changes that are required as new status information on the fishery population is gathered, market demands change, and technological improvements are made in harvesting and handling techniques. As economics dictates, the benefits gained by the plan must outweigh the costs of implementing it.

Essentially, the objectives of the plan should be threefold. It must first define the fishery and determine the total allowable catch level. From the economic perspective, this should be the effort level of the maximum social yield. Secondly, it must determine a method of distributing or allocating the total allowable catch to the fishermen.

Thirdly, it must, through a feedback system, monitor the fishery to determine if the plan objectives are accomplished, and if not, what directions changes should be made in.

B. DATA REQUIREMENTS

To meet these objectives adequate data must be collected in each of several categories. In order to define the fishery the biological data, such as biomass, geographic distribution of biomass, reproductive, longevity and natural mortality rates, migratory patterns, maximum and minimum critical population levels, competition for niches at various population levels, etc., must be determined. The end product of the biological data should be the production of a sustainable yield curve, disaggregated by geographic area if necessary.

The fishery, of course, includes the fishermen as well. So, such data as the present number of boats available, their geographic distribution, their fishing power, their costs of operation, including both labor and capital costs, and the market prices of inputs and outputs, both present and forecast, should be determined. The end product of this data are the various cost and revenue curves for the fishery, including marginal, average and total revenue and cost curves for the individual fisherman and the industry.

Data, which can be used to predict the costs of management, data collection, and enforcement must be determined so that the administrative costs of implementing the alternative plans can be determined.

Given that the above data can produce, for the Council, the total allowable catch for the fishery, the additional and subtle data of socio-economic pressures, geographic employment levels, balance of trade, recreation, and pure and simple political pressures must be ascertained and weighed when determining the distribution of the total allowable catch.

Finally, for the feedback system, data from all the above sources must be continually inputed and monitored by the Council in order that modifications to the plan can be made as necessary.

C. ADDITIONAL CRITERION

If some form of regulation is to be a necessary part of the plan, it should not be regulation through forced inefficiency, but rather such that it provides the optimal harvest at the least cost of supplying the total quantity of fish caught.

The plan should be such as to encourage innovation and the development of new and improved harvesting, handling, and processing techniques.

In order to maintain equity and vitality in the fishery, the plan should allow for ease of entry and exit of fishermen.

Finally, the plan should be such that it encourages complete and thorough utilization of the resource, throughout its range.

D. THREE ALTERNATIVES

It would appear that there are but three basic alternative management techniques available to the Regional Council for the sablefish fishery. All three make the assumption that domestic fishing pressure is great enough that foreign fishermen would be excluded from the fishery.

The first alternative would be the maintenance of the status quo. That is, there would be no regulation of the domestic fishermen within the fishery.

The second alternative would be a form of regulation of the fishery, through the establishment of a tax on fish landed per unit of fish.

The third alternative would also be a form of regulation of the fishery, through the establishment of a licensing program, in which licenses are granted to harvest a prescribed amount of fish.

E. ALTERNATIVE 1

The first alternative is to continue with the regulations as prescribed by the preliminary management plan for sablefish as prepared by the Secretary of Commerce. This plan essentially provides for no restrictions of domestic fishing operations. It excludes foreign directed fisheries for sablefish and sets certain maximum incidental catch limits for foreign trawl fishing operations directed at other species such as hake. An incidental catch would be defined as the catch of any species of fish other than that for which the

fishing operation is directed. The supposition of this plan is that the total allowable catch is being nearly completely harvested by the domestic fishermen such that none remains available for the foreign fishermen.

This alternative has the least enforcement costs. There are essentially no federal enforcement costs for the domestic fishery. To ensure that no foreign directed fishing is taking place, some form of periodic surveillance patrols, such as aircraft patrols, would be necessary. These patrols would not have to be very frequent, however, for the chances of a foreign directed fishing operation coming in, setting gear and retrieving it without being spotted and reported by domestic vessels would be slim. Aircraft patrols, in fact, would seem to have the greater value as "presence" and assurance to the domestic fishermen, that the patrolman on the beat is doing his job.

Enforcement costs would continue to exist, as they do today, in the area of gear conflicts. As long as the foreign fishery operations for any species are conducted in the proximity of domestic sablefish fishing operations, there exists the potential for gear conflicts.

The enforcement of the incidental catch limits for sablefish by the foreign trawl vessels would require no additional costs. These vessels would be regularly and routinely located and boarded as a function of the enforcement of their directed fishing operations. These boardings

would be conducted to ensure compliance with applicable regulations for their fishery, including incidental catch restrictions. Additionally, some of these vessels may have U.S. observers on board to continually assure compliance with the law.

This alternative has the least administrative costs because of its simplicity. Few people and little hardware are required to monitor it.

Data collection costs, however, may be greater under this alternative than under other more restrictive alternatives. This alternative produces only a slight amount of data in itself because of the fact that there are no domestic regulations or geographic breakdowns of the fishery. Thus, if additional data is necessary, it must be collected by an additional, and thus more costly, means.

There are two primary advantages to this alternative. First, it is the least cost and least complicated alternative. Second, it is the least disruptive of present fishing operations, and thus, likely to be the most politically acceptable, because of its acceptance by the fishermen. It keeps the "foreigners" out and allows complete freedom to the U.S. fishermen.

There are several disadvantages to this alternative. First and foremost, it does not appear to be economically sound. From an economic perspective, it is unlikely that the open access domestic fishery would be operating at a level that is less than the desired optimal level unless

the total fishery is underutilized, which would mean that the total allowable catch is actually being understated. If this is the case, then the domestic fishery is not, in fact, harvesting up to the total allowable catch level, and therefore, under the provisions of the Act, the foreign fishing operations should be allowed in. On the other hand, if the open access domestic fishery is exceeding the optimal level, this alternative fails to optimally manage the resource. In which case, it is not meeting the requirements of the Act either.

Additionally, due to the generally localized nature of the domestic fishing operations, if the biological data indicates that severe local depletion is detrimental to the fishery as a whole, this alternative does not provide a means of discouraging severe overfishing and critical resource depletion in a local area. Likewise, it does not encourage new fishing in presently underutilized areas.

Finally, the lack of domestic regulation provides no check on the potential increase in fishery effort levels above the total allowable catch that would arise following a significant increase in market demand. Such an increase could be brought on by foreign entry, in large quantities, into the market.

This alternative would appear to be a fine interim alternative, quite satisfactory for the preliminary management plan. However, for the longer term, it does not appear to be sufficient to meet the requirements of the Act.

F. ALTERNATIVE 2

The second alternative is to regulate the domestic fishery through the imposition of a tax on the fish harvested. Such a tax would be collected at a rate applied per unit of fish landed. If determined necessary, it could be broken down and applied at different rates for different sizes or different geographic areas. A starting premise of this alternative also is that the foreign directed fishery operations would be excluded from the sablefish fishery because the domestic capability exceeds the optimal harvest level. Foreign trawl fishing operations directed at other species would have a maximum incidental limit set for sablefish.

The purpose of the tax would be to discourage the least efficient fishermen from remaining in the fishery, thus reducing the total effort level down to the desired level. The exact size of the tax would be calculated from projections of market demand and industry costs. The tax would be such that it could be completely passed through to the consumer, so that there would be no change in the average revenues received by the fishermen.

If the biological data suggested that the total fishery should be managed in smaller geographic units, the taxes could be set by these individual geographic areas. This would, of course, be more complicated and would drive up administrative and enforcement costs.

The revenues received through the tax collection could be used to offset management, administrative, research,

and enforcement costs as well as to assist, in some manner, the relocation and re-employment of the displaced fishermen.

Foreign enforcement would be the same as under alternative 1. Domestic enforcement would be in two primary areas. First, some enforcement effort must be applied at the various landing points to tally the catches as they are landed to ensure that the proper tax is assessed. This landing point enforcement would logically be conducted by the State Fish and Game agencies with National Marine Fisheries Service assistance. Second, some enforcement effort would have to be made to prevent a black market in untaxed sablefish being established. This effort could be much the same as other anti-smuggling efforts conducted by the Coast Guard and Customs.

The costs of this alternative would be higher than those of alternative 1. The primary cost increases would be in enforcement and in the data collection and analysis in order to determine the proper amount of tax to assess. However, some data collection costs could decrease slightly from alternative 1 levels, in that data can be collected in concert with the enforcement and management of the fishery.

Consumer costs could be expected to rise significantly as the tax is passed through to them. The new market prices, however, should be thought of as reflecting the true value of the sablefish to society.

The primary advantage of this alternative is that it should meet the criterion of the Act to optimally manage

the sablefish fishery. It does so without specifically limiting entry or exit from the fishery. It encourages the development of new and more efficient technology. Finally, taxation can be used to encourage the development of presently underutilized areas.

There are several disadvantages however. The first of which is that much resistance to taxation as a means of regulation, can be expected from the fishermen themselves. After all, this is a form of regulation on a heretofore unregulated fishery. Those with the loudest objections, of course, could be expected to be the least efficient fishermen, those who would be unable to cope with the tax and thus "forced" to leave the fishery. The most efficient, on the other hand, would be expected to complain little.

The consumer, too, would be expected to complain as the market price of sablefish jumps substantially.

Both of these groups, fishermen and consumers, could be expected to put considerable pressure on the Regional Council to not regulate the fishery at all. Due to their very regional makeup the Regional Council would be vulnerable to such localized political pressure. The large percentage of industry representation on the Council itself could be expected to put strong internal pressure to avoid such an alternative as taxation.

Another disadvantage is in the complexity of the tax determination process. It would be a complicated process, continually affected by changes in market demand and industry

costs. Consequently, the tax rates would have to be continually assessed and when necessary, changed. This would be even more complicated if taxes were determined on a geographic or size of fish basis.

Finally, and perhaps the greatest disadvantage of all is that, subject to interpretation of the Act itself, such a landing tax may not be authorized as a management tool. Depending on how the Act is interpreted, it neither provides for, nor specifically prohibits such a tax. A definitive ruling is needed on this matter.

G. ALTERNATIVE 3

The third alternative is to regulate the domestic fishery through a licensing program which in effect limits access to the fishery and prescribes a maximum amount of fish which can be harvested per license. Again, a starting premise of this alternative is that the foreign directed fishery operations would be excluded from the sablefish fishery because the domestic capability exceeds the optimal harvest level. Foreign trawl fishing operations, directed at other species, would have a maximum incidental catch limit set for sablefish.

These licenses would provide an allocation of the desired effort level for the fishery. They would provide, to the recipient, the right to harvest a certain amount of fish within a prescribed time period.

As in alternative 2, if the biological data suggested that the total fishery should be managed in smaller geographic units, the licenses could prescribe geographic areas as well. This, of course, would be more complicated and would drive up administrative and enforcement costs.

Foreign enforcement would be the same as under alternative 1. Domestic enforcement, as in alternative 2, would be in two primary areas. The first area of enforcement would be at the various landing points to tally the catches as they are landed, to ensure a proper license is held and to calculate the balance remaining to be caught under the terms of that license. Again, the landing point enforcement would logically be conducted by the State Fish and Game agencies with National Marine Fisheries Service assistance. Secondly, as in alternative 2, some enforcement would be necessary to prevent a black market in unlicensed sablefish. This effort would probably be less, at sea at least, than under alternative 2, because it would be easier to detect an unlicensed vessel fishing for sablefish. At sea, the Coast Guard would be the primary enforcement agency.

The costs of this alternative would be higher than under alternative 1, and depending on the method of distribution of licenses selected, probably less than alternative 2. Enforcement costs should be slightly less than alternative 2. Data collection and analysis costs should definitely be less than the taxation alternative. Not as much data would be required to make management decisions unless a

very complicated distributional scheme was designed. If the data indicated more fishing effort could safely be expended, new licenses could be granted, and if effort should be restricted further, old licenses need not be renewed.

Consumer costs could be expected to rise significantly as the supply of fish is reduced to that of the desired effort level. Again, the new market prices should be thought of as reflecting the true value of sablefish to society.

Under this alternative, the potential exists for the development of a futures market for sablefish. A fish broker could buy a fisherman's catch, which he had been authorized to harvest by the license, in advance of him actually harvesting the fish. Thus, the fisherman secures a fixed, predetermined amount of money in advance, and the broker guarantees himself a fixed amount of fish at some predetermined time in the future. Through the fisherman's and broker's election to participate in the futures market or not, they can assume the amount of risk, or gain the amount of security they desire. The futures market has the potential to improve market efficiency, and through that, benefit the consumer with lower costs.

This alternative, as does alternative 2 as well, because of the fisherman's freedom to harvest his quota at any time during the year, has the potential to provide fresh fish, on a regular basis, to the market place through the entire

year. This capability enhances the fresh fish market, through continuous availability to the consumer, and enables the processing industries to operate year round. These are significant advantages in an overall industry that is characterized by only seasonal availability of many species.

The primary advantage of this alternative is that it, like alternative 2, can meet the criterion of the Act to optimally manage the sablefish fishery. However, depending on the method of allocation, it does so at the expense of a restriction in free access and exit from the fishery. Depending on the license distribution method, it may or may not encourage the development of new and more efficient technology.

The primary problem with this alternative is the complexity and difficulty in selecting a just and equitable license distribution system. Some of the different methods of distribution are listed below with their pros and cons.

1. Lottery

A lottery could be conducted to distribute the licenses, in which applications are submitted and then drawn in a random manner. This would be a most equitable method, if equitable means every party has an equally likely chance of obtaining a license or not. The problems with this method are that, first, it does not require efficiency to be successful in obtaining a license. Because of this it does not encourage development of technological improvements

or a better understanding of sablefish life history and behavior. Unless the licenses are multi-year in length, fishermen would not be encouraged to make the capital investments necessary. A lottery provides no protection to those presently in the fishery who have already made the capital investments.

2. Grandfather System

In order to reduce the impact of imposing regulation on the existing fishery, a different method of distribution would be to grant licenses to all those presently in the system. A difficulty arises in reducing the number of outstanding licenses to the desired effort level. One method would be to restrict all others from entry and withdraw licenses from the system as present holders retire, until the desired level is achieved. This process could prove to be not very timely and therefore, ineffective.

A modification of this system would have the government buy back the number of outstanding licenses necessary to restrict the effort level to that desired. A fisherman would sell when the purchase price approximates the present value of his anticipated income stream from continued fishing. Holdouts would tend to benefit the most, as others left and the return per unit effort of the fishery increased as well as the value of the license increasing by the very nature of there being fewer outstanding.

A major objection of this buy back program would arise from the fact that money to buy back the outstanding

licenses would come from general funds. Thus it would be a form of subsidization of the fishery by the rest of the economy.

Another modification of this distribution method would have the licenses freely transferrable. This would enable freedom of entry and exit from the fishery. In order to enter, a prospective fisherman need only have the desire and adequate money to buy out an existing license holder. The government would continue to manage the total number of licenses outstanding by buying back or selling additional licenses as necessary.

3. Auction

Another method of distribution would be to offer the licenses for sale through an auction. The number of licenses offered up for sale could be either the number that would produce the desired effort level immediately or some number in excess of that with a buy back plan so that fluctuations in the desired effort level could be more easily accommodated. The competitive bidding would tend to encourage efficiency of operation in order for the bidder to maximize his return. This method would tend to protect the interests of the existing fishermen, especially the most efficient, since they would have already made the investments in capital equipment. This method would probably have better public support than some of the others in that the revenues collected in the bidding process would go into the general funds.

A major potential disadvantage of this proposal is that, depending on how the wording of the Act is interpreted, it too may not be authorized by the Act. The Act does not address specifically, competitive bidding as a means of limiting access to the fishery (Sec. 303,b.). However, it does address fees (Sec. 304,d.), and specifically prescribes that fees charged, pursuant to the issuing of permits, shall not exceed the administrative costs incurred in issuing those permits. If one elects to interpret the bids as fees for a permit, they would be unauthorized. However, if there is a minimum bid required, and it is established as a function of administrative costs, it would be in compliance with the Act, and bids in excess of the minimum could fall into a category other than fees for permits. A court clarification or a legislative change could clarify the issue.

In addition to these methods of distribution there are undoubtedly countless other methods as well. If the Regional Council were to select this licensing alternative they would have to weigh the various pros and cons of each distributional scheme in setting up the optimal management plan for the sablefish fishery.

Before the Council may select any alternative which proposes to limit access to the fishery they must take into account, as required by Sec. 303,6,6, the:

(A) present participation in the fishery,

(B) historical fishing practices in, and dependence on the fishery,

(C) the economics of the fishery,

(D) the capability of fishing vessels used in the fishery to engage in other fisheries,

(E) the cultural and social framework relevant to the fishery, and

(F) any other relevant considerations.

These factors, quite obviously, are subject to different interpretations as to meaning and requirements. The disadvantage then, is that these different interpretations become the arguments for, or the arguments against a proposal of regulation through limitation of access.

VI. CONCLUSIONS

A. COAST GUARD

Coast Guard planners, when attempting to determine the long range Coast Guard requirements for fisheries law enforcement, must consider the suggested alternative management plans which may be developed and eventually implemented by the Regional Councils. Coast Guard planning, programming, and budgeting (PPB) should reflect the significant range of Coast Guard requirements necessary to enforce the possible alternative management plans.

In order to insure that accurate enforcement costs are considered and applied in the development of viable management plans, the Coast Guard should become actively involved in the plan development process. Excessive enforcement costs should cause the Regional Councils to exclude from consideration any alternative.

The Coast Guard image, of the good guy in the white hat, will probably be affected by the enforcement of these new domestic regulations. To cope with this, the Coast Guard should play an active role in informing the industry and the public of the new Coast Guard requirements and of the plan objectives.

B. REGIONAL COUNCILS

The regional makeup of the Regional Council subjects them to strong local political and social pressures. Thus,

the importance of the regional fishing industry may loom larger than national interests. Management plans developed may well be oriented to improve the economic wealth of regional elements of the industry at the expense of the nation as a whole. Such a plan might be one in which large national inputs are made for research and administration while calling for no fees from the fishermen or placing little or no restrictions upon them, the beneficiaries of the plan.

On the other hand, the national objectives and standards sections of the Act, as well as the oversight role of the Secretary of Commerce, should act to restrain the Regional Councils from acting in a nationally nonbeneficial manner.

An additional concern is that these regionally oriented managers and industry representatives on the Council may act, as Crutchfield [1977] points out, as a minority veto power, capable of paralyzing effective action by the Council. He points out further, that the record of regional fishery commissions, such as the Pacific Marine Fishery Commission, is not encouraging with respect to the boldness of their actions in this kind of organization.

Thus, the Regional Councils require strong dynamic leadership, with active participation by economists to reflect social costs, enforcement agencies to reflect enforcement costs and feasibilities, consumer groups to represent consumer interests, and marketers to forecast domestic and foreign demand.

The Regional Councils should try to avoid the paralysis of perfection that commonly grips planning bodies. The threat is that for want of a little more data a "perfect plan" could be developed. A sufficient level of data should be determined, and when achieved, the plan should be developed from it. From the best data available, the plan should be developed, and it should be designed so the plan itself will generate information needed to more accurately and precisely manage the fishery. The plan should have the flexibility to change and accommodate new developments or revelations from generated information.

C. ALLOCATION OF ECONOMIC PROFIT

From an economic perspective, it matters little who collects the economic profit generated by optimal fishing effort levels, be it the fishermen or the government. Politically, however, it would appear to matter. If the government can directly collect these profits and then allocate them to the expenditures made for enforcement, research and development, and administration, it would appear superior to indirectly collecting them via the fishermen's expenditures into the economy as a whole. If the Office of Management and Budget, who is desperately looking for corners to cut to reduce federal spending, is faced with funding these costs without some form of offsetting revenues, they may feel compelled to severely limit the funds for fishery research, management, and enforcement, which could result

in suboptimal management of the fishery. To the taxpayer it would appear, that the Act intends, in the section stating only administrative costs can be recovered directly, that he, the general taxpayer, is to foot the bill for fishery research, management, and enforcement, without receiving any direct benefit.

D. RECREATIONAL FISHING

This thesis has primarily examined the fishery management problem from the perspective of managing the commercial industry and has completely ignored the recreational fishing aspects. This was warranted in the sablefish fishery because there appears to be only little recreational fishing pressure. However, in other fisheries, the recreational aspect is very significant. The integration and balancing of commercial interests with recreational interests considerably complicates the management problem. The fact that recreationalists are seeking pleasure and an experience, of which the capture and consumption of fish is only a segment, makes costing and yield determination more difficult. If "trophy" size fish are the recreational fisherman's objective rather than pounds of flesh which the commercial fishermen desire, then the optimal yield curves for the recreational fishery would be different than those for the commercial fishery. In general, there has been little economic analysis done of the recreational fishery.

The problem of evaluating all segments of the fishery, including recreational, and designing and implementing an optimal resource management plan remains with the Regional Councils.

E. ALTERNATIVE SELECTION

The management alternative selected by the Regional Council will depend on many things. A management plan such as alternative 1, which is essentially no domestic control, would only seem appropriate if the costs of research, management, and enforcement outweigh the benefits to be gained from the fishery. It would seem unlikely that this would be the case in the sablefish fishery.

If fishing efforts are to be regulated through taxation, then the problems of interpretation of the Act would have to be clarified or the Act modified such that taxation can be used effectively. Additionally, revenues collected should be earmarked to offset costs of research, management, and enforcement, such that the management plan can be more clearly defined, justified, and consequently, publically accepted.

If fishing efforts are to be regulated through a permit or licensing method, then the very politically sensitive problem of distribution will have to be addressed. If revenues are collected they should be applied to cover research, management, and enforcement costs, as well as to any buy back programs, if applicable. If insufficient revenues are

collected to offset these costs, then the benefits accrued by the fishermen, the portion of the economic profit they retain, will have to be determined in order to establish and maintain desired effort levels.

If some other alternative is selected, it should be such that it meets the justification of maximizing the social welfare from the fishery as well as meeting the requirements of the Act.

F. RECOMMENDATIONS FOR FURTHER STUDY

As a result of this thesis work the following areas would appear to merit further analysis.

1) What should be the composition and organization of the Regional Councils in order to be effective and efficient in developing and maintaining management plans for the maximum benefit of the nation?

2) How can the Coast Guard determine, on the long and short range horizons, the resources necessary to enforce the Council developed management plans?

3) Develop a workable economic model to maximize the social welfare gained from fishery resources, which could be used by the Regional Councils.

4) What is the potential impact of foreign entry in the domestic fish markets?

5) How does a prospective individual fisherman determine his capital requirements and potential returns?

APPENDIX A

CONTINENTAL SHELF FISHERY RESOURCES

The term "Continental Shelf Fishery Resources" means the following:

Colenterata

Bamboo Coral - Acanella spp.
Black Coral - Antipathes spp.
Gold Coral - Callogorgia spp.
Precious Red Coral - Corallium spp.
Bamboo Coral - Keratoisis spp.
Gold Coral - Parazoanthus spp.

Crustacea

Tanner Crab - Chionoecetes tanneri
Tanner Crab - Chionoecetes opilio
Tanner Crab - Chionoecetes angulatus
Tanner Crab - Chionoecetes bairdi
King Crab - Paralithodes camtschatica
King Crab - Paralithodes platypus
King Crab - Paralithodes brevipes
Lobster - Homarus americanus
Dungeness Crab - Cancer magister
California King Crab - Paralithodes californiensis
California King Crab - Paralithodes rathbuni
Golden King Crab - Lithodes aequispinus
Northern Stone Crab - Lithodes maja
Stone Crab - Menippe mercenaria
Deep-sea Red Crab - Geryon quinquedens

Mollusks

Red Abolone - Haliotis rufescens
Pink Abolone - Haliotis corrugata
Japanese Abolone - Haliotis kamtschatkana
Queen Conch - Strombus gigas
Surf Clam - Spisula solidissima
Ocean Quahog - Artica islandica

Sponges

Glove Sponge - Hippiospongia canaliculata
Sheepswool Sponge - Hippiospongia lachne
Grass Sponge - Spongia graminea
Yellow Sponge - Spongia barbera

LIST OF REFERENCES

1. Anderson, Lee G., The Economics of Fisheries Management, The John Hopkins University Press, 1977.

2. Bell, F. H., and J. T. Gharrett, "The Pacific coast blackcod, Anoplopoma fimbria," Copeia, 1945(2), 1945.

3. Christy, Francis T., Jr. "Limited Access Systems under the Fishery Conservation and Management Act of 1976." Economic Impacts of Extended Fisheries Jurisdiction, ed. Lee G. Anderson, pp. 141-56, Ann Arbor Science Publishers, 1977.

4. Clark, Colin W., Mathematical Bioeconomics: The Optimal Control of Renewable Resources, John Wiley & Sons, 1976.

5. Crutchfield, James A., "Evaluation of the Conference by an Economist," Economic Impacts of Extended Fisheries Jurisdiction, ed Lee G. Anderson, pp. 381-6, Ann Arbor Science Publishers, 1977.

6. Crutchfield, James A., and A. Zellner, "Economic Aspects of the Pacific Halibut Fishery," U.S. Fish Wild. Ser., Fish. Ind. Res. 1(1), 1962.

7. DiDonato, G., Special Report on The Status of the Washington Sablefish Fisheries. Int. Trawl Fish. Committee, Eleventh Annu. Meet., San Francisco Calif. July 22-24, 1970, 11p., 3 fig. (Processed.) 1970.

8. Edson, Q.A., "Preliminary Report on the Alaska Sablefish Fishery," Pac. Mar. Fish. Comm., Bull. 3: pp. 73-85, 1954.

9. Frey, H. W., ed. California's Living Marine Resources and Their Utilization, Calif. Dept. Fish and Game, 1971.

10. Gordon, H. S., "Economic theory of a common-property resource: the fishery," Journal of Political Economy, v. 75, pp. 124-42, 1954.

11. Huppert, Daniel D., "Constraints to Welfare Gains under Extended Jurisdiction Fisheries Management," American Journal of Agricultural Economics, v. 59(5), pp. 877-82, 1977.

12. Hyman, David N., The Economics of Governmental Activity, Holt, Reinhart and Winston, Inc., 1973.

13. Kodolov, L. S., "Reproduction of the sablefish (Anoplopoma fimbria (Pall.)), Vop. Ikhtiol. 8(4): pp. 662-8, In Russian. (Transl. in Probl. Ichtyol. 8(4): pp. 531-5.), 1968.

14. Low, L. L., "Status of sablefish in the Bering Sea and Northeastern Pacific Ocean through 1974," Natl. Mar. Fish. Serv., NOAA, Northwest Fish. Center, Seattle, Wash. Unpubl. manuscr, 1976.

15. Low, Loh Lee, George K. Tanonaka, and Herbert H. Shippen, "Sablefish of the northeastern Pacific Ocean and Bering Sea," Natl. Mar. Fish. Serv., NOAA, Northwest Fish. Center, Seattle, Wash. Unpubl. manuscr, 1976.

16. Philips, J. B., "The sablefish fishery of California," I. History and Research. Pac. Mar. Fish. Comm., Bull. 3, pp. 5-22, 1954.

17. Pruter, Alonzo T., "Age and growth of the Oregon sablefish, Anoplopoma fimbria", Pac. Mar. Fish. Comm., Bull. 3, pp. 121-8, 1954.

18. Sasaki, Takashi, Loh Lee Low, and Kenneth N. Thorsen, "Sablefish (Anoplopoma fimbria) resources of the Bering Sea and northeastern Pacific Ocean," Natl. Mar. Fish. Serv., NOAA, Northwest Fish. Center, Seattle, Wash. Unpubl. manuscr. (Submitted to Int. N. Pac. Fish. Comm. by the Japanese and U.S. Natl. Sections.) 1975.

19. Schaefer, M. B., "Some considerations of population dynamics and economics in relation to the management of marine fisheries," Journal of the Fisheries Research Board of Canada, v. 14 pp. 669-81, 1957.

20. Thompson, W. F., "A note on the spawning of the blackcod (Anoplopoma fimbria)," Copeia, 1941(4), p. 270, 1941.

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