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NATIONAL MARINE FISHERIES SERVICE SOUTHWEST FISHERIES CENTER TIBURON LABORATORY 3150 PARADISE DRIVE TIBURON, CALIFORNIA 94920

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REPORT OF A WORKSHOP ON SABLEFISH RESEARCH NEEDS

By

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Report of a Workshop on Sablefish Research Needs

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Summary

Fifteen researchers and managers from United States and Canadian fishery agencies attended a workshop at Tiburon, California in July 1983. The objective of the meeting was to delineate future research needed for the management of sablefish stocks and fisheries.

After a consideration of past and present research and of sablefish management problems, the workshop produced recommendations which encompassed the following research and management areas.

1. Immediate Management Strategy Investigations
2. Monitoring and Sampling
3. Age Validation and Production Aging
4. Relative Biomass Production
5. Stock Identification and Movement

The specific recommendations will be useful to agencies charged with the responsibility of sablefish management. Follow-up meetings will be needed to coordinate and track the implementation of these recommendations.

Introduction

Sablefish, Anoplopoma fimbria, has recently become the object of special interest by Pacific Coast fishery research and management agencies. This has resulted from greater management responsibilities in the United States and from an increasing market demand.

In March 1983 the University of Alaska Sea Grant Program coordinated the International Sablefish Symposium, held at Anchorage, Alaska. At that meeting scientists from several North Pacific nations presented reports on past and current sablefish research activities. As a sequel to the Symposium, a workshop with the objective of defining specific research needs for sablefish management was held at the Tiburon Laboratory, Southwest Fisheries Center, in July 1983 under the sponsorship of the National Marine Fisheries Service, NOAA. This workshop was attended by fishery workers from most agencies along the Pacific Coast (Table 1); unfortunately, scientists from Alaska were unable to participate. Workshop results should be useful to regional fishery management councils, National Marine Fisheries Service units, state fishery agencies, Canada, and the Canada-U.S. Groundfish Committee.

Table 1.--Participants in Sablefish Workshop

Mr. Norman J. Abramson National Marine Fisheries Service Southwest Fisheries Center Tiburon, CA 94920	Mr. Tom Jow California Dept. of Fish and Game Menlo Park, CA 94025
Dr. Richard J. Beamish Dept. of Fisheries and Oceans Pacific Biological Station Nanaimo, B. C. Canada V9R 5K6	Dr. William H. Lenarz National Marine Fisheries Service Southwest Fisheries Center Tiburon, CA 94920
Mr. Tom Dark National Marine Fisheries Service Northwest and Alaska Fisheries Center Seattle, WA 98112	Mr. Gordon MacFarlane Dept. of Fisheries and Oceans Pacific Biological Station Nanaimo, B. C. Canada V9R 5K6
Mr. Maxwell Eldridge National Marine Fisheries Service Southwest Fisheries Center Tiburon, CA 94920	Mr. Allan Millikan Washington Dept. of Fisheries Seattle, WA 98105
Mr. Svein Fougner National Marine Fisheries Service Southwest Region Terminal Island, CA 90731	Dr. Gary Stauffer National Marine Fisheries Service Northwest and Alaska Fisheries Center Seattle, WA 98112
Mr. Jim Hardwick California Dept. of Fish and Game Monterey, CA 93940	Mr. Edward Ueber National Marine Fisheries Service Southwest Fisheries Center Tiburon, CA 94920
Mr. Larry Hreha Oregon Dept. of Fish and Wildlife Astoria, OR 97103	Dr. Jeannette Whipple National Marine Fisheries Service Southwest Fisheries Center Tiburon, CA 94920
Dr. John Hunter National Marine Fisheries Service Southwest Fisheries Center La Jolla, CA 92038	

The first portion of the workshop consisted of reports by participants on past and present research results, interests, and issues. The contents of these presentations as well as written reports given at the workshop are attached. Also attached is a letter from Dr. A. J. Gharrett, University of Alaska, describing some recent work on sablefish genetics and posing questions for further consideration; the letter was not received in time to be considered at the workshop.

Major Topics of Discussion

The presentations stimulated free-flowing discussions which pointed out the presence or lack of data on certain subjects, highlighted areas of agreement or disagreement, and generally provided a background for developing a list of research needs. Major topics of discussion were the following:

1. The distribution of stocks is incompletely known and the extent of relationship between resources in different areas has not been studied sufficiently. The southern end of the range of the stock(s) appears to be off Baja California, Mexico where it has been reported that 2,000 mt were taken in 1978. This seems like a large harvest, however, for the fringe of a stock. On the other hand, there is very little evidence to judge whether there are different stocks along the Pacific coast.

2. The distribution and movement of sablefish at early life stages are not well established. While there appears to be pronounced seasonality of spawning, there is little survey information to indicate increased numbers of eggs and larvae after this seasonal peak. Although small sablefish larvae appear to be neustonic, there has been insufficient survey work to demonstrate larval transport patterns and mechanisms.

Juvenile sablefish appear to move inshore and northward.

3. There is a long time series of commercial landings data in agency files, but landings data alone are insufficient for stock assessments. First, landings are not equal to total catch since discards are made at sea. Second, the landings typically are recorded in large, medium, and small fish categories; but sizes within categories change due to market conditions so that landings receipts may not record accurately the real changes in length composition of the landings. Third, discards vary depending on economic and regulatory conditions. Fourth, there has been insufficient at-sea and shoreside sampling to collect detailed catch, effort, landings, and biological data. Such sampling as has occurred has been neither systematic nor coordinated.

4. The degree to which trawl fishermen can avoid or minimize incidental catches of sablefish is unknown. Some fishermen and biologists claim that significant reductions in by-catches can be made when fishing for flatfish; others claim by-catches could be reduced only slightly.

5. There appear to be many sets of data which have not been systematically compiled, organized, and reviewed--for example, results of tagging and tag recovery programs. Also, additional comparison and analysis of different organizations' research is needed. For example, aging by Canadian biologists indicates that sablefish may grow to be much older

than the results of aging by U. S. biologists would indicate. Further, it is unknown if the level of test fishing at abundance index sites has been sufficiently high to be statistically reliable, or whether different test fishing gear (pots or longlines) would be more or less successful.

6. There is unknown merit to the claim that there are "silver bellied" sablefish. Some fishermen believe that these fish, caught in trawls and fixed gear, migrate more than others, suggesting there are two or more distinct types of sablefish. Many sablefish stomach samples have been found to contain myctophids and sauries, indicating pelagic feeding. This apparent phenomenon needs investigation.

7. It appears that occasional year classes are strong enough to support the fishery for several years. The 1977 year class is one which seems to fit this hypothesis. However, this has not been confirmed for the Washington-Oregon-California (WOC) area. If true, it would suggest a potential for a sharp decrease in harvests in the WOC area because 1981 and 1982 catches were quite high relative to sustainable yield estimates.

8. The usefulness of minimum size limits to protect the stock(s) is unknown. One problem with minimum size limit management is that it could lead to increased discards and an unknown amount of mortality from this source. It may be possible to offset this problem through trawl mesh restrictions,

or pot and trap mesh size, or escape port measures to allow small fish to escape. Unfortunately, few gear tests have been conducted. Canadian tests, however, showed 60% of all fish less than 55 cm escaped from 3¼-inch mesh traps; and all fish less than 55 cm and many 56-59 cm fish escaped from 3½-inch mesh traps. At the same time, it may make sense to set a maximum size limit, recognizing that larger fish are more fecund. Again, no tests have been conducted. Meanwhile, it may be that market forces will promote fishing for larger fish. The Japanese market apparently is moving toward a 60-cm size fish as the preferred product.

9. There may be significant potential for sablefish aquaculture. It has been shown that sablefish can be captured, transported, and grown in captivity. Growth is twice as rapid as in the wild.

Determination of Research Needs

There was a great deal of discussion concerning research needs, and the following general "problem" areas were identified.

1. Determine biomass, by area (Baja California, Washington-Oregon-California, British Columbia, Alaska)
2. Establish optimum removal rates
3. Determine total catch (landings plus discards, by gear and area)
4. Collect for length, weight, age and other biological information
5. Define management units (stock units)
6. Establish recruitment processes
7. Determine distribution and movement of juveniles
8. Define migration patterns
9. Determine importance of longevity to management strategies
10. Collect economic data

It was noted that some of these items were objectives requiring data collection and analysis tasks, while other items were activities in themselves. It also was noted some items were long-term research, some were continuing activities, and others were (or could imply) short-term, specific research. A number of sugges-

tions were made to establish a framework within which to recommend priorities among activities or programs. It was agreed to designate five working groups to develop recommended priorities in each major category as follows.

Fishery Monitoring and Sampling

Age Validation and Production Readings

Relative Biomass Estimation

Stock Identification and Movement

Management Procedures for Immediate Use

Recommendations

The workshop participants considered the reports by the working groups and endorsed the following recommendations. Except for the first category, which was considered the most important, these are not listed in order of priority.

1. Immediate Management Strategy Investigations

(a) The effort initiated by Gary Stauffer to compile and prepare a synopsis of available information on sablefish fisheries from California to the Bering Sea should be supported and completed. This effort should include an assessment of the potentially broader applicability of Terry and Balsiger's bioeconomic simulation model of sablefish in the Gulf of Alaska, and completion by Fujioka of his project to assemble and establish a computer file of tagging and tag recapture data.

(b) The implications of extrapolating the results of analysis of Alaska fishery data to the WOC area should be thoroughly explored. It may be possible to infer from this analysis the impacts that different harvest strategies in the WOC area would have on sablefish resources.

(c) While it may not be possible to develop a reliable, comprehensive bioeconomic model of the WOC sablefish fishery in the immediate future, analyses can and should be conducted of management of the fishery by size limit, by season, and by

some combination of size limit and season.

(d) A thorough study of the economics of the sablefish fishery in the WOC area should be undertaken, including consideration of Alaska and Canada fisheries and international markets. This will take a concerted effort. As a starting point, a focus on the harvest level would be useful, especially with respect to landings and value by gear type and fish size categories.

Rationale: There are several actions that can be taken to provide a basis for management decisions which must be made in the absence of improved stock assessments and bioeconomic models. A considerable amount of information has been collected which could be helpful if it were compiled and analyzed appropriately. The above recommendations involve activities which could be or have been initiated with previously collected information or data. It is essential that there be full cooperation of all agencies in making data available, including landings and value data, sampling data, and logbook data.

2. Monitoring and Sampling

A coastwide, statistically-sound sampling plan should be designed, tested, and implemented to obtain catch, effort, and biological and economic data on the fishery. The sampling program should cover the major gear types (trawl, longline, pot/trap, gill net) and all principal port areas,

including Canada and Alaska. There should be at-sea and shoreside sampling. The former could be used to collect total catch, catch characteristics, effort, operating cost data, and aging structures. Shore sampling could collect landings, characteristics of landings, landings values, effort, aging structures, and market data, and could obtain additonal biological data if needed. An outline of the sampling program is attached. Sampling could be supplemented by observer and logbook programs.

Rationale: A time series of accurate and reliable catch, effort, and biological and economic data is needed for several purposes, including stock assessments, definition of stock structure, determination of the costs of fishing operations, and estimation of the impacts of alternative management strategies. Comparable coverage is needed for all areas in which the fishery operates. The sampling program in Canada should be thoroughly reviewed for initial planning of the coastwide program.

Outline of Sablefish Sampling Program

1. Gear Categories - trawl, longline, pot/trap, gill net
2. Areas of Coverage
   (a) California-Oregon-Washington (including west coast of Mexico)
   (b) Canada
   (c) Alaska
3. Types of Data
   (a) At-sea:
      Aging structures
      Length
      Weight (if possible)
      Discards (number, length, and age)
      Hours worked
      Number of crew members
   (b) On-shore:
      Aging structures
      Length
      Weight
      Sex
      Maturity
      Crew size
      Landing value
      Weigh-backs (number and length)
      Length frequency by market groups

3. Age Validation and Production Aging

a) Age validation work now in progress in Canada should be continued and new work should be initiated in regions where Canadian results may not apply.

(b) The June 1983 recommendations of the Technical Subcommittee (TSC) of the Canada-U. S. Groundfish Committee should be supported. The TSC has recommended that a second workshop be held by the Committee of Age Reading Experts (note: This workshop was scheduled for early August 1983 in Seattle) to accomplish several tasks, including working toward a goal of standardizing methods for aging sablefish. The TSC recognized that the otolith thickness ("break-and-burn") method is preferred for determining ages of sablefish and therefore workshop participants should focus their efforts on that method.

(c) After the second workshop, standardized procedures should be adopted and reading of otolith collections now on hand should be initiated. The results of validation work to date provide sufficient justification to initiate production readings, although additional information from continuing and new studies may result in modification of age determination procedures. The concept of single entities or organizations being responsible for sablefish aging in the U.S. and in Canada is supported.

(d) An exchange of otoliths between the Nanaimo Laboratory (Canada) and the U. S. organization(s) should be a regular part of production aging. Precision could be evaluated by the index of average percent error technique developed in Canada, and efforts should be maintained to eliminate significant differences between laboratories.

Rationale: Age structure information for the stock and catch is essential to understand population dynamics and the effects of fishing. This information is incomplete for some portions of the species' range and unavailable for others. Given the distribution of the species across international boundaries and the variation in age estimation by different organizations, it is important that there be consultation and agreement on aging techniques.

4. Relative Biomass Estimation

(a) Existing trawl and fixed gear logbook data should be analyzed to estimate relative changes in sablefish biomass in recent years, and the coastwide fixed gear logbook program should be implemented to improve the data base in the future.

(b) The feasibility of deriving relative biomass estimates from current or redesigned pot surveys should be evaluated.

(c) U. S. scientists should encourage the Fishery Agency of Japan to continue conducting the annual longline survey in Alaska.

(d) Biomass estimation should be incorporated as an objective in the design of comprehensive tagging and tag recovery programs.

Rationale: Interim measurements of changes in relative abundance have to be considered and used for management prior to the development of comprehensive biomass estimates. Relative biomass estimates based on existing data (e.g., logbook and tagging data) and abundance indexing surveys can provide guidance for current management decisions.

5. Stock Identification and Movement

(a) Existing data from tagging and tag recapture programs, ichthyoplankton surveys, and biochemical investigations, and data on the size composition of catches in the northeast Pacific should be reviewed and synthesized.

(b) Stock identification and movement should be determined. Research needs should be identified, research priorities should be set, and specific programs should be recommended to fill those needs. This assessment should include identification of the requirements of a quantitative sampling program for early life stages of sablefish.

(c) Juvenile tagging and tag recovery programs should be designed and implemented to serve several purposes. Possible purposes are determination of sablefish movements, recruitment processes, stock identification, and age validation.

Rationale: The stock structure of sablefish in the northeast Pacific has not been established. Also, the extent of movement by sablefish and interactions among sablefish in different areas have not been determined. Given the international aspects of sablefish fisheries and recent changes in the WOC fishery (e.g., increase in total landings, shift from fixed gear to trawl as gear component making majority of landings, shift to smaller fish), it is important that stock structure and movements be investigated for future management decisions.

The workshop felt that additional meetings will be required to coordinate and trace the implementation of specific recommendations. Such follow-up meetings should be held in conjunction with other groundfish meetings to minimize travel costs and enable maximum participation.

Summary of Oral Presentations

Following are the oral reports given by participants at the beginning of the workshop. These served the function of acquainting the group with the extent to which various members had been involved with sablefish research.

John Hunter, Southwest Fisheries Center, said the La Jolla Laboratory had not conducted any systematic research on sablefish, but has interest in sablefish. The limited work done included survey work off Pt. Conception, off the Coronados Islands, and down to Cedros Island.

Tom Jow, California Department of Fish and Game, reported that his involvement in sablefish research has been limited. He has access to data by fishery (trawl, longline, pot) and has worked on some cooperative tagging with NMFS. He has performed sablefish analyses for the Pacific Fishery Management Council Groundfish Plan.

Jim Hardwick, California Department of Fish and Game, summarized sablefish research and data collection efforts dating back to 1950, indicating that in some instances, data were collected but had not been processed, or analytical results had not been published. It was noted that some data sources are of unknown reliability. For example, logs have not been evenly collected, and length frequency data

collected in shoreside sampling may not be usable because there is no way to account for discards at sea after sorting for size.

Maxwell Eldridge, Tiburon Laboratory, indicated he has not worked on sablefish research tasks in the past.

Richard J. Beamish and Sandy MacFarlane, Pacific Biological Station, Department of Fisheries and Oceans, British Columbia, reported on a number of studies conducted off the west coast of Canada from 1977 to the present. Among the principal items studied have been age structure (mainly by otolith readings with some oxytetracycline bone marking for validation), growth rates (including differentials between males and females), spawning patterns and fecundity, and tagging and movement studies. The latter show most adults remain in the area of release, and juveniles tend to move into and remain in inside waters until just before maturity (age 4+). Also studied were the apparent ability of strong year classes (e.g., 1977) to support the fishery for several years and the potential for culturing sablefish (growth in captivity may be twice as rapid as in the wild).

Jeannette Whipple, Tiburon Laboratory, indicated her interest in determining the potential of applying some striped bass research techniques to sablefish research problems. Her past work includes research into epidemiological processes and pollutant uptake in striped bass.

Ed Ueber, Tiburon Laboratory, expressed his interest in economic studies for management decisions. He has worked on a market study to determine product movements in the WOC area, a study of recovery rates after processing to determine yields by gear type and fish length, and a study of how fishermen in Monterey respond to economic, stock, and regulatory changes. He also has tried to follow fishery conditions in Mexico and market conditions in Japan. He indicated he is also interested in mesh selectivity studies and gear tests to determine if net or fixed gear mesh size restrictions can be effective management tools.

Svein Fougner, Southwest Region, indicated that the Region and others are interested in improving the information base for managing sablefish fisheries under the Pacific Council's Groundfish Management Plan. Conditions in the fishery have changed considerably since preparation of the plan, including a large increase in total catch, development of a market for small fish, and a shift to trawl as the gear type making the majority of landings in 1982. The Council needs to know more about yield potentials, relationships between stocks in different areas, gear selectivity, and incidental catch rates and discards at sea.

Larry Hreha, Oregon Department of Fish and Wildlife (ODFW), indicated his agency has landings by gear/port/weight

category/year and has conducted some at-sea sampling to check on discards. They also have fish receipt data, some dressed vs round weight conversions, and some logbook data, although the latter have not been analyzed. However, there has not been a systematic sampling program. The ODFW conducted trawl surveys 1971-76 from Cape Blanco to Cape Flattery, but the results were incomplete since much of the known bathymetric range of sablefish was not included because these surveys were designed primarily for flatfish abundance estimation. Washington Department of Fisheries (WDF) participated in the surveys off the Washington coast during 1975-76.

Tom Dark and Gary Stauffer, Northwest and Alaska Fisheries Center, reported that their Center has been involved in studies of sablefish biology, behavior, and stock dynamics since 1971. The projects and programs include an international tagging program from California to Kodiak; supplementary tagging at abundance index sites where traps or pots have been fished in a standard manner since 1978; a systematic longline survey with the Japanese Far Seas Research Laboratory; ichthyoplankton sampling for early life history characteristics; annual status reports on Eastern Bering Sea and Gulf of Alaska sablefish resources; and simulation modeling of Gulf of Alaska stocks to evaluate impacts of alternative management strategies on the domestic longline fishery and stocks. This summer, Stauffer will

start to prepare an updated, comprehensive synopsis of sablefish over its range from California to the Bering Sea, to provide a basis of comparison for assessing the status of sablefish in different regions. Jeff Fujioka, (Auke Bay Laboratory, NWAFC) is preparing a computer data file of all tag recovery data and a summary document accessible to all agencies.

Al Millikan, Washington Department of Fisheries (WDF), indicated that, aside from the time series of landings and value data, the WDF has not conducted research on sablefish since the 1950's. Trawl logbook data could be helpful, but data on discards are not available. Two individual pot fishermen are keeping detailed logs and are making data available to the NWAFC, but these data are confidential.

Written Contributions

The following are written contributions made available or presented at the workshop and the aforementioned communication from Dr. Gharrett dealing with sablefish genetics.

SABLEFISH RESEARCH AT THE PACIFIC BIOLOGICAL STATION

Beamish, R. J., and D. E. Chilton. 1982. Preliminary evaluation of a method to determine the age of sablefish (Anoploma fimbria). Can. J. Fish. Aquat. Sci. 39:277-287.

Beamish, R. J., and G. A. McFarlane. 1983. Summary of results of the Canadian sablefish tagging program. Presented at the Second Lowell Wakefield International Sablefish Symposium, March 30, 1983, Anchorage, Alaska, USA. 37 p.

Beamish, R. J., C. Wood, and C. Houle. 1978. A summary of sablefish tagging studies conducted during 1977. Fish. Mar. Serv. Data Rep. 77. 103 p.

Beamish, R. J., C. Houle, and R. Scarsbrook. 1980. A summary of tagging and biological studies conducted during 1979 by the Pacific Biological Station. Can. MS Rep. Fish. Aquat. Sci. 1588. 194 p.

Beamish, R. J., G. A. McFarlane, and D. E. Chilton. 1983. Use of oxytetracycline and other methods to validate a method of age determination for sablefish. Presented at the Second Lowell Wakefield International Sablefish Symposium, March 29, 1983, Anchorage, Alaska, USA. 22 p.

Beamish, R. J., C. Houle, C. Wood, and R. Scarsbrook. 1979. A summary of sablefish tagging and exploratory trapping studies conducted during 1978 by the Pacific Biological Station. Can. Data Rep. Fish. Aquatic. Sci. 162. 113 p.

Kennedy, W. A. 1972. Preliminary study of sablefish culture, a potential new industry. J. Fish. Res. Board Can. 29:207-210.

Kennedy, W. A. 1974. Sablefish culture--final report. Fish. Res. Board Can. Tech. Rep. 452. 15 p.

McFarlane, G. A., and R. J. Beamish. 1983. Biology of adult sablefish (Anoplopoma fimbria) in waters off western Canada. Presented at the Second Lowell Wakefield International Sablefish Symposium, March 29, 1983, Anchorage, Alaska, USA. 22 p.

McFarlane, G. A., and R. J. Beamish. 1983. Overview of the fishery and management strategy for sablefish (Anoplopoma fimbria) off the west coast of Canada. Presented at the Second Lowell Wakefield International Sablefish Symposium, March 29, 1983, Anchorage, Alaska, USA. 23 p.

McFarlane, G. A., and R. J. Beamish. 1983. Preliminary observations on the juvenile biology of sablefish (Anoplopoma fimbria) in waters off the west coast of Canada. Presented at the Second Lowell Wakefield International Sablefish Symposium, March 29, 1983, Anchorage, Alaska, USA. 17 p.

Mason, J. C., R. J. Beamish, and G. A. McFarlane. 1983. Sexual maturity, fecundity, spawning and early life history of sablefish (Anoplopoma fimbria) off the Pacific coast of Canada. Submitted for publication May 1983.

From 1968 to 1971 there was a sablefish culture project. Biological and stock assessment studies commenced in 1977 and are still being conducted. The following is a brief listing and summary of projects.

1. Sablefish culture demonstrated that juvenile sablefish could be captured, transported and reared in captivity. Growth in captivity was about double the rate of wild growth.

2. Age determination studies showed that the otolith was the most suitable structure for age estimation. Annuli could only be determined accurately by examining a broken cross-section of the otolith. Validation studies using tagged fish, some of which are injected with a bone marker (oxytetracycline) are confirming the accuracy of the age estimates. Ages in the fishery average 4 to 35 years and maximum age to date is 68 years.

3. Growth studies have indicated that females grow larger than males and that this growth difference occurs before maturity. Relatively few males exceed 70 cm, while up to 50% of females in the commercial fishery may exceed 70 cm. Growth and maximum sizes of both sexes are quite variable and it is common to have relatively small fish that are very old. In general, growth in length is rapid in juveniles and decreases with age 10 to 15, after which growth is greatly reduced.

4. Sex ratio for juveniles is 1:1 and for adults in the commercial fishery is 1 male to 1.5 females.

5. Spawning occurs almost simultaneously about mid-February, along the entire west coast of Canada, west of Vancouver Island, Queen Charlotte Sound, and Queen Charlotte Island. Spawning occurs at depths greater than 300 m and eggs are bathypelagic. The fecundity equation is

$$F = 1.11987FL^{2.8244}$$

6. Strong year classes are key features in the stock structure. Strong year classes occurred in 1977, late 1960's, late 1950's and early 1960's, and early 1950's.

7. Tagging studies have shown that most adults tend to remain in the area of release. There has been more movement of adults released off the Queen Charlotte Islands than of those released off Vancouver Island. Of all recoveries, approximately 9% (corrected for 70% non-reporting in the U. S. zone) have been recovered in the U. S. zone. American studies suggest there is net movement of adult fish into the Canadian zone in the vicinity of the Dixon Entrance boundary.

8. Juveniles tend to move into inside waters and remain until just prior to maturity (age 4+). The majority of juveniles in the Hecate Strait, Queen Charlotte Sound area show a movement into the Gulf of Alaska.

9. Sablefish feed on a wide variety of organisms depending on the season and location and availability of prey. Fish species were dominant in adult sablefish, particularly rockfish and herring. Fish species were the dominant prey for juveniles and euphausiids were the important invertebrate prey.

10. Preliminary biomass estimate for adult sablefish using tag-recapture data was approximately 37,000 t. The biomass of the strong 1977 year class may be as large as the total adult biomass in the Canadian zone.

11. Sablefish have been exploited in the Canadian zone since the late nineteenth century. However, heavy exploitation did not start until 1968 when large foreign fleets targeted on sablefish off Canada. The domestic fishery, almost exclusively trap boats, expanded rapidly after the establishment of the extended jurisdiction zone. Since 1980, no foreign fishing has taken place and the total quota has been landed by domestic vessels.

12. Initially, a 5,000 t quota was established in 1977. This was reduced to 3,500 t in 1978, based upon analysis of Japanese longline catch and effort data from 1968-1978. However, new age information indicates that the time series of data is not sufficient to allow the use of general production modelling. Biological characteristics such as longevity, strong year classes, and stock boundaries have been identified and must be considered when evaluating management strategies.

Past and Current Sablefish Research
NWAFC, Seattle and Auke Bay

Tom Dark and Gary Stauffer
Sablefish Research Planning Workshop
SWFC Tiburon CA July 7-8, 1983

Since 1971 the Northwest and Alaska Fisheries Center (NWAFC) has been engaged in a number of studies of sablefish biology, behavior, and stock dynamics. A review of these studies is provided below.

INTERNATIONAL SABLEFISH TAGGING PROGRAM

The first major study of sablefish by the NWAFC began in 1971 during a period when foreign exploitation was causing concern about local depletions in some areas and the implications to the stock in general. A cooperative international tagging program was initiated to determine the extent of sablefish migrations and the relationship of different stocks within the species range. The work began in 1971 and included the NWAFC, California Department of Fish and Game, The Oregon Department of Fish and Wildlife, Pacific Research Institute of Fisheries and Oceanography (TINRO) of the Soviet Union and the Fisheries Research and Development Agency of the Republic of Korea. In recent years the Far Seas Fisheries Research Laboratory of Japan has become involved in this cooperative research. Tagging continued through 1977 and was conducted from California to Kodiak Island. About 35,000 tagged sablefish were released, 1,002 tagged fish were returned and the results were reported by Wespestad, Thorson, and Mizroch (1978). Wespestad et.al. (1983) updated that work through 1980.

Presently, Fujioka at the Auke Bay Lab, NWAFC is compiling a comprehensive tag recovery data base that will include NMFS, Alaska Department of Fish and Game, Japanese and hopefully Canadian sablefish tag releases. His intention is to create an accurate computer data file of all tag recovery data along with a summary document accessible to all agencies. The file will not contain tag release information on non-recovered fish or fishing effort data.

NWAFC SABLEFISH TAGGING

As an extension of the international tagging program, the NWAFC has tagged sablefish at abundance index sites since 1978. Over 20,000 tagged fish were released from Southern California to Southeastern Alaska and more than 600 have been returned. Results were used to examine movement, direction, distance, and propensity to migrate by area and size group. Results and conclusions are presented by Dark (in press).

HISTORIC OVERVIEW AND POPULATION DYNAMICS

Intensive foreign and domestic exploitation of the sablefish resource in the Bering Sea and Northeast Pacific Ocean in the 1960's and early 1970's increased the need for management action and promoted a study by Low, Tanonaka, and Shippen (1976). Their study was a comprehensive review of the species biology and life history, the fishery, management, and status of stocks. The latter was primarily based on foreign reported catch and effort data. A simulation model of the Gulf of Alaska stocks was developed by Balsiger and Terry (ms) to evaluate alternative management strategies on the domestic longline fishery there. The strategies were defined in terms of alternative fishing mortalities and minimum size restrictions for the simulation period of 1981 through 1985. The model was found to be relatively sensitive to several parameters for which the actual values are not known with certainty. ADFG is continuing with this modelling study. The NWAFC prepares annual reports on the status of the Gulf of Alaska and Eastern Bering Sea sablefish resources. These reports, originally based on the 1976 Low et al report, are updated annually using NMFS trawl and pot index survey data, length frequency data, foreign fishery statistics, and the Japanese longline survey. Beginning this summer Stauffer (NWAFC) will start to prepare an updated comprehensive synopsis of sablefish over its range from California to the Bering Sea. The primary objective of this synopsis is to provide a basis of comparison for assessing the status of sablefish in a region relative to other areas.

ABUNDANCE INDEXING

The reduction and exclusion of foreign sablefish fisheries through bilateral agreement and the MFCMA resulted in interruption of the catch and effort data base used to monitor stock condition. In 1978, the NWAFC undertook a program to supplement the loss of the commercial data by using string of traps or pots fished in a standard fashion at selected sites. Four sites were occupied first off Southeastern Alaska during 1978-1983, four sites were fished off Washington and Oregon during 1979-1981, and two sites were fished off California during 1980-1982. Some sablefish taken at abundance indexing sites were tagged and released; biological data were collected from others.

Catch per unit of effort statistics were compiled as an indicator of major changes in population abundance and size composition at the index areas. Results of the study have been reported by Zenger (in press) and Parks ad Shaw (in press).

Monitoring continues at sites off Alaska by the Auke Bay Lab. Work off the West Coast was interrupted in 1982 and 1983 pending an evaluation of the precision of past results through an analysis of the magnitude and sources of variation.

Since 1978 the NWAFC has cooperated with the Japanese Far Seas Fisheries Research Lab in conducting an annual systematic longline survey. The primary abjective is to determine relative abundance, distribution, biological characteristics and migration of sablefish and Pacific cod in the eastern Bering Sea, Aleutian Islands, and Gulf of Alaska. The survey is conducted by a Japanese commercial longline vessel on charter to the Far Seas Lab. In recent years approximately 100 stations have been occupied. The fishing gear is a longline made up of 160 hachi set perpendicular to the isobath from a depth of 101 to 1000 m. One station is occupied each day. Station soaking time averages 5 to 6 hours. Each hachi (skate) is a 100 m ground line with 45 hooks attached to 1.2 m gangion. The bait is ring cut squid. In addition to biological samples, sablefish are tagged. Annual reports are presented at meetings of INPFC and US-Japan bilaterals.

AGEING

Currently the NWAFC does not do any routine or production ageing of sablefish. The Center is supporting one graduate student. He is comparing various ageing techniques and structures including otoliths (surface and break-and-burn), scales, dorsal spines, and pectoral fin rays for sablefish and three other species. In his sablefish samples the trend in age readings increases from scales, surface otoliths, break-and-burn otoliths, to dorsal spines. All methods give similar results for the first 5 or 6 years. Readable sections from pectoral rays are not easy to prepare because of the oily nature of the structure From his Gulf of Alaska collections he finds about 5-10% of the animals greater than 10 years of age with a maximum of about 15 years of age using break-and-burn techniques. This relative young age composition compared to the Canadian results could result from either differing criteria for annuli identification, location or depth of sample collection, or geographic differences in stock structure.

EARLY LIFE HISTORY

The ichthyoplankton group at the NWAFC lead by Art Kendall routinely sample fish and larvae off the US west coast and Gulf of Alaska. Sablefish larvae are frequently sampled by surface

neuston nets. Reports are being prepared for sablefish larvae distribution off the US west coast from the series of cooperative US-USSR spring surveys. A pilot study along the eastern Coast of the Gulf of Alaska was conducted in 1983. Future plans for surveys targetting on sablefish have not been made. In cooperation with Oregon State University and Bori Olla at NMFS Newport Lab, Kendall is supporting research on larval growth rates using daily growth rings and laboratory rearing of captured larvae fed ad libitum rations. Early results suggest that laboratory reared larvae are capable of phenomenal growth rates of 7 to 10% per day in body length.

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SABLEFISH RESEARCH & MONITORING BY CALIFORNIA FISH & GAME, 1950 TO *

Julius B. Phillips and Seigi Imamura studied catch rates, the length-weight relationships, spawning season, size at maturity, the relationship between size of fish and depth of capture, and length frequencies of Eureka trawl landings and sablefish caught by longliners operating out of Eureka, Ft. Bragg, and Monterey in the early 1950's. They reported on this work in PMFC Bulletin 3. Richard H. Parrish brought Phillips and Imamura's analysis of sablefish landing records up to date through 1969 with a 1973 paper in California Fish and Game.

Parrish conducted 17 longline cruises between July 1969 and May 1972 to determine species associations, distribution, and abundance of bottom fishes in relation to depth and substrate. A total of 330 sets were made at a variety of locations from the Eel River Canyon near Eureka to Cortes Bank in Southern California. Depths fished ranged from 4 to 600 fms. Each set consisted of a single basket containing a 100 fm ground line with 220 hooks on 18 inch gangens. Fish not tagged were weighed, measured, and sexed. This data has not been published.

Logs submitted by trap fishermen operating from Monterey area ports from 1974 through 1978 have been analyzed and a report written, however, this report is yet to be published. Trap logs from other areas and other years have been collected but have not been processed. Trawl logs are processed as they are received but little information obtained from them has been published.

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* Presented by James E. Hardwick at a Sablefish Workshop on Research Needs held at the NMFS Southwest Fisheries Center Tiburon Laboratory 7-8 July 1983.

California has no sablefish sampling plan but various interested parties have frequently sampled the landed catch for lengths. Discarding and sorting by size at sea make it difficult to use these lengths. A report on the number and size of sablefish discarded by trawlers operating out of Monterey Bay ports is being prepared.

THE
UNIVERSITY
OF ALASKA,
JUNEAU

12 July 1983

Norman Abramson
Director, Tiburon Laboratory
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NOAA
Southwest Fisheries Center
Tiburon Laboratory
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Tiburon, CA 94920

Dear Dr. Abramson;

I hope you receive this in time for it to be of use.

Before writing this letter, I have reexamined much of the genetic data taken for sablefish by Lisa Wishard and myself. Answers to the following questions would be of interest in further understanding the biology of sablefish. You can decide for yourself which impact short term or long term management.
Working from south to north (see figure attached)

1) It appears sablefish occurring along central and southern California are genetically similar, but as one moves further north to Oregon and Washington, there appears to be geographically discrete groups. Two of the groups from Oregon and Washington were pooled from subsamples taken in the same general area. There was no heterogeneity within smaller areas. Questions: Do these distinct groups remain stable (genetically) from year to year, how large is or what determines a distinct group, how many of them are there, and is the reevidence for different grouping for immature and mature fish?

2) A single southern southeastern Alaskan sample is also different from adjacent collections. No data has been collected for British Columbian stocks. Dr. Beamish proposes the existance of two or more disticnt stocks in Canadian waters. Questions: Do distinct stocks exist off Canada, are they discernable from U.S. stocks, is there genetic evidence for movements of immatures either north or south, and if so to what extent do they migrate?

3) Northern southeastern Alaskan samples taken at various locations both inside and offshore and taken in different years include samples of many age classes, including juveniles (approximately 30 cm. more or less). These samples are relatively homogeneous. Samples taken from Kodiak Island west and along the Aleutian Chain are also relatively homogeneous and are not substantially differnt from the northern southeastern Alaskan samples. Those taken from the northern gulf of Alaska are distinct from both groups. Questions: How large is this distinct area in the Nothern Gulf and what determines it?

4) Most of these data were taken between 1977 and 1981. Questions: Do the genetic compositions remain relatively stable?

The loci that reflect the most genetic divergence are often the ones that possess numerous alleles and are, therefore, difficult to interpret. While data, taken for fish from the same general geographical area (1° lat - 1° Long) by different labs, reflect the homogeneity of fish from a given area, it would still be satisfying to reexamine some locales to confirm these interpretations.

For any tissue sampling done on sablefish in the future for genetic analysis, it is essential to include lengths and sex with the tissues. For the samples be relatively large - 1 cubic inch or large, - and that the samples be frozen quickly - flash frozen or frozen laid out in a single layer on something like a large baking sheet until froze. A sample size of approximately 80-100 fish per collection site is recommended for this kind of study.

The genetic analysis of sablefish is not straight forward. There is a large oil content that mechanically interfers with the process and the large number of alleles found at some loci make interpretation difficult; in fact, many samples must be assayed two to four times to assure proper interpretation. The result is that these samples are more expensive to analyze than most other species. Analysis of the 18+ loci we have done previously costs approximately $20 per fish when the total number of fish exceeds 500.

If you have any questions about my suggestions or the kinds of questions that remain, please contact me.

Sincerely,

A.J. Gharrett by DH

A.J. Gharrett
Associate Professor
School of Fisheries and Science

Attachment