The Northwest Fisheries Science Center
1999 Report
to the Technical Subcommittee of the
Canada-US Groundfish Committee

May 4-6, 1999

Northwest Fisheries Science Center of the
National Marine Fisheries Service

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Research, Assessments, and Management

A. Agency Overview

The Northwest Fisheries Science Center (NWFSC) provides scientific and technical support to the National Marine Fisheries Service (NMFS) for management and conservation of the Northwest region's marine and anadromous resources. The Center conducts research in cooperation with other federal and state agencies and academic institutions. It has positioned itself to provide the best possible science, anticipate solutions to emerging fishery resource challenges, and develop strong constituent relationships. Five divisions—Conservation Biology, Environmental Conservation, Fish Ecology, Resource Enhancement and Utilization Technologies, and Fishery Resource Analysis and Monitoring—conduct applied research to resolve problems that threaten marine resources or that deter their use. Center's main facility and laboratories are located in Seattle. Other Center research facilities are located in Pasco, Big Beef Creek, Mukilteo, Manchester, Washington; Newport, Hammond, and Clatskanie, Oregon; and Kodiak, Alaska.

The Fishery Resource Analysis and Monitoring Division (FRAMD) is the focus for most of the research reported by the NWFSC to the Technical Subcommittee of the Canada-US Groundfish Committee. The FRAMD works in partnership with state and federal resource agencies, universities, and the groundfish industry to achieve a coordinated groundfish program for the West Coast.

The Division develops and provides scientific information necessary for managing West Coast marine fisheries, striving to provide useful, accurate, and reliable stock assessment data with which fishery managers can set ecologically safe and economically valuable harvest levels. It develops models for managing multispecies fisheries and designs programs to provide information on the extent and characteristics of bycatch in commercial fisheries as it looks at methods to reduce fisheries bycatch. Research facilities in Newport on the Oregon coast are particularly important for groundfish research. The Newport location provides opportunities for the FRAMD staff to work with and share information and ideas with researchers from Oregon State University, the Oregon Department of Fish and Wildlife, Alaska Fisheries Science Center, U.S. Environmental Protection Agency, and the fishing industry.

The Conservation Biology Division is responsible for characterizing the major components of biodiversity in living marine resources, using the latest genetic and quantitative methods. It also has responsibility for identifying factors that pose risks to these components and the mechanisms that limit natural productivity. The Division's multidisciplinary approach draws on expertise in the fields of population genetics,population dynamics, and ecology.

The Environmental Conservation Division (ECD) conducts nationwide research on the effects of chemical pollution and harmful algal blooms on habitat quality and fisheries resources. ECD is also a leader in NMFS' National Marine Mammal Health and Stranding Response Program's biomonitoring and quality assurances projects.

The Fish Ecology Division's role is understanding the complex ecological linkages among important marine and anadromous fishery resources in the Pacific Northwest and their habitats. The Division particularly places emphasis on investigating the myriad biotic and abiotic factors that control growth, distribution, and survival of important species and on the processes driving population fluctuations.

The Resource Enhancement and Utilization Technologies Division draws together multidisciplinary groups to address existing and developing challenges of captive rearing of salmon and other marine fish, improved hatchery practices, smolt quality, disease control, and developing technologies for full utilization of bycatch and fish processing waste.

For more information on Northwest Fisheries Science Center programs, contact Center Director Dr. Usha Varanasi at (206) 860-3200, usha.varanasi@noaa.gov.

B.Multispecies Studies

1. Research

a. Fishermen fishing strategies

Work progressed on defining fishing strategy and catch assemblages in the commercial groundfish trawl fishery. The strategies and assemblages were defined using data collected by observers in 1985-1987. The strategies were based on selection of gear and depth of fishing. Logbook data collected in 1987 and 1996 were separated into groups based on those defined strategies. The logbook targets and catches in tows grouped by the defined strategies indicated some changes in the assemblages/strategies between 1987 and 1996. Redefinition based on those changes made the strategy and assemblage definitions more applicable to the recent fishery.

For more information please contact Dr. Jean Rogers at or at (541) 867-0153

b. Juvenile groundfish

Further work was conducted on relating juvenile groundfish catch assemblages to environmental variables. In cooperation with the NMFS Tiburon Laboratory,

assemblages of juvenile groundfish fish were defined using data collected by that laboratory off the coast of central California. Those assemblages were related to environmental variables in an attempt to understand differences in abundance over time. The environmental variables examined included invertebrate abundance; water temperature, salinity, and density; upwelling, wind turbulence, moonlight, and cloud cover.

For more information please contact Dr. Jean Rogers at or at (541) 867-0153.

C. By species, by agency

1. Shelf Rockfish

Stock Assessment

An assessment of the canary rockfish (*Sebastes pinniger*) population within the U.S. Vancouver through Columbia International North Pacific Fisheries Commission areas was completed in 1999. The age-based version of the Stock Synthesis model utilized to model the population. Fishery data included catches and length and age frequency distributions from the Oregon and Washington trawl fisheries. Fishery independent data included a biomass index and length and age frequency compositions from the NMFS triennial shelf survey.

The absence of older females (> 20 years of age) in all the age distributions were modeled based on two alternate hypotheses: 1) females die at an earlier age than males or 2) females are less 'vulnerable' to the fishing and sampling gears. The first hypothesis led to a model in which males had a natural mortality of 0.06, and females had natural mortality of 0.06 for ages 1-10 and mortality steadily increasing after age 10 to reach 0.20 for fish greater than age 25. Selectivity in the fishery and survey was assumed to be time invariant and asymptotic for both sexes. The second hypothesis was expressed in a model in which natural mortality was a constant 0.06 for both sexes, selectivity in the fishery changed yearly after 1980, and selectivity in both the fishery and survey was dome-shaped for females and asymptotic for males. Both models results indicated that the 1999 spawning biomass was less than 30% of the spawning biomass at its unfished level.

Uncertainty in recent (1996-1998) recruitments also led to two alternate hypotheses. High recruitment was based on actual estimates of recruitment from the two models reflecting different assumptions regarding the absence of large females. Alternately, low recruitment was based on those estimates reduced by one-half. The two sets of recruitments were used in forecasting the allowable biological catches for 1999-2001. Those forecasts indicated that the catch needed to be reduced substantially, about 70% over those three years.

For more information please contact Dr. Jean Rogers at or at (541) 867-0153.

6. Sablefish

Research

1. Survival of discarded sablefish

In 1995, a collaborative study with the University of Washington was undertaken to evaluate the actual survivorship of discarded sablefish from trawling operations. This research was expected to provide results that could be used to critically investigate assumptions made in stock assessments and to identify what variables associated with fishing practices are most likely to influence the survival of trawl-caught sablefish. A field study on board a trawl vessel during the summer of 1998 represented the third of three field seasons (see Erickson et al. 1997a, 1997b, and 1997c). A pilot study during 1996 was designed to test a sea-bed caging method developed by Pikitch et al. (1996) for estimating short-term survival of discarded animals. A second, larger scale trial was conducted during 1997 to estimate survival of discarded sablefish over a wide range of fishing conditions (Erickson et al. 1997c). Nearly all discarded sablefish died during the 1997 field season, the low survival being attributed to high surface water temperatures (> 20o C). The third and final study was conducted because of the anomalous water temperatures observed during 1997. Water temperatures were cooler during 1998 than observed during 1997, and survival was substantially higher. Survival of trawl caught and discarded sablefish was similar between this field season and the 1996 pilot study when tows were short and deck exposure was less than 20 minutes (see Erickson et al., 1997a and b). Temperature-depth profiles also were similar between 1998 and 1996 trials. These results support the hypothesis that nearly all trawl-caught and discarded sablefish die when surface water temperatures reach 20 oC.

2. Biology of West Coast Sablefish

A pilot project was undertaken to develop a recruitment index for sablefish from a survey of pelagic juveniles. In the past year, a draft manuscript was prepared summarizing the results of the study on bathymetric variation in sablefish reproduction and fecundity. Sablefish living in shallow water (< 400 fm) are significantly younger but larger and more fecund (124 eggs/g vs 93 eggs/g) than deep living sablefish. Ovaries of adult sablefish collected during the previous two winters (prior to spawning) were analyzed. Contrary to the researchers hypothesis, the data generally suggest that spawning in sablefish does not proceed sequentially by age-class. However, the researchers do not believe that the question has been definitively answered because of inadequate temporal coverage of samples and possible confusion due to pooling of samples from a variety of depths. Otoliths of pelagic juveniles collected in 1998 are

being prepared for birthdate analysis. The pelagic juvenile survey was begun in April, 1999. Five sampling trips were completed along transect lines off northern California (400 50' N), Oregon (440 50' N), and Washington (470 00' N). Seven more trips are scheduled through early June. Pelagic juveniles are being collected by simultaneously towing a 1 m manta net and a 3.7 m neuston trawl net at night at stations spaced 2.5 mn apart beginning in 60 fin. Juvenile sablefish were found as far offshore as they were sampled (- 55 nin; > 1,000 fin).

For further information, contact Dr. Richard Methot at (206) 860-3365; Steve Berkeley at (541) 867-0135; or Dan Erickson at (541) 747-9266.

D . Other related studies

1. Age readers

Age composition data are critical for studies of fish growth, recruitment patterns, bathymetric dispersion rates, and application of age-structured assessment methods. The group of three age readers that forms part of the cooperative ageing project contributed to many projects. In 1997 readers produced ages for otoliths taken from dover sole, sablefish, and darkblotched rockfish. In 1998 the group produced ages for dover sole and sablefish. During the first half of 1999, the age readers produced ages for petrale sole and canary rockfish; the group is planning to begin work to validate the ages being determined on some of these species.

2. Rockfish food habits and feeding ecology

The long-term goal of this research is to further our understanding of the food habits, feeding ecology, and degree of niche overlap of the commercially important rockfish species that occur off northern California, Oregon, and Washington. Under a grant to Oregon State University from the Northwest Fisheries Science Center Mr Yong Woo Lee has been riding aboard commercial trawlers and collecting stomachs from rockfish. To date Mr Lee has obtained rockfish stomach samples from five commercial fishing trips operating out of Newport, Oregon. He also obtained samples of rockfish stomachs while participating in one leg of the 1998 NMFS trawl survey of the US continental shelf. The analyses of the stomach contents data will focus on quantifying dietary overlap among rockfish species and contrasting the food habits observed under ocean conditions that were influenced by a strong El Nino event with the food habits observed in samples of rockfish stomachs collected during the summer of 1980, when ocean conditions were not influenced by an El Nino event.

For further information, contact Dr. Richard Methot at (206) 860-3365; David B. Sampson, Associate Professor of Fisheries, Coastal Oregon Marine Experiment Station Oregon State University; (541) 867-0204.

3. West Coast slope survey

Scientists from NMFS' Northwest Fisheries Science Center (NWFSC) carried out a coastwide bottom trawl survey of the slope zone (100-700 fm) aboard four chartered commercial trawlers during August, September, and October 1998. The survey area extended from Cape Flattery, Washington, to Point Conception, California, and targeted the deepwater species complex of Dover sole, longspine and shortspine thornyhead, and sablefish (DTS species complex). The survey provided information about the distribution and biological status of these resources which will be useful for stock assessments, and it validated methods for conducting such work aboard vessels from this fleet, thus supporting NMFS's hopes to conduct similar efforts in the future.
Goals of the survey included: 1) to develop and test a survey design suitable for multiple-vessel surveys; 2) to develop biological and catch-sampling methods and technology appropriate for use on coastal trawlers; 3) to obtain data on distribution, relative abundance, and biological status of DTS stocks in the slope zone; and, 4) to assess the feasibility of this approach for developing abundance indices.

Survey sampling stations were randomly located along 80 East-West transects, with 10 minutes of latitude between adjacent transects. Each of the four vessels occupied its own subset of 20 transects separated by 40 minutes of latitude such that by the end of the survey all 80 transects had been occupied. Under the direction of a NMFS-designated chief scientist a 15-minute bottom trawl haul was made at each station location, conditions permitting. With the assistance of the crew, the scientific parties examined each catch and recorded various biological data (species, size, and age composition) and catch per unit of effort (CPUE) data. Those portions of the catch not required for biological samples or specimens, and that had commercial value, were retained and sold by the vessel to help defray charter costs. New technology including electronic scales and measuring boards was employed to improve the productivity of the small field parties that could be accommodated by these vessels.

Roughly 85% of the 400 assigned stations were successfully occupied. Inclement weather, extremely rough or steep bottom topography, or inability to complete the day's last tow during daylight hours accounted for most of the stations not occupied.

We are still in the process of analyzing the data. Length and age data will be available relatively soon and will be incorporated into stock assessment models. CPUE data on relative abundance will take longer to evaluate, then incorporate into stock assessment procedures. The challenge is to determine the extent and impact of vessel-to-vessel variations in catching efficiency within and between years, but as approaches are developed and a time series evolves it will have

increasing influence on stock assessments, offering an independent indication of trends in population abundance and structure.

4. Spot prawns

a. Bycatch reduction in the Spot prawn trawl fishery

Bycatch of finfish in the West Coast fisheries for spot prawns (Pandalus platyceros) causes wastage of fish which cannot be landed and utilized and causes conflicts when the species of bycatch are desired by other fishery segments. Reduction of bycatch is especially critical for several species of rockfish (Sebastes spp.) whose stocks are in poor condition or where rebuilding efforts are underway. Even where there is no substantial impact on commercially valuable species, fish bycatch imposes a burden on shrimp trawlers, increasing the need for sorting and reducing the quality and value of the catch.

Current efforts and innovations have shown some promise, but use of bycatch reduction devices is patchy. Acceptance has not been wide, due to reports of high shrimp loss and the lack of adaptation of the devices to local conditions. The project tested three types of bycatch excluders on a commercial spot prawn trawler operating off the West Coast. Direct video observations and catch comparisons were used to assess the performance of each device.

Difficulties were experienced with the use of a mesh separator panel due to difficulties in getting it to take up an appropriate shape during trawling, and with blocking of the panel due to organic debris. Similar blocking was seen with a plastic angled grid, similar to a nordmore grid. Moderate success was achieved with a pair of fish eye excluders mounted in the top panel of the cod-end. This seems to be the most appropriate device for use in this fishery.

b. Investigation of the status of the spot prawn stock off Washington.

An offshore fishery targeting spot prawns off Washington began in the early 1990's. Development of the fishery has been relatively rapid, with approximately 20 trawl and trap vessels fishing in 1998. This development has prompted the Washington Department of fish and wildlife to limit the number of licensed entrants to the fishery in 1998 to 6 trawlers and 9 pot vessels. This legislation is in terms of an experimental fisheries classification, and will expire in 5 years. It is therefore important that within this period some guidelines about how the fishery should be managed in the future are developed.

The data available on this fishery is mainly in the form of fishermen's logbooks. Although this data may be incomplete, it contains information about the position at which each catch was taken and information on the effort applied

(number of pots * soak time, towing time). Information on life history of this specific stock is limited, but some data is available from Canada and from California, so it can be assumed that the Washington stock of prawns will fit somewhere in between these in terms of growth rates and other life history parameters.

The combination of all the available data may be sufficient to develop a model to assess the spot prawn stock in this area. If it is not, this work will at least provide a good indication of where data collection efforts should be concentrated.

5. New Logbook projects

The Northwest Fisheries Science Center (NWFSC) of the NMFS is developing a prototype Electronic Fish Catch Logbook (EFCL) with funding by the Innovation Fund Committee of the National Performance Review. In the fall of 1997, the Center began development by conducting surveys of users of fisheries dependent data, including fishers, fisheries managers, fisher organizations, processors, marketers, port biologists and state and federal scientists who use or analyze the data. Systems currently in use for collecting fishery dependent data were also reviewed, as were potentially applicable technologies. A report was then distributed as a discussion draft for additional input. The project then requested proposals from private sector developers of software. Scientific Fisheries, Inc. of Anchorage was selected. Testing on the full system, including an on-board application, a web interface and a backend database, begins this week with shore-based tests.

The project in part is an effort to be responsive to the Washington, Oregon and California trawl fleet, which, during a constituent meeting in 1996, requested the NWFSC develop a system to collect and analyze fish catch and logbook data. The industry was looking for opportunities to improve reliance on logbook data for fishery management because fishery managers appeared reluctant to use logbook data. Because the grant called for nationwide application, the system had to be developed based on needs for information in fisheries outside the west coast. Nonetheless, the project developers will prototype the system specifically for the WOC trawl fishery.

Many concerns, primarily about data verification, have limited the use of logbook data in fishery management. Essentially, real time or near real time reporting using an electronic logbook, like the one being developed here, has a significant potential to improve data verification, quantity, and timeliness. At present, primary verification of logbook data occurs by comparing it to landing data recorded by processors, a time consuming and nonstandard process. Optimal information collection would capture electronic data streams from fishers and from processors, and relate this data to spatio-temporal data collected on the vessel. An additional EFCL goal is to develop technology to use fishing vessels

for collecting environmental data in relation to catch effort (for example: conductivity, temperature, and depth), and in relation to scientific data collection needs.

The on-board EFCL prototype, an application on a PC, will sample location data from a GPS. Fish catch data will be key entered into a custom application that will allow integration with commercial charting packages. Bundled data will be transmitted to shore database/s via modem/cellular-phone or satellite device to a web accessed database. A research interface will allow access to central data and GIS analysis tools. Recording of CTD data from autonomous net mounted sensors during fishing events is also planned. Reconciliation and integration with fish ticket data will be a part of the system.

The design is modular, to allow for example, different gear types to be used, and to exploit emerging technology within an overall coherent design while allowing high levels of data security.

During the last year we completed the system design in two states.. In July, 1998, a Draft System Design was prepared and distributed /presented to many data and system users. In October an opportunity was offered for partners to join the NWFSC in a Cooperative Research and Development Agreement (CRADA). Negotiations with potential partners have almost been completed. In February 1999 supplemental funding was made available to the project to add an observer module to the system.

In late April, following review of dozens of data collection systems and comments, the System Design was finalized. The next stage of the project is development. We hope to launch the prototype in late summer and fall of 1999.

For more information please contact Stewart Toshach at 860-3200 or by e-mail at stoshach@noaa.gov.

6. Environmental Stress

Studies at the NWFSC are being conducted to assess the impacts of anthropogenic stressors on groundfish assemblages in nearshore marine and estuarine habitats. These investigations have examined the effects of chemical contaminants on a wide range of physiological processes in marine groundfish. Areas studied include toxicopathic disease, especially neoplasia, reproductive function, growth, and immune function. Ecotoxicological modeling studies have also been conducted to link adverse health effects of contaminants on individual fish to potential population level impacts. The primary species studied has been English sole in Puget Sound, though data have also been collected and

published on rock sole, starry flounder, flathead sole, and yellowfin sole. As well as detecting toxicant effects of groundfish health, these studies have provided background data on normal growth, reproductive development, and other aspects. An important function of the NWFSC research staff is to conduct assessments of fish injury at sites which are targets for resource damage assessment and restoration actions, in cooperation with NOAA's Damage Assessment and Restoration Center. The NWFSC is also an active participant in cooperative research projects with the Washington Department of Fish and Wildlife to monitor health and habitat quality for groundfish species in Puget Sound, such as the Puget Sound Ambient Monitoring Program. This research is being broadened in conjunction with new capabilities and staff at the NWFSC and in collaboration with state agencies and the BC/WA Transboundary Task Force, to address cumulative effects of multiple stressors on groundfish in the waters of the Pacific Northwest and Canada.

For further information, contact Lyndal L. Johnson @noaa.gov or at (206) 860-3345

7. Lingcod Enhancement

Recent advances and successes in stock enhancement of marine fish species suggest that fishery enhancement of lingcod may be possible. Marine fish such as rockfish, white seabass, sea bream, red drum, striped bass, sturgeon and mullet have been successfully used to enhance commercial and/or sport fisheries. Where data are available, return rates to the fishery range from 2% to more than 33% of stocked fish, depending on, species, release strategy and numbers released. Working cooperatively with the Washington Department of Fish and Wildlife, and the University Washington, we intend to test this approach with lingcod in southern Puget Sound.

Current research activities are intended to improve and scale-up laboratory culture techniques for lingcod and begin test releases of juveniles in southern Puget Sound. A variety of specific experiments will improve techniques for mass culture, acclimation of juveniles to receiving habitats, and make pilot releases of marked juveniles into selected areas. It is envisioned that the general sequence of events will include the following elements: 1) Conduct research on captively spawned fish to improve spawning, egg incubation, larval rearing and marking techniques. 2) Survey areas to be stocked for nesting adults. 3) Collect a small portion of eggs from about 10-15 nests located in the survey. 4) Mass rear collected eggs to a size suitable for stocking. 5) Develop in situ methods to acclimate juveniles prior to release. 6) Evaluate contribution to fisheries of released juveniles through mark and recapture studies. 7) Determine habitat requirements for wild early life stages. 8) Evaluate ecological and genetic impacts of released juveniles on their wild cohorts and other species. 9) Transfer technology to the private aquaculture sector or public agencies to provide a

future source of juveniles ready for stocking.]

In 1998 we successfully spawned and reared the offspring of lingcod to a size suitable for stocking. We intend to build and improve on this success in the winter 1999 and produce enough juveniles to test the feasibility of stocking lingcod into selected areas of Puget Sound. The pilot releases will be carefully monitored to determine impacts on the stock and recreational fishery in the release area. Procedures and protocols will follow the guidelines developed by Blankenship and Leber (1995) and recommended by the American Fisheries Society. Adequate progress has been made on items 1 and 7 to conduct specific experiments which will address all the other items listed above over the next 5 years.

For further information contact Michael Rust at mike.rust@noaa.gov or 206-860-3382.

APPENDIX 1

Recent Publications and Reports Pertaining to Groundfish and Marine Habitatsby Authors at the Northwest Fisheries Science Center

Arkoosh, M. R., E. Casillas, P. Huffman, E. Clemons, J. Evered, J. E. Stein, and U. Varanasi. Increased susceptibility of juvenile chinook salmon (*Oncorhynchus tshawytsch*) from a contaminated estuary to the pathogen *Vibrio anguillarum.* Transactions of the American Fisheries Society. (In press)

Arkoosh, M. R., E. Clemons, A. N. Kagley, R. Olson, P. Reno, E. Casillas, andd J. E. Stein. Effect of pollution on fish diseases: Potential impacts on salmonid populations. Journal of Aquatic Animal Health. (In press).

Casillas,E., B. B. McCain, M. Arkoosh, J. Stein and U. Varanasi. 1997. Estuarine pollution and juvenile salmon health: Potential impact on survival. In Emmett, R. L. And M. H. Schiewe (eds). Estuarine and ocean survival of Northeastern Pacific salmon: Proceedings of the workshop. U. S. Dept. Comm., NOAAQTech. NMFS-NWFSC-29, 313 p.

Clemons, E., M. R. Arkoosh, and E. Casillas. Enhanced Superoxide anion pro-duction in activated peritoneal macrophages from English sole (*Pleuronectes vetulus*) exposed to polycyclic aromatic compounds. Marine Environmental Research. (In press)

Collier, T. K., L. L. Johnson, M. S. Myers, C. M. Stehr, M. M. Krahn, and J. E. Stein. 1997. Fish injury in the Hylebos Waterway of Commencement Bay, Washington. Interpretive Report prepared for NOAA Damage Assessment Center. Released to the public 3/27/97.

Collier, T. K., L. L. Johnson, C. M. Stehr, M. S. Myers, and J. E. Stein. 1998. A comprehensive assessment of the impacts of contaminants on fish from an urban waterway. Mar. Environ. Res. (In press)

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Crone, P. R., and D. B. Sampson. Evaluation of assumed error structure in stock assessment models that use sample estimates of age composition. Proceedings of the International Symposium on Fishery Stock Assessment Models for the 21st century: combining multiple information sources, Anchorage, Alaska. (In press)

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Johnson, L. L., B. Norberg, M. L. Willis, H. Zebrowski, and P. Swanson. 1997. Isolation, characterization, and measurement of plasma levels of

somato lactin in Atlantic halibut *(Hippoglossus hippoglossus)*. Gen. Comp. Endocrinol. 105:194-209.

Johnson, L. L., S.-Y. Sol, D. P. Lomax, G. Nelson, and E. Casillas. 1997. Fecundity and egg weight in English sole (*Pleuronectes vetulus*) from Puget Sound, WA: Influence of nutritional status and chemical contaminants. Fish. Bull. 92:232-250.

Johnson, L. L., D. Misitano, S. Sol, G. Nelson, B. French, G. Ylitalo, T. Hom. 1998. Contaminant effects on ovarian development and spawning success in rock-sole (*Lepidopsetta bilineata*) from Puget Sound, WA. Trans. Am. Fish. Soc. (In press).

Johnson, L. L., D. Misitano, S. Sol, G. Nelson, B. French, G. Ylitalo, T. Hom. 1997. Contaminant effects on ovarian development and spawning suc cess in rock sole *(Lepidopsetta bilineata)* from Puget Sound, WA. Trans. Am. Fish. Soc. (In press).

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Landahl, J. T., L. L. Johnson, T. K. Collier, J. E. Stein, and U. Varanasi 1997. Marine pollution and fish population parameters: English sole *(Pleuronectes vetulus)* in Puget Sound, WA. Trans. Am. Fish. Soc. 126:519-535.

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Methot, R. D. 1998. Application of Stock Synthesis to NRC test data sets. In V. Restrepo (ed). Analysis of simulated data sets in support of the NRC study on stock assessment methods. NOAA Tech. Memo. NMFS-F/SPO. (In press) Myers, M. S. L. L. Johnson, T. Hom, T. K. Collier, J. Stein, And U.

Varanasi. 1998. Toxicopathic hepatic lesions in subadult English sole (*Pleuronectes vetulus*) from Puget Sound, Washington, U.S.A.: relation ships with other biomarkers of contaminant exposure. Mar. Environ. Res. 45(1):47-67.

Rogers, J. B, M. Wilkins, D. Kamikawa, F. Wallace, T. Builder, M. Zimmerman, M. Kander, and B. Culver. 1996. Status of the remaining rockfish in the Sebastes complex in 1996 and recommendations for management in 1997.

Appendix E in Appendix volume II to the status of the Pacific coast ground fish through 1996 and recommended acceptable biological catches for1997. 59 pp.

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