The Rockfish Working Group An Overview

Management of rockfish (*Sebastes* spp.) stocks in waters off Alaska is hampered by limited information and considerable uncertainty as to current stock abundance and long-term productivity. With the exception of Pacific ocean perch (*S. alutus*), relatively little is known about the biology, distribution, and population dynamics of many of the commercially important rockfish species. This lack of information, combined with an uncertainty in biomass estimates for the deeper-water and more commercially valuable species such as shortraker (*S. borealis*) and rougheye (*S. aleutianus*) rockfish, prompted the Alaska Fisheries Science Center's (AFSC) Rockfish Working Group (RWG) to develop a comprehensive working plan to improve rockfish stock assessments and management recommendations.

Composed of fishery scientists from the AFSC's Resource Ecology and Fisheries Management (REFM) Division, Resource Assessment and Conservation Engineering (RACE) Division, Auke Bay Laboratory (ABL), and the University of Washington (UW), the RWG completed a draft working plan in April 1991 which identifies, develops, and prioritizes specific research activities to improve rockfish stock assessments. More specifically, the goal of the working plan is to develop better estimates of acceptable biological catch (ABC), the starting point used by fishery management in setting annual harvest levels. The RWG concluded that better estimates of ABC would be obtained by explicitly acknowledging and evaluating the potential sources of bias and uncertainty in the ABC estimates and by incorporating a better understanding of the biology, distribution, behavior, and population dynamics of rockfish stocks. The approach adopted by the RWG was to identify and develop sound data collection techniques and analytical methods which would improve the two key components that comprise an estimate of ABC--exploitable biomass and optimal exploitation rate.

Initial Observations Aboard Commercial Rockfish Vessels

The fishing industry utilizes specialized skills and techniques when harvesting rockfish, especially the deeper-water species such as shortraker and rougheye rockfish. Many of the deep-water species are known to inhabit areas of very rough bottom--areas generally inaccessible by survey trawl gear but readily accessible by many commercial rockfish trawlers. By working closely with industry and utilizing its expertise in fishing rough areas, the RWG is devising several new survey approaches that incorporate the specialized harvesting skills and gear that characterize a commercial fishing operation.

As part of these research efforts, the RWG arranged with industry to place scientists onboard commercial rockfish vessels to observe and document their harvesting and processing operations. Scientists were placed on two commercial rockfish trawlers during the July 1992 rockfish opening in the central Gulf of Alaska. The scientists collected detailed information on harvesting strategies employed, areas and depths fished, gear used, vessel operations, and species composition of the catch (Fig. 1), information that will better assist the RWG in refining its new survey approaches before they are attempted on a large scale. The RWG hopes that involving the industry during the early stages of survey development will set the stage for more ambitious cooperative studies in the future.

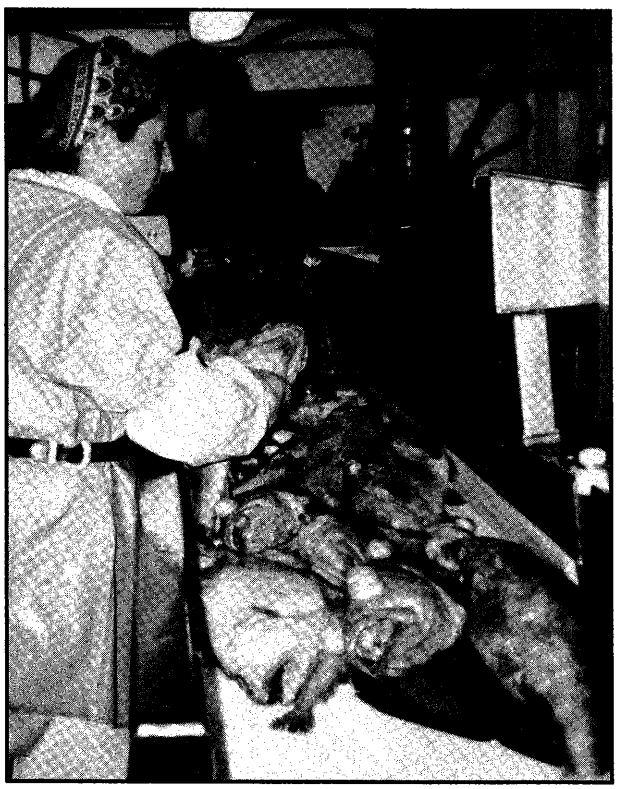

Figure 1. Susanne Finckh of the UW samples rockfish catch aboard a commercial rockfish trawler.

Habitat Preference and Rockfish Behavior Studies

More than 60 species of rockfish inhabit the North Pacific Ocean and occupy a wide variety of habitats. Determining the habitat preferences of the economically important species is an important research endeavor of the RWG. If habitat preferences can be determined, and habitat types quantified, sampling stratification will be more accurate and efficient. Critical habitat can then be sampled more intensively, resulting in improved species-specific abundance estimates.

The RWG believes that hydroacoustic techniques may become a useful tool for assessing the abundance of rockfish stocks. However, hydroacoustic approaches are only applicable in situations where fish targets are distinguishable from the bottom. Many rockfish species are associated directly with the bottom but may move up in the water column during certain times of the day or night. Therefore, an evaluation of rockfish behavior, particularly with regard to their on- and off-bottom distribution, is necessary to determine the feasibility of using hydroacoustics as a direct means of estimating rockfish biomass.

In May 1992 the RWG initiated a study to 1) describe the habitat, behavior, and spatial distribution of shortraker and rougheye rockfish, 2) describe and chart substrates for testing sonar bottom-typing equipment, and 3) evaluate the behavior of Pacific ocean perch relative to the bottom. Since research on rockfish habitat preferences and behavior is best suited to *in situ* observations, the RWG chartered the two-person submersible (submarine) vessel *Delta* (Fig. 2) for 10 days during the study. Thirty-three submersible dives were completed in waters off Southeast Alaska to depths of 365 m. All observations were visually and voice recorded by internal and external 8-mm video cameras; visual observations were also recorded by an external 35-mm still camera. The dives produced video footage of varied habitats, substrates, fish fauna,and behavior along the upper continental slope and shelf regions. The processing of this data is ongoing, with a report detailing the preliminary results of this cruise expected by year's end.

Analysis of Available Research and Fishery Information

The AFSC houses large quantities of data on fisheries research and commercial fisheries recorded since the early 1960s. This information is perhaps among the best on demersal fisheries in the world.

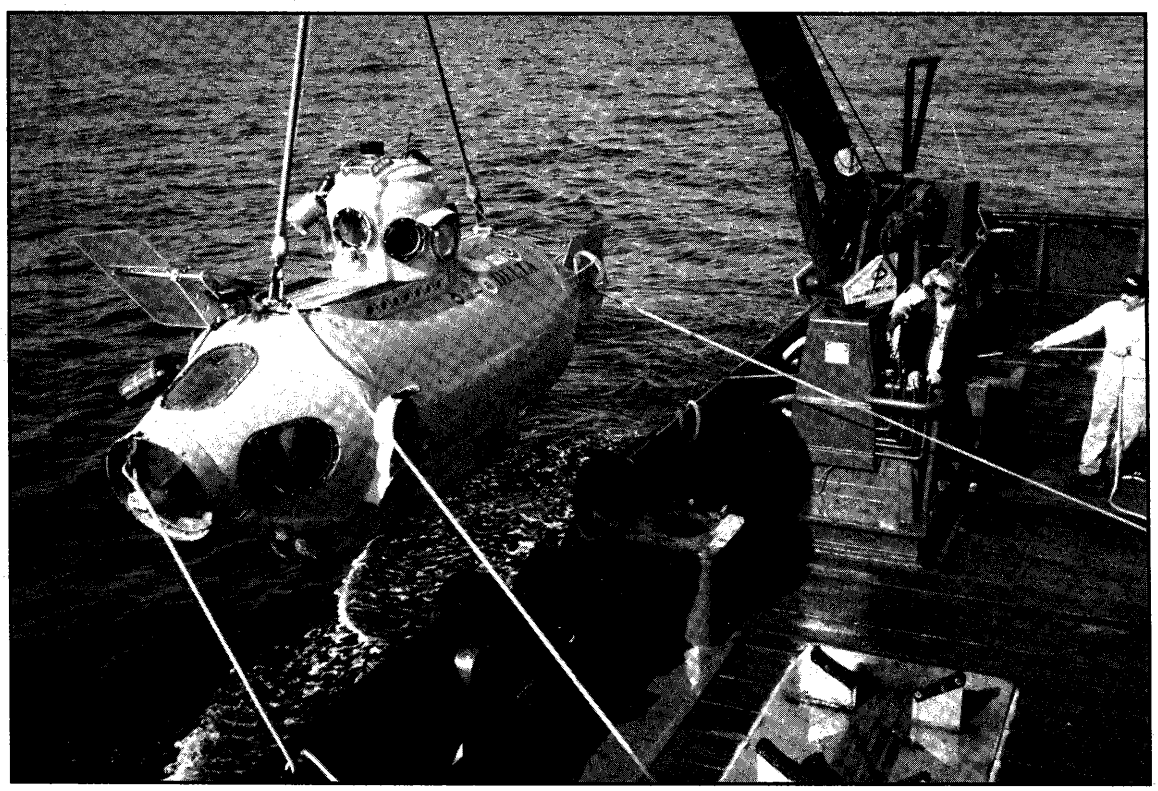

Figure 2. The submersible Delta being launched from the support vessel Jolly Roger.

Incompatible database programs, data formats, and other computer-related logistics problems have made accessing this information difficult. The RWG is constructing a rockfish database which will facilitate more efficient access and analysis of the data.

As a first step in creating the rockfish database, the RWG has focused on obtaining all the available research and fishery information on Pacific ocean perch. Once the RWG is satisfied with the database on Pacific ocean perch, information on the other rockfish species will then be incorporated. To date, the National Marine Fisheries Service (NMFS) research trawl survey database, the International North Pacific Fisheries Commission (INPFC) foreign reported database, and the U.S. Fisheries Observer Program foreign and domestic databases have been queried and the pertinent information extracted. Information extracted includes sampling locations by longitude and latitude, depth sampled, time fished, and gear used; environmental information such as water temperature and salinity; and biological data such as size, sex, age, and maturity.

Although not yet complete, the rockfish database is already being used by REFM and ABL stock assessment scientists to produce the stock assessments of Pacific ocean perch in the eastern Bering Sea, Aleutian Islands, and Gulf of Alaska. All of the available size, age, catch, and effort information from research surveys and the commercial fishery were extracted, analyzed, and summarized for inclusion in the 1992 stock assessments. This task would have been quite cumbersome without access to the rockfish database. Scientists from the REFM Division are also using the rockfish database to extract, summarize, and document the locations and harvest levels of Pacific ocean perch from the early 1960s to the present. The database will eventually be interfaced with mapping and statistical software to generate interactive screen maps and data summaries based on selection criteria such as depth, gear type, season, water temperature, salinity, etc. This new technology should improve the sampling design and allow for more efficient stratification of future rockfish surveys.

Stock Identification Studies

Coastwide movements of adult rockfish are generally assumed to be minimal; however, lack of confirmation or evaluation of this assumption contributes to uncertainty in survey results and management recommendations. Moreover, little is known about the discreteness of rockfish stocks in time and space. Separation of fish stocks into discrete entities is recognized as a prerequisite to rational management of fisheries. Therefore, the RWG has developed a number of research activities to determine the discreteness of rockfish stocks and to determine if rockfish populations undertake extensive coastwide movements.

The RWG has begun identifying and delineating the stock structure of rougheye and shortraker rockfish. Scientists at the ABL are currently examining 200 samples of these species for the presence of parasites. The prevalence and intensity of parasites has proven useful as a biological tag for separating stocks of rockfish species. The specimens for the current study were collected from five INPFC areas during the 1991 NMFS Longline Survey of the Gulf of Alaska. Initial autopsies suggest that there is little movement between the areas for either species. It is hoped that some parasites, which are easily identified and quickly sampled, will be found to serve as future stock separation markers. Morphometric measurements from these specimens are also being recorded as a further means of identifying discrete stocks and local aggregations.

More refined stock differentiation techniques are hoped for in the future, such as allozyme analysis and mitochondrial DNA analysis. Recently, tissue samples (eyeball, liver, and muscle) were collected for electrophoretic analysis from shortraker and rougheye rockfish taken from the area ranging from the southern coast of Washington to the northern tip of Vancouver Island, British Columbia. These samples were collected by scientists aboard the NOAA ship *Miller Freeman* during the 1992 West Coast hydroacoustic survey of Pacific whiting (Fig. 3). The samples are currently stored in a special deep-freeze freezer at the AFSC until funds can be allocated for processing and analyzing the samples. Also during this cruise, detailed morphometric measurements and meristic counts were recorded from each specimen.

Age and Growth Studies

Knowledge of the age composition and growth characteristics of a fish population is essential for good resource management. However, accurate age and growth information for many of the economically important rockfish species is lacking. The RWG recently completed developing the ageing criteria and technique for production readings of rougheye rockfish otoliths (ear bones), the bony structures used to age the fish. Based on the resulting ages, growth parameters have been estimated and will be useful in future analytical stock assessments of this

resource. The methodology for reading rougheye rockfish otoliths will be extended to shortraker rockfish. Also, a comparative study of shortspine thornyhead ageing structures is currently under way. This study examines the utility and validity of various ageing structures, such as otoliths, fin-rays, scales and opercles. Finally, the RWG is funding a 1-year research contract with the University of Washington to evaluate the feasibility of radiometrically ageing six rockfish species: Pacific ocean perch, shortspine thornyheads, and rougheye, shortraker, dusky, and northern rockfishes. The longevity of some rockfish species has been estimated to be as much as 140 years, though those estimates have yet to be independently validated. Results of the radiometric ageing study should provide such an independent test of the longevity estimates of the key rockfish species.

Hydroacoustics Research

Hydroacoustic techniques show great promise for improving rockfish stock assessments in two fundamental ways. First, as an efficient means for determining and quantifying bottom relief and substrate type for purposes of habitat identification and stratification; and secondly, as a noninvasive means for directly estimating rockfish abundance.

One problem with trawl surveys in the North Pacific Ocean is how to deal with sizeable tracts of untrawlable ground. Currently, these tracts are included in regionwide estimates of absolute abundance even though these areas are not sampled during the survey. This approach may lead to overestimation or underestimation of abundance, depending on habitat preferences and behavior of the various species. At this point, untrawlable areas cannot be excluded from the biomass estimates because it is simply not known how large the areas are; so for now, the bias imposed by untrawlable bottom cannot be corrected. Appropriate hydroacoustic hardware and software that defines bottom roughness would provide a potentially cost-effective, quantitative classification and mapping system of specific rockfish habitats. The size and type of these habitats could then be explicitly incorporated into the biomass calculations to produce a more accurate estimate.

The RWG is also exploring the utility of hydroacoustic approaches for directly assessing rockfish abundance. Rockfish are an ideal acoustic target due to their large, closed swimbladder. However, only off-bottom targets can be readily detected with precision. As mentioned before, many rockfish species are known to associate directly with the bottom. An evaluation of rockfish behavior, particularly with regard to their on- and off-bottom distribution, is necessary to determine the feasibility of using hydroacoustic techniques as a noninvasive means of directly measuring absolute or relative abundance of rockfish stocks.

The RWG has submitted a research proposal to the National Undersea Research Program (NURP) for use of a submersible in 1993. The primary goal of this research is to determine the feasibility of using hydroacoustic techniques to assess the abundance and distribution of rockfish populations. Initial efforts will be directed at Pacific ocean perch, although results of this work will be relevant to other rockfish species. The proposed study has four objectives: 1) to conduct submersible surveys to determine the abundance and spatial distribution of Pacific ocean perch, 2) to conduct hydroacoustic surveys concurrent with the submersible surveys to determine abundance and spatial distribution of Pacific ocean perch within the same area, 3) to quantify the behavioral and distributional response of Pacific ocean perch to the submersible, and 4) to compare estimates of Pacific ocean perch abundance and distributional patterns based on the submersible and hydroacoustic surveys. Funding should be determined by January 1993.

Also, the RWG has provided funding for an acoustics specialist in the RACE Division to conduct a feasibility study of employing hydroacoustic approaches for rockfish stock assessments and habitat typing. A report of the findings and recommendations will be available to the RWG by the end of 1992.

New Analytical Techniques

Fishery assessment models are valuable tools for quantitatively evaluating the condition of exploited stocks and for measuring the impact of various exploitation patterns. These models aid the decision-making process in three major ways. First, a wide range of management alternatives can be readily evaluated. Second, assumptions and data can be tested, and results can be used to identify and prioritize additional data needs. Third, all assumptions and judgments are exposed for everyone to analyze and question. The RWG realizes that stock assessment models have been, and will continue to be, the main avenue for generating estimates of optimal exploitation rates. Continued evaluation and development of new analytical techniques, such as the stock synthesis (SS) model, are necessary for optimizing the use and interpretation of available data sources.

Recent stock assessments of Pacific ocean perch in the North Pacific Ocean have relied on the stock

reduction analysis (SRA) model to provide historical trends in the fishery. One limitation with SRA is that the underlying age-structure of the population and other auxiliary information are not directly incorporated into the analysis. The SS model, on the other hand, is a form of catch-at-age analysis that has been designed to incorporate age composition and a diversity of other information into a single computational framework. By explicitly tracking age structure, the SS model allows information on age composition to be used in the estimation process. Stock synthesis functions by simulating both the dynamics of the population and the processes by which the population is observed. This simulation, which incorporates both imprecision and bias in the observations, is used to predict expected values for the observations. These expected values are then compared to the actual observations (data) from surveys and the fishery. The SS model is now being used by REFM and ABL stock assessment scientists as the primary assessment tool for evaluating the condition of Pacific ocean perch in the North Pacific Ocean.

Figure 3. Dave Baker and the author (right) take tissue samples, morphometric measurements, and meristic counts aboard the Miller Freeman from shortraker and rougheye rockfish.

Collection and Analysis of Biological Data

With the exception of Pacific ocean perch, relatively little is known about the biology of the other commercially important rockfish species. To increase our understanding of the basic biology of these other species, especially shortraker and rougheye rockfishes, the RWG has funded a 2-year contract with the University of Washington to collect and analyze biological information on shortraker and rougheye rockfish from the North Pacific. Information such as seasonal availability, times and seasons of birth, and gonadal somatic index (GSI) information are currently being collected and analyzed.

Future Directions

The original RWG working plan drafted in April 1991 identifies additional studies that would contribute significantly to improving rockfish stock assessments and management recommendations. Due to funding limitations, many of these research endeavors have been postponed, such as studies on rockfish early life history and recruitment processes, examination of the utility of adaptive management approaches, and analyses of rockfish assemblages. A detailed report summarizing the current progress and major accomplishments of the RWG is being drafted and is expected to be completed by the end of January 1993.This report will include recommendations for new research activities that were not addressed in the original working plan.

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