Government-Industry Cooperative Fisheries Research in the North Pacific under the MSFCMA

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Introduction

In the United States, the Federal Government is responsible for management of most commercial fish stocks in the Exclusive Economic Zone (EEZ) from 3 to 200 nmi offshore. In most cases, management of these stocks is carried out under provisions of the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA).

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ABSTRACT—The National Marine Fisheries Service's Alaska Fisheries Science Center (AFSC) has a long and successful history of conducting research in cooperation with the fishing industry. Many of the AFSC's annual resource assessment surveys are carried out aboard chartered commercial vessels and the skill and experience of captains and crew are integral to the success of this work. Fishing companies have been contracted to provide vessels and expertise for many different types of research, including testing and evaluation of survey and commercial fishing gear and development of improved methods for estimating commercial catch quantity and composition. AFSC scientists have also participated in a number of industry-initiated research projects including development of selective fishing gears for bycatch reduction and evaluating and improving observer catch composition sampling. In this paper, we describe the legal and regulatory provisions for these types of cooperative work and present examples to illustrate the process and identify the requirements for successful cooperative research.

The MSFCMA was first authorized in 1976, following establishment of the U.S. EEZ. Off the coasts of California, Oregon, Washington, and Alaska, however, NOAA's National Marine Fisheries Service (NMFS) and its predecessor, the Bureau of Commercial Fisheries (BCF) had established a tradition of conducting cooperative research with U.S. fishing companies, and with agencies and organizations from foreign nations long before that date. Following implementation of MSFCMA, policies and regulations for continued cooperative research activities were put in place, and this regulatory framework has evolved during the subsequent 25 years in response to changes in the Act itself and to specific requirements within each of the five regional administrations of NMFS. The last reauthorization of MSFCMA occurred in 1996 (Anonymous, 1996).

The history of cooperative research in the waters off the U.S. west coast and Alaska is long, and it has been remarkably successful and productive. For example, in the Gulf of Alaska, exploratory fishing began in the late 1940's (Ronholt et al.[1]). Bottom trawl surveys were conducted from research and chartered commercial fishing vessels and participants included the BCF, the Fisheries Research Board of Canada, and the International Pacific Halibut Commission. These early research surveys were the precursors of routine, regular (annual, biennial, and triennial) groundfish surveys now carried out by NMFS off the Pacific coast, including Alaska. Most of these surveys are conducted aboard chartered commercial vessels, because the amount of sea time required greatly exceeds the amount of research vessel time available. These surveys are designed and directed by NMFS, the sampling and data collection is conducted by NMFS personnel, and great care is taken to address concerns regarding consistency. Nevertheless, the work is considered to be cooperative and relies heavily on the skill, experience, and participation of skippers and crews for carrying out the fishing operations in support of the scientific objectives of the surveys.

The AFSC resource assessment survey database constitutes the most important and extensive time series available to fisheries scientists in this region. While it may be the most noteworthy product of ongoing cooperation, it is by no means unique. For more than 30 years, NMFS and the fishing industry have cooperated on a broad range of studies in such areas as commercial and research gear development, studies of marine mammals and seabirds, and collection of fish samples for utilization research, age and growth studies, feeding behavior, maturity and reproduction research, and other aspects of fish biology and ecology. In the Gulf of Alaska and the Bering Sea/Aleutian Islands (BSAI) areas, ongoing industry/agency cooperation supports a substantial marine fisheries observer program which is responsible for collecting data essential to stock assessment and inseason management of catch and bycatch. Costs of this program are shared between the agency

[1] Ronholt, L. L., H. H. Shippen, and E. S. Brown. 1978. Demersal fish and shellfish resources of the Gulf of Alaska from Cape Spencer to Unimak Pass 1948–1976 (a historical review) U.S. Dep. Commer. NOAA, Nat. Mar. Fish. Serv., Northwest Alaska Fish. Sci. Cent., Proc. Rep., Aug. 1978, Seattle, 955 p.

and the industry (Karp and McElderry, 1999).

As the Alaska groundfish fisheries have evolved during the last 30 years, so have the technology and information needs of scientists, managers, and participants in the fishery. For example, increased emphasis on bycatch reduction and reduction of marine mammal and seabird takes has stimulated developments in gear technology and fishing methods, while inseason fleet quota monitoring requires accurate real-time catch accounting, and vessel-specific quota monitoring further increases the accuracy and precision requirements for catch accounting. The research needed to address these kinds of questions may be carried out independently by NMFS or participants in the fisheries, but there is often considerable advantage to be gained from a cooperative approach.

In this paper, we review some provisions for cooperative research, describe three cooperative research studies which were designed to evaluate questions pertaining to catch weight estimation, catch composition sampling, and bycatch reduction, and discuss factors which contribute to the success of cooperative research activities.

Provisions for Cooperative Industry/Government Research

Fisheries research conducted within the U.S. EEZ may be authorized either through a Letter of Agreement (LOA), a Scientific Research Permit (SRP), an Exempted Fishing Permit (EFP), or an Exempted Educational Activity Authorization (EEA). LOA's are generally issued to non NMFS research institutions such as state fishery agencies, universities, or foreign government agencies carrying out research in U.S. waters. SRP's are required for all NMFS research activities carried out aboard government-operated or chartered vessels operating under contracts. EFP's are required for industry-sponsored research when suspension of fishing regulations is required (i.e. when fishing would occur in a closed area or during a closed season, or when a prohibited type of gear would be used). EFP's are also required if compensatory fishing is involved. When compensatory fishing is authorized, the vessel(s) involved are allowed to harvest additional fish after the research has been concluded and to sell this fish to help offset research costs. EEA's are required for educational field trips and small-scale sample collecting.

Even though SRP's are not mandated under MSFCMA, NMFS policy requires that they be issued. In addition to describing the planned research and the need for the work, concerns regarding potential impacts of the research on endangered species, marine mammals, and the environment must be addressed in an SRP.

The LOA's, SRP's, and EEA's are issued by NMFS in accordance with agency directives and guidelines. The process for issuing EFP's, however, is more complex. In general, an application which details the reason for the proposed research, the experimental design and procedure, and the required allocations of fish (if any) must be submitted. The application is first reviewed by NMFS (although applications are often developed in cooperation with NMFS). Following satisfactory review by NMFS, the application is reviewed by the appropriate regional Fishery Management Council (FMC). At this stage it may be endorsed, rejected, or sent back to the applicant with recommendations for resubmission. If endorsed by the appropriate FMC, the application is published in the Federal Register to allow opportunities for public comment. Then, providing it meets legal and policy requirements, the permit is issued. Specific permit requirements are detailed in the relevant fishery management plans. Agency participation is not required under an EFP, but industry organizations may work closely with agency scientists when planning and conducting research under an EFP.

An additional vehicle for cooperative research is provided under Public Law 91-412 (U.S. Code 1525) (Anonymous,1970). This statute allows the Secretary of Commerce to engage in joint projects with nonprofit organizations, research organizations, or public organizations or agencies, and apportion the costs equitably. For example, a nonprofit organization, such as a research foundation, could cooperate with NMFS to expand the scope of a resource assessment survey by covering costs associated with provision of an additional chartered vessel. Research conducted under such an arrangement would still require an SRP and would also require a Memorandum of Understanding between the agency and the nongovernmental organization involved. Thus, even though authorization and permitting requirements may depend on whether the work is initiated by the industry or the agency, on the source of funding, or on the objectives of the research itself, it is usually possible to implement a well designed research study which involves industry/agency cooperation in the Gulf of Alaska and the BSAI.

Example 1: Bycatch Reduction

Background

An important aspect of groundfish management in the Gulf of Alaska and Bering Sea Aleutian Islands concerns the so-called prohibited species catch (PSC). In the groundfish management plans for these regions, certain species are considered to be fully utilized by other fisheries and their possession aboard groundfish vessels is restricted or prohibited. For example, trawlers are prohibited from retaining Pacific halibut, *Hippoglossus stenolepis*, and several important Alaska trawl fisheries often close prematurely when their halibut bycatch allowances are reached (Pennoyer, 1997).

Three approaches are available to the industry for reducing halibut bycatch mortality: avoidance of areas where bycatch rates are high, reduction of handling mortality, and modification of fishing methods to reduce bycatch rates. Avoidance measures have been quite successful, and the fleets now take advantage of retrospective data analysis and real-time catch reporting to avoid high halibut bycatch areas. However, target species catch rates are often high in areas of high halibut abundance such that avoidance of these areas will likely reduce a vessel's daily production and therefore income. Reduction of handling mortality is also effective.

Halibut caps are expressed as metric tons of halibut mortality and observers are trained to determine the condition

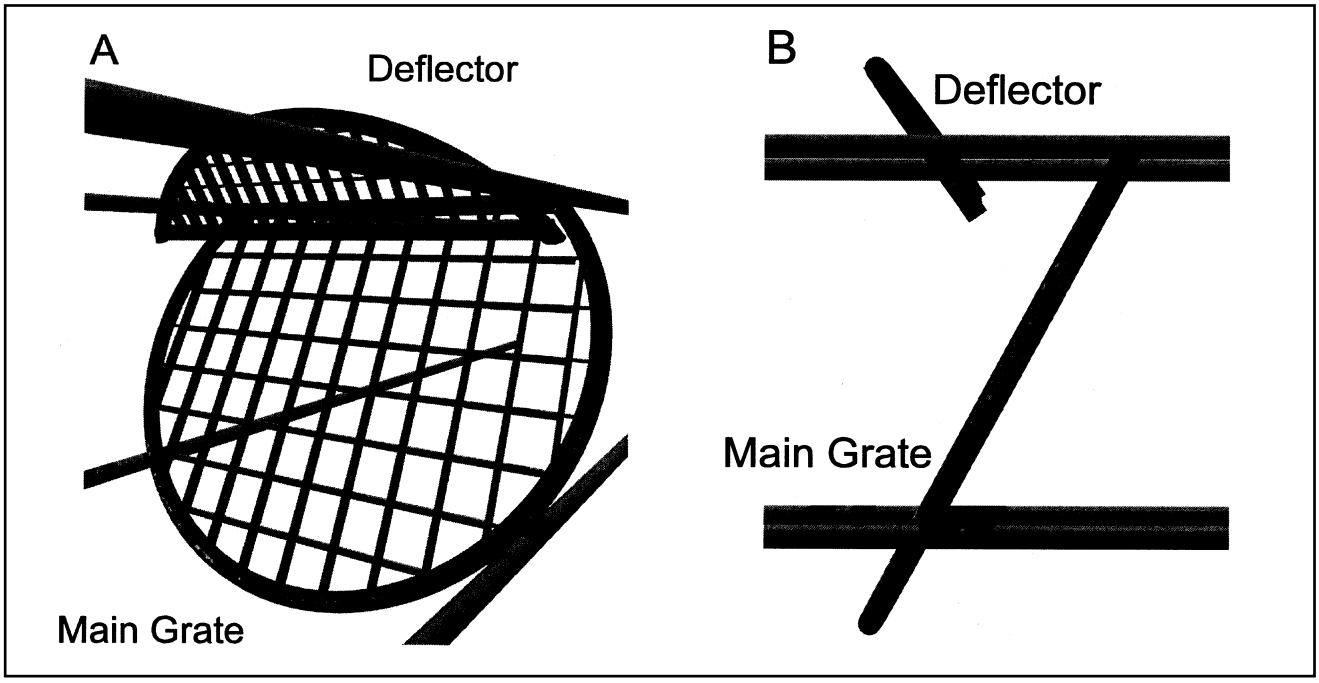

Figure 1.—Oblique view (A) and side view (B) of the halibut excluder grate installed in the intermediate section of a trawl. Mesh sides of the intermediate have not been drawn but riblines are illustrated. From Rose and Gauvin (2000).

(and hence survival rate) of halibut returned to the sea. Survival rates may be enhanced by certain fishing practices, and by taking steps to return incidentally caught halibut to the sea as rapidly as possible. Innovations in gear technology and fishing methodology have also been effective in reducing the retention of intercepted halibut, albeit often at the cost of reduced catch rates for target species. However, owners and operators of some flatfish trawlers have been particularly successful in reducing halibut bycatch rates, and the following section describes research which was initiated to identify one of the more promising innovations and evaluate its effectiveness during a directed flatfish fishery.

Approach

The Groundfish Forum[2], a fishing vessel owners association, submitted an EFP application to test a halibut excluder device for flatfish trawls in April 1998. The EFP was developed with assistance from scientists at the NMFS Alaska Fisheries Science Center and specified the quantities of catch and bycatch species that would need to be caught to carry out the experimental design of the study. The fishing vessel for conducting the EFP was selected through a request for proposals solicitation distributed to owners of interested flatfish trawlers. Individuals submitting proposals were required to describe their proposed bycatch reduction devices and provide necessary supporting information, including fishing practices and resources available to support observers who would be responsible for documenting the quantity and composition of catch and bycatch from each trawl.

Summary

The four applications submitted were evaluated by a team of NMFS scientists based on expected effectiveness, history of previous testing, and evaluation of the suitability of the vessel and its fishing gear. A rigid grate design, submitted by the owner of the 36-m (117-foot) F/V *Legacy* was selected.

The halibut excluder consisted of a rigid grate mounted at an angle (bottom further forward than top, approximately 28° slope) in the intermediate section of the net. Fish approaching the grate from the mouth of the net could either pass through the 15 × 15 cm openings into the aft section of the net or be deflected upward toward an escape tunnel. An auxiliary deflector grate was installed with a top-forward slant ahead of the main grate to direct fish downward. It was similar in construction to the main grate but with 7.6 × 7.6 cm openings. The back edge of the deflector and the main grate formed a 23 cm wide slot through which fish had to pass to reach an escape tunnel (Fig. 1).

Since the experimental design required more tows than could be accomplished by a single vessel in the available time, a second vessel was selected, the smaller 33-m (107-foot) F/V *Alliance*. Tests were conducted in 1998 in the Gulf of Alaska on a deepwater flatfish complex including the economically important flatfish rex sole, *Glyptocephalus zachirus;* Dover sole, *Microstomus pacificus;* and flathead sole, *Hippoglossoides elassodon*, and the low-value but abundant arrowtooth flounder, *Atherestes stomias*.

The experimental design involved paired tows for each vessel. The first tow in each pair or block (control or experi-

[2] Mention of trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

mental) was determined randomly, and the second tow was carried out as closely in time and space to the first as possible. Tow duration varied between blocks, and data were analyzed on a catch-per-distance-towed basis. Catch sorting and weighing were carried out by trained, certified observers with assistance from the crew and NMFS scientists.

The combined data sets indicated that, overall, the excluder retained only 6% of the halibut while excluding only 38% of the aggregated deepwater flatfish species. Retention rates for individual flatfish species varied between 48% and 79%. Retention rates were similar for both vessels for all species except rex sole, with a tendency for the larger F/V *Legacy* to allow more escapement than the F/V *Alliance*. Larger halibut were excluded more effectively than smaller individuals, although only fish weighing 3 kg or less were retained in high (46% by weight) proportion. Since length sampling of target flatfish was not a high priority, size-specific retention rates could not be determined.

This research demonstrated the effectiveness of the rigid grate halibut excluder device in reducing halibut bycatch. It was also evident that the device could be handled successfully on a small catcher-processor vessel such as the F/V *Alliance*. Reduction in catches of some target species was, however, of concern and the inability to determine size-specific retention rates of target species is unfortunate.

Further research to evaluate size-specific retention rates and mechanisms for reducing an accumulation of large fish and debris in front of the mesh is warranted, and the investigators suggest that evaluation of mesh excluder systems, which are easier to handle, also be evaluated. Further details can be found in Gauvin and Rose (2001) and Rose and Gauvin (2001).

Example 2: Species Composition Sampling

Background

Sampling for species composition aboard commercial vessels presents unique challenges. Catches may be large and varied, particularly aboard bottom trawlers. Access to the catch may be restricted because of space limitations or processing and operational requirements, and stratification by size and species may occur in the codend. Random or systematic sampling of catch is required for proper characterization of catch composition but may be difficult to achieve.

When fleetwide quota monitoring is the only management goal, within- or among-haul sampling variability may not be of great concern. This is because inaccuracies due to sampling variability generally average out across the fleet and, since all vessels must stop fishing as soon as the overall quota is reached, vessel owners are not greatly concerned about sampling difficulties on their individual vessels. However, when catch or bycatch quotas are managed at the vessel level, managers and owners quickly recognize the potential consequences of biased sampling, and the sampling and estimation process may receive greater scrutiny.

During the last few years, the North Pacific Fishery Management Council (NPFMC) has implemented a number of vessel-specific catch and bycatch programs, and a great deal of attention has been focused on species composition sampling by observers. Sample sizes are often small relative to catch sizes (even a 500 kg sample is small relative to a 30 t or even 150 t catch), and the random sampling requirement may be compromised by vessel operations such that observers only have access to, for example, the first fish to be spilled from the codend after the catch has been dumped. In some of these programs, individual vessels must stop fishing when they reach their catch limit for any of the allocated species, and industry members have raised serious concerns regarding the accuracy of sample-based catch accounting. This may place observers in difficult situations while at sea and has the potential to undermine confidence in the overall catch estimation process.

Thus, both the fishing industry and NMFS identified a need to better understand the problems associated with catch composition sampling in certain fisheries and then to seek solutions to some of these problems. Consequently, the Groundfish Forum took the initiative to draft an EFP application which sought improvements in species composition sampling through identification and quantification of potential inaccuracies of existing sampling practices. The concept and experimental design were developed with the assistance of NMFS scientists.

Approach

The study was designed to examine species composition sampling aboard a trawler targeting flathead sole in the Bering Sea and catching mixed flatfish and roundfish. Interested fishing companies were asked to prepare proposals explaining how catch processing could be managed on their vessels to meet the sampling, catch census, and discard weighing requirements of the study. The factory trawler *American No. 1* was selected. NPFMC and NMFS approved the EFP application which provided for a sufficient quantity of catch and bycatch (672 t in total) to support the sample size requirement for 62 hauls.

From each haul, six 100 kg samples were taken at random for estimation of species composition, then all remaining halibut, snow crabs, *Chionoecetes* spp., and skates, *Rajidae*, were removed and weighed. Production and discard records were also maintained.

Following the fieldwork, the data were analyzed to compare sample-estimated weights to census-based weights for skates, Pacific halibut, and snow crabs (crab comparisons were based on numbers of individuals), and to compare haul-specific, daily, and total-cruise estimates based on observer samples with those based on production and discard estimates for retained species (walleye pollock, *Theragra chalcogramma*; Pacific cod, *Gadus macrocephalus*; yellowfin sole, *Limanda aspera*; Alaska plaice, *Pleuronectes quadrituberculatus*; and flathead sole). Data from individual samples within hauls were also analyzed on a species-by-species basis to determine if stratification (sorting by species and/or size) occurred.

Summary

Even though each method has serious shortcomings, species composition estimates based on observer sampling were

generally similar to estimates based on vessel production plus discards at the haul and cruise level. For commonly occurring species (each making up 15–20% of the composition of individual catches), catch estimates agreed well and variances were low, even at the haul level. However, for bycatch species (generally making up less than 2% of the composition of individual hauls), variances associated with catch estimates were high, particularly at the haul level although agreement between estimates improved when catches were aggregated to the week or cruise level. Within-catch stratification was observed for walleye pollock, yellowfin sole, Pacific cod, Alaska plaice, and "others." Stratification was relatively strong for pollock, yellowfin sole, and Pacific cod and could account for up to 20% of pollock catch estimation variability. Stratification was not detected for crabs. Catches of skate and Pacific halibut were too small to analyze for stratification trends. Sampling conditions during this research cruise were ideal; access to the catches was unrestricted so that observers were able to collect replicate random samples without difficulty. This type of situation rarely occurs during normal fishery operations.

Even though stratification within catches is of concern, this study supports the perspective that current sampling methods are appropriate for fleetwide monitoring of most catch and bycatch quotas. Variability may be high, however, particularly for nontarget species. Stratification may contribute substantially to this variability although its effects may be ameliorated by drawing several random samples from each haul. Observer sampling and production plus discard methods generally produce comparable results.

Concerns arise for the flathead sole fishery and other fisheries with similar catch characteristics, when monitoring for rare bycatch species is on an individual haul or daily basis. Over- or underestimates of rare species can be expected for individual hauls. Thus, the haul-by-haul catch monitoring requirements of individual vessel quota managed fisheries may be difficult to achieve. Many of the vessels participating in the Community Development Quota program in the Bering Sea operate under a requirement that accounting against individual quotas be based on samples taken by observers from each haul. Uncertainty in the resulting haul-by-haul catch estimates may result in premature closures for some vessels and delayed closures for others.

As a result of this study, sampling limitations are better understood by NMFS and the fishing industry. This shared perspective may lead to cooperative solutions to some problems, such as modifications to vessel operations and observer practices to mitigate the effects of codend stratification. It may also result in initiatives to redesign management programs based on unrealistic sampling expectations and, perhaps, to more realistic standards for the design of new programs.

Example 3: Estimation of Catch Weight

Background

In the large-scale catcher-processor trawl fisheries of the BSAI, observers generally estimate catch weight by first determining the volume of the catch and then applying a density factor (volume to weight conversion factor) to calculate weight. In some cases, marked and illuminated holding bins are used to contain individual catches, and volume measurement is relatively straightforward. In most situations, however, suitable bins are not available and observers must resort to making measurements of the codend, using these measurements to estimate catch volume, and then making the conversion to weight using a density factor.

Until recently, managers were concerned only with fleetwide catch estimates so that vessel-to-vessel variability in catch accounting was not taken into account. However, with the advent of vessel-specific management requirements, the need to address vessel specific catch accounting accuracy issues became apparent. Several alternatives for improving catch weight determination are available including direct weighing at sea and improved, standardized methodologies for estimating catch volume coupled with improved density factors.

NMFS recognized the need to evaluate current methods and new approaches but understood that the success of this type of evaluation would depend on the applicability of their findings in commercial fishing situations. Since the results of this research might be used to support potentially unpopular regulatory change, the independence and objectivity of the study was of paramount importance.

Approach

Even though industry participation and cooperation were essential to the success of this research, the study was initiated and designed by NMFS, and the experimental design required NMFS to direct the fishing and processing of the vessel. The participating company would be required to equip its vessel with a motion-compensated flow scale, ultrasonic sensors for measuring depth of fish in bins, and to perform other modifications. They would also be required to conduct research tows within and outside the normal fishing seasons. NMFS issued a request for proposals (RFP) to fishing companies interested in providing a factory trawler with the crew and equipment required to perform the work. Companies responding to the RFP had to address all the requirements laid out in the Statement of Work and provide a bid price, the amount they were willing to pay the government. After the contract was awarded, NMFS issued an SRP which authorized fishing outside the normal fishing season, consistent with the research plan. In this instance, the vessel was allowed to retain catches taken during the research study.

Fieldwork was carried out in 1996 and 1997, although only the 1997 work is summarized here (Dorn et al.,1999). The objectives of this research were to determine the accuracy of a flow scale and evaluate procedures for monitoring flow scale performance, evaluate the accuracy of volumetric methods of catch weight determination, evaluate the use of ultrasonic bin sensors for determining fish volume in holding bins, obtain accurate density factors for use in volume to weight conversion for

walleye pollock catches, and evaluate current and alternative methods used by observers to determine density.

The overall study design required between 150 and 200 individual trawls to be taken over a range of catch sizes. This provided the basis for conducting comparisons of catch weight estimates obtained from the flow scale with volumetric estimates obtained from codend measurements, direct measurements of bin volume, or ultrasonic (bin sensor) measurements of bin volume.

Scale performance was closely monitored during the study. Evaluation of observer methods for estimation of fish density was conducted by estimating density directly (weighing known volumes of fish on the flow scale) and a new method for density estimation by observers was tested. This utilized a prototype sampler designed to address problems with standard observer density estimation methods which utilize small perforated baskets. The prototype was constructed from a plastic barrel of approximately 55 gallons (0.21 m^3) and was designed for ease of filling, emptying, and volume measurement by observers.

Summary

The flow scale was found to be a reliable tool for measuring catch weights and it operated within established error limits throughout the project. However, comparisons with fish samples of known weight indicated a consistent positive bias of approximately 1% during this experiment (Dorn et al., 1999).

Codend volume measurements were found to be consistent and reliable although a tendency for overestimation of volume (or reduction of density) for large codends was apparent when codend volume/density based weight estimates were compared with flowscale observations. Bin volume measurements (for this ideal situation where bins were properly calibrated, marked, and illuminated) were found to be very precise. Ultrasonic bin sensor methods were also found to be reliable except when bins were relatively full.

Results obtained with the density sampler were encouraging. They were consistent and did not vary by observer. Overall, density estimates obtained by the basket and density sampler methods compared well with estimates obtained from flowscale/bin volume methods while flowscale/codend volume estimates tended to indicate higher density values. Based on these results, the investigators recommended changes (increases) in the standard density factors for pollock. They also recommended changes in observer training to improve volumetric estimates of large codends (Dorn et al., 1999).

Discussion and Overall Summary

While each of these studies reviewed here was designed to address a specific area of concern, they share several of the attributes of successful cooperative research. NMFS and the fishing industry have broadly overlapping interests in reducing bycatch, understanding better the constraints on accurate catch accounting, and implementing improvements in catch accounting systems. Furthermore, agency and industry catch accounting concerns have become more acute with the implementation of management programs which require monitoring of individual vessel performance. Thus, NMFS and the fishing industry recognized the need for each of these studies. Industry took the initiative in the first two cases, and took advantage of EFP provisions and the opportunity to work in partnership with NMFS. In the third case, NMFS identified the need to carry out the work, and determined that contracting with a fishing company would be necessary. As in all situations where the agency initiates the research, an SRP was required for this study.

When the Groundfish Forum initiated the bycatch study they recognized the advantages of working with NMFS scientists knowledgeable in the field of experimental design and fish behavior in relation to fishing gear. The concept of evaluating potential participants on the basis of the design of their bycatch reduction device was particularly innovative and would have been difficult to implement in a NMFS-initiated study. The Groundfish Forum's ability to act quickly to implement the work following approval of the EFP illustrates an additional benefit of the industry-initiated approach.

The catch composition sampling study was also initiated by the Groundfish Forum. NMFS scientists had been working on improved sampling protocols, enhanced observer training, and industry outreach to address sampling accuracy concerns, and they recognized the opportunities afforded by the Groundfish Forum research proposal. The Groundfish Forum was able to develop its proposal in response to industry concerns regarding the potential problems associated with sampling biases when catch accounting occurs on a haul or vessel-specific basis. And, again, they were able to implement the study much more rapidly than would have been the case in a government-initiated study.

NMFS initiated the catch-weight estimation study. Evaluation of flowscale performance at sea was essential given the direction of the NPFMC to require these systems aboard certain vessels. NMFS took advantage of this opportunity to evaluate current and innovative volumetric methods and an improved method for density estimation at sea. It was essential that the work be carried out aboard a commercial vessel during normal, production fishery operations. The direct participation of fishing company personnel contributed markedly to the success of the work and to the credibility of the results. However, the contractual arrangement did provide government scientists with the authority to direct scientific operations and to make changes in the research plan when minor problems arose. As a consequence of this study, NMFS adopted a revised standard density factor for converting pollock catch volume estimates to estimates of weight. Because the new density factor was higher than the one previously employed, this result was not popular with the fishing industry. Therefore the results received a high degree of scrutiny. The results of cooperative research cannot always be expected to be welcomed by all parties involved.

Integral to each of these studies were the certified observers of the NMFS North Pacific Groundfish Observer Program. Observers are deployed aboard groundfish vessels to document catch

quantity and composition; their training and experience makes them uniquely qualified to collect research data in studies of the type described herein. Furthermore, each of these studies was concerned, to some degree, with observer sampling methodology, and the catch weight and catch composition sampling studies provide significant opportunities for evaluating and improving observer data collection protocols. The catch sampling requirements for studies of this type are often extremely demanding, and the availability of suitably trained and experienced field biologists is of paramount importance. Because of the involvement of observers in these studies and, especially, because observer sampling practices were evaluated explicitly during two of the projects, opportunities were afforded for industry to recognize the difficulties that observers encounter when performing sampling duties aboard fishing vessels. This has resulted in some suggestions for innovative solutions to sampling problems and improved recognition of the limitations of the observer-based catch monitoring system.

The success of cooperative studies depends on the ability of scientists and industry personnel to work together at all levels, including the senior staff who develop research concepts and provide political and fiscal support, those involved in the detailed design and planning, and scientists and industry personnel involved in data collection, analysis, and reporting. This commitment may be seriously tested when research results are not deemed favorable. The finding that led to an increase in the standard density factors for estimating pollock catch weight was unpopular with the industry, so questions regarding the applicability of the study had to be resolved. As a result of the catch composition sampling study, agency assumptions regarding the appropriateness of basing haul and vessel-specific catch accounting on sample data collected by observers have been challenged.

Collaborations between NMFS and industry may be particularly attractive, because NMFS allows retention and sale of fish caught during the EFP to fund the research that would otherwise be too costly to conduct. For instance, the EFP research to investigate catch composition sampling in the multispecies flatfish fishery provided a set aside of flatfish and other species for the fishing associated with the experiment. The company owning the vessel that participated in the sampling experiment was able to support the vessel's fishing costs and the substantial additional crew duties associated with the experiment from the proceeds of the sale of fish caught during the experiment. The expected charter cost of the vessel to conduct the experiment without retention of the catch would have been approximately $20,000 to $25,000 per day or close to $500,000 over the 3 weeks of the experiment. This estimate is based on the vessel's expected revenue per day if the vessel participated in one of the possible fisheries open at the time of the experiment.

For certain types of research, the applicability of the results may depend upon the extent to which research conditions resemble the actual commercial fishing conditions. This resemblance is likely to be greater when the vessel depends on the revenues from the fish it catches. For instance, if the sampling research had been conducted under a research charter, the skipper and crew would, perhaps, have had an incentive to catch smaller quantities with less complex composition than would occur in a normal commercial catch. This is because the extra work of sorting and weighing catch by species would be less if the catch per haul was smaller or less diverse.

We have described only three of the many successful cooperative studies that have taken place in the waters off Alaska. We have also demonstrated that either industry initiated or agency initiated cooperation can be effective. In some cases, such as the long-term charters for annual stock assessment surveys, agency initiated contractual arrangements are the most suitable. In other cases, such as the bycatch study discussed above, industry initiated research is more appropriate. For other cases, either approach could be successful. Regulatory provisions developed under the MSFCMA and other statutes, together with agency administrative procedures, provide viable mechanisms for supporting cooperative research. Of paramount importance, however, is the commitment by agency and industry personnel to work together and to recognize the importance of carrying out high quality, scientifically defensible research, regardless of the results which might be obtained.

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