

Summary Report
Alaska Fisheries Science Center Science Data Collection Program Review
September 7, 2013

The NOAA Fisheries Alaska Fisheries Science Center (AFSC) in Seattle, Washington conducted a program review to examine the direction and quality of its scientific data collections as they relate to federally managed fisheries in Alaska. The review was conducted over a four-day period from August 26 – 28 and was formatted around presentations on fishery independent data, fishery dependent data and data streams spanning both fishery independent and dependent sources. For clarification, the latter category primarily addressed ecosystem and environmental process studies. Fifteen presentations were made by various AFSC staff (mostly the scientists leading major components of the research), providing an overview of major topics at varying levels of detail. Typically, each presentation provided not only background materials, but also an expression of strengths, challenges and solutions.

The review panel was comprised of six members, each with fisheries science and management familiarity or expertise. Their affiliations included the University of Washington, University of Alaska, NOAA Fisheries Northwest and Southeast Centers and NOAA National Ocean Services. The panel was chaired by a member of the USGS Pacific Regional Office with past experience with NOAA Fisheries. Each panel member was asked to consider the materials provided in the presentations and an extensive set of supplementary readings, then use that input to draft independent reports identifying strengths, weaknesses and suggestions for the three broad topical concerns noted above. In addition, the panel chair prepared this summary by looking across the individual reports. The summary highlights common themes and underscores those points considered particularly critical by individual or multiple panel members.

General Observations

The Alaska Fisheries Science Center has developed the science and processes necessary to ensure timely and quality science inputs as the foundation for managing Alaska groundfish fisheries. The growth and expansion of AFSC capabilities has been aided by an extensive period of strong Congressional support and partnerships with the fishing industry. Through outstanding science expertise, industry support and reasonably predictable funding over time, the Center has established potent capabilities to evolve and adjust to changing circumstances in these fisheries. The presentations offered by Center staff clearly demonstrated the path they forged and the science enterprise they currently have in place. Likewise, success has been demonstrated through a consistent avoidance of overfishing and its impact on maintaining a consistently healthy Alaskan groundfish fishing industry.

Despite the legacy of success and the extensive portfolio of capabilities that currently exist, the Center faces a significant and potentially protracted period of fiscal constraint which has, and will continue to threaten growth, diminishing their ability to ensure

retention of the core functions necessary for ongoing production of high quality and timely stock assessment products. Data inputs, as the entry point from which science products flow, are especially vulnerable given costs associated with collection and the complexity inherent in designing them to match their intended use.

The Center has communicated their awareness of these circumstances and stated that its principal goal is to “retain core function” that allows ongoing stock assessment efforts. Various members of the panel embraced and agreed with the wisdom of this direction but it was also noted that there are many moving parts contained in “core function” and there are many hard choices that may need to be made across those functions which ultimately effect how well or how differently future performance will be. This presents both concerns and opportunity. Concerns are warranted if the consequences of single and combined decisions are not robustly considered in terms of the long term relevance and usefulness of the science they precipitate. On the other hand, opportunity exists if looming constraints are viewed as a stimulus to accelerate the pace of innovation and efficiency. In either case, some movement toward structured planning over more than just the coming year or two was viewed by several panel members as a particularly valuable direction.

Collectively, the panel saw several places where accelerated and more rigorous consideration of exactly what and how much data are needed and the consequences of decisions concerning those choices should be considered. Three overarching themes emerged:

- Planning for an uncertain future in the face of constrained federal budgets
- The need to consider statistical basis for sampling designs
- Identification and maintenance of core capabilities

These concerns are expressed in a variety of ways across the individual reports while the following list of 12 items capture many of the most significant points.

Panel Findings of Greatest Concern

1. Maintain core capability to complete assessments with the existing data sources. Several panel members acknowledged and applauded the Center’s explicit intention to avoid degrading the quality of its science and maintain the flow of science input for the management of Alaskan groundfish fisheries.
2. While maintaining a focus on the priority noted above, the Center is encouraged to do so *with a more explicit understanding of exactly what data inputs and how much, are required*. This concern relates to both sample size and uncertainty in the collection of fishery dependent and independent data but also to the types of *environmental and ecological* data that offer the most promise to both provide contextual understanding, and the potential to relax the data demands in those other arenas.

3. The fishery independent surveys were described in terms of their purpose and application, but not so in terms of the underlying rationale for their design (including sample sizes). A more explicit characterization of what drives scope and extent would help understand not only why it is done in a certain way today, but also provide opportunity to reflect on whether the status quo approach should remain the way of the future.
4. The Center is in a defensive position as it tries to retain its core functions. This may be constraining the time and effort needed to seek innovations that could untimely lead to significant improvements and efficiencies. This issue was apparent in several presentations where ideas for creative new approaches were noted, but the majority were almost immediately dismissed for lack of resources or a clear acknowledgement of leadership support. While panel members recognized that this fiscal environment is not ideal for exploring new directions, several saw value in retaining or expanding at least some focus on particularly important new directions.
5. In the discussion of age determination, it was unclear what criteria are being used to determine sample sizes. The supplementary report given to the panel provided some information, but did not address two underlying questions. In light of diminishing age determination capacity, a) are all incoming requests supported by statistical power considerations as justification for sample size, and b) what criteria are being applied to judge the importance and relevance of requests that are not absolutely essential to the annual stock assessments based on age-structured models?
6. The industry is supporting some aspects of the Center's fishery dependent data collection, which panel members recognized as a creative and effective way to leverage federal dollars. One caution expressed, however, was that the demand for industry sponsored research may rise, but Center staffing capacity to address those needs may be unable to keep up, suggesting the need to manage expectations and consider priorities carefully.
7. The extensive communications among the various groups within the Center, and extending to the Region, the Council and constituent partners was widely viewed by panel members as a highly valuable aspect of AFSC's approach to the stock assessment process. The Center was encouraged to retain these features in their definition of "core function".
8. Many presentations highlighted an erosion of staff through both attrition and diminished staff support funding. Given the training and expertise needed to successfully perform many of the Center's functions, yet an increasing demand for those services, several panel members felt that more focused attention on

succession planning is essential. While the concern applies broadly to all aspects of the Center's data collection and processing, the risks were most obvious in the age determination presentation. It was not clear how quality of readings can be maintained with seasoned staff moving on and being replaced by various forms of temporary labor. On a more technical note, how the cross checking process addresses error or bias in the overall sample was not clear.

9. The acoustics work as a major component of the pollock surveys was widely viewed as a valuable and innovative research direction. Several panel members sensed that it offered considerable promise in even more ways than currently possible and wondered if efficiencies could be explored as a way to free up some capacity or, conversely how more value could be extracted from the current survey design (e.g., realizing a way to incorporate a forage survey as discussed).
10. The issue of how to address the "untrawlable bottom" problem resonated as one of the most significant issues raised. The need to address this issue was discussed, but none-the-less, it is unclear where this fits in the Center's relative prioritization going forward.
11. By design, every presentation highlighted successes and challenges and the panel members commonly acknowledged those items as both a reflection of expertise and awareness of what is yet to be solved. Interestingly, however, virtually all "success" examples were couched in either past performance or existing activities with little or no expression of their role in the future, or their ability to weather an uncertain future through flexibility or adaptation. Likewise, most "challenges" noted were associated with ongoing activities and little focus on how to grow, shrink or stay the same while remaining relevant. Because this was such a common pattern, it begs the question how much emphasis is being placed on strategic consideration of how each individual facet of the "core mission" may need to evolve over the long view.
12. The issue of priorities and how they are determined arose often in panel discussions. Specifically it was not clear whether any structured planning that incorporated relative costs and benefits underpinned annual decisions on what the Center would support each year. In essence, the panel could not grasp whether or not there was a clear *vision* for the Center. We heard described an annual guidance process that essentially requested proposals from across the Center, scored them according to qualitative criteria and prioritized more or less according to those scores. While this does represent an attempt to apply a consistent annual decision process, it is less clear how this incorporates a longer view and an understanding of the consequences such incremental decisions may have on future Center capabilities. In essence are decisions really being made in a tactical sense when strategic direction seems warranted?

AFSC Data Collections Science Program Review, August 26-30, 2013

Reviewer 1

General Remarks

Strengths

Alaska Fisheries Science Center (AFSC) has developed a comprehensive and informative data collection system of fishery-dependent, fishery-independent, biological and ecological data (see sections below) to support assessments of stocks managed by the North Pacific Fishery Management Council (NPFMC). The program has a cadre of scientific and technical professionals who are intelligent, articulate, and enthusiastic about their responsibilities and successfully develop the necessary data in a scientific and timely manner. Communication between those in the data collections units and the stock assessment unit is good. In addition, the data collections program provides information to NPFMC and NMFS Regional Office staff to inform the development of fishery management plan amendments. Many AFSC personnel attend NPFMC meetings and are involved in Plan Teams and the Scientific and Statistical Committee (SSC).

Over the last 30 years, stock assessments have become increasingly complex to provide more biological realism and greater precision in estimation of population parameters. The gold standard for current stock assessments is age- and length-structured assessment models, which integrate all relevant data sources and the population dynamics model containing parameters such as recruitment, natural and fishing mortality, gear selectivity and catchability, and reproductive parameters (maturity, fecundity, sex-ratio). Almost half of stock assessments use this gold standard, and more are expected. These models must specify the underlying statistical distributions describing uncertainties in the data sources; thus, it is imperative that data collections have a statistically sound sampling basis that leads to realistic depictions of uncertainty. Overall, the data collections program is making great strides in this area (with some caveats discussed below). These strides rest on innovative experiments and studies that validate the quality of the data and the validity of underlying assumptions. I congratulate AFSC staff for going beyond routine data collection to undertake these studies which should result in greater precision and accuracy in data.

Weaknesses

Documentation of and rationale for the sampling and/or experimental design for each data collection system needs to be improved. For bottom trawl surveys, the rationale or justification for the number of stations and their placement should be documented. For hydro-acoustic surveys the spacing between transects and the protocol for making trawls to obtain species and size composition should be specified. For both surveys, desired levels of precision for key data components should be set and used to justify the level of coverage. Similarly, desired sample sizes for aging to achieve specified levels of precision should be determined following methods along the lines of those found in Quinn and Deriso (1999, section 8.1) and Hulson et al. (in prep.). [This will probably need to be a collaborative effort with stock assessment scientists].

Due to freezes on hiring, AFSC has had to resort to use of contractors, post-docs, and students for various data collection activities. While this short-term solution is tolerable for now, it is not sustainable. All programs are losing FTE's due to retirement and relocation, which makes it more difficult for each data collection to achieve its goals. Experienced staff and recruitment of young professionals is necessary to keep a program successful.

Funding shortfalls have led to some cutbacks in survey effort (e.g., 60 stations instead of 80 in the recent bottom trawl survey in the Gulf of Alaska). Such a cutback creates a substantial decrease in precision and possibly some bias due to lack of consistency. The end result of continued cutbacks is likely to be reductions in levels of OFL, ABC, and TAC for many species due to this increased uncertainty.

Recommendations

The core activities in the survey, observer, and aging programs must be maintained, hopefully at current levels. Analyses of data needs mentioned above may result in efficiencies that allow for less effort, but the justification for a cutback should have a solid scientific basis. No new programs should be started to the detriment of core programs.

Document the loss of data quality due to failure to hire permanent FTE's and funding shortfalls. Enlist the aid of NPFMC to make such sure lost data quality is brought to the attention of the federal government.

Fishery-independent information

Strengths

Bottom trawl surveys have been conducted since the late 1970s: annually on the Bering Sea shelf, biennially in the Gulf of Alaska, periodically in the Aleutians, and occasionally on the Bering Sea slope, providing a long and consistent record of survey biomass and size and age composition that has been very useful in stock assessments. The surveys now follow NOAA-wide protocols developed in 2003. Not only are surveys done routinely but, experiments are done to better understand catchability and its components: availability and efficiency. Due to potential confounding of catchability and natural mortality, such experiments are useful in understanding results from stock assessments. Another key finding is that availability may be density-dependent, meaning that catchability is not constant over time, an assumption commonly made in stock assessments.

Acoustic-Trawl (AT) surveys are done in the Gulf of Alaska, Bering Sea, Bogoslof, Shelikof Strait, and in the Shumagin Islands. Several excellent studies have been done to examine (1) fish avoidance to ship noise, (2) species classification by frequency backscatter, (3) target strength refinement, (4) bias in MACE trawl selectivity, (5) higher resolution sampling of species with an open trawl net and video camera, and (6) automatic data processing of video. Improvements have been made in variance

estimation, communication with stock assessment scientists, by using acoustic data collected during annual trawl surveys to generate an additional abundance index (AVO), examining the use of moored echo-sounders, and dissemination of information via briefings presentations, reports and peer-reviewed publications. This is clearly a vibrant program that is paving new ground in understanding groundfish abundance and distribution.

A domestic sablefish survey for sablefish has been conducted since 1987, continuing a time series originated by Japanese scientists. The survey covers all habitat from British Columbia to the Aleutians and Bering Sea, and various improvements in coverage have been made. The survey is also used for rockfish, harks, and grenadiers. QA/QC is performed at sea, which makes it possible to have survey data made available quickly in time for stock assessment. Data summaries are reported on the web. This survey has resulted in a long, high-quality survey with small AFSC cost due to cost recovery of the fish caught during the survey.

Weaknesses

Catchability in bottom trawl surveys is generally not well understood. Factors such as availability, fish herding, fish avoidance, gear performance, and measurement errors can result in catchability being above or below 1. Stock assessment scientists often estimate catchability, either as a constant or with time variation, but Plan Team and SSC members have been reluctant to accept those estimates because reliability of the estimates is not well understood.

Regarding acoustic surveys, there is much uncertainty about spring spawning surveys, due to pollock in the Gulf of Alaska having spatial variability (hence the expansion to the Shumagins). Target strength is usually validated once and then left unchanged. Like bottom trawl surveys, catchability may not be constant over time.

Regarding the longline survey, the biggest problem is whale depredation of sablefish on survey gear. Catchability may vary over time due to hook competition, hyperstability, and a host of other factors. The survey has used fixed stations but whether total abundance is proportional to CPUE at these stations has not been evaluated.

Recommendations (see also General Remarks section above)

For all surveys, work with stock assessment scientists to determine if time-varying estimates of catchability perform well. In addition, field studies that examine factors affecting catchability should continue.

The biggest issue affecting bottom-trawl surveys is whether density estimates from trawlable habitat are the same as those from non-trawlable habitat, as is currently assumed. This assumption could be investigated using an underwater submersible with a video camera if visibility is good, or using an alternate gear type (longline, pot).

For bottom trawl surveys, it would be worth investigating if density-dependence of survey catchability can be estimated well, either internally in the stock assessment

model or through post hoc analysis of CPUE versus abundance estimates from the stock assessment model.

For the acoustic survey, I agree with the concept of establishing a total uncertainty model for acoustic estimates. It could be worthwhile to conduct an experiment to determine if a cost-effective, precise, and accurate index of zooplankton abundance using a 333 kHz sensor.

For the longline survey, continue to investigate methods to correct for whale depredation. Similar to bottom-trawl surveys, investigate whether hyperstability and/or gear saturation are statistically detectable.

Fishery-dependent information

1. Sablefish logbook program

Strengths

The sablefish assessment is the only NPFMC assessment to use logbooks, both as an index of abundance and as a means to apportion biomass into regions. The logbook program has excellent coverage. Industry is supportive because their data reflects their view of the status of the population. It also supplements the survey data because the fish occurs over a much longer time of the year in many regions.

Weaknesses

As the sablefish CPUE index is fishery-dependent, it may be influenced by changes in participation, gear, and operations over time, thus making the index not proportional to abundance and hyperstable. It costs money to operate the program that might otherwise be spent on sablefish research. The new changes to the observer program may have effects on comparability of the data to previous years.

Recommendations (see also General Remarks section above)

I agree that the most important new task for the sablefish logbook program is to perform standardization of CPUE for a variety of factors: year, season, vessel characteristics, region, etc. Also CPUE should be examined for hyperstability by comparison to abundance historically.

2. Observer program (Fisheries Monitoring and Analysis Division, FMA)

Strengths

The observer program is one of the most critical to provide fishery-dependent information about retained catch and its composition, discarded bycatch, prohibited species catch, fishing effort, and biological samples such as tissues and otoliths. The ability to estimate bycatch sets the Alaska region apart from most of the rest of the country by having real information. It results in estimates of total removals needed for stock assessment and in-season catch rates for in-season management. This is the first year under a new system in which NMFS randomizes the placement of observers on vessel trips; previously the vessel skipper contacted the observer contractor directly. For vessels with partial coverage (say 30%), this means that bias could occur due to

deliberate selection to avoid certain trips. Almost since its inception in 1990, there have been calls by the SSC and other scientists to randomize this coverage, so this is indeed a welcome change.

In the short time available to make the transition, the whole program has been revamped. The program is operational, the staff is making things work, and the program has the support of industry and NPFMC (with some naysayers from new program participants). Funding is mainly from industry (\$16-18M), with \$5M from NMFS. This provided for about 45,000 observer days, with 4500 days for vessels, which is very important in the Gulf. The staff have attempted to set up a transparent process, have set up an annual performance review, have reviewed and conducted special projects (as in the past), are considering advanced technology alternatives, and have developed a 3-person analytical team to put the program on a solid statistical basis for the first time. Operationally, observers are adaptable to different conditions and projects, there is a culture of safety as the top priority, and data are transferred quickly to the database. Many agencies use these data (NMFS, Alaska Dept. of Fish and Game, International Pacific Halibut Commission) and collaborations have been successful.

In addition to data from observers, logbooks are to be kept by all vessels. Catcher-processors, motherships, and shoreside plants must submit production reports. All of this information is combined to get catch and effort statistics and to perform quality control checks. Timeliness has been improved by advances in electronic reporting.

Weaknesses

The biggest challenge is the current hiring freeze and reduced funding. Future retirements of senior staff will jeopardize the continued operation of the program. Issues involving safety and support arise. Many objectives are given to the Observer program, which raises the issue about setting priorities. There are new technologies that should be evaluated. Some participants still have negative feelings about the program. The observer workload increases every year; nothing gets dropped.

Recommendations (see also General Remarks section above)

Continue to persevere with implementing the restructured observer program. Continue to work with enforcement personnel with safety and legal issues (NMFS Enforcement, Coast Guard). Set up processes for coordination among agencies and for setting priorities internally. Conduct outreach with disaffected parties to explain the program's objectives and how their data will be used. Conduct a critical evaluation of an observer's workload and drop or reduce projects if possible. Continue to refine the sampling design by examining stratification and trip selection algorithms. Continue to improve catch estimation by examining alternate estimators of catch and its variance and post-stratification of discards, eventually leading to specification of precision protocols tied to stock assessment precision.

3. Electronic monitoring

Strengths

NPFMC has long encouraged NMFS to look at electronic monitoring (EM) as an alternative or augmentation to get data from vessels that cannot carry an observer, being too small. Similar efforts to promote EM have been made by industry and Congressional

members. In response NMFS developed a Strategic Plan for electronic monitoring, which was adopted by NPFMC in June 2013. AFSC has established a program to look at what can be accomplished with electronic monitoring of the small boat fleet (40 – 57.5'). Preliminary results suggest that this is a promising technology with support for implementation and that improvements are occurring rapidly. An EM system on a vessel can collect effort and catch-per-unit effort (when total fishing time is known). There is an option to have a camera on board. Fisheries for which EM might be used include the trawl and longline fisheries for Pacific cod and the longline fisheries for sablefish and some rockfish species. In the future additional improvements are anticipated, such as other datasets, automated downloading, and a user interface for harvesters to do data entry.

Weaknesses

There is a possibly unrealistic expectation that EM can provide data of the same quality as the observer program. It will never be able to do this, but it may provide enough information to supplement the observer program sampling.

Recommendations

AFSC should continue to investigate the uses and limitations of EM. This is state-of-the-art work.

Biological and Ecological Data Collection

1. Age and Growth Unit

Strengths

The aging unit ages about 30,000 – 40,000 otoliths annually from more than 30 species in the North Pacific. These ages are critical for age-structured stock assessment models. The unit has developed a web-based sample request and prioritization process, in which requests are submitted in January-February and the age data are available by the end of September. There is an age determination manual to ensure consistency in ageing and to reduce age reader effects. The staff is well-trained, the process for ageing requests is transparent, and IT support is good. Age unit personnel regularly participate in meetings of the Committee of Age Reading Experts, with representatives from many agencies and departments. Some staff members carry out age validation experiments to assure that aging is done reliably.

Weaknesses

There is a shortage of 3 FTE's and a hiring freeze. The number of otoliths being requested for aging has grown to over 50,000. There is increased interest in non-target species, which requires that aging standards first be developed and approved. As a result, some requests cannot be processed in a year. It was not clear how the prioritization is accomplished or whether there is ample justification for the number of otoliths to age.

Recommendations

AFSC is using contractors and students to fill in for unfilled FTE's. While this temporary solution may be necessary for now, it probably weakens the quality of the data. This solution should be abandoned as soon as feasible, and high priority should be given to hiring experienced age readers. In the meantime, the quality control procedures that govern the use of contractors and students for aging should be documented. It is also possible that some age validation work can be shifted to Universities, in which students would be supervised by a professor.

As mentioned in General Comments above, it is not clear that sample size for aging has a solid statistical basis. Initial determination is simple using two-stage cluster-sampling (Quinn and Deriso 1999). The next step would be to include additional variance due to ageing error. A more complex approach would also account for process errors (Hulson et al. *in prep.*) Earlier work on sample size requirements by Volstad et al. should also be consulted. Sample size determination for selected species would also be a good thesis topic for a graduate student at a University.

2. Food habits (stomach sampling)

Strengths

Food habits data are used to fulfill assessment and agency needs, short-term studies, and research on predator-prey interactions generally and in multi-species models. The data come from the observer program and are processed by contractors. The program also contains 2 senior analysts and 1 database specialist, 1 modeler, and 2 post-docs. An astounding number of stomachs (12,000 – 20,000) are analyzed annually, for a total collection of about 400,000 since 1982, one of the largest in the world. Several publications have resulted from this information and there are good relations with assessment scientists and stakeholders.

Weaknesses

Data are only collected in the summer, meaning that any seasonal shifts in diet cannot be detected. There is limited funding for this program, and limited modeler capabilities. Because of the high number of predator-prey interactions that vary by age of both predator and prey, the seemingly large sample size actually results in sparse data matrices of predator consumption of prey. Whether a large enough sample size could ever be collected to meet typical precision requirements is an open question.

Recommendations

Partner with agencies and Universities that do non-summer research cruises. Continue to make advances in multi-species (and ecosystem) modeling that highlight the utility of food habits data.

3. Maturity and reproductive information

Strengths

Maturity (and fecundity) information is critical for groundfish and crab stocks in order to develop a measure of reproductive potential (such as spawning biomass). Both visual and histological methods have been developed. The key is to collect data during peak spawning time in which it is easier to determine maturity and female gonads with eggs can be collected. This type of study has led to many graduate student theses.

Weaknesses

Studies have shown that peak spawning time varies by year, so that maturity may be time-varying as well. The level of variation is not understood. As a consequence, biased estimates of spawning stock biomass could occur if time-varying maturity is not accounted for.

Recommendations

AFSC should develop a protocol for when to collect new maturity data for each species, starting from the data availability table in Hollowed's presentation. Continue research to examine validation protocols and work with harvesters to ensure that specimens can be properly stored (some harvesters don't want formalin on deck).

4. Ecosystem studies

Strengths

The Stock Assessment and Fishery Evaluation document contains a chapter that summarizes environmental information and highlights recent trends. In addition, each stock assessment author has a section in the individual species assessment that describes environmental effects that may affect that species. In at least one assessment, results from the ecosystem model Ecosim are presented for contrast with the single-species assessment.

AFSC has also been heavily involved in process studies, two of which are funded by NPRB (one of these has funding from NSF too): BSIERP and GOAIERP, integrated ecosystem research projects in the Bering Sea and Gulf of Alaska. There is also a funding program called Fisheries and the Environment (FATE) for doing research on environmental variables that could affect a fish population and its biological reference points. The main point is that AFSC is on the forefront of research activities to move toward ecosystem-based fisheries management.

Weaknesses

AFSC scientists are spread very thin in doing research in three main areas (Bering Sea, Aleutians, and Gulf of Alaska) and now new initiatives are being developed in the Arctic. There is a need to prioritize research by AFSC scientists, to decide whether it will be long-term or short-term, and establish priorities across areas. This is especially true because future government funding and hiring of personnel is not likely to increase, at least in the near future.

Recommendations

In light of funding and personnel limits, AFSC should increase its work with its partners (PMEL, universities, ADF&G, USFWS). Process studies cannot be limited to one area. The factors affecting fish in the Bering Sea are likely to be different than those in the Gulf of Alaska, Aleutian Islands, and the Arctic.

Data Adequacy for Stock Assessments

Strengths

It is clear from the above dissection of AFSC programs that AFSC is doing a superb job of collecting the data needed for stock assessments. Some AFSC assessments are better than most assessments around the world. That AFSC can provide the information necessary to annually determine ABC and OFL for 51 stocks of groundfish and 4 stocks of crab is the best performance of agencies with stock assessments in the world. AFSC probably does a better job of determining total removals by fisheries, especially including discards, thanks to its 34 year old observer program and total catch accounting system. While most assessment scientists feel that they could use more information, the amount of information they receive is incredible compared to that from terrestrial systems or even marine mammals. Still, improvements in data collection can make a difference in the quality of stock assessments, and scientists should continually probe or propose new sources of information that could be useful.

Weaknesses

I highlight two weaknesses in data collection at AFSC. First I agree with presenter Ianelli that one weakness is that not all concerns with an individual stock assessment can be addressed from one year to the next. Sometimes the requests are too extensive to be done; other times there are too many requests to investigate. However, each stock assessment author must address previous Plan Team and SSC comments in the SAFE document and explain what progress has been made or is planned for the future. I believe that most assessment authors are conscientious about their responsibilities and do their best to make improvements.

The second weakness is that understanding the connection between data quality and assessment quality in terms of accuracy and precision is not well understood (see General Comments).

Recommendations

This evaluation of the connection of data and assessment quality should be done as a joint exercise between assessment authors and data collection personnel to see if the amount of data in the various datasets being collected is too much, too little or just right.

Review of the Alaska Fisheries Science Center Program for Data Acquisition for the Annual Stock Assessment Process

Conducted August 26-30, 2013 in Seattle Washington

Reviewer 2

Before the commencement of the Review, the Review Committee was informed that “The goals of NMFS Science Reviews are to:

- Ensure that NMFS research is scientifically rigorous, relevant and effective
- Integrate NMFS science across the Science Centers and the Office of Science and Technology (ST).
- Enhance strategic planning of NMFS science at the agency level
- Optimize coordination and utilization of resources for NMFS science
- Illustrate the benefit of NMFS science to stakeholders and the public.”

To implement these goals, we were provided with copies of recent CIE reviews, background material on the relevant work conducted at the Alaska Fisheries Science Center (AFSC), access to recent peer-reviewed publications and copies of the presentations provided to the Review Committee by AFSC staff. As the Review process unfolded, it became clear to this reviewer that we were to be in a position to comment on the quality and effectiveness of the science done at the AFSC (Goal 1 above), and the processes used for prioritizing and planning in a period of declining budgets (Goal 4 above), but that we were not going to be able to address Goals 2 and 3. Goal 5 was addressed indirectly through evaluation and discussion of the effectiveness of the stock assessments provided to the North Pacific Fishery Management Council. This report is organized in four sections: 1) Summary of major Points, 2) Evaluation of Fishery Independent Surveys, 3) Evaluation of Fishery Dependent Surveys, 4) Other Biological and Ecological data streams developed from either of both of the above survey types.

Summary of major points:

1) The quality, quantity and timeliness of survey data provide to the Assessment Teams and Authors is generally excellent and state-of-the-art. From the perspective of a North Pacific Fishery Management Council Scientific and Statistical Committee member, the resulting stock assessments are of top quality and have provided the means of maintaining well-managed fisheries in the waters off Alaska. **Going forward, it will be critical to maintain the high quality and completeness of data acquisition required to support the assessment process.**

2) The survey methods have been under continuous evaluation, and there has been incremental improvement of survey quality. That said, there appears to have been little effort expended in assessing quantitatively the design of surveys and the sampling effort needed to achieve a desired level of precision in the data provided to the assessment authors. In an era of uncertain and declining budgets, **it would seem prudent to**

evaluate quantitatively the survey effort required to achieve the desired goals, and the numbers and types of biological and ecological data required to support high quality assessment products.

3) With the exception of the BASIS surveys (not presented or reviewed here), there appears to be minimal standardized collection of data on the biological environment of the fish and shellfish being surveyed and assessed. Time series of fish stocks do not occur in an unchanging environment and require ecological data for their interpretation. Additionally, there are now requirements that fisheries management explicitly include an ecosystem context. It would be useful to **evaluate the types, quality and quantity of environmental data required to support stewardship of the managed marine environments and add the acquisition of the appropriate data to the overall survey program.**

Fishery Independent Surveys and Data Sources:

The AFSC conducts a variety of fishery-independent surveys to assess the stocks of fish and crab in the waters off Alaska. These surveys include bottom-trawl surveys in the Bering Sea, Aleutian Islands and Gulf of Alaska, Acoustic-trawl surveys, and long line surveys. The data resulting from these surveys are of sufficiently high quality to support an excellent and timely stock assessment program. The result has been the successful management of groundfish and most crab stocks off Alaska by the North Pacific Fishery Management Council. A striking indication of the quality of these assessments is that not only fishery scientists, but also the fishing industry, the environmental community, and the general public has an explicit trust and satisfaction in the quality and timeliness of the scientific data provide by the AFSC to the North Pacific Fishery Management Council. An additional mark of the respect with which the AFSC data and assessments are held is the fact that the Council has never overruled the SSC on the setting of the Allowable Biological Catch.

Although the overall survey design for the fishery-independent surveys was set in the 1980s, there have been considerable improvements in the data on the size of the opening of the nets used, as well as experimental studies on net efficiency. However, there appear to have been relatively few quantitative studies as to how the variance of stock estimates might be affected by changes in the frequency of surveys (annual, biennial, triennial), extent of surveys, the use of a randomized sampling design rather than a standardized design, and changes in the length of tows, among other survey attributes. An issue repeated brought up by the CIE reviewers was the possibility that species of importance to the survey and assessment process have a portion of their biomass outside the bottom-trawl survey area. This may also require consideration.

The assessments of rock fish, especially in the GOA and the Aleutian Islands, are impeded by the presence of untrawlable regions and a lack of knowledge of bottom types. The maps of trawlable and untrawlable bottom types presented to the Review Committee contained a great many areas (blocks) where bottom type was apparently unknown. Is it possible that either observed or unobserved trawls by industry could be used to reduce the proportion of unknown bottom types? There is need for more information on bottom

types, and for the development of methods for assessing stocks within untrawlable habitats.

As long as funding is adequate, and the survey program yields sufficient data of sufficient quality to support the assessment process, it might be argued that the status quo is working well and thus leave it alone. However, budgets are uncertain at best, and likely to continue to decline. Reduced funding has already resulted in decreases in survey effort in the 2013 Gulf of Alaska trawl survey and it is likely that further funding decreases will result in insufficient support for the present survey program. Changes will be forced, possibly without much time for a statistically valid assessment of the consequences. It would seem prudent to use the present comprehensive survey efforts to evaluate statistically the implications of a possible reduction or change in the scope and thoroughness of the survey program, including the evaluation of ecological data (bottom temperatures, zooplankton composition and abundance, mixed layer depth, etc). It would also be good to accelerate the adoption of new technologies (acoustic surveys, upward-looking moored acoustic instruments, gliders, etc.) as means of gathering data more efficiently and over a greater seasonal range than is possible on ship-based surveys alone.

If there is a reduction of the confidence that can be placed in the survey products, these uncertainties will translate through the assessment process to greater buffers between Allowable Biological Catches and Annual Catch Limits and Overfishing Limits. Thus, increased uncertainty will lead directly to leaving more fish in the water and reduced opportunities for industry.

Industry-Dependent Surveys

Industry-dependent surveys include the information gathered by the observer program, catch statistics and fish tickets, etc. These data are essential for both in-season management and for assessing fishing mortality. There have been concerns about the adequacy of the observer program, in particular the former practice of allowing captains to select the trips on which they would carry observers. A revamping of the observer program has led to considerable improvements, though there is apparently push-back from industry of having 2-3 month deployments of observers on some of the smaller boats (this is not an issue on the larger vessels on which there is 100% to 200% observer coverage). The randomization effort has put the whole data set on a much firmer statistical basis. The data from the observer program is vital to the management of the fisheries, and these data are of very high quality, especially considering all of the tasks required of the observers and the conditions under which they must work.

The records of bycatch, prohibited species catch, and the biological sampling of the catch, in addition to the basic job of assessing the catch, are all of critical importance. As the work load continues to increase with increased interest in age-structured assessments, genetic studies of stock structure and the origins of salmon in prohibited species catch, the demands on the observers are beginning to exceed what can practically be accomplished without inducing burnout and degradation of data quality. There is thus a need to assess quantitatively the spatial distribution and numbers of samples of various sorts required to accomplish the mission. In a situation with limited resources, over-

collection of data can be as damaging to the program as a whole as under-collection of data. A statistically-based optimization of sampling effort should be explored for all data streams dependent of the observer program.

Other Biological and Ecological Data:

In addition to the Industry-Independent and Industry-Dependent Surveys of groundfish and crab, the AFSC collects or develops data streams on the ages and stomach contents of fish in the trawl-survey and the fishery (via the observer program), genetic structure of the stocks and of the prohibited species catch, and some environmental variables such as bottom temperatures (from instruments attached to the bottom trawls), and euphausiids (krill), as detected using high frequency acoustic survey techniques. These data, where and when gathered, are of high quality. Some of these data go directly into the assessment equations (age of fish in the stock and in the fishery), while others are just beginning to be incorporated into assessments (bottom temperatures as a co-variate of availability of some flatfish to the trawl survey). Others do not seem to be used in the assessment process (stomach contents).

Recent work in the extensive Bering Sea Project has also shown that early spring conditions can affect the abundance of key zooplankton prey species. The BASIS program has shown that the overwinter survival of age-0 and age-1 pollock is affected by the summer availability of lipid-rich large crustacean zooplankton that affects the energy content of the juvenile pollock. At present, the SAFE document for EBS pollock provides no data for age-1 pollock (last given in 2007, when all were assigned 0.007 kg). It could be useful to obtain and report actual weights of age-1 and age-2 pollock caught in the bottom-trawl and Acoustic Trawl Surveys. This information, in addition to appropriate zooplankton data, could then be used to develop quantitative predictions of the survival of pollock to age-2 or 3, which could be a valuable improvement to the EBS pollock assessment. Elsewhere in the United States, where the appropriate zooplankton data have been gathered, they have proven to be of value in assessments and in understanding and predicting inter-annual variability.

Although a superb Ecosystem Considerations SAFE is prepared yearly and is presented at the SSC meeting in advance of the annual setting of ABCs, it remains unclear to what extent the fisheries off Alaska are managed in a truly ecosystem context. Certainly bycatch and prohibited species catch are taken into account, but for the most part, it seems as if the broader ecosystem components may not be taken into account except when they rise to the level of endangered or formally protected species, (e.g. marine mammals, especially Steller Sea Lion). Perhaps there are more studies and time series available than were presented at this review, and that the role of environmental data in the fisheries' management process will become more clear when these data are presented at a subsequent review. However, at present it seems that more and better use could be made of environmental and biological data in the management of the fisheries off Alaska.

AFSC Data Program Review

Reviewer 3

General Observations

I want to commend the Center for a well-organized program review. It is very clear that the Alaska Center has a comprehensive set of surveys and fishery dependent data collections that currently supports high quality stock assessments for management of fisheries in Alaska; however, it was abundantly clear that constrained resources and the high likelihood of constrained resources in the future could potentially lead to a decrease in data quality and increase the uncertainty when providing scientific advice for annual catch limits as required under the Magnuson Stevens Act. This is not unique to the Alaska Center but pervades across the Science Centers of NMFS. It was also clear that Center leadership and staff recognize these potential impacts and have taken initial steps to proactively address them. Nonetheless, it will be important for the Center to take the next step in taking a more in-depth and quantitative assessment of the tradeoffs for different options for responding to the constraints while minimizing any degradation in data quality of core surveys.

It is important to also note that Center scientists are very strong contributors, if not leaders, in increasing understanding of how Alaskan ecosystems are responding to climate variability and change. The FOCI program is an excellent example of using interdisciplinary partnership and consistent support of investigations to address ecosystem response to climate and identify mechanisms. With constrained resources there is a real risk that collections of environmental data, both physical and biological, will be reduced or eliminated to maintain core surveys of FMP-managed species. With climate change the loss of such data could compromise significantly the ability to interpret fishery survey data in the future.

I also want to commend the Center on the overall structure, conduct and background material for this review. The presentations were at the right level. They were comprehensive on 'why' a particular topic was important to mission, sufficiently detailed on 'how' data was collected, processed and analyzed for use in stock assessments, but not too deep into the details of any individual step in the process. Moreover, I commend all presenters for the clarity of presentation and for straightforwardly answering the panel's questions.

Fishery Independent Data

The suite of fishery independent surveys form what appears to be adequate survey capability to meet the core needs of SAs for FMP-managed species in the Gulf of Alaska, Bering Sea and Aleutian Islands. The Center also has taken steps to adjust surveys to meet the realities of reduced DAS on NOAA ships and overall budget constraints. There is some concern that the staff are putting in extra effort to maintain current survey capacity and that this increased effort may not be sustainable over the long term. The panel heard of efforts to carry quantitative assessments of the tradeoffs for different options in reducing overall survey effort in individual surveys. I strongly encourage the Center to continue these assessment efforts. It will be important to 'think outside the

box' as far as the potential options for adapting to the new resource constrained reality. It is a real possibility that given the constraints, maintaining the status quo in conducting the current set of surveys will not be viable. It is therefore important that in the assessment of options that a wide range of options is evaluated. These efforts are also important because it is my strong recommendation and endorsement of the Center's leadership priority to maintain the time series for the surveys that are critical to the stock assessments for FMP managed species.

My specific suggestions are as follows: 1) while very difficult, there must be continued work to address the issue of surveying untrawlable habitat and I encourage the Alaska Center consider offering leadership in developing a cross-Center effort on the untrawlable habitat issue, 2) I strongly support continued consideration of adding an acoustic survey component to the current bottom trawl survey. Conducting joint surveys is one of the most viable options to respond to reduced DAS and reduced/constrained funding for charters, 3) The acoustics team at the Center is clearly a leader in evaluating new acoustics technology and in evaluating existing technology and configurations to collect additional information on target species and non-target species, such as prey field. I encourage the team here to reach out more to the other Centers to engage acoustics teams in joint efforts such as on the use of the Cam-Trawl in acoustic surveys as well as of moored echosensors to supplement ship board surveys. In addition, I recommend that additional work on the complex and difficult issue of finding ways to move from a 'mow the lawn' survey design to one that allows stratified sampling, i.e., the ability to focus transects in areas where there is high probability of aggregations of target species. The last recommendation is made in recognition that acoustics technology has that ability to further support process studies and to acquire important data on prey. However, the current 'mow the lawn' survey design limits the ability to optimally use limited DAS to conduct the survey while also collecting valuable ancillary information. It would be of great value to find a means to more efficiently use DAS to carry out multi-mission acoustics surveys. 4) The longline survey for sablefish is an excellent example of cooperative survey with industry that allows a million dollar survey to be conducted at a cost of approximately \$125 K to the Center. The killer whale depredation issue poses a real threat, however, to the continuation of the survey if not resolved. Because of the value of the survey and its cost effective nature a favorable resolution on the use of pingers to deter killer whale depredation is of mission critical value to the Alaska Region in effectively managing the sablefish fishery. 5) Finally, my only comment on the value of a survey is in regard to the slope survey. First, I recognize that the slope survey is the only source of data for slope species; however, it appeared from the presentation that the value of the survey to stock assessments for FMP managed species was minimal. I recommend that at a minimum a better articulation is made of the value of the slope survey to managed species, or that there be an evaluation of both the spatial and temporal intensity of this survey. In other words is this survey a candidate to be reduced in spatial and temporal coverage if resources for core survey are further constrained?

Fishery Dependent Data

The unique nature of the level of industry support for the Center's observer program is noteworthy, and the program and Center are to be commended for taking full advantage of this partnership and for skillfully adapting to directives for a restructured observer program. I also commend the observer program for instituting a rigorous annual performance review to constantly improve the collection and value of fishery dependent data. I, therefore, recommend that the observer program continue to revise and improve the annual performance review process and consider reaching out to other NMFS Science Centers, if they have not already, to transfer lessons learned to the other observer programs. A concern was raised when I heard that the data requests will never go away and that the demands for additional data or products will continue to increase. I acknowledge this reality of constituents wanting more. But under a situation of constrained resources there is a real limit of 'doing more with less', and I strongly encourage an assessment by the observer program and Center leadership in defining the limit on what the program can deliver with stable or decreasing agency funding and current staffing levels and capabilities. Such an exercise would be essential to managing any expectations of continuing increase in delivery of products and services when there will be a real cap on delivery it would appear given constraints.

More specifically I recommend continued support and development of eLandings as a good approach to increasing the accuracy and timeliness of delivery of data for management as well as aiding in reducing redundant reporting. Furthermore, in regard to the efforts on the electronic monitoring and reporting the Center has taken a leadership role in evaluating how video and other technologies can be incorporated into fishery dependent systems. The development of a strategic plan and implementation plan were important steps in gaining agreement and mutual understanding of the Council action and direction to be taken to respond to the action. Managing expectations and consistent communication to maintain and further mutual understanding of the options and constraints of electronic monitoring techniques as new tools in the tool box of observing fisheries will be important. I am not saying this is not being done well, but rather that it is an area needing constant attention.

While I see the potential for EFIS as an advance in electronic reporting it was not clear whether this is solely Alaska Center initiative or Center response to constituent needs. It appears to be the former and if this is the situation then I recommend more involvement of social scientists and economists at the Center to provide analyses or possible savings of industry adopting the technology before too much additional work is carried out in developing the system. The risk is that there is considerable investment in R&D and little acceptance by the industry to adopt EFIS.

Biological and Ecological Data

For this major section of the review I will provide my comments by subtopic.

Age and Growth – It is clear that the program providing age data to support age-structured stock assessments is meeting the base need for assessments, has a strong QC program, is supportive of a coast-wide collaboration among all labs to share techniques

and perform cross-laboratory QC programs, and seriously addresses data quality and timely and accurate data delivery. It was noted that the lab has lost staff and that there are potential future retirements that could lead to a loss of age reading capacity and potentially a decrease in data quality. This is a consequence of decreases in budget and the current hiring freeze. Maintaining data quality and a base level of otoliths aged annually will be very important to maintaining stock assessment quality. The constraints on budget and backfilling for retirements will very likely continue. I recommend that 1) the program conduct an assessment of potential future staffing scenarios (level and decreasing) and the implications for the annual production of otoliths aged (e.g., option A – 10, 000 ages/year, option B – 20,000/year, etc.). It would appear from the presentation that the likelihood of maintaining the current production schedule is not high; doing this analysis will be critical in developing criteria to allocate that production to stock assessments. Moreover, I encourage additional collaboration between the ageing lab, survey scientists and stock assessment scientists to continue to tackle the issue of altering sample collection and stock assessment age need to reduce the number of aged otoliths for meeting the base need of a stock assessment. I acknowledge this is a tough problem, but given the circumstances it would appear to deserve continued attention.

REEM Biological Sampling (food habits) – The food habits program has collected and is continuing to collect an impressive time series on prey and predators, has effectively been coupled with ecosystem modeling, has used the model outputs to prioritize sample collection and processing and is conducting both at-sea and in-lab analyses of stomachs. The data generated have clearly been of value to the stock assessment scientists even though not used directly in the assessments. The approach that the Center is currently taking in supporting this program as far as funds and FTEs is appropriate in the current budget climate and should allow continuation of the program while maintaining critical mass of core positions of two senior analysts and a database specialist. I concur with the need to develop partnerships for both collecting non-summer samples and in getting samples from non-groundfish species.

Maturity Schedules – The presentation on maturity was a good example of the value of research on biological/physiological parameters that can have a significant effect on the quality of a stock assessment. A number of challenges were highlighted and the research to validate the use of visual scans by observers for assessing reproductive maturity as a means to get needed data demonstrates innovation to address obstacles. Investigations of this type further highlight that challenges the Center faces in prioritizing the allocation of staff and resources as budget constraints continue for at least the next few years. To pose the challenge as a question – Is the Center's current prioritization scheme for projects/activities sufficiently robust and quantitative to determine the impact of funding or not funding a project such as determining interannual variability of maturity on the quality of stock assessments? In other words, given two projects of comparable scale and scope of investigating maturity schedules is the prioritization sufficiently objective to allow for an accurate prioritization?

Ecosystem Studies – The section of the program review directly gets to the issue of relative balance between conducting process studies/mechanistic studies and

maintaining the current high quality and diversity of surveys directly feeding stock assessments. Developing partnerships as demonstrated by the Alaska Center to conduct process studies on the scale needed to have substantive impact in stock assessments or as high value strategic advice that is valued and used in decision making is a very viable if not the only real option for conducting process studies at the scale needed to inform fishery management through the Council process. The information presented on BSIERP, for example, clearly showed the value of hypothesis driven interdisciplinary research to discern ecosystem scale mechanisms governing productivity that have clear application to improved fishery management. Moreover, I concur with Center leadership priority to give a high priority to continuing BASIS (Bering Arctic Subarctic Integrated Survey) as an important process survey.

Data Adequacy – This presentation highlighted successes and challenges in how data quality and timeliness impacts overall stock assessment quality. A great deal of information was presented and a number of good examples of how high quality data had a positive effect on stock assessment quality. The information presented provided additional support for further exploring adding an acoustic survey component to the bottom trawl survey.

AFSC Science Program Review

Reviewer 4

Center wide Overview

The Alaska Fisheries Science Center (AFSC) has five Large Marine Ecosystems that they oversee and have emphasized two core research foci: 1) Support assessments required for the current North Pacific Fishery Management Council (NPFMC) tiers for fish, crab, and marine mammal Stocks, and 2) Provide information to the NPFMC and Alaska Regional Office (AKR) to for management decisions, to support quota monitoring, and for legal and regulatory analyses. This review panel was asked to evaluate the fishery independent and the fishery dependent data that are used to support these two core research foci.

Fishery Independent Data

Strengths

The AFSC fishery independent survey programs comprise a set of vigorous long-term data collection activities that sample across multiple marine habitats and species' life history stages that assist in developing indices of abundance that track critical changes in stock abundance in both a temporal and spatial setting.

The AFSC fishery independent data collection presentations identified several strengths and challenges to each of the programs. In most discussions proposed solutions were offered to the panel. Some of the general strengths identified included such things as: most assessments were accomplished through plan development teams that allow for participation by the various survey groups, individual survey priorities were also set up group involvement, and the ability for rapid availability of the data following the survey since the timing for the assessments is an annual process that has set times to be accomplished by the AFSC. I was impressed by the excessive communication between individuals involved in the design and implementation of the surveys and the individuals overseeing the planning and prosecution of the assessments. Many of the

survey groups have established annual coordination meetings with the assessment group to discuss accomplishments, challenges, and to set the sampling priorities for the next season. I would highly recommend that these coordination meetings continue. They are of great value to the AFSC and allow the surveys to continue their exceptional data quality.

The acoustic team showed the current methods that are being used for the surveys. They discussed the deployment of a multiple opening and closing codend device that seems to show great promise for the survey results. I was impressed by the team's ability to look for technological advancements while still meeting the data collection goals of the survey.

All the fishery independent survey groups are starting to update their database interfaces for the survey data storage. This should give the AFSC better and quicker access to the data, and allow for more rapid analysis of the data following its collection. I encourage the AFSC to continue to develop these advances in their databases.

Challenges / Solutions

Some of the general self-identified challenges outlined by the presentations included: limited number of sea days (weather- or vessel-related interruptions), expected decreases in number of sea days, untrawlable habitat because of lack of good sediment or bottom type maps, inability to determine or estimate catchability coefficient of the sampling nets, sample processing time, complex data structure, and limited geographic coverage.

With regards to data output from the surveys it was apparent during the discussions that there was the need for very rapid turn around of the survey data for use in the stock assessments. While this allows the assessment to go forward in a timely manner there was the sense that this rapid turn around did not allow for effective error checking of the data. The AFSC needs to continue to develop automated error checking software to help this situation. Also, the trawl survey was still using paper logs to work up their data from the stations. It is recommended that they continue to develop and being the migration into electronic data collection methods to speed up the process and avoid potential data entry errors.

In the trawl survey, the untrawlable bottom is a very critical issue. The big question becomes – do the fish occur at the same abundance as in the trawlable habitat? The indication during the presentation was that there were no good bathymetry maps available. Getting these maps could help to overcome this issue. External partners may be able to help to get the necessary data to complete these benthic maps. The AFSC should continue to build on its partnerships with NOAA NOS, and the USGS to advance benthic-mapping support. Also, the AFSC should look at using the Acoustic survey or other types of sampling gear (i.e., cameras) in these untrawlable locations for comparison with trawlable areas.

As budget and personnel are decreasing, it is important for the AFSC to determine which surveys or survey stations have priority over others. Since any changes in survey design could cause the variance and bias to increase, these changes need to be statistically evaluated before decisions are made by the AFSC.

All of the fishery independent surveys are accomplished each year. Yet, there seemed to be little time for research efforts on new equipment and other areas of important research (i.e., experimental estimation of q). The AFSC needs to develop effect plans to continue to collect the core data that is critical for the assessment, but still allow for the experimental research that is critical to keeping the survey's quality data gathering tools both cost effective and up to date with technology.

Loss of personnel is starting to become an issue with getting the surveys accomplished and still allowing for the necessary pre and post survey preparations. Some individuals are required to do more days at sea and this is causing a loss in their ability to do the onshore work necessary for data analysis and survey preparation. This is an area that the AFSC will need to develop an action plan.

Fishery Dependent Data

Strengths

From the information provided to the panel within this scientific review, the AFSC seemed well aware of the any data deficiencies and weakness to

timely reporting within the complex of the fishery dependent data collections systems.

The AFSC has just undergone an intense restructuring of the offshore observer program. Sectors of the fleet that were not covered in the past are now being covered and a good statistically sound sampling design for observer deployment was developed by the program. The halibut fishery is also included in the experimental design. This observer program restructuring is a major accomplishment and will allow for better statistically valid data to be collected by the program with the new fully randomized sampling design. It was also pointed out in the presentation that both AFSC scientific and OLE program outreach was very important in helping the sectors move into this new restructured program.

The industry pays for observer travel and salary in both the full coverage and partial coverage fleets. The AFSC has a long history of cooperation with most of industry in this area. This cooperative nature helped in moving the program restructuring effort along over the past year.

The observer program has developed an observer science team to look at the performance of the observer program. This team is used to review observer deployment, data access, and data quality. The team also provides a logical approach to implementing changes to the program. The members of the team are selected from those that work with the observer data – both in the collection of the data and the use of the data. This science review team methodology is excellent and should be retained by the AFSC.

The AKR uses the observer data to estimate total catch for the fisheries. Comprehensive databases developed by the program were designed for timely estimates to support effect in-season management of the various species. There are exceptional well-established interactions and links between AKR and AFSC, and these interactions need to be maintained by the program.

The presentations demonstrated that the AFSC is moving into the area of electronic monitoring (EM) and electronic reporting (ER) of data.

Electronically submitted data by vessels (i.e., eLanding, Atlas, Elog, Eticket) are beginning to allow interagency access to all the data in a short period of time. The AFSC has a FTE that is assigned to the development and oversight of the EM/ER program. This is a wise investment of personnel.

Challenges / Solutions

The sablefish assessment fits a CPUE index using data from a self-report logbook. During the presentation AFSC scientists raised potential issues with the data including possible under reporting of the catch and limited data on discards. No solutions to this issue were offered by the AFSC. The AFSC need to look for solutions for this potential issue.

Observers are not under direct NMFS contract and thus not under NMFS control. This can make management of the program a struggle for the staff. While the restructuring of the program helped in sampling design development, it did not address any potential observer contract issues that may be present at the AFSC.

The interaction between the AFSC observer programs and the NPFMC seem very complex. NPFMC demands of observer analytics are now reported to be “continuous”. The program must develop mechanisms to prioritize the demands that are being placed on the program staff. While I am sure there are some, none were offered during the presentations.

Tender vessels (i.e., vessel that off load catch to another vessel that lands the catch) operations seem to be a loophole in the observer deployment system, since a vessel that does not land does not need an observer. This potential issue needs to be addressed by the observer program to allow for these vessels to receive the necessary coverage levels developed by the observer program.

At the October 2012 NPFMC meeting a motion was presented that recommended NOAA Fisheries report to them on EM options that may be appropriate to replace or supplement human observers on the vessels. While the AFSC seems to be making considerable progress in this area, development of EM should not be rushed. Choosing EM has long-term implications such as lack of agreement on monitoring objectives, data

needs, and priorities. In many cases information demands can exceed the capacity of people or EM (i.e., unconstrained by reality). At the present time there are no operational video monitoring programs in NMFS-managed fisheries where data extracted from video are used for science or management purposes. The reasons for this include such things as the inability to accurately identify species, weights and biological samples cannot be obtained, and length of time required obtaining and reviewing video. Development of EM/ER integration takes time and must be a scientific process. OLE also needs to be involved in the developmental process. In it's current state, the presentation showed that AFSC feels that EM deployment on vessels would degrade the statistical results of the observer data.

Other Supporting Data

Strengths

The goals of the ecological process studies are to develop and address questions to better understand weaknesses in the assessment (i.e., temperature-catchability model for yellowfin sole). The AFSC is actively involved in several FATE projects to address these potential questions. Currently there are a couple of assessments that are able to use the environmental data.

The food habit studies group seems to have a good direct collaboration with modelers. The food habit group has over 30 years of data for long-range ecosystem monitoring, and they are able to annually process 12,000-20,000 stomachs (i.e., processing rate depends on species).

Maturity schedules are a critical input into the assessment models. The AFSC has started to have observers begin to collect these data. This collection activity should continue.

Challenges / Solutions

There are a great many stock assessments overseen by the scientists at the AFSC, but with that high number there are limitation to develop and address all concerns regarding assessments. This will be the discussion at the next review.

Ageing prioritization is based on NOAA Fisheries missions and NPFMC tier system. Ageing that is mission critical are accomplished first. There is a well-developed and expert staff in the ageing laboratory, but there seems to be little ability to move long-term agers into the laboratory to help as these individuals begin to leave the agency. Thought should be given to how these replacements will occur.

Overall Summary

The AFSC has done an excellent job in documenting their scientific data collection programs and activities that are used as input for the assessment of their managed stocks. The AFSC provided the review materials in a very logical and organized manner that has allowed individuals with somewhat limited knowledge of their programs to grasp the complexity of their missions and core activities.

The AFSC has a current budget around \$63KK, which is down from \$68KK. They have lost about 50 FTEs over the past several years. During the presentations budget and personnel were a consistent theme. The AFSC leadership needs to continue with its development and share with the organization its plans for succession of staff. It has done a very good job of bring in young scientists to take over the as individuals retire, but better planning needs to be undertaken in this area.

The AFSC have several very long-term surveys that are used to capture the fishery independent indices that contribute to the assessments of the stocks. Because of their importance to these critical assessments, these surveys are carried out each year as a core activity. Budget and personnel are starting to affect the surveys in a negative manner. Sea days and thus stations are being cut to allow the surveys to be conducted each year with a lower budget.

The AFSC seems to find itself in a very defensive position. It has to protect the long-term fishery independent and fishery dependent data collection activities and thus sacrifice the research activities that could be used to

enhance these important activities. Formation of external partnerships could be a solution to this quandary.

The AFSC needs to look into statistical evaluation of the core surveys. In other words, could the surveys be accomplished in a more economic or statistically valid manner and still be able to collect the necessary core data that is critical for the assessments.

The fishery dependent activities are being conducted with industry funding support. This is allowing these programs to continue at the same level of coverage even with the recent cuts to the budget. However, while the observe portion is covered by industry, the AFSC observer support staff will need to receive the needed funding.

The AFSC did not presented a clear plan as to how to improve the accuracy, centralization, cross-linkages, and availability of the data they store and disseminate to the public, NPFMC, AKR, and AFSC staff. While the data are stored by each AFSC Division and data dissemination needs are being met, thought should be given to development of a more AFSC centric data management system to help in the coordination of data storage and dissemination.

AFSC Data Collections Science Program Review, August 26-30, 2013

Reviewer 5

General Observations

The Alaska Fisheries Science Center (AFSC) has designed and implemented a top notch data collection program in a region presenting numerous challenges. The program is the foundation not only of their strong scientific reputation, but also the success of the North Pacific Fishery Management Council's ability to maintain sustainable fisheries in Alaska. AFSC has been a national leader and garners tremendous respect with industry and the scientific community. During the review of the program I found many strengths and no red flags, but identified a number of topics AFSC would benefit from addressing in order to position them for the future. I would also like to commend the staff for the depth of preparation for the review, their sincere interest in using this opportunity to improve their efforts, and their honest and candid discussions of the issues.

The terms of reference of this review asked the team to consider a number of questions related to data collection supporting fishery stock assessments conducted pursuant to the Magnuson-Stevens Act. I will address the overarching questions here and the specific ones in subsequent sections.

Relationship of current and planned fishery assessment data activities to Center fishery assessments mandates and requirements – is the Center doing the right things?

The Center is doing the right things to meet the needs of its customers from assessment authors to the North Pacific Fisheries Management Council. They are providing timely, high quality data including turning around survey data collected in the summer in time for assessments completed in the fall of the same year. This said, the Center is increasingly struggling to maintain this capability due to the continuing loss of financial and human resources. While Center management has a strategic science plan and a clear and transparent process for prioritizing work at the center, the focus on maintaining the status quo with regard to surveys needs to be evaluated to ensure it does not cross a tipping point. As hard as it will be to ask staff to carve out the effort for reviews of survey design and capability assessment, now is the time to do so.

All but one of the presentations were given by Center staff. I believe the review team would get a better sense of how well the Center is doing on in supporting fishery stock assessments if there had been presentations by some of AFSC's stock assessment customers such as the NMFS Alaska Regional Office (Sustainable Fisheries) and the North Pacific Fishery Management Council (NPFMC). These groups would be able to provide insight on how well the data is able to inform management decisions. In

addition, they would provide information on upcoming issues and needs that would allow the review team to assess how well the Center is positioned to meet future needs.

Opportunities – are there opportunities that the Center should be pursuing in collecting and compiling fishery assessment data, including shared approaches with partners?

AFSC takes advantage of many opportunities to partner with industry and other entities. They have built a strong relationship with industry that has enabled the maintenance of a large observer program and cost recovery surveys. In addition, the Center has successfully acquired resources from the Bureau of Ocean Energy Management (e.g. Arctic surveys), the North Pacific Research Board (e.g. BSIERP, GOA-IERP), and others.

To continue to improve the quality of their assessments, additional partnerships will likely be necessary in the coming years. AFSC may want to look at what other vessels are already in their survey areas and what data they could collect and already are collecting. This will especially be useful as more autonomous technologies become trusted, and can be easily deployed by vessels of opportunity.

Out of the box opportunities should also be explored in relation to ensuring the Center is bringing new talent in to their workforce and to further advance survey technology research and development. From more traditional Interagency Personnel Act staffing to joint appointments/ventures, design challenges, and federal-student collaboratories¹, AFSC - if creative and persistent- can be a model for moving forward in a hiring environment full of barriers. Discussions with the Alaska Region of the National Weather Service may also be useful as they are in the multi-year process of adapting their staffing, facilities, and operational programs to the needs of the future without the help of any new resources. While in a completely different field, the NWS has similar issues with having a mandate to produce products and services with limited data.

Scientific/technical approach – are the Center’s fishery data objectives adequate, and is the Center using the best suite of techniques and approaches to meet those objectives?

The Center's data objectives are adequate and they are using both standard and novel techniques and approaches to meet them. Many examples of how the Center continually evaluates their techniques and gear to ensure the representativeness of their data collections were provided to the reviewers. From experiments to determine fish avoidance to demonstrating the value of acoustic and camera identification

¹ Examples: Air Force Collaboratory (collaboratory.airforce.com)
http://www.nytimes.com/2013/07/29/business/media/air-force-asks-students-to-solve-real-world-problems.html?_r=0

methods, AFSC has been willing to try new ways of doing business. I have every reason to believe that the center will continue their efforts in this regard as they evaluate survey design and the needs of the data stakeholders.

Organization and priorities – is the Center’s fishery data system properly organized to meet its mandates and is the allocation of resources among program appropriate?

This component was only partially addressed by the Center's presentations. Most presenters touched on some aspect of data management, but generally focused on the quality of the data, tools to collect the data, and the strengths/limitations of data. What we heard on the data management side was good- the center turns around data very quickly and it is made widely available. However, the review team did not receive a holistic briefing of how the data moves through various data bases to the assessment authors and beyond. Follow-up discussions assured me that the Center's data is adequately maintained and backed up, but it is difficult to provide a complete assessment. Here are a few observations and associated questions for the staff to consider:

- The data from all the surveys is not linked. If survey design changes or if the center was starting from scratch, what linkages would be implemented that do not exist today?
- Over-collection can be as detrimental as under-collection. Discussions on the aging and food habits presentations revealed increasing requests for collections and analyses. What is the capacity of center staff and how are these requests being evaluated for need and priority?
- Techniques such as acoustics and video feeds are far more data storage intensive than counts from observers and industry. With additional electronic monitoring systems and autonomous technologies coming down the pike, what considerations are AFSC staff planning for with regard to storage, management, and information extraction?
- Big data: The trend toward larger data sets allowing correlations is increasing. What will this mean for the use of fisheries stock assessment data? How can AFSC gain from the development of these datasets in designing how it uses and manages data in the future?

AFSC is monitoring NOAA plans for its data centers as they will be required to provide and archive their data with them. This is adequate, but this reviewer believes the Center would be better served by being a little more proactive in this regard. Ensuring stock assessment data is meaningfully archived and readily accessible will be a challenge requiring collaboration between fisheries and data management experts.

Scientific conduct – are the Center’s fishery data programs being conducted properly (survey design, standardization, integrity, peer review, transparency, confidentiality, PII, etc.)?

The overall scientific conduct of the Center is high class. There are no red flags and many strengths. The staff are aware of areas for improvement and take recommendations from independent reviews seriously. How increasing demands on the Center combined with the current downward trend in staff and resources affect operations in the long term remains to be seen, but with diligence can continue to be managed successfully.

In sum, the Center to date is doing an excellent job of providing the data needed to produce high quality stock assessments. Balancing immediate needs with investments is a challenge and the best thing the Center can do is strive to be ahead of the curve. During the review we heard examples of where the Center is excelling in this regard (e.g. cam trawl) and also where it is falling behind (e.g. HR). Management has been clear on their priorities and transparent in implementing them. The next step for the Center is to make the tough decisions to ensure there is enough time and energy for innovation and regular review of the data collection paradigm.

The greatest challenge to the center appears to this reviewer to be the management of its human resources. The Center has been losing people in order to maintain the surveys. This has stretched the staff thin and raised questions of whether the AFSC can sustain a number of its capabilities. Specifically we heard that with declining numbers of staff and stable to increasing workloads, the data collection staff have "swung past the sweet spot" in the number of surveys they are needed to conduct each year, and there are few young scientists joining the ranks to ensure successful succession of the workforce. Care must be taken to ensure points beyond recovery aren't passed. Tactical maneuvers must be made within a larger construct or the consequences of incremental decisions could result in the lab not having the brain power it needs to be a leader. A couple of questions AFSC can challenge themselves with are: What are the fundamental government functions the Center must provide and what do you want to be world renowned for in 15 years? With that in mind, what does the workforce need to look like? How do you transition to get there? By paying additional attention to defining what the needs will be in the 10-20 year time horizon and using the resources at hand to move in that direction the AFSC will remain at the forefront of fisheries science.

Fisheries Independent Data

Strengths

AFSC's acoustic trawl surveys, cross organizational plan teams, Cam Trawl system, cost-recovery model for long line surveys, and fish avoidance investigations show the strength and diversity of their fisheries independent data collection program.

- Acoustic Trawl surveys. AFSC is making steady progress in improving the information available to estimate groundfish abundance through the use of acoustic methods. Among the various aspects presented, I was particularly drawn to the encouraging results on using the different frequencies to identify specific species, the potential for acoustic work to free up vessel assets by targeting work, and the ability to acquire data about other parts of the food chain. Which of these avenues to pursue and whether acoustics should be added to bottom trawls are being considered by the staff. Work in this area should be continued and has the promise to aid in ecosystem studies as other signatures are identified.
- Cross organizational plan teams. During this portion of the agenda, the review team was made aware of how the survey groups regularly communicate with the assessment group on the strengths and weaknesses of the surveys and annual priorities. AFSC clearly showed the value it gains from plan team meetings where different divisions share needs and address issues related to the data collections. Lessons learned from each survey are identified and address through this mechanism and offer a best practice for other centers. Expanding this concept, the Center could look to holding similar events with the other science organizations in NOAA and relevant external entities.
- Cam trawl. The Cam Trawl is an innovative, no harm, technology having great potential for the improvement of surveys. The system uses video cameras on the gear and fish identification software to estimate abundance, size, and other attributes. Having the ability to gain this kind of information without having to bring the catch on deck is appealing. Development of the tool should be continued and testing expanded. To make the most of their limited resources, the Center might consider how it could accelerate R&D on this method by looking outside the of the organization for resources and mechanisms. For example, how might AFSC tap into technology improvement challenges and crowdsourcing for insights on how to advance the system.
- Cost recovery model for long line surveys. Cost recovery surveys gain the center critical data on Sablefish and other species at approximately one tenth of the cost of doing the survey themselves. This is a proven model that seems stable for the foreseeable future.

- Fish Avoidance. AFSC's work on fish avoidance is beneficial to the best possible understanding of the true biomass in the ocean. Their efforts underscore the value of having access to the NOAA Ship Oscar Dyson (a reduced noise vessel) for fishery independent work. With days at sea continuing to be vulnerable to cuts, the Center should contemplate the future of this work. Survey design and new technologies should be considered in this discussion.

Challenges

Most of the weaknesses in the AFSC's fishery independent surveys were identified up front by the staff in their presentations. In my review, increasing long-line predation, readiness for a potential Gulf of Alaska gear shift from long lines to pots, unrealized data potential, and several issues with trawlable/untrawlable habitat surface as the key challenges.

- Increasing Long Line Predation. Staff identified whale predation as a major issue on long line fished species such as Sablefish. The ability to confidently account for the predation- and the increasing rate of it- in the data the Center collects remains illusive. I support continued effort by AFSC to address this issue.
- Readiness for gear shift in the Gulf of Alaska from long lines to pots. Long line predation is prompting the industry to consider switching gear to pots in the Gulf of Alaska. If this occurs, it is unclear how well continued AFSC long line surveys would provide the information needed to manage the fishery. I encourage AFSC to get out ahead of this potential shift and prepare plans for how they would transition and change their data collection design and methodology to address this.
- Unrealized Data Potential. The AFSC could gain information and aid the greater scientific and management communities by thinking bigger about the data it could access to refine its work and the ancillary data they currently and could collect during surveys. As discussed in my opening comments on opportunities, a key question is how can AFSC leverage other research and non-fisheries vessels in their areas of interest in acquiring fishery independent data or refining areas to be surveyed.
- Trawlable/Untrawlable habitat. This is one of the largest issues the Center has. The staff noted questions they have about how many of the species they study via trawls occur in the margins of the untrawlable habitat, whether this changes in high or low abundance years, and overall what the area of untrawlable habitat

is. They cited ways they hope to determine whether areas are trawlable/untrawlable without learning the hard way (losing/damaging nets), explore untrawlable habitat to see what's there, and account for the uncertainty. Gliders, AUVs, and other technologies seem key to these pursuits and it is good to hear AFSC pursuing them. I recommend AFSC management make efforts to engage the Integrated Ocean Observing System (IOOS) program and continue working with NOAA's office of Oceanic and Atmospheric Research to make acquiring fishery data a mission of underwater technology research and development.

Additionally, AFSC has tried to make use of NOAA hydrographic survey data to identify untrawlable habitat. They have digitized the Office of Coast Survey smooth sheets for sea floor information and asked for surveys to be conducted in their areas of interest, success has been limited due to the Office of Coast Survey's priority areas not coinciding with survey areas and the tuning of their sonars not being optimized to capture bottom type accurately enough for AFSC purposes. With the increasing emphasis on Integrated Coastal and Ocean Mapping within NOAA, I encourage center staff to keep seeking assistance from the National Ocean Service.

Fisheries Dependent Data

The primary strengths and challenges both relate to the observer program. In addition, the Center's work to use electronic reporting facilitates real-time fishery management and rapid data assimilation into assessments is commendable.

Strengths

- Extent and Support of the Observer Program. The North Pacific Fishery Observer Program is extensive and plays a large role in the successful management of the fisheries. Industry support is significant and the program is the envy of other regions. Maintaining this component of the management system is important.

Extending the observer program to vessels under 60 feet is a significant accomplishment. This allows for a much more robust statistical framework and adds to the accuracy and precision of the assessments. A key to the future of this program will be outreach to spread the understanding of the benefits of adding these vessels to the program. The more the center can do to show why observers on these vessels are important and articulate the benefits of this

action the better.

- Electronic Reporting. Center staff provided an update on the different types of electronic reporting available to them. From electronic logbooks to flowscales and the ATLAS system for collecting observer data, these tools play a large role in the ability of the Center to include current year data in assessments and in-season management.

Challenges

- Small Boat Observer Program. While the benefits of data from the small boat fleet are clear, the logistics of implementing the program are difficult for many captains causing significant complaints.
- Tender Vessel Loophole. AFSC identified and is acutely aware of the observing loophole related to tender vessels. The issue is the definition of a trip, the ability it gives commercial fishermen to circumvent observer presence, and the opportunity for mischief. No solutions were proposed by the Center, but it is clear they would like to see it addressed.
- Electronic Monitoring. AFSC has supported the implementation of a number of electronic monitoring systems over the years. Examples of these include the vessel monitoring system and the use of video monitoring for compliance in several fisheries. The Center is now being pushed to adopt video monitoring to replace observers. Citing examples in Canada, advocates believe the AFSC should move faster in evaluating video camera systems for small boats and other applications. The challenge for AFSC is partially scientific and partially communications (see last bullet). On the scientific side, the Center will need to evaluate how current and future systems can meet the data objectives and at what costs and benefits. Through Council direction the AFSC has developed a strategic plan for electronic monitoring and electronic reporting in the North Pacific. How effective the Center is at keeping the Council's eye on meeting the suite of data objectives for compliance monitoring and fishery management information will affect the outcome of this debate.

In addition, a good point was raised in the discussion the presentation on this subject that law enforcement should be part of the discussion.

- Public and Political Pressure. Politics and public pressure have always been part of fisheries management discourse. However, as the way people receive information is changing through drama/hyperbole-oriented reporting, soundbyte/tweet length information depth, interest group funded media campaigns, and social media, it is more important than ever for the AFSC to

conduct effective communications and outreach to ensure an educated debate on the merits of an issue can occur. How well AFSC is able to describe the complex nature of fisheries data and the way it is collected will play an increasingly significant role in the success of fishery management in the North Pacific.

Other Supporting (Biological and Ecological) Data

Strengths

The supporting data that AFSC collects and provides is integral to the quality of the assessments. Without the data on age, growth, diet, maturity, and ecosystem conditions, the authors would have a far less holistic view of the health of the stocks.

- Number and quality of age classifications. This group ages approximately 30,000-40,000 otoliths annually and has a backlog of less than a year. The experience of the personnel and the quality control checks they have in place result in a higher certainty range than needed for the models.
- Input to Stock Assessment and Fishery Evaluation (SAFE) Ecosystems Chapter. The AFSC participates in a number of ecological process studies providing a system level look at the health of the ecosystem. AFSC's work in this area forms the basis of the ecosystem chapter in the annual Stock Assessment and Fishery Evaluation (SAFE) document. Continued involvement in integrated ecosystem programs such as BASIS and GOAIERP makes sense as priorities for the Center.

Challenges

Challenges exist for each of the programs described in this section of the review (age and growth, food habits, maturity, and ecosystem studies). Whether it is timing the spawning of species of interests, the need for more ecosystem information on the whole, or the influx of requests for age, growth and food habits analysis, the AFSC staff are well aware of the areas where improvement is desired.

- Maintaining Critical Mass in AFSC's Age Classification Capability. Funding limitations, retirements, and a hiring freeze are reducing AFSC's age and growth capacity. Staff noted that there has been a steady increasing trend in the number of aging requests and it is unclear how the group is going to handle the workload. Questions AFSC should ponder include: What is the viability of this group without the opportunity to bring new classifiers into the organization? What is the effect of temporary and student labor on the quality of the aging program? What are the trends in the aging requests? Are all of the requests

appropriate for AFSC to accept? What is the acceptable uncertainty range for ages in the models? And how does could the group prioritize or filter requests based on the uncertainty levels needed for the models?

- Food Habits - Need for Year Round Information. The food habits data is currently only collected in the summer. The staff is well aware of the limitations of this situation and agrees that the program would be improved by data collected in other times of the year. This being said, the capacity of the group should be considered when exploring partnerships to acquire additional data. While the staff is currently able to handle the workload, discussion did not explore how that might change if there was a large increase in the number of stomachs needing to be processed.

End Note: The Arctic.

The prospect of fisheries moving north has been one of the tag lines in the national conversation on the Arctic. AFSC activities in determining the abundance of fishery populations and understanding changes occurring in this region were touched but not focused upon in this review as there are no active federally managed fisheries in the area.

AFSC relies on reimbursible funding from the Bureau of Ocean Energy Management and others to support surveys and ecological process studies in the Arctic. Here as in the other large marine ecosystems AFSC has responsibility for, defining and focusing on achieving data objectives will be critical. Survey designs will be limited by the realities of the remote location and limited assets and time/weather windows available for the work.