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INTEGRATING COLLABORATIVE DATA COLLECTION WITH MANAGEMENT: A LOBSTER FISHERY TEST CASE

FINAL REPORT
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EXECUTIVE SUMMARY

Cost-effective programs for gathering essential fisheries information (EFI) are critically needed to improve the data-poor state of fisheries in California and worldwide. The California Marine Life Management Act (MLMA) recognizes this need and requires development of fishery management plans (FMPs) that identify suitable protocols for collecting data, and use of the best available scientific information to inform management. Furthermore, in the United States, several state and federal laws require the engagement of fishermen and others in fisheries management. To address these needs, we developed a collaborative at-sea sampling program (CASP) by:

- determining the key regulatory, administrative and operational features of established collaborative fisheries data collection programs,
- developing a robust sampling design with associated protocols for the commercial California spiny lobster fishery,
- designing, testing and modifying data collection and management components of the sampling program, and
- exploring options for sustaining the program into the future.

The goal of the program was to provide a model for generating an ongoing stream of diverse data and interpretation for integration into management, thereby supporting use of more sophisticated and robust models for managing California fisheries.

We used the California commercial fishery for spiny lobster, for which an FMP is being developed, as a test case. This project built upon earlier work by the co-PIs developing a CASP for California's southern rock crab commercial fishery (Culver et al. 2010) and by Neilson to implement a lobster fishery data collection program similar to one used in the New Zealand rock lobster fishery.

The California Spiny Lobster Fishery CASP

Framework

We developed a CASP framework that included contributions from three entities:

- commercial lobster trap fishermen who collected data at sea and assisted with data interpretations and program improvements,
- fishery managers (CDFW) who contributed to all discussions and provided or reviewed data analyses, and
- neutral, third party scientists (California Sea Grant Extension, University of California Santa Barbara, Santa Cruz and San Diego) who led and coordinated the effort.

This collaborative team approach enabled integration of local knowledge and fishing practices with fisheries management and took advantage of existing relationships among these groups. This approach is used in the other data collection programs reviewed as part of this project, even though the roles for the management, analysis and review, and sharing of data vary among programs.

The primary program expenses were for a coordinator and compensation for participating fishermen. Both are critical components of this CASP, with the latter expense required to cover

the costs of a deckhand needed to assist with data collection as well as the additional fuel and time required to conduct sampling. Non-monetary compensation for participating fishermen, such as waived permit fees or a tax write-off for data collection for the state, may be means for reducing this major expense. Grant funds covered the expenses to develop and test this program, but a funding mechanism that includes collection and administration of funds to sustain the program for the long term is still needed. Other such programs have been funded in various ways, through industry- or government-levied taxes or fees which ensure contributions from all participants in the fishery – an important feature since all such fishery participants will benefit from the program. However, in California these funding mechanisms require organization and agreement among the fishermen and, in some cases, government action (e.g., legislation or administrative rulemaking).

Data Collection Protocols

As a first step, the team worked together to develop protocols that could be adapted to a variety of fishing operations and areas fished. Fishermen then were trained in sampling methods and collected data while fishing. Each fisherman's data were validated through sampling at the port one to two times per season. In Year 1, a larger quantity and variety of data were collected per sampling trip, with some information recorded for *every* trap pulled. The collected data were used to identify and establish a sampling design for the CASP that enabled subsampling of the traps while still providing an accurate estimate and representation of the catch. The resulting CASP sampling design was used in the second and third years of the project. It entailed fishermen completing six sampling trips: two trips per month for the first two months of the season (October, November) when fishing is most active, and one trip per month in the next two months of the season (December, January) when fishing activity is moderate. Fishermen followed one of two protocols depending on the area they were sampling, with a minimum of 60 lobsters sampled from 12 or more traps. The protocols varied in the number and spacing of traps sampled due to differences in the spatial distribution of lobsters among regions.

A total of 21 fishermen participated in the program, with numbers increasing each year as the program developed and with some fishermen participating in more than one year. Those who did not return usually were supportive of the program but did not want to take time away from fishing to participate again. Some early participants and potential new recruits were concerned about how others viewed their involvement and/or the implications of the program for the FMP. Importantly, participation of *all* fishermen in the sampling program is not needed; sampling effort is most effectively done by a small group of fishery participants whose fishing activities, collectively, cover the full geographic range of the fishery.

Fishermen generally found the sampling protocols to be easy to follow, and estimated that it took about one hour away from fishing to complete the sampling. Highly accurate data were collected, as determined through a dockside validation process. Two types of data were more difficult to collect: multiple GPS coordinates and trap density. The former was problematic for only some fishermen and is readily addressed, but the latter issue persists and requires additional discussion to develop and evaluate options for obtaining trap density data.

CASP-Collected Data

Participating fishermen collected a substantial amount of data, with nearly 200 sampling trips conducted, just over 13,000 traps sampled, nearly 33,000 lobster counted, and size and sex determined for over 10,000 lobster. This EFI collected by the CASP augments existing data collected by CDFW (landings receipts, logbooks), enabling more accurate estimates of CPUE and numbers of recruits and sublegal lobsters, and providing data on size distributions and sex ratios that has not been collected throughout the entire range of the fishery.

Our analyses identified significant geographic patterns in these parameters among three regions: South (San Diego to Dana Point, including San Clemente and Catalina Islands), North Coast (Newport to Point Conception) and Northwest Islands (Northern Channel Islands, San Nicolas Island, Cortez Banks). In Yaeger et al. (submitted) we describe the area-based differences in size distributions, sex ratios, number of recruits, and CPUE, some of which were not evident from existing data, and identify a large discrepancy between CDFW and CASP data for average lobster size for one region. We also discuss the management implications of these findings, including their influence on estimates of the spawning potential ratio, one of the triggers for the proposed harvest control rules in the FMP, and on measures of trap vulnerability, another component of the model. Overall, our findings support area-based management for the California spiny lobster fishery. Our findings also illustrate the ability and need to collect and incorporate this EFI into lobster management and a more robust model as initially intended, addressing recommendations of a recent scientific review panel for the lobster FMP (Field et al. 2015).

Utility of the Lobster CASP

This project demonstrated the utility of a CASP for the California spiny lobster fishery. It provided a large amount of accurate essential fisheries information on the entire catch (not just landed catch) across the fishery's geographic range for three consecutive years. These data have been used in the FMP process, allowing a cross-check of the evaluation of the landings and logbook data for potential harvest control rules. The CASP also has demonstrated the importance of collecting size distribution and sex ratio data given the differences among regions, and the implications of these data for current management. Importantly, such data provide an opportunity to use a more robust model for managing the lobster fishery, as intended by CDFW's lobster fishery biologist and other CASP PIs and recommended by the FMP Scientific Review Panel. The CASP also has provided a framework for engaging interested parties in management of the fishery. More generally, the lobster CASP provides a model for moving collaborative fisheries research to a new level. It provides a robust mechanism for contributing continuous, high-quality information for managing diverse fisheries not only to address a specific management question, as has been the focus of most previous collaborative research, but also to enable managers to address a broad range of questions as they arise.

The demonstrated usefulness of the CASP data has generated support among fishermen, managers and scientists for implementing an ongoing CASP for the lobster fishery. The need for such a program is supported by the recent scientific peer review of the lobster FMP, which indicated that data such as those provided by the lobster CASP are critically needed to manage the fishery (Field et al. 2015). Continued collection of these data also would be useful for

evaluating the trap limit program that is expected to be implemented in the fishery in 2016. While grant money may enable the program to continue at some level for the short term, its long-term continuation will require additional assistance from within and outside the fishery, and recognition of the program's value and role in fishery management by the State. Given the need for and the value of the data collected, and the enhanced engagement of fishery participants and others in management resulting from this process, such collaborative effort undoubtedly would be beneficial for obtaining, analyzing and interpreting data for the lobster fishery - and other fisheries - in California. As such, we recommend the following for the continuation of the lobster CASP, and its potential use as a model for other fisheries:

- Engage a minimum of 12 and a maximum of 24 fishermen that are distributed throughout the geographic range of the fishery in the program to provide sufficient and optimal spatial coverage and data.
- Follow a selection process as described in this report and compensate participating fishermen for their efforts. Options for types of compensation should be reviewed with state authorities and others who may have ideas and insights about non-monetary options.
- Review the data categories and protocols annually to ensure that the data are collected accurately and efficiently and that they continue to be of use to management.
- Use the data to move to a more robust fishery model, such as an age-structured model, with area management considered.
- Evaluate long-term funding mechanisms and obtain state support for the program. Fishermen should be fully engaged in this effort.
- Establish a CASP subcommittee consisting of fishermen, scientists, managers and program coordinator to discuss ways to involve other groups in the program.
- Explore development of a complementary program for the recreational fishery.

INTRODUCTION

It is widely recognized that management of California fisheries has been, and continues to be, hindered by insufficient biological and socioeconomic data. In particular, this lack of data has made it difficult to implement and evaluate the outcomes of two state laws, the Marine Life Management Act (MLMA) and the Marine Life Protection Act (MLPA). Although steps are being taken to gather more data ('essential fishery information', or EFI) to meet these needs, most data collection efforts presently are funded only for the short term. With funding and staff expected to remain limited in the future, alternative cost-effective data collection programs that can be sustained over the long term are critically needed for the management of California's marine resources.

This need is particularly evident for the California spiny lobster fishery, for which the state is developing of a fishery management plan (FMP) in accordance with the MLMA. The FMP requires identification of suitable protocols for collecting EFI for long-term management. Furthermore, EFI such as age/size structure, sex ratio, recruitment and fishing mortality, are required for robust evaluations. While the lobster logbook and landings data provide some of these data, information on size structure and sex ratio throughout the range of the lobster fishery would greatly enhance the models that could be used to manage the fishery.

Collaborative at-sea sampling programs (CASPs) that engage fishermen in the collection of EFI offer a viable cost-effective means for gathering data continuously for long-term management. CASPs differ from traditional collaborative fisheries research projects in that they are long-term (not short-term), broadly applicable (not spatially limited), and provide for the continuous collection of a suite of EFI (not just specific information for addressing a single research question) that is then analyzed and used to inform and support fisheries management. These programs, which are being used effectively elsewhere, were identified at an international workshop on managing data-poor fisheries organized by the California Sea Grant Extension Program in collaboration with the California Department of Fish and Wildlife (CDFW), as a promising and cost-effective approach for addressing the pressing need for EFI and improved fisheries management (Starr et al. 2010). Recognizing the potential usefulness of CASPs, fishermen, managers, scientists and NGO representatives have expressed interest in developing such programs for California fisheries. However, their development and integrated into state and federal fishery management of California fishery resources requires overcoming a number of regulatory, administrative and operational hurdles.

Goals/Objectives

The goal of this project was to facilitate the integration of a collaborative at-sea sampling program (CASP) with existing fisheries management processes in California so as to support use of more robust and sophisticated models using the spiny lobster fishery as a test case. Our objectives included:

- determining the key regulatory, administrative and operational features of established collaborative fisheries data collection programs

- developing a robust sampling design and associated protocols for the California spiny lobster fishery
- developing data management components (handling, storage and sharing) for a CASP
- developing a plan for sustained funding of the program into the future

With funding from Collaborative Fisheries Research West and in-kind support from project participants, we built a collaborative team of commercial lobster fishermen, fisheries managers and California Sea Grant and other university scientists to achieve the project objectives. Here we describe our findings and discuss the utility of a CASP as a cost-effective way to gather biological EFI for managing California's fisheries.

METHODS

Review of Existing CASPs (Objective 1)

To help inform the design of a California-based CASP we conducted case studies of four ongoing at-sea data collection programs:

1) New Zealand lobster fishery CASP
2) Southeast Alaska geoduck dive fishery CASP
3) British Columbia geoduck dive fishery CASP
4) Australia abalone dive fishery CASP

These programs were chosen because we understood based on preliminary work that they engaged fishermen not only in collection but also interpretation of data, with the data integrated into the management process. The New Zealand program also was included because it was the basis for the methodology and initial program developed by CDFW for the California spiny lobster fishery, and served as a model for a similar rock crab CASP pilot tested in southern California (Culver et al. 2010).

For each of these CASPs, we conducted archival research (literature review, web-based searches) and semi-structured interviews guided by a questionnaire we developed (Appendix A) to gather information about methods of data collection, management and analysis; fisherman recruitment, training and compensation; program financing; and processes used to review, develop and implement recommendations for management. Archival sources included refereed and grey literature, and websites. Based on our preliminary research and using a snowballing approach (Goodman 1961), we identified and interviewed a "key contact" and several other individuals associated with each program (n=21). Interviews were conducted by telephone or Skype and typically lasted from 45 to 90 minutes. Interview notes were transcribed, then coded along with archival materials using qualitative data analysis software to identify and organize information related to various themes such as CASP history, participation, structure, challenges and outcomes. This information was summarized, presented and discussed at a project workshop and used to explore key regulatory, administrative and operational features for developing and sustaining a CASP for the California lobster fishery.

In addition, we drew on past and ongoing research experience combined with archival research to consider three collaborative at-sea data collection arrangements within California which, even though their integration with management is more limited, afford additional useful and contextually relevant insights:

1) California sea urchin data collection program
2) California salmon genetic sampling initiative project
3) California wetfish and squid data collection program

Sampling Design & Protocols (Objective 2)

We used group discussions, trainings and field research to design robust sampling protocols for the collection of EFI for the commercial lobster fishery. In Year 1 we engaged eight fishermen in collection of several categories of data from a few monthly sampling trips (Table 1). General information, including counts of legal and sublegal lobsters, was recorded for each trap, with more detailed information, including carapace length, sex, and tail width, recorded for a subset of traps (Appendix B.1). Fishermen were supplied with waterproof electronic calipers to increase the ease and time required to read the caliper, as well as support accurate readings. We also provided hand counters to fishermen who encountered high numbers of lobster per trap (typically >15 lobster) as a means for standardizing and minimizing counting errors. Fishermen helped develop protocols for collecting these data and they were trained in and used the techniques that proved to be both scientifically robust and logistically feasible in the field (Appendix C.1).

Data from Year 1 were then analyzed to determine a sampling regime (number of animals and traps) that would provide an accurate estimate of the catch and identify parameters that would be most beneficial for management for the long-term. To do this, fishermen, scientists and managers reviewed the data needs and potential protocols for Year 2, streamlining what was done in the first year by identifying key data needs and those parameters that varied throughout the area fished. The intent was to develop a CASP that minimized the time taken away from fishing activities to reduce the burden on fishing partners having different operational fishing procedures while ensuring the collection of robust and scientifically sound data required for management. The protocols were refined as needed. Additional fishermen were recruited and all were trained in the CASP protocols and data collection requirements (Table 1; Appendix B.2, C.2).

In Year 3, a few further refinements were made to the CASP protocols following discussions amongst project collaborators. Commercial fishermen were trained in the amended protocols, with data collected for another lobster season (Table 1-2; Appendix B.3, C.3).

Validation of Collected Data

Each year we validated the data collected by individual fishermen. To do this, the fishermen kept the legal portion of the catch they sampled at sea separate from the rest of their catch. Upon returning to port, we then collected the same data (size, sex, count) on this separated sample. We compared our measurements of carapace length and counts of legal males and females to

what they recorded while at sea. For each fisherman we validated two samples during their first season in the program, and then one sample per season after that.

Data Analysis
The three years of data were analyzed for differences of several fisheries parameters among regions of the Southern California Bight. Parameters included total catch, size, sex ratio, number of recruits and catch-per-unit-effort. We discussed the findings from Year 1 and 2 with our project team, and also held a workshop with CDFW and a fisheries modeler to discuss integration of the data with the current model being used to set the harvest control rules for the fishery.

CASP Data Management (Objective 3)
To achieve Objective 3, our team worked together to develop and use data management procedures for handling, storing, sharing and analyzing the collected CASP data. We described findings from the case studies (Objective 1) to inform our discussions about various options for data management. We quantified the support for the involvement of various groups (CDFW, Sea Grant, NGOs) in the different areas of data management, and potential roles they might play.

Long-Term Implementation (Objective 4)
Sustaining the CASP for the long term requires identifying an appropriate organizational structure, participants, and a mechanism for continued funding. Based on our case studies and related research (Objective 1), we drafted options for these components. We then discussed them with our CASP partners as part of a CASP workshop, to determine fishing partners' interest in and support for them, and any potential hurdles to their adoption and use.

RESULTS

Here we present results, organized by project objective. To date, we have presented information on this commercial lobster fishery CASP and associated findings at two conferences:

- Southern California Academy of Sciences Annual Conference (2014)
- World Small-Scale Fisheries Congress (2014)

The resulting data and analyses also are the primary focus of a manuscript (Yaeger et al.) in preparation for submission to the American Fisheries Society's journal of Marine and Coastal Fisheries and an associated Master's Thesis (Yaeger 2015).

Review of Existing CASPs (Objective 1)
Despite some key differences in context between the case studies and the California spiny lobster fishery, three of the (non-California) case studies provided valuable insights into key regulatory, administrative and operational features of a CASP. As we pursued the case studies, it became evident that the fourth case study, which focused on the Australia abalone dive fishery in the state of Victoria, did not meet our criteria for a CASP and as such, is not addressed in this report. However, ongoing efforts there and in other Australian states (see Mayfield, 2012, Mundy 2012 and Norwood 2014) may provide useful insights in the future. The three California data collection

efforts also were useful for providing more state-specific, contextually relevant information. Here we provide selected details of each case study example, followed by a table comparing their key features (Table 3). A full summary of each of the three programs outside California, including program costs, is provided in Appendices D.1-D.3.

New Zealand lobster fishery CASP

New Zealand's commercial rock lobster (*Jasus edwardsii*) fishery CASP has been providing data for management since 1993, when vessel owners became dissatisfied with the limited quality and quantity of data generated by government stock assessments and the resulting management measures. This CASP is financed by statutory fees assessed on each fishery participant and determined by the New Zealand Rock Lobster Industry Council (RLIC) in consultation with the fishery's nine regional management advisory councils. The CASP includes a voluntary Rock Lobster Logbook (RLLB), for which participating fishermen complete 1) a logbook for each fishing trip (now done electronically) (Appendix D.1, Figure 1), 2) an annual survey of their fishing patterns, and 3) an annual description of the pots they use for sampling. In most of the country's nine management areas, a coordinator supervises data collection and ensures that data are transmitted to the RLIC. The RLIC contracts with a government-approved consulting firm to manage the logbook database, conduct data analyses, and report back to participating fishermen, their regional advisory committees, the RLIC, and the government's Ministry of Primary Industries. The National Rock Lobster Management Group, a multi-sector stakeholder group, uses the logbook results in its deliberations about fishery management to provide advice to the Ministry. The length-frequency data generated by the RLLB have contributed substantially to the development of fishery assessment models, resulting in adjustments to the allowable catch over time.

CASP participation has been relatively strong and consistent in a third of the fishery management areas, moderate in another third, and very low to nonexistent in the remaining areas. In 2013, a total of 66 (14%) of 461 permit owners (25% of 261 boats) participated in the CASP. Although fishermen historically did not receive financial compensation for their participation, participants in some management areas receive custom clothing that effectively recognizes their contribution to the fishery, and those in one management area are paid a base rate per season with a bonus for each month of logbook data they contribute (in that case in lieu of paying a full-time coordinator; see Appendix D.1).

Southeast Alaska/Yakutat dive fishery CASP

The CASP for the Southeast Alaska geoduck clam (*Panopea generosa*) fishery has provided data for management since the late 1990s, when commercial divers sought to have additional geoduck beds identified and opened by the state. To accomplish this, the industry formed the Southeast Alaska Regional Dive Fisheries Association (SARDFA), a private, non-profit organization in 1997. In 1998, legislation was passed authorizing the organization to tax its membership - all commercial geoduck divers - to support research and related activities (Alaska House Bill 198 (1997). Initially, those funds were supplemented with NOAA Nearshore Project grants and funds donated by local municipalities and others. With the opening of more geoduck beds and improved markets, the fishery assessments have been sufficient to fund the CASP and other SARDFA activities.

While the majority of data collection by fishermen through this CASP is not done during commercial fishing activities *per se*, the data are directly integrated into management decisions for the fishery. For example, geoduck divers conduct reconnaissance surveys in the off-season to identify and qualitatively evaluate the commercial viability of beds according to protocols developed in collaboration with the Alaska Department of Fish and Game (ADFG). For each bed surveyed, the collaborating fisherman provides a brief description of the bottom, vegetation, and presence of other species of interest, and his impression of the bed's fishery potential, along with data on geoduck density (based on a five-point scale), and bed location, depth, range and width (Appendix D.2, Figure 1). ADFG biologists use this information, in consultation with the fisherman, to design and conduct a stock assessment to determine guideline harvest levels for beds. The reconnaissance survey and stock assessment results are used in pre-season discussions between SARDFA's Geoduck Committee and ADFG staff about which beds will be opened when. The CASP also includes in-season testing for natural biotoxins (paralytic shellfish poison and domoic acid), with participating divers collecting sample geoducks from specified beds and shipping them to a state lab for testing, all according to prescribed procedures (Scanlan 2012), before the beds can be opened to fishing.

Participation in this CASP has been limited to five to ten fishermen (about 8-16%) of the 60 permitted geoduck divers for the reconnaissance surveys, with an average of three (about 5%) divers per year participating in the biotoxin sampling. These fishermen are contracted by SARDFA to conduct the data collection following a selection process where applicants are reviewed and chosen based on qualifications including vessel and equipment, fishing knowledge and experience, and ability to consistently and accurately collect, record and report the data. CASP fishermen are paid about $1,000 per day for the reconnaissance surveys, and $400-$1,500 per area (contingent on location and number of areas to be sampled) to collect and handle geoduck samples for biotoxin testing.

British Columbia Geoduck Dive Fishery CASP

The British Columbia commercial geoduck (*Panopea generosa*) dive fishery CASP has provided data for management since 2004 (James 2008). This CASP was established by the Underwater Harvesters Association (UHA), a non-profit association formed in 1981 by the fishery's 55 license holders to fund fishery-independent stock assessment and fishery-dependent research. The UHA started co-managing the fishery with Canada's Department of Fisheries and Oceans (DFO) in 1989, by contracting and funding an independent company to implement a geoduck dockside monitoring program to provide the DFO with fishery-dependent data, as the agency lacked the financial resources to do that work. Using UHA membership fees, the organization expanded its activities to include at-sea sampling (i.e., the CASP) in an effort to address persistent and growing concerns about limited data quantity and quality, which had led to more conservative management and reduced quotas than fishery participants felt were warranted.

For this CASP, divers complete a voluntary "Bed Questionnaire" for each fishing trip (Appendix D.3, Figure 1), which has been integrated with the mandatory "Validation & Harvest Logbook" since 2008. The bed questionnaire is used to collect information about geoduck density, market

quality, juveniles observed, ease of bed digging, density of horse clams (managed with geoduck), and need for bed quota adjustment, along with observations on the estimated size of the bed, sea otter presence and average clam size (DFO 2012). An on-grounds monitor or dockside observer collects and checks each fisherman's data sheets, then forwards them to a government-certified service provider for data entry and analysis on behalf of UHA. These data are combined with those from other UHA-led research activities (e.g., SCUBA surveys, biological and market/dockside sampling) to estimate biomass and provide the basis for calculating quotas for individual beds within each of several management areas. A Geoduck Sectoral Advisory Committee comprised of fishery stakeholders (i.e., licensees and others) and DFO staff meets regularly to exchange information and views on fishery management issues.

Since 2008, most of the fishery's 55 license holders have been completing the "Bed Questionnaire" for each fishing trip voluntarily and without compensation. The high participation rate in this CASP is attributed to equal quota shares among licensees (although that may be changing), meaning that each licensee is entitled to an equal share of the quota. The generation of more and finer-scale data enhances stock assessments, in turn enabling fine-tuned and adaptive management toward ensuring the fishery's productivity and profitability.

California-Based Data Collection Efforts

The three California CASP-like arrangements we examined operate under distinct institutional arrangements, including a statewide commodity group (salmon), a private, non-profit organization (wetfish and squid), and a combination of these two (red sea urchin). Each type of arrangement affords both advantages and disadvantages for developing, conducting and sustaining a CASP. In particular, some arrangements are independent from state agencies (e.g., association) thereby affording greater latitude in designing and conducting its work. At the same time, groups affiliated with state government (e.g., commodity group) have a direct institutional connection, enhanced recognition by and access to relevant agencies, and, contingent on establishing legislation, clearly identified roles and responsibilities for collaboration between producers and agency personnel.

California Sea Urchin Data Collection Program

This program was initiated in 2001 by the San Diego Watermen's Association (SDWA), a non-governmental organization, in collaboration with academic scientists and CDFW biologists, in an effort to provide robust data for finer-scale fishery management (Schroeter et al. 2009). Since then, the program has operated variously through the SDWA and, at times, the California Sea Urchin Commission, a statewide commodity group under the California Department of Food and Agriculture. For this program, commercial divers for red sea urchin (*Strongylocentrotus franciscanus*) collect data on sea urchin density, size distributions, and environmental variables during their normal harvesting operations (Schroeter et al. 2009).

Of about 200 active permit holders, the majority of data have been collected by six to nine San Diego-based commercial sea urchin divers (3-5% of active permit holders) with 15 local divers participating in data collection over time. Participation is voluntary, with no

compensation provided. Divers in the statewide fishery have participated in workshops with academic scientists and CDFW staff to review data collection and program evaluation results and plan for future work. However, to date, this program remains localized and not integrated into state fishery management.

California Salmon Data Collection Program

This program, known as the West Coast Genetic Stock Identification Collaboration (GSI) project, has generated data on the Chinook salmon fishery off California and Oregon since 2010. Project collaborators include the California Salmon Council (a CDFA commodity group), the Oregon Salmon Commission and associated commercial fishermen, and scientists from the National Marine Fisheries Service, CDFW and the Oregon Department of Fish and Wildlife. Funded variously by NOAA Saltonstall-Kennedy grants and federal fishery disaster relief funds, the GSI project has contracted with salmon fishermen through the California and Oregon Salmon Commissions to collect fish tissue samples and other information for analysis by agency scientists, to more precisely identify geographic and temporal distribution of salmon stocks, and thereby enhance fishery management.

Captains and crew of more than 85 vessels (of about 1,200 permittees; 7%) have participated in the sampling off California (Bellinger et al. 2015). Commercial salmon fishermen also are active partners in project design, sampling methodology improvements, and data collection and management. A fleet manager and port liaisons employed by the California Salmon Council identify, train and support fishermen samplers, who receive a small stipend for each sample they provide. Results are reported back to the Salmon Council and fishery participants at the end of each season. However, integration of these data into federal and state fishery management has been limited, in part, due to very low sample sizes.

California Wetfish Data Collection Program

This program, managed by the non-profit California Wetfish Producers Association (CWPA), has helped produce data on the state's sardine and squid resources since 2004 in collaboration with state, federal and independent fisheries scientists (CWPA 2010). Funded by federal and state grants and CWPA fisherman and processor membership fees, the program has included aerial and boat-based surveys, designed collaboratively by CWPA members and agency staff, to document spatial and temporal distribution of fishery resources. Initially several purse seiners (captains and crew) collected data in connection with their fishing trips. In 2010, following the realization that the scientific protocol required substantial time away from fishing and foregone revenue, the CWPA changed its approach, contracting with a charter vessel to collect fishery-independent data (e.g., species distributions). Although the CWPA's efforts do not provide a continuous data stream, the organization continues to provide financial support and work with fisheries scientists within and outside state and federal agencies to address information needs related to the sardine and squid fisheries.

Sampling Design & Protocol Development (Objective 2)

Sampling Design

During Year 1 of the study, each sampling trip entailed fishermen counting the number of legal and sublegal lobsters in every sample trap with lobsters measured in a subset of the traps. An analysis using these data found that for a single line of traps a minimum of 60 lobsters from a minimum of 12 traps would be needed to adequately estimate the numbers and size distributions of lobsters. In Years 2 and 3, counts and measurements of lobster were confined to a subset of traps on a line that would yield the minimum of 60 lobsters. The number and spacing of traps in the subset varied among regions to accommodate differences in the spatial distribution of lobsters. In the North Coast and Northwest Island regions lobster densities were low and distributed in such a way that sampling from many traps was required to yield 60 lobsters. Thus, fishermen from these regions sampled and recorded data from each trap until reaching 60 lobsters. In the South region, 60 lobsters were typically captured within the first few traps, resulting in a potentially spatially biased sample. In order to get adequate spatial coverage over the area sampled by a trap line in the South region, subsampling was done on the first 60 traps, with counts of legals and sublegals recorded for all 60 traps, and carapace length and sex recorded for 12 subsample traps -- the first two traps for every 10 traps over the first 60 traps (Appendix B.3, C.3).

The CASP protocols used in Years 2 and 3 were streamlined by excluding several categories of data that were collected in Year 1. Tail width was only intended to be measured in Year 1 to provide ample data for evaluating the correlation between it and carapace length. CDFW was interested in these data to determine whether lobster tails (no carapace attached) encountered by CDFW wardens came from legal or sublegal lobsters. We also excluded information about shell condition (soft, hard), reproductive condition (plastered, gravid) and toss reason as there was little variation in these data both within and among sites throughout the season. These data illustrated that the current fishery season was protecting lobster when they were molting and reproducing. We also removed the bycatch categories from the protocol as it increased the time it took the fishermen to sample and it was not the focus of the data collection effort.

Ease of Sampling for Fishermen

Overall, our fishing partners found the sampling protocols to be relatively easy -- taking about one hour away from their fishing time, depending on conditions -- but some areas for improvement were identified. For example, the most difficult data to record was trap density. While we discussed better ways to achieve this estimate, it has proven to be difficult to assess. Identifying a good protocol that fits all fishing situations requires further discussions. Also, some fishermen from the North Coast and Northwest Islands regions found the increase in recording GPS coordinates from 3 times in Year 2 to 8 times in Year 3 (the number required in both years for the South region) to be more time consuming. These data are needed to determine the spatial coverage of the sampling effort; the fishermen do not move along a straight line thus taking coordinates from the first and last traps sampled is not adequate for determining the area sampled. In addition, we had a single incidence where the data sheets were lost in the mail. Following this event we discussed with the fishermen their willingness to take photographs of the

datasheets with their phones as a backup before putting them in the mail. They were willing to do so, although a few fishermen did not have phones with a camera feature. Some fishermen asked if scanning and emailing the data sheets might be better than mailing the sheets, but we discussed the issue of sending confidential data electronically. When this issue was considered, they all preferred the current system of mailing the datasheets. The use of voice recorders or electronic devices instead of hand-written data sheets also was discussed. The scientists and managers were concerned that it would be too hard to decipher what was being said on the voice recorders due to wind and other noises and/or lack of enunciation. There also was a time issue of having to listen to the tapes to obtain the data. We also met with a developer of an electronic log book to discuss the types of data we were collecting and how an electronic form might be designed. All groups were concerned about the need for the fishermen to scroll through pages and many fields to record data for a single trap, but remained open to pilot testing the system if the data entry could be streamlined to a point where entering the data would be as quick, or quicker, than recording (writing) the data on paper.

Validation of Collected Data

Overall the data collected at sea by the fishermen were not significantly different than data collected by us in port. The average difference in carapace length measured at-sea and in port was 0.12 mm ($t= 0.89$, $p= 0.38$). The difference is even smaller when four samples with significantly larger differences in measurements are excluded; 0.07 mm ($t= 0.02$, $p= 0.99$). The number of lobsters counted at-sea and in port was identical for 81.7% of the samples, differing for only nine samples (18.3 %) that were conducted by six fishermen over the three years. For six of these nine sampling trips, fishermen notified us that they did not adequately separate out the sampled lobster from the catch because they either forgot to do so when at sea (n=4), they mixed in a non-sampled lobster with the sampled lobster (n=1) or the zip ties they used to mark the subsampled lobsters came off of a few of the animals (n=1). For unknown reasons, two samples had one extra lobster counted by either the fisherman at-sea or by us in port. Sex ratios determined at sea and in port also were not significantly different ($p=0.09$; $t= 1.73$; Fig. 2), being identical for 85.7% of the samples. For those that differed (n=7; 14.3%), five samples differed by a single lobster, one sample differed by two lobster and one sample (occurring on a fisherman's first sampling trip) had a difference of five sexes.

In general, larger differences were detected for the first sample collected by a fisherman. That is, the differences between the at sea and port sampled data decreased with the number of sample trips completed by an individual fisherman presumably because they became more experienced with sampling and recording the data. In one or two cases, differences in sample measurements and counts continued to be noticed with a particular fisherman. We also noticed errors on the datasheets for some trips; the counts for a trap and the number of lobsters measured in the same trap didn't match up. When such errors where noticed, and for fishermen that had reoccurring differences in measurements and counts, time was taken to work with the individual to correct the potential sources of error. Regardless of these few situations, the data were quite accurate.

Spatial Variation in Essential Fisheries Information Parameters

As reported in Yaeger et al. (submitted), the CASP data indicated significant differences in CPUE, size distributions, number of recruits, sex ratios, and egg production among the three sampling regions (South, North Coast, Northwest Islands (Fig. 1). Key findings included:

- Overall, mean CPUE (legal lobster only) was not significantly different among regions. However, sub-legal CPUE was consistently highest in the South followed by the North Coast, and North Islands.

- For size distributions:
    - The South region was dominated by sub-legal lobsters (recruits that would be entering the fishery next year) and legal lobsters that had just recruited into the fishery; large legal lobsters were rarely caught in this region.
    - The Northwest Island region was dominated by large legal lobsters, with few sub-legal lobsters caught there.
    - The size distribution in the North Coast region was intermediate between the South and Northwest Island regions.

- The highest proportion of prospective fishery recruits occurred in the South Region as compared to the North Coast and Northwest Island Regions.

- In Year 2, the sex ratio of legal lobsters was significantly higher than the expected 50:50 (F:M) sex ratio in the Northwest Island and North Coast regions, but not the South region. However, the South region had the highest proportion of sub-legal females, as compared to the North Coast and the Northwest Islands.

- The total egg production per trap was highest in the South, followed by the North Coast and the Northwest Islands.

    - Sublegal lobster contributed substantially to egg production in the south, whereas legal lobster contributed the most eggs in the two north regions.

- In Year 2, catches in the Northwest Islands and North Coast Regions removed substantially more adult females than the South Region, potentially reducing reproductive capacity in those northern regions.

Overall, CASP data supported estimates of the CPUE and mean weight of lobster derived from CDFW data (Yaeger et al. submitted). Of notable exception was average weight of legal lobster for the Northwest Islands where CASP data indicated a smaller average weight (0.92 kg vs 1.33 kg). Data from other studies agree with this CASP finding, indicating some shortcomings with the landings receipts and logbooks for this region.

Data Management (Objective 3)

All CASP participants supported the continuation of a collaborative team approach to managing the program, involving commercial fishermen, CDFW managers and California Sea Grant and other university scientists. Specifically, all fishing partners supported having the data shared with both the CDFW (the resource agency) and California Sea Grant and associated university scientists (third party). However, the majority (67%) of fishermen preferred having the data initially handled and housed with the third party. Similarly, the majority of fishing partners (67%) supported having the third party and associated scientists and CDFW jointly analyze the data as done during this project, with a few fishermen preferring the analyses be done solely by the third party with review by others following completion of the initial analyses. All fishermen wanted to continue having annual workshops to review the data and results, not just receive an annual summary report. Several fishermen offered to be on a review committee that would facilitate integration of their input into the analyses and resulting workshops and reports. Almost all (83%) fishermen supported CDFW handling requests for the data made by other groups, but with requests reviewed by a subcommittee consisting of at least 1 fishery manager (resource agency), 1 scientist (Sea Grant Specialist, University researcher) and 3 fishermen from different ports and regions. This committee also would develop protocols to define the role of the committee and its composition and considerations for others using the data (e.g., rule of three (when needed), who could access, approved purposes for use of the data).

Long Term Implementation (Objective 4)

CASP members discussed long-term implementation of the program including a framework that addressed three primary program components:

- organizational structure
- participation (participants & roles)
- long-term funding

Organizational Structure

Team members variously supported two organizational structures: 1) a commodity commission under the California Department of Food and Agriculture (CDFA) or 2) a non-governmental organization (NGO). Of the three types of CDFA-sponsored commodity groups (commissions, councils, and marketing boards), a commission was considered to offer the best potential fit with the research- and management-oriented goals of the spiny lobster CASP. (See CDFA 2006 and CDFA 2007 for more information on these arrangements.) A commission also would provide a mechanism for collecting funds from all fishery participants (typically via an assessment per pound of one's landings or receipts) and administering those funds for CASP activities. Establishing such a commission requires the passage of enabling legislation, followed by a referendum of fishery participants to establish the organization and its funding rules, by which all fishery participants are bound. The California Sea Urchin Commission, for example, supports marketing and research activities (CDFA 2008), including data collection (at times) by commercial urchin divers.

However, some CASP fishing partners were not convinced that such a commodity group would be appropriate for the program, expressing three primary concerns. First, they did not like the high administrative costs paid to CDFA to oversee the commission. Through discussions, the group learned that "administrative costs" consist of many of the expenses required to run such an organization, including personnel, financial management, convening meetings, other communications, and reporting. As organizations of all types require many of these administrative tasks, the group realized that some of these costs could not be avoided; however, they also discussed the idea of reducing or eliminating some of these costs by having a structure that allows volunteers with appropriate skills and experience to complete some of the tasks. Second, they were concerned that CDFW would not engage with and use the data collected through the CASP, as has occurred with sea urchin data collection efforts. To address this issue, CASP members agreed it would be critical that the enabling legislation define the process for integrating the CASP and resulting data into the management process for the fishery. Provisions specifically for integrating research results into management were not included as part of the Sea Urchin Commission. The need for such provisions are supported by the scientific peer review of the Lobster FMP that called for the collection of additional EFI, including such data as provided through the lobster CASP. Lastly, fishing partners were not convinced that they would be able to obtain majority support among fishery permit holders via referendum -- at least 40% of fishery participants must vote, with 65% voting in favor and representing at least 65% of the volume landed in the fishery – for the legislation. Obtaining support of the commercial fishermen for a lobster commission remains a hurdle that may be overcome if CASP-supportive fishermen are able to educate and gain support among their colleagues.

Another option supported by CASP team members was the establishment of a non-governmental organization as was done with the California Wetfish Producers Association (see California-Based Data Collection Programs). This structure has the benefit of allowing members to operate independently of the state, with more direct control over administrative costs, organization and the full range of program functions. However, this independence also can make it more challenging to explicitly link the organization with the management process, which is necessary to ensure that the CASP data are used to inform management. Some fishermen suggested combining efforts with the current lobster fishery association, while others thought it might be better to establish a new organization dedicated to the CASP. Further discussions are needed to fully explore the potential for establishing a new or using an existing NGO for the lobster fishery CASP.

CASP Participants and Roles

Collaboration among many groups is required to ensure that the CASP produces robust, useful data, analyses and interpretations, and to foster buy-in for the data collected, the analytical results, and management recommendations. With this in mind, we outline the roles of each of the groups we consider essential to a CASP (noting that buyers and public members also may be included):

- Program Coordinator
- Commercial Fishermen

- CDFW Staff
- Scientific Advisors

Program Coordinator
A program coordinator is needed to handle all of the daily tasks of the program, including:

- recruiting, training and communicating with fishing partners
- ordering and shipping/delivering supplies (e.g., data sheets, calipers) to fishing partners
- validating data via port sampling
- data entry, QA/QC
- providing basic data summaries and updates on data collection activities
- organizing and conducting program meetings and calls
- overseeing secure data housing

The program coordinator could be affiliated with California Sea Grant (as done with this pilot CASP) or a different university-based program or researcher, CDFW or another party (e.g., independent consultant, fishery NGO). CASP fishing partners were most comfortable with maintaining the current arrangement, with California Sea Grant and other university researchers together overseeing the coordinator position. In discussions, they cited the long history of fruitful collaboration among Sea Grant, the researchers on the team, commercial fishermen and CDFW.

With the program at optimum capacity (24 fishing partners; see next section), the coordinator would be needed at 100% time for a minimum of 10 months (83% FTE) per year, that is, the six-month lobster season, plus two months each before and after the season. Preferably, this position would be held by the same person across years to build and retain institutional capacity and ensure that the program runs smoothly from year to year.

Commercial Fishermen
The CASP seeks to provide good spatial coverage and high quality data while minimizing impacts on participating fishermen. It is not necessary that *all* fishermen participate, especially since it increases the risk of obtaining lower quality data from those who do not want to participate and/or have fishing operations that are not well-suited for data collection. Optimally, the CASP would include 24 commercial lobster fishermen distributed throughout the Southern California Bight (Table 4). This optimal number of participants allows for better coverage and replication within each region, ensuring area coverage in case a fishing partner has to drop out of the program during the season (e.g., due to vessel or equipment breakdown). That said, the program could be run with as few as 12 fishermen, from appropriate areas, although this minimum can put the research at risk should any of them stop participating.

Selection criteria for CASP fishing partners were discussed and included:

- Landings (pounds) greater than a minimum threshold
- Landings occurring in each of the first four months of the season

- Meets geographic needs of program (i.e., fishes in area where sampling is needed)
- Fishing operation is suitable for data collection (e.g., fishing areas are not typically hazardous; has a deckhand or can obtain one for sampling days)
- Clean fishing record (no citations)
- Experience with collaborative research
- Performance on previous CASP data collection (if applicable)
- Recommended by program member(s)

Each year fishing partners would be selected based on the agreed-upon selection criteria.

Fishing partners would be expected to complete six sampling trips per season in accordance with the program protocols, and participate in trainings and an annual meeting to discuss the data. Some fishing partners also would participate in subcommittees to address particular issues or functions such as requests for data, data handling, quality analysis/quality control, etc. as described within this document. Throughout the season, the Program Coordinator would keep notes about difficulties encountered with the data collection effort. Although not done during this pilot project, we recommend the team development an evaluation form that provides a means for documenting the performance of those collecting data that can be used to determine continued participation in subsequent years.

CDFW

The Department's involvement in the CASP is imperative for integrating the data with management – the very reason for the CASP. Ideally all staff from the CDFW Southern California Invertebrate Team would attend meetings and be involved in the data analyses to enhance and ensure mutual understanding of the CASP, the data it generates, and its applications in management. At a minimum, at least one CDFW manager would need to participate in the program, with a formal commitment of a portion of his/her time allocated to CASP activities. These activities include:

- meetings with fishing and science partners
- data analysis with non-agency scientists
- development of an annual summary, including recommendations on potential management actions as appropriate and discussions with CASP participants
- delivery of that summary to the Department and the Fish and Game Commission

In addition, a CDFW staff biologist would assist the CDFW manager in this role (e.g., as with the Dungeness Crab Task Force), providing scientific support, as needed. Presumably, CDFW expenses (staff time, travel) incurred for the CASP would be covered by Department funds (see Program Costs and Long-Term Funding).

Scientific Advisors

At least one (non-CDFW) scientific advisor is needed for the CASP, although ideally at least three advisors -- a biologist, a fishery modeler and a social scientist -- would participate. The advisors'

role would be to provide data analyses, discuss findings with CASP participants, and assist with the development of annual summaries. In addition, they would participate in program review and provide advice about potential improvements to the program. Stipends to cover costs associated with data analysis, annual reviews and participation in meetings would be provided by the CASP.

This lobster fishery CASP included two California Sea Grant Extension Program scientists (a biologist and social scientist) and two other university scientists (ecologists). California Sea Grant has a long history (dating back to the mid-1970s) of facilitating and participating in collaborative research projects with fishermen and CDFW (and other groups) and is recognized for its neutral, third-party scientific advisors. Likewise, other University of California and California State University researchers have built relationships with the state's fishing communities, including those involved in this research. Regardless of the affiliation of the advisors, having nonpartisan expertise in the subject area and an established working relationship with and trust across a broad range of fishery participants is essential for the success of the CASP.

Other Potential Participants

Buyers, members of other agencies, environmental and fisheries NGOs, and the general public may want to participate in the CASP. Having additional input from such groups likely would enhance interest in and support for the program and provide additional insights useful to the program and management of the fishery. While no such groups were involved in the pilot CASP, the project team discussed this topic. The inclusion of buyers and processors was considered, such as has occurred with the Sea Urchin Commission, where buyers and processors have been engaged and played a positive role, but their support has varied over the years, posing some challenges for the Commission. The CASP fishing partners expressed strong reservations about other groups being involved. They were most concerned about unconditional sharing of the CASP data and being open with these groups. They cited concerns about other parties' limited understanding of the data and their appropriate use. The fishermen also said they likely would not be as open and forthright at meetings if individuals from these groups participated. That said, several team members recognized that certain individuals from these other groups may provide useful input related to data analysis and interpretation. Due to timing and these concerns, we did not engage other groups in the pilot program. However, their inclusion, along with rules about information sharing and use within and beyond CASP participants (fishermen, non-agency scientists, CDFW staff and any other parties), should be discussed and considered further if a CASP is implemented for the long term.

Long-Term Funding

CASP Costs

We estimate the cost to operate a CASP for the California spiny lobster fishery to be about $210,000 per year (Table 5). This estimate is based on expenses incurred during the pilot program and the optimum number of fishing participants (n=24). The program could cost more or less depending on the number of participants, compensation rates, the structure used to administer the funds, and any additional expenses not included in our estimate. (Some of these additional expenses may be one-time, start-up and/or intermittent items.) For example, if fishing partners were compensated by receiving reduced permit fees and/or a tax write-off, sampling costs would

be reduced. Likewise, if fewer fishermen participated, the costs for sampling and meeting stipends would be reduced. Also, the overhead (indirect cost) rate will vary depending on the organizational structure. Furthermore, we did not include any funds for CDFW staff; they may require travel or other compensation.

Long-Term Funding Options

A major challenge for sustaining the lobster fishery CASP is securing long-term funding for it. To date, grant funding along with in-kind contributions from California Sea Grant (partial salary/benefits for two Specialists, one the project lead) have covered the program costs. While it may be possible to secure additional grant funding in the future, such funding is highly unpredictable. A more consistent and stable form of funding would better ensure the viability of the program.

Whereas participation as a fishing partner in the CASP would not be mandatory (recalling, also, that 24 fishing partners is optimal), fishermen's participation in funding the program ideally would be mandatory, with equitable cost-sharing among all fishery participants the CASP serves. CASP programs in other places have been funded through mandatory permit fees or self-imposed assessments on landed product, thereby representing equitable cost sharing among all fishermen participating in the fishery. CDFW explained that while it might be possible to increase permit fees consistent with projected CASP funding needs, the additional fees could not be placed into an account dedicated to a specific program or activity such as a CASP. In California, the establishment and maintenance of dedicated funds such as these have been possible only through the formation of a commodity commission or council (see State of California Department of Food and Agriculture Marketing Branch 2008). Such an entity could be organized for the lobster fishery, and indeed there is talk of doing so, but CASP fishing partners were skeptical of certain aspects of the commission structure (see Organizational Structure). Another option would be to form a non-profit, non-governmental organization. However, team members were not sure that such an organization could generate adequate funds to support a CASP, as these organizations typically rely on voluntary membership fees to cover the costs of their activities. It remains unknown how much money could be generated through membership fees for a lobster association. It also is unclear whether legislation could be written to allow an association (instead of a Commission/Council) to oversee a tax assessment on landings as is done in the Southeast Alaska geoduck dive fishery (see Review of Existing CASPs and Appendix D.2).

DISCUSSION

Through this three-year project we illustrated the effectiveness of a collaborative at-sea sampling program (CASP) for informing management of the California spiny lobster fishery. Working together, our team of commercial fishermen, fishery managers and university scientists developed scientifically robust protocols and collected data for three seasons over the entire range of the fishery, resulting in the first data set of its kind for the fishery. Fishery dependent data characterizing lobster size distributions, sex ratios, and number of recruits are now available from throughout the Southern California Bight for the same time period. This dataset also enables validation and more accurate estimates of average weight of catch and catch-per-unit-

effort (CPUE) made from landing receipts and logbooks. A recent scientific panel convened by the Ocean Science Trust to review the draft management plan indicated that the use of data, such as those collected through our recent collaborative efforts, is critically needed for managing the California spiny lobster fishery (Field et al. 2015)

The data collected through the CASP were highly accurate as determined through the validation process. The use of high precision digital calipers and standardized measurements and observations that fishermen and biologists are familiar with (carapace length, legals/sublegals, male/females) and are easily repeatable likely contributed to the high agreement in measurements and counts between each group. Also, the continual participation of several fishermen in the program likely increased the collection of more accurate data as there were fewer differences in the data collected at sea and validated at port for those samples collected by returning fishermen. Nonetheless, the accuracy of the data could be further improved through a few simple changes to the protocols. In particular, during this project, fishermen separated the catch they sampled at sea (the subsample) by either 1) marking the measured individuals with cable ties around the antenna, 2) placing them in a different receiver from the rest of their catch or 3) placing them in burlap sacks. The data for the subsamples that were separated by the latter approach (burlap sacks) never differed between the fishermen and scientists, suggesting this is the best way to separate subsampled lobster from the catch. Discrepancies occurred when the other two methods were used as cable ties sometimes fell off the lobster's antenna so they were no longer identifiable as part of the subsample and some fishermen on occasion added lobsters to the 'sub-sample' receiver after they have finished with sampling resulting in differences between the data recorded at sea versus at the port. Port sampling also may have contributed to differences in the recorded data, as it often was done at night in low light conditions and with a large number of lobsters needing to be measured. Use of a head lamp (which was implemented partway through the program) and having two people present to handle the sample and record the data would likely minimize errors. Nonetheless, mistakes are inherent with any type of data collection, but proved to be extremely minimal for the CASP-collected data.

While the data were highly accurate, the validation process conducted at port proved to be costly and a difficult feature of the program. Travel costs were high (several $1,000s per year) as fishermen were spread throughout harbors along a 250 mile stretch of coastline covering five coastal counties, including the highly populated counties of Los Angeles, Orange and San Diego. The time it took the coordinator to travel among ports was impacted by the traffic that occurs through much of this area, particularly given the timing of the returning fishing vessels (typically late afternoon/early evening). Scheduling the days and times for validating the data also proved to be especially complicated, as fishermen often sampled at similar times of the week making it difficult to spread out the validation trips. Furthermore, buyers were often waiting at the port upon the arrival of the fishing vessel. While the buyers were supportive of the effort, there was a need to port sample quickly.

To address these issues with the validation program we explored other ways to validate the data. In particular, we considered working with various volunteer and student groups that were located close to the harbors where participants landed their catch. However, because the

validation schedule was random and infrequent we found it difficult to identify anyone that could be flexible enough to meet our needs. Our fishing partners also were not comfortable with us assigning someone they didn't know to handle their catch. Another option we considered was to have the project coordinator (a graduate student and university employee) go out with the fishermen and observe and validate the data as it was being collected. However, vessel insurance of $2 million dollars was required for each vessel as per the university insurance requirement for all staff, students and volunteers working on non-university vessels. Initial investigations into obtaining this insurance suggested this would be quite costly as the coordinator would be working on 15-20 different vessels, each requiring a modification to their insurance on sampling days. One other option that we were not able to explore was working with the buyers to conduct sampling at their facilities, as has been done for various scientific studies involving red sea urchins (S. Schroeter pers. comm.). Doing such would require that the buyer keep the subsamples separated and identified by fishermen until the coordinator could get to their facility. It is not clear whether there would be time to conduct the sampling prior to the lobster being sold and shipped out. Still, this option should be explored further for this and other CASPs looking to validate the data. Despite the costs and difficulties with this process, validation of the data remains critical for illustrating the accuracy of the data, and the subsequent trust in the data by others.

The lobster fishery CASP proved to be not only a useful tool for collecting essential fisheries information, but a very cost-effective sampling method. Project costs were minimized largely by spreading the work among many people – a characteristic of CASPs – and through in-kind contributions of all team members. Commercial fishermen provided their fishing vessels, gear and some of their time. They received only minimal compensation -- $350 per trip, with a $900 bonus if all six trips were completed on time -- for permit and salary costs of a deckhand, some gas and a small fraction of their time. Minimizing the number of trips (n=6) required of each fishermen helped to reduce the impacts on individuals while still allowing collection of data at important points during the season (twice in the first two months when the fishery is most active, followed by once in the middle two months when there is moderate activity). Two UCSB scientists donated part or all of the time they contributed to the project. In addition, two other scientists and all fishery managers/biologists contributed their time, being paid by their perspective employers (California Sea Grant, CDFW). In Year 3 when we had the most fishing participants, the costs for the CASP was about $80,000 (including $12,000 (15%) administrative overhead). For this amount, 75 sampling trips were conducted by 14 fishermen throughout the Southern California Bight with more than 4000 traps sampled, nearly 11,000 lobsters counted and 4275 measured and sex determined, with all data entered and analyzed. It would be virtually impossible for any agency or university research team to collect and analyze this amount of data with the same amount of funding. Are estimate for continuing the program is higher than this ($210,000 vs $80,000), primarily due to nearly double the number of fishing partners, payment for three scientists (which was covered largely by other funds during the project), salary and benefits for a coordinator (instead of a graduate student), and slightly higher overhead (26%; off campus University rate).

Implications for Management

Data obtained through the lobster CASP greatly enhanced the data collected from landing receipts and logbooks (see also Yaeger et al. submitted). In particular, size and sex data illustrated important area-specific characteristics of the fishery that have implications for management. While some of these area differences were noted by CDFW biologists (D. Neilson pers. comm.), the CASP provided more comprehensive spatial and temporal coverage. These CASP data also provide important cross-checks of the CDFW data on CPUE and average weight of lobsters. The latter is critical, since it is used to estimate SPR, one of the primary triggers of harvest control rules in the present FMP. Our estimates, which relied on *actual* counts of lobsters and traps that were recorded for a *subset* of the catch, were found generally to be similar to estimates based on logbook data that include only *estimates* of the number of traps serviced and *all* legal and sublegal lobsters encountered. While many have questioned the accuracy of these and other estimates reported in the logbooks, we found no significant discrepancy between the estimates based on CASP and logbook data. Nonetheless, CDFW has identified some issues with the way these numbers are reported, particularly for multi-day trips, often making it difficult to calculate accurate CPUE for some trips. As a result, CDFW must devote a significant amonut of time to clean up the logbook data. In contrast to the count and CPUE data, the cross-check of lobster size, found that logbook-based estimates overestimated sizes, data critical in estimating SPR, in the Northwest Islands.

While the Parrish Cable Model (2013, 2014, 2015) has made good use of the data that were previously available, it nonetheless had some shortcomings that can contribute to misinterpretations of the fishery. This problem can be addressed by using a more robust model – one supported by the lobster CASP – to manage the fishery. Specifically, the size distributions resulting from the CASP data support findings reported by Parrish (2013, 2014, 2015) and recognized by CDFW biologists (D. Neilson pers. comm.) that lobster in the south are being harvested as soon as they reach legal size, leaving few larger lobsters to contribute to the reproductive capacity of the population. However, the number of recruits determined from the CASP data suggests that there is an abundance of sublegal lobster – including many sexually mature females – that contribute significant reproduction to the population in that region. This is not the case for the North Coast and the Northwest Island regions, where few recruits were evident in the CASP samples. Further, sex ratios also varied among regions, indicating a difference in trap vulnerability of females, particularly in the two northern regions. This suggests that more females may be being removed from the population, potentially with an even larger impact on egg production in these regions. In addition, whereas many of the parameters of the Parrish model were based solely on data from the Northern Channel Islands, the CASP data illustrate how these parameters vary among regions. Taken together, these findings point to a need to move away from a data-poor model to a more data-rich model such as an age structured model. Doing so will enhance CDFW's modeling efforts for this fishery into the future and address recommendations by the external scientific review panel for the lobster FMP (Field et al. 2015).

More broadly, the variation in fishery parameters (size distribution, number of recruits, sex ratios) strongly supports the need for area-based management for this fishery. Currently the fishery is treated as a single area, with much of the data used to derive the harvest control rules

in the Parrish Cable Model coming from only one of the fishery's distinct areas (the Northern Channel Islands). Oceanographic conditions differ throughout the bight, with accompanying biological differences illustrated by the CASP data and the limited data from other recent studies. In addition, the North Coast region appears to be a transition area for the fishery. As such, region-specific data likely would improve the analyses used for setting harvest control rules.

The data analyses and discussions that occurred during this project also identified the critical need for gathering some basic life history information for lobster throughout the fishery's range. In particular, fecundity measurements, which are critical for estimating SPR, are based on egg production estimates that use an equation that was developed in the early 1900s based on egg counts of only a few lobsters from a single location. As the harvest control rules rely heavily on estimates of the spawning potential ratio, it is essential that better measurements of egg production be obtained for lobsters of all sizes throughout the Southern California Bight. Likewise, size at maturity and growth rates used in the FMP have been derived primarily from spatially and temporally limited studies, rather than long-term, bight-wide data collection. These parameters are likely to vary throughout the bight, with smaller, faster growing lobster maturing earlier in the south. Altogether, these factors point to the need for bight-wide studies of these life history parameters to enhance management of the state's lobster fishery.

Future Program

A main goal of the CASP is to obtain-high quality EFI over the entire range of the fishery from a small number of fishermen rather than requiring that every fisherman in the fleet participate. Based on the lobster fishery in California, we recommend at least 12 and optimally 24 fishermen that fish different areas (see Table 4) be engaged in the program; this is about 15% of the permit holders that actively fish. During the pilot program we expanded the program to include 15 fishing partners, but additional fishermen will be needed to reach optimal capacity. The program would benefit from a more formalized approach for recruiting participants and reviewing participating fishing partners.

The concept for this program was informed by a similar program that has been used in New Zealand for more than 20 years as a data collection method, in combination with other fishery-independent sampling, for managing the rock lobster fishery there. However, we have designed the California CASP differently for a few reasons. First, our program requires sampling from more traps than the New Zealand program (12 or more versus 4), but sampling is conducted on fewer trips (6 versus every day fishing and encountering marked traps). While the New Zealand program may be easier for the fishermen, we found the sampling design did not provide an adequate representation of the catch in California. Not only do California fishermen encounter more traps that lack lobster (and thus measurements), the fishermen also move their gear around throughout the season making it difficult to establish set sampling traps at the beginning of the season as done in New Zealand. The first year of our pilot project, data were collected from all traps solely to identify a sampling design that would provide a good estimate and representation of the California catch and evaluate the adequacy of the New Zealand CASP methods for the California fishery.

Fishermen continue to be interested in streamlining the data collection process. In particular, some have asked whether the legal lobster could be measured by another group once they get into port or at the buyers/distributors. While such may be an option, the travel and staff costs for someone else to do the work would likely raise the cost of the program. Also, recording of GPS coordinates during the sampling process seemed to be cumbersome for some fishermen. A review of the importance of these data is needed to determine whether fewer points could be recorded without jeopardizing the usefulness of the data. Nonetheless, the majority of fishing partners found the sampling effort to be fairly simple, getting easier the more they did it and typically taking only one hour away from fishing on the six days during the season when they collected data.

Funding remains an issue for the long-term stability of the lobster fishery CASP despite the value of the data to the state. The primary expenses are 1) compensation for participating fishermen and 2) salary and benefits for a project coordinator. Because fishermen can fish while conducting the sampling, minimal compensation is needed. However, some compensation is deemed necessary as it takes more time and fuel to conduct the sampling and a deckhand is essential for assisting during the sampling trips. Compensation in forms other than cash, such as tax write-offs or reduction or waiving of license fees, would be considered by the fishing partners if a mechanism for such existed. Individually the cost is quite minimal; about $3000 per fisherman. This amount plus the other CASP expenses represents only 1.6% of the ex-vessel value of the fishery; a small amount given the value of the collected data for management.

Funding mechanisms used by similar programs are not simple to apply in California. For example, some programs fund data collection through fees assessed as part of a quota or fishery license. However, in California collection of fees by the resource agency cannot be placed into a dedicated fund for a CASP. Taxes on landings -- with a minimum amount assessed per permit whether fishing or not – that support a commodity commission/council or a non-profit organization has also been used to fund similar programs. While there is interest among the commercial lobster fishermen to establish such an entity, many doubt such could be achieved because it requires consensus within the industry and/or legislative backing; no small feat. Yet, all agree that all fishermen with permits should contribute as they will benefit from enhanced management of the resource. Given the number of permit holders (192 in 2013/14), the CASP program could be run by assessing a fee of $1100 per fishermen, and less if the buyers also contributed. Grant funds have funded the program thus far, and may help to continue the effort at least at some level. However, the fishermen will need to come together and build support for the program, as additional efforts are now needed to secure funding and establish a framework that will continue for the long term. Having such a program will not only address the need for data as identified by a scientific panel, but it also will help to continue a collaborative approach to managing the spiny lobster fishery in California.

SUMMARY

Overall, this project successfully demonstrated the utility of a collaborative at-sea sampling program (CASP) for the California spiny lobster fishery, with the following benefits:

- Collection of data from entire catch, not just landed catch (augment existing fishery data)
- Collection of data on size and sex of lobsters over a large spatial and temporal range with minimal effort (effort spread among a group of fishermen fishing different areas)
- Collection of data to enable use of more sophisticated fishery models
- Collection of data to allow for area-based management decision/harvest rules (considers spatial differences)
- Collection of data to allow analysis of newly implemented management actions (e.g., trap limits)
- Involvement of diverse parties in data analysis and interpretation
- Cost-effective sampling
- Generation of a long-term data set (track population structure over time)

Moreover, the CASP developed and tested through this project serves as a model for data collection to improve fisheries management in the state, nationally and world-wide.

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Table 1. Participation in and data collected through the California spiny lobster collaborative at-sea sampling program (CASP).

Sampling Effort	Season One 2012-2013	Season Two 2013-2014	Season Three 2014-2015	Total
Fishermen	8	13	15	21*
Trips Sampled	32	74	77	183
Traps Sampled	4208	4,403	4,423	13,034
Lobster Counted	11,031	11,577	10,234	32,842
Traps Sub-Sampled	387	2,633	2,801	5,821
Lobsters Sub-Sampled	1,425	4,575	4,415	10,415

*Fishermen who participated in the CASP for multiple seasons are counted only once.

Table 2. Participation in the California spiny lobster collaborative at-sea sampling program (CASP) by location (coast or islands) in 2014-2015.

CASP-Defined Region	Coast		Islands	
	Geographic range	Number of participants	Geographic range	Number of participants
Northwest Islands	n/a	n/a	San Miguel, Santa Rosa, Santa Cruz, Anacapa, Santa Barbara, San Nicolas	3
North Coast	Santa Barbara – Orange Counties (from Newport north)	4	n/a	n/a
South	Orange (Dana Point south) - San Diego Counties	5	Catalina, San Clemente, Cortez Banks	3

Table 3. Comparison of selected features of three case study Collaborative At-Sea Sampling Programs (CASPs).

	British Columbia Geoduck	New Zealand Rock Lobster	Southeast Alaska Geoduck
Fishery context			
Fishery status when CASP started	Established	Established	Emergent
Basis for fishery participation	Catch shares	Catch shares	Limited entry
Number of captains	53 divers/ 40 vessels (2012)	270 (2013)	89 (2012)
Approx. landings	1,500 mt	2,545 mt (2013)	336 mt (2012)
Approx. ex-vessel value	US $43.9 million[1] (2012)	US $205.5 million[1] (2013)	US $5.1 million (2012)
Motivation for CASP	Shift to catch shares & cost-recovery for management	Concerns about government-collected data	State agency need for data to enable expansion of emergent fishery
Year CASP established	2004	1993	1998
Organizational home	Non-profit industry group, government-certified to participate in management	Non-profit industry group, government-certified to participate in management	Non-profit industry group, government-certified to participate in management
Funding sources	Permit-based membership fees	Permit- and production-based membership fees	Assessment based on individual landings value
Operational features			
Roles[2]			
Protocol design	Agency	Third party firm, fishery participants	Agency, fishery participants

CASP coordination	Third party firm	Third party firm, fishery participants	Fishery organization
QA/QC	Third party firm	Third party firm	Agency, fishery participants
Data analysis		Third party firm	Agency
Results interpretation	Third party firm, fishery participants	Third party firm, fishery participants	
Data storage	Third party firm	Third party firm, agency	Agency, fishery organization
Data collection			
Fishery-dependent	✓	0	✓
Voluntary	0	✓	✓
Percent of fishermen	~100%	~25%	7%
Fishery-independent	✓	✓	✓
Data collection tool	* bed questionnaire/log	* trip logbook * annual fishing patterns survey * one-time description of pots used for sampling	* bed reconnaissance survey
Compensation for fishermen			
Monetary	0	2	2
Non-monetary	0	3	0

[1]Adjusted for exchange rate in December of the year indicated

[2]For both the British Columbia and New Zealand cases, the third-party firms are scientific research entitites that have been licensed or otherwise certified by government as science providers for management.

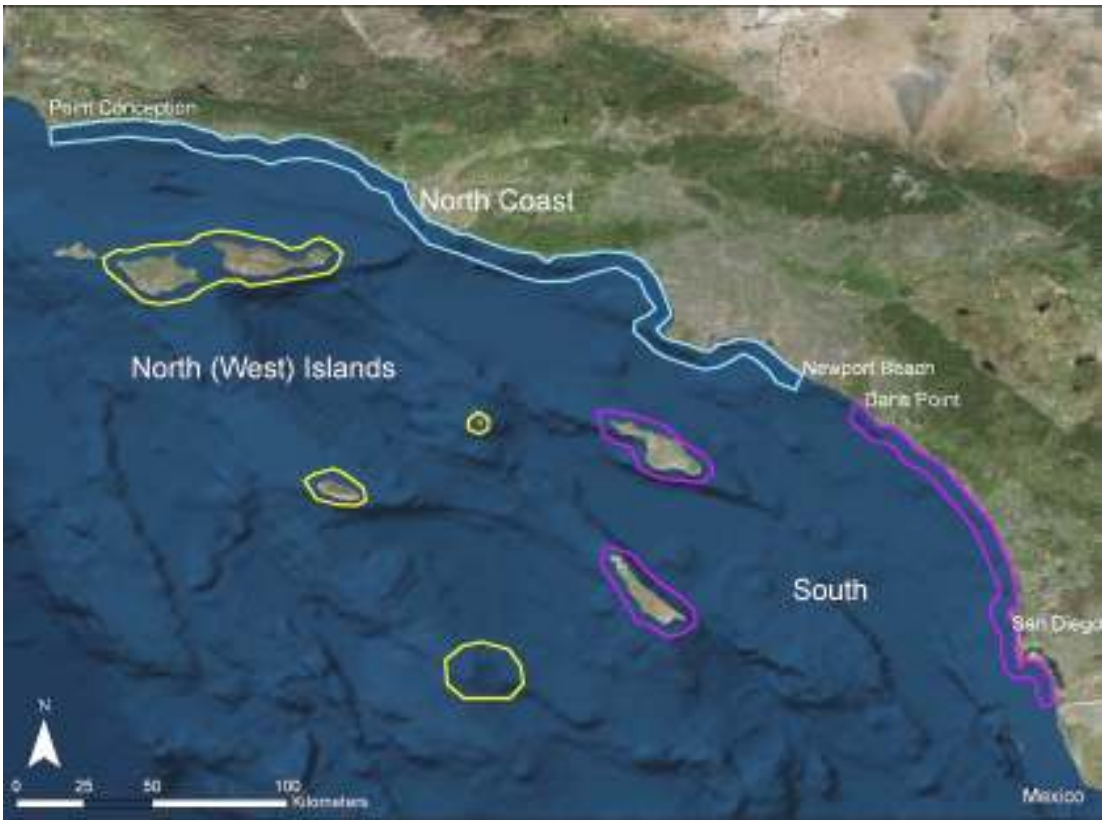
Table 4. Participation requirements (number of fishermen) by region for the California spiny lobster fishery collaborative at-sea sampling program (CASP).

CASP-Defined Region	Coast		Islands	
	Geographic Range	Minimum to Optimum Participation	Geographic Range	Minimum to Optimum Participation
Northwest Islands	n/a	n/a	San Miguel, Santa Rosa, Santa Cruz, Anacapa, Santa Barbara, San Nicolas	3-6
North Coast	Santa Barbara – Orange Counties (from Newport north)	3-6	n/a	n/a
South	Orange (Dana Point south) - San Diego Counties	3-6	Catalina, San Clemente, Cortez Banks	3-6

Table 5. Estimated costs for the California spiny lobster fishery collaborative at-sea sampling program.

Expense Type	Estimated Amount
Coordinator	
Salary/Benefits	$ 50,000
Travel	5,000
Commercial Fishermen	
Sampling - 6 Trips @ $500/trip x 24 fishermen	72,000
Meeting Stipend - $400 x 24 fishermen x 2 per year	19,200
Scientists	
Meeting Stipend - $400 x 3 scientists x 2 per year	2,400
Data Analysis/Review - $3000 x 3 scientists	9,000
Managers	
Meetings – Stipend & Travel	In-kind
Data Analysis/Review	In-kind
Supplies	
Field – electronic calipers, waterproof paper, sample holding bins	5,500
Office – phone, postage, toner cartridges, thumb-drives	750
Computer – software	1,000
Meeting Expenses	
Food and beverages - $20 x 32 people x 2 per year	1,280
Subtotal	$166,130
Indirect Costs (26%)	43,194
TOTAL	$209,324

Figure 1. Three biogeographically distinct regions with varying parameters in the California spiny lobster fishery; South (purple), North Coast (blue), Northwest Islands (yellow). Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus.



APPENDIX A

Interview Questionairres

Key Contacts

We are doing a review of the literature and other sources to characterize these CASPs and the fisheries they address to the extent possible before the interviews are conducted. We also will ask potential interviewees to provide program materials to help ground our understanding and the interviews and better enable us to probe as needed while minimizing burden on interviewees.

Interviews will be prefaced by 1) an invitation to participate/be interviewed, asking to identify a convenient time for the interviewee, and 2) a review of human subjects research principles and informed consent (overview of the research purpose and process, how data collected will be handled, etc., determination of consent to participate).

Program history

1. Program name (or concise descriptor)

2. How the program started
   a. When
   b. By whom
   c. Why
   d. For what (questions/information needs addressed)

3. When and how you became involved
   a. Your role/title/job related to the CASP

Program description

4. Data collection procedures/protocols
   a. How and by whom they were created
   b. Were any other fisheries used as a model?

5. Data collected
   a. Biophysical/ecological (e.g., counts, size, sex, reproductive condition, bycatch, location caught)
   b. Fishery-related (e.g., effort/gear, costs, fishery participants' experiential knowledge, their characteristics – operational, demographic)

6. Equipment used to collect and record data (e.g., data sheets, measuring tools, counters)

7. Timing of research
   a. During or apart from commercial fishing trip
   b. Length of trip (single v. multi-day)
   c. Seasonal v. year-round
   d. Frequency and duration of sampling

8. People involved and roles
    a. Captain, crew, others (who/how many, what role(s), how chosen)
        i. Percentage/representativeness of the fleet
    b. Scientists
    c. Managers
    d. Others

9. Participant recruitment
    a. Criteria (skills, area-based, etc.)
    b. Required commitment (e.g., x sampling trips in a given time period)

10. Participant training

11. Data handling
    a. At-sea to shore (what, how, when/where, to whom)
    b. Data storage (what, how, when/where, with whom)
    c. Data validation/QA/QC (what, how, by whom)
    d. Data access by others not involved in the program

12. Data analysis (what, how, by whom)

13. Interpretation of results (what, how, by whom)

14. Research products
    a. How and with whom the data/results are shared
    b. How and by whom the data/results have been used for management

Program costs and financing

15. Costs
    a. Start-up
    b. Recurring
    c. Compensation for fishery participants and others
        i. Types (monetary, other)
        ii. How determined

16. Funding
    a. Sources
        i. Fishery-based (e.g., landing fees)
        ii. Government (state or federal)
        iii. Other non-government
    b. How identified and secured

17. Extent of cost coverage (recovery) (partial, complete)

Program changes and challenges

18. How the program has changed over time in terms of (e.g.,)
    a. Who's involved
    b. Roles played
    c. Operational aspects (data collection, handing, analysis, interpretation)

d. Financing
e. Outcomes (for management, the fishery)
f. Impacts (on management, the fishery)

19. The most challenging aspects of the program to date, e.g., in terms of:
    a. Participant recruitment, retention/turnover
    b. Participant roles
    c. Data collection
        i. Practicalities, logistics
        ii. Process
        iii. Consistency, validity, reliability
    d. Data handling/storage
    e. Data analysis
    f. Interpretation of results
    g. Integration of results into management
    h. Financing/cost recovery
    i. Other

20. How and to what effect these challenges have been addressed

21. Concerns about
    a. the accuracy of the data
    b. fishermen's ability (viz. skills, time, interest) to engage in the research and/or management efforts
    c. access to the data by those within and those outside the program (too much, too little, confidentiality)

22. How – and to what effect – these concerns have been addressed.

Institutional context

23. Policies, circumstances or events that led to or otherwise supported the establishment of the program

24. Hurdles/obstacles/challenges to establishing the program

25. Policy changes, circumstances or events since that have affected the program

26. Hurdles/obstacles/challenges to maintaining the program

27. How the program relates to or interacts with other data sources, data collection efforts, etc.

28. Other fisheries in your state/area for which this type of program has been implemented.
    a. Program name, fisheries
    b. Particular knowledge of the program(s) that is related to the topics we've discussed
    c. Name of a contact so we can learn more about that program

    If no:
    d. Why such a program is not used more extensively

Program outcomes and impacts

29. What has been learned (information) about
    a. The resource
    b. The fishery

30. How fishing activities have changed as a result of the program
    a. How management has changed as a result of the program (e.g., data, other information/understanding)

31. How relationships have changed as a result of the program:
    a. Among those involved in CASP (fishermen, scientists and managers)
    b. Among member of the fleet
    c. Among scientists, managers and fishermen in general

32. Unintended consequences (outcomes or impacts) of the program

Recommendations

33. Lessons learned about collaborative fisheries research and its integration into management

34. Advice to others interested in developing such a program (may be addressed in previous question)

35. Who else (fishermen, scientists, managers) we should interview to learn more about experience with the program

Many thanks & next steps.

Fishermen

The same human subjects research procedures will be used as for key contacts.

Program involvement

1. How long have you participated in the (at-sea sampling) program?

2. Have you participated in other such programs?

3. What program activities do you participate in?
   a. At-sea data collection
   b. Data validation
   c. Data analysis
   d. Interpretation of results
   e. Conveying/integrating result into the management process
   f. Other

4. How often do you collect data?

5. What is the most difficult part about collecting data while fishing?
   a. How much time does it take for you to collect data when fishing?
   b. How much time do other program tasks take?

6. Are you compensated?
   If so:
   a. Please describe
   b. Do you feel the amount is fair?

Program expectations, experience and outcomes

7. Why do you participate in the program (motivations, expectations)?

8. What are the advantages (or up sides) of participating in the program?

9. What are the disadvantages (or down sides) of participating in the program?

10. In your opinion, what have been the biggest challenges for the program?
    a. How and to what extent have these been resolved?

11. In your opinion, what have been the most important outcomes and impacts of the program?

12. Has management of the fishery changed as a result of the program? If yes:
    a. How so?

13. Do you feel the 'collaborative' approach to data collection and interpretation has improved management of the fishery?
    If yes:
    a. How so? If not:
    b. Why not?

14. Do you feel your role in management has changed due to your participation in the program? If yes:
    a. How so?

15. Has the way the fishery is carried out changed as a result of the program? If yes:
    a. How so?

16. Have relationships among fishermen, scientists and managers changed as a result of the program? (improved, worsened, stayed the same; nature of change)

17. Have there been outcomes or impacts of the program that you did not expect? If yes:
    a. Please describe

Lessons learned

18. Are there ways in which you think this program could be improved? If yes:
    a. Please explain

19. Would you encourage other fishermen to participate in such a program?
    If yes:
    a. Why?
    If no:
    b. Why not?

20. If you could advise fishermen, managers and scientists on how to set up and maintain such a program, what would you suggest?

21. Are there others (fishermen, scientists, managers) we should interview to learn more about experience with the program?

Managers

The same human subjects research procedures will be used as for key contacts.

Program involvement

1. How are you involved in or interacted with the program? (past and current roles)

2. Have you participated in or interacted with other such programs?

3. What program activities do you participate in?
   a. At-sea data collection
   b. Data validation
   c. Data analysis
   d. Interpretation of results
   e. Conveying result to the management process
   f. Using results to design and implement management
   g. Other

Institutional context

4. Were there policies, circumstances or events that led to or otherwise supported the establishment of the program?

5. Were there hurdles/obstacles/challenges to establishing the program?

6. Have there been policy changes, circumstances or events since that have affected the program?

7. Have there been hurdles/obstacles/challenges to maintaining the program?

8. How does the program relate to or interact with other aspects of management?

Program expectations, experience and outcomes

9. Are there challenges or problems in using data collected by the fishermen in management? If yes:
   a. Please explain.

10. Have there been concerns about the validity of the data? If yes:
    a. How have those concerns been addressed?

11. What are the benefits of using data collected by the fishermen in management?

12. Are program data shared with others outside the program? If yes:
    b. Has this posed any problems or challenges? If so:
       i. How have they been addressed?
    c. Have there been benefits of sharing program data with others outside the program? If so:
       i. Please explain.

13. As a result of the program, what has been learned
    a. About the resource?
    b. About the fishery?

14. In your opinion, what have been the most important outcomes and impacts of the program?

15. Has the program or its results affected management of the fishery? (data or other information resulting from the program, changes in relationships, changes in roles)
    If yes:
    a. How so?

16. Do you feel the 'collaborative' approach to data collection and interpretation has improved management of the fishery?
    If yes:
    a. How so? If not:
    a. Why not?

17. Has your role in management has changed as a result of the program? If yes:
    a. How so?

18. Has the way the fishery is carried out changed as a result of the program? If yes:
    a. How so?

19. Have relationships among fishermen, scientists and managers changed as a result of the program? (improved, worsened, stayed the same; nature of change)

20. Have there been outcomes or impacts of the program that you did not expect? If yes:
    a. Please describe
    b. Are there ways in which you think this program could be improved? If yes:
    c. Please explain

21. Are there ways in which you think this program could be improved? If yes:
    a. Please explain

22. Are there other fisheries in your state/area for which this type of program has been implemented?
    If yes:
    a. Program name, fisheries
    b. Particular knowledge of the program(s) that is related to the topics we've discussed
    c. Name of a contact so we can learn more about that program

    If no:
    d. Why has such a program not been used more extensively?

Lessons learned

23. Are there any "lessons" about collaborative fisheries research and its integration into management that you have learned your experience with the program?

24. Would you encourage others to develop and use such a program?
    If yes:
    a. Why?
    If no:
    b. Why not?

25. If you could advise fishermen, managers and scientists on how to set up and maintain such a program, what would you suggest?

26. Are there others (fishermen, scientists, managers) we should interview to learn more about experience with the program?

Scientists

The same human subjects research procedures will be used as for key contacts.

Program involvement

1. How long have you participated in the (at-sea sampling) program?

2. Have you participated in or interacted with other such programs?

3. What program activities have you participated in?
   a. At-sea data collection
   b. Data validation
   c. Data analysis
   d. Interpretation of results
   e. Conveying/integrating result into the management process
   f. Other

Program expectations, experience and outcomes

4. Why do you participate in the program (motivations, expectations)?

5. What are the advantages (or up sides) of participating in the program?

6. What are the disadvantages (or down sides) of participating in the program?

7. In your opinion, what have been the biggest challenges for the program?
   a. How and to what extent have these been resolved?

8. Have there been concerns about the validity of the data? If yes:
   a. How have those concerns been addressed?

9. Are program data shared with others outside the program? If yes:
   a. Has this posed any problems or challenges? If so:
      i. How have they been addressed?
   b. Have there been benefits of sharing program data with others outside the program? If so:
      i. Please explain.

10. In your opinion, what have been the most important outcomes and impacts of the program?

11. Has management of the fishery changed as a result of the program? If yes:
    a. How so?

12. Do you feel the 'collaborative' approach to data collection and interpretation has improved management of the fishery?
    If yes:
    a. How so?
    If not:
    b. Why not?

13. Do you feel your role in management has changed due to your participation in the program? If yes:
    a. How so?

14. Has the way the fishery is carried out changed as a result of the program? If yes:
    a. How so?

15. Have relationships among fishermen, scientists and managers changed as a result of the program? (improved, worsened, stayed the same; nature of change)

16. Have there been outcomes or impacts of the program that you did not expect? If yes:
    a. Please describe

17. Are there ways in which you think this program could be improved? If yes:
    a. Please explain

18. Are there other fisheries in your state/area for which this type of program has been implemented?
    a. Program name, fisheries
    b. Particular knowledge of the program(s) that is related to the topics we've discussed
    c. Name of a contact so we can learn more about that program

    If no:
    d. Why has such a program not been used more extensively?

Lessons learned

19. Would you encourage others to participate in such a program? If yes:
    a. Why? If no:
    b. Why not?

20. If you could advise fishermen, managers and scientists on how to set up and maintain such a program, what would you suggest?

21. Are there others (fishermen, scientists, managers) we should interview to learn more about experience with the program?

ALL TRAPS Page of

Date:	
Location:	
F/V:	

	1st Trap	Last Trap
GPS Lat:		
GPS Long:		
Water Depth:		

Trap Size*:	
Bait Type:	
Soak Time:	
Total Lbs Landed:	

* S (small) or L (large) for trap size serviced that day (if you use two sizes). If the size varies among traps, indicate size in 'Notes' column below.

	# of Lobster					
Trap	Alive		Dead		Bycatch (Specify type and number in each trap)	**Notes:** If trap type or bait type changes, indicate new type here.
No.	Legals	Shorts	Legals	Shorts		Also record tag color, number, size and other observations here.
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						

Select Trap # 1

Page of

Date:	
*Trap #:	
F/V:	

GPS Lat:	
GPS Long:	
Water Depth:	

Measure 30 lobsters max per 'select' trap - 15 legals, 15 shorts
Record total number of legals and shorts in highlighted boxes
* Record corresponding trap # from "All Traps" datasheet in box to the **far** left

Status (L / S)	Number	Size (CL)	Tail Width (2nd segment)	SEX (M/F)	Reproductive Condition	Shell Condition	Toss Reason	**Notes:** Record tag color and number if tagged. Other observations here.
L	1							
L	2							
L	3							
L	4							
L	5							
L	6							
L	7							
L	8							
L	9							
L	10							
L	11							
L	12							
L	13							
L	14							
L	15							
L								
S	1							
S	2							
S	3							
S	4							
S	5							
S	6							
S	7							
S	8							
S	9							
S	10							
S	11							
S	12							
S	13							
S	14							
S	15							
S								

KEY

Status

L, legal-sized lobster
S, short lobster

Reproductive Condition

Females:
*UN, unplastered
PW, plastered white
PG, plastered grey
PB, plastered black
BO, berried orange
BG, berried grey

Males:
I, inflated ducts
*NI, not inflated

* Can put slash or n/a if prefer

Shell Condition

OH, old hard (fouled)
NH, new hard
NS, new soft

Toss Reason

S, short
DF, dead - fish predation
DO, dead - octopus predation
D, dead - specify reason if known
E, eggs
Other, specify

Own Categories

SAMPLE TRAPS

First Sixty Lobster

General Trip Information	
Date:	
F/V:	
Location:	
Trap Size*:	
Mesh Color:	
Bait Type:	
Soak Time:	

	1st Trap	Last Trap Sampled	Last Trap Serviced
GPS* Lat:			
GPS* Long:			
Water Depth:			
Time:			

***GPS Format:** Decimal Degrees, Decimal Minutes or Degrees/Minutes/Seconds (check one)

Sample Area	
Dimensions of Sample Area	
# of **OWN** Traps In Area*	
# of **OTHER** Traps In Area**	
End of Day	
Total # Traps Serviced	
Total # Legals for Day	
Total # Shorts for Day	
Estimated Total Pounds for Day	

* If you use two sizes, indicate S (small) or L (large) for the size of the majority of sample traps. If size changes, indicate trap number(s) and size in 'Notes' section.

* Total number of **your** traps deployed in area where you sampled, whether serviced or not today

** Estimated number of **other** traps (not yours) in area

Counts			
Trap No.	# of Lobster		Bottom Type
	Legals	Shorts	
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

Counts			
Trap No.	# of Lobster		Bottom Type
	Legals	Shorts	
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			
38			
39			
40			

Counts			
Trap No.	# of Lobster		Bottom Type
	Legals	Shorts	
41			
42			
43			
44			
45			
46			
47			
48			
49			
50			
51			
52			
53			
54			
55			
56			
57			
58			
59			
60			

Bottom Type Key	
K	Kelp
SG	Surfgrass
FBK	Feather Boa (Ribbon) Kelp
R	Rock
S	Sand
O-type	Other - specify type

NOTES

If trap size, mesh color, bait type or bottom type changes, indicate the change and the associate trap number(s). Also record other observations, including lobster size and tag color & number for tagged lobster.

LOBSTER MEASUREMENTS

F/V:
Date:

First Sixty Lobster

*** Don't forget to record GPS coordinates for first and last trap sampled ***

Lobster No.	Trap No.	Status (L/S)	Size (CL)	SEX (M/F)	Lobster No.	Trap No.	Status (L/S)	Size (CL)	SEX (M/F)	Lobster No.	Trap No.	Status (L/S)	Size (CL)	SEX (M/F)	Lobster No.	Trap No.	Status (L/S)	Size (CL)	SEX (M/F)
1					21					41									
2					22					42									
3					23					43									
4					24					44									
5					25					45									
6					26					46									
7					27					47									
8					28					48									
9					29					49									
10					30					50									
11					31					51									
12					32					52									
13					33					53									
14					34					54									
15					35					55									
16					36					56									
17					37					57									
18					38					58									
19					39					59									
20					40					60									

NOTES: Record observations, including lobster size and tag color & number for tagged lobster.

SAMPLE TRAPS

First Sixty Traps

General Trip Information	
Date:	
F/V:	
Location:	
Trap Size*:	
Mesh Color:	
Bait Type:	
Soak Time:	

	1st Trap	Trap #60	Last Trap Serviced
GPS* Lat:			
GPS* Long:			
Water Depth:			
Time:			

GPS Format: Decimal Degrees, Decimal Minutes or Degrees/Minutes/Seconds (check one)

Sample Area	
Dimensions of Sample Area	
# of **OWN** Traps In Area*	
# of **OTHER** Traps In Area**	
End of Day	
Total # Traps Serviced	
Total # Legals for Day	
Total # Shorts for Day	
Estimated Total Pounds for Day	

* If you use two sizes, indicate S (small) or L (large) for the size of the majority of sample traps. If size changes, indicate trap number(s) and size in 'Notes' section.

* Total number of **your** traps deployed in the area where you sampled, whether serviced or not

** Estimated number of **other** traps (not yours) in area

Counts			
Trap No.	# of Lobster		Bottom
	Legals	Shorts	Type
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

Counts			
Trap No.	# of Lobster		Bottom
	Legals	Shorts	Type
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			
38			
39			
40			

Counts			
Trap No.	# of Lobster		Bottom
	Legals	Shorts	Type
41			
42			
43			
44			
45			
46			
47			
48			
49			
50			
51			
52			
53			
54			
55			
56			
57			
58			
59			
60			

Bottom Type Key	
K	Kelp
SG	Surfgrass
FBK	Feather Boa Kelp
R	Rock
S	Sand
O-type	Other - specify type

NOTES
If trap size, mesh color, bait type or bottom type changes, indicate the change and the associate trap number(s). Also record other observations, including lobster size and tag color & number for tagged

LOBSTER MEASUREMENTS

F/V:
Date:

First Sixty Traps

*** Don't forget to record GPS coordinates for first and last trap sampled ***

ID No.	Trap No.	Status (L/S)	Size (CL)	SEX (M/F)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

ID No.	Trap No.	Status (L/S)	Size (CL)	SEX (M/F)
21				
22				
23				
24				
25				
26				
27				
28				
29				
30				
31				
32				
33				
34				
35				
36				
37				
38				
39				
40				

ID No.	Trap No.	Status (L/S)	Size (CL)	SEX (M/F)
41				
42				
43				
44				
45				
46				
47				
48				
49				
50				
51				
52				
53				
54				
55				
56				
57				
58				
59				
60				

ID No.	Trap No.	Status (L/S)	Size (CL)	SEX (M/F)
61				
62				
63				
64				
65				
66				
67				
68				
69				
70				
71				
72				
73				
74				
75				
76				
77				
78				
79				
80				

NOTES: Record ID number and observations, including lobster size and tag color & number for tagged lobster.

SAMPLE TRAPS

General Trip Information	
Date:	
F/V:	
Location:	
Trap Size*:	
Bait Type:	
Soak Time:	

Decimal **or** Degrees (circle)	1st Trap	Last Trap Sampled	Last Trap Serviced
GPS Lat:			
GPS Long:			
Water Depth:			
Time:			

* S (small) or L (large) for sampled traps (if you use two sizes). If sizes encountered, indicate size and trap number(s) in 'Notes' section.

End of Day	
Total # Traps Serviced	
Total # Legals for Day	
Total # Shorts for Day	
Estimated Total lbs. for Day	
Sample area productivity compared to rest of fishing grounds (Circle)	Low Medium High
Sample area productivity compared to same area previous seasons	Low Medium High

Counts			
Trap No.	# of Lobster		Bottom Type
	Legals	Shorts	
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

Counts			
Trap No.	# of Lobster		Bottom Type
	Legals	Shorts	
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			
35			
36			
37			
38			
39			
40			

Counts			
Trap No.	# of Lobster		Bottom Type
	Legals	Shorts	
41			
42			
43			
44			
45			
46			
47			
48			
49			
50			
51			
52			
53			
54			
55			
56			
57			
58			
59			
60			

Bottom Type Key	
K	Kelp
EG	Eelgrass
FBK	Feather Boa Kelp
R	Rocky
S	Sand
O-type	Other - specify type

NOTES

If trap size, mesh color, bait type or bottom type changes, indicate trap number when it changes and the new type. Also record tag color, number, size & other observations. If forgot to measure lobster record trap number

F/V:

Date:

LOBSTER MEASUREMENTS

	10th Lobster	20th Lobster	30th Lobster	40th Lobster	50th Lobster
GPS Lat					
GPS Long					
Water Depth					
No. Traps in 100ft Radius					
Area Trap Density (Circle One)	Low Medium High		Low Medium High		Low Medium High

GPS for 1st and 60th lobster on sample trap page

Lob No.	Trap No.	Status (L/S)	Size (CL)	SEX (M/F)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10*				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

Lob No.	Trap No.	Status (L/S)	Size (CL)	SEX (M/F)
21				
22				
23				
24				
25				
26				
27				
28				
29				
30*				
31				
32				
33				
34				
35				
36				
37				
38				
39				
40				

Lob No.	Trap No.	Status (L/S)	Size (CL)	SEX (M/F)
41				
42				
43				
44				
45				
46				
47				
48				
49				
50*				
51				
52				
53				
54				
55				
56				
57				
58				
59				
60				

Lob No.	Trap No.	Status (L/S)	Size (CL)	SEX (M/F)

TRAP LOG

F/V:
Date:
Readings: Decimal or Degrees (circle one)

Lobster # 1 (1st Trap)	
GPS Lat	On Sample Trap Sheet
GPS Long	
Water Depth	

Lobster # 20	
GPS Lat	
GPS Long	
Water Depth	

Lobster # 40	
GPS Lat	
GPS Long	
Water Depth	

Lobster # 10			
GPS Lat			
GPS Long			
Water Depth			
No. Traps in 100ft Radius			
Area Trap Density (Circle One)	Low	Medium	High

Lobster # 30			
GPS Lat			
GPS Long			
Water Depth			
No. Traps in 100ft Radius			
Area Trap Density (Circle One)	Low	Medium	High

Lobster # 50			
GPS Lat			
GPS Long			
Water Depth			
No. Traps in 100ft Radius			
Area Trap Density (Circle One)	Low	Medium	High

Lobster # 60 will be the last trap sampled, record GPS on 'Sample Trap' datasheet

SAMPLE TRAPS

General Trip Information	
Date:	
F/V:	
Location:	
Trap Size*:	
Bait Type:	
Soak Time:	

Decimal **or** Degees (circle)	1st Trap	Last Trap Sampled	Last Trap Serviced
GPS Lat:			
GPS Long:			
Water Depth:			
Time:			

End of Day			
Total # Traps Serviced			
Total # Legals for Day			
Total # Shorts for Day			
Estimated Total lbs. for Day			
Sample area productivity compared to rest of fishing grounds (Circle)	Low	Medium	High
Sample area productivity compared to same area previous seasons	Low	Medium	High

*S (small) or L (large) for sampled traps (if you use two sizes). If sizes encountered, indicate size and trap number(s) in 'Notes' section.

Counts			
Trap No.	# of Lobster Legals	# of Lobster Shorts	Bottom Type
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11*			
12			
13			
14			
15			
16			
17			
18			
19			
20			

Counts			
Trap No.	# of Lobster Legals	# of Lobster Shorts	Bottom Type
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31*			
32			
33			
34			
35			
36			
37			
38			
39			
40			

Counts			
Trap No.	# of Lobster Legals	# of Lobster Shorts	Bottom Type
41			
42			
43			
44			
45			
46			
47			
48			
49			
50			
51*			
52			
53			
54			
55			
56			
57			
58			
59			
60			

Bottom Type Key	
K	Kelp
EG	Eelgrass
FBK	Feather Boa Kelp
R	Rocky
S	Sand
O-type	Other - specify type

NOTES
If trap size, mesh color, bait type or bottom type changes, indicate trap number when it changes and the new type. Also record tag color, number, size & other observations. If forgot to measure lobster make a note of trap number here

LOBSTER MEASUREMENTS

F/V:

Date:

** Don't forget to record GPS coordinates for traps 1, 11, 21, 31, 41, 51, 60 and the last trap serviced in the day **

ID No.	Trap No.	Status (L/S)	Size (CL)	SEX (M/F)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

ID No.	Trap No.	Status (L/S)	Size (CL)	SEX (M/F)
21				
22				
23				
24				
25				
26				
27				
28				
29				
30				
31				
32				
33				
34				
35				
36				
37				
38				
39				
40				

ID No.	Trap No.	Status (L/S)	Size (CL)	SEX (M/F)
41				
42				
43				
44				
45				
46				
47				
48				
49				
50				
51				
52				
53				
54				
55				
56				
57				
58				
59				
60				

ID No.	Trap No.	Status (L/S)	Size (CL)	SEX (M/F)
61				
62				
63				
64				
65				
66				
67				
68				
69				
70				
71				
72				
73				
74				
75				
76				
77				
78				
79				
80				

NOTES: Record ID number and associated tag color, number, size & other observations.

F/V:

Date:

Readings: Decimal or Degrees (circle one)

SELECT TRAP LOG

Trap # 1	
GPS Lat	On Sample Trap Sheet
GPS Long	
Water Depth	

Trap # 21	
GPS Lat	
GPS Long	
Water Depth	

Trap # 41	
GPS Lat	
GPS Long	
Water Depth	

Trap # 11			
GPS Lat			
GPS Long			
Water Depth			
No. Traps in 100ft Radius			
Area Trap Density (Circle One)	Low	Medium	High

Trap # 31			
GPS Lat			
GPS Long			
Water Depth			
No. Traps in 100ft Radius			
Area Trap Density (Circle One)	Low	Medium	High

Trap # 51			
GPS Lat			
GPS Long			
Water Depth			
No. Traps in 100ft Radius			
Area Trap Density (Circle One)	Low	Medium	High

Trap 60 (last trap sampled), record GPS, water depth, and time on 'Sample Trap' datasheet

APPENDIX C.1

Protocol – Season 1

1. Pull up trap.
   If it is the ***first*** trap, fill out the top portion of the "All Traps" datasheet.
   If it is the ***last*** trap, also record GPS coordinates and water depth.

If the trap *is not* one of your 12 'select' traps:

2. Count the number of legal and short lobster (based on your gauge), plus each type of bycatch. Do this by removing individual animals from the trap while letting your deckhand know what category of animal it is (legal (alive, dead), short (alive, dead), type of bycatch). Have your deckhand use the counter to keep track of each type of animal, recording the total counts once you have finished going through the trap. Return shorts and bycatch to the sea as you go through your catch. Clear the counter before starting with the next trap.

If the trap *is* one of your 12 'select' traps:

Have the deckhand switch to the "Select Traps" datasheet and fill out the information at the top of the datasheet. Be sure to record the corresponding trap number from the 'All Traps' datasheet where indicated.

3. Randomly pull an individual animal from the trap and have the deckhand record on the counter the category for the organism: 1) legal lobster (based on your gauge), alive or dead, 2) short lobster (based on your gauge), alive or dead, 3) bycatch (indicate the type).

4a. If the animal is a lobster (legal or short) record: 1) size (carapace length), 2) tail width (2^{nd} set of spines, just above first pair of swimmerets), 3) sex, 4) reproductive condition, 5) shell condition, 6) reason tossed (if tossed). Refer to the key on the datasheet for items 4-6. Use the provided caliper (using metric – millimeters) for the measurements (items #5-6). Record the entire number provided on the digital readout – do not round the number. Do not leave any space blank, put a slash through the box or write 'n/a' if it not applicable for that animal. Once all the data are recorded for the individual lobster, return it to the sea if it is a short.

4b. Record the information from Step 4a for the first 15 legal and the first 15 short lobsters (30 total lobster) from the trap, or for all lobster of each category if there are less than 15. If there are more than 15 legal and/or short lobster, use the counter to tally the remaining lobster and record the total number for each category in the shaded box on the datasheet. Also record this total count on the "All Traps" datasheet.

5. If the animal is bycatch, only a count is needed. Have the deckhand keep track of the count for each type of bycatch on the counter. Once all animals have been handled from a trap, record the total count for each type of bycatch on the 'All Traps' datasheet.

NOTE: The 12 'select traps' should be uniformly distributed throughout your catch. Divide the total number of traps you will be servicing by 12 to figure out which traps will be your select traps. For example, if you have 120 traps that you are servicing, every 10^{th} trap will be a 'select' trap. Similarly, if you have 275 traps, use every 20^{th} trap (round down to an easy number). If there are no lobster in a 'select' trap, use the next trap that has lobster as your 'select' trap. Be sure to record the corresponding trap number from your 'All Traps' datasheet on the 'Select Traps' datasheet.
Tip: Determine the number of traps you will service before starting and then circle on the "All Traps" datasheet the traps that will be your select traps based on the above calculation. The circled trap number on the 'All Traps" sheet will alert you to when a 'select' trap is next.

Sample once a month, preferably 3-4 weeks apart. Sample trips do not have to be to the same area. Just pick a day that works for you and provide the needed information from that day's catch.

APPENDIX C.2

Protocols – Season 2
60 Lobster

1. Pull up trap.
   If it is the ***first*** trap, fill out the **general information** at the top portion of the "Sample Traps" datasheet and record **GPS coordinates**, water **depth** and start **time**.
   For ***all traps*** sampled, record the dominate **bottom type** for the area where the trap was set. If it has not changed from the previous trap, just run a line down indicating it is the same. When applicable, make note if the trap size, mesh color, bait type or soak type changed from what you recorded on the top of the datasheet. Other notes of interest should also be recorded (e.g., predation on lobster; berried female; poached).

2. Pull out and **count** all **legal** (based on your gauge) lobster in the trap and record the total number on the "Sample Traps" datasheet. If you have a large number of lobsters, use a counter to keep track of the total. Set legal lobster aside.

3. **Count** all **short** lobster in the trap and record the total number on the "Sample Traps" datasheet. If you have a large number of lobsters, use a counter to keep track of the total.

4a. Pull out a **short** lobster from the trap. Using the provided caliper (set on metric – millimeters), measure the carapace length and record the **size** on the "Lobster Measurements" datasheet. Be sure to record the entire number provided on the digital readout – do not round the number. Also record the **sex** of the lobster. If the lobster was tagged, record the Lobster/ID number and associated tag color and number in the "Notes" section. Return shorts to the sea as you go through your catch.

4b. Retrieve **legal** lobsters that were set aside. Using the provided caliper (set to metric – millimeters), measure the carapace length and record the **size** on the "Lobster Measurements" datasheet. Be sure to record the entire number provided on the digital readout – do not round the number. Also record the **sex** of the lobster. If the lobster was tagged, record the Lobster/ID number and associated tag color and number in the "Notes" section.

5a. If you measure **fewer than 30 lobster within the first 10 traps**, repeat Steps 1-4 until you have measured at least 60 lobster. Measure all lobster in the trap that contains the 60th lobster (do not stop at 60th lobster unless there are no more lobster in the trap).

5b. If you measure **30 or more lobster within the first 10 traps**, do not measure any lobster in the next 10 traps. Instead just count and record the total number of legals and shorts (Steps 2 and 3) for the next 10 traps. After completing counts for 10 traps, record the GPS coordinates and begin measuring again until you have measured at least 60 lobster (follow Steps 1-4). When you hit lobster #60, continue measuring all remaining lobster in the trap (do not stop at 60th lobster unless there are no more lobster in the trap).

6. Once you have measured 60 or more lobsters, record the **time**, and **GPS location** and **water depth** for the **last trap sampled** at the top of the "Sample Traps" datasheet.

   Also complete the "**Sample Area**" section on the datasheet by estimating and recording the a) **dimensions** (length x width, square mile or other unit you specify) of the area between your first and last sample traps and number of additional traps in the area, including b) your **own** that were sampled AND those not pulled when sampling AND c) those fished by **others** working in the sample area.

7. When you have ***serviced*** the last trap for the day, record the **time** and **GPS location** and **water depth** for the **last trap serviced**. In addition, fill out the **'End of Day'** section on the 'Sample Traps' datasheet.

Sampling Frequency

Sample **twice** a month, 1½ - 2 weeks apart, in **October** and **November**.
Sample **once** a month, 3-4 weeks apart, in **December** and **January**.
Sampling trips do not have to be to the same area.

Port Sampling

Port sampling will occur for 2 of the 4 sampling trips in November-January.
The **measured** legal catch will need to be **separated** from the rest of the catch on these sampling days.

60 Traps

Sampling is described for 10 traps at a time.
The steps should be repeated six times for a total of 60 traps.

1. Pull up trap.
   If it is the ***first*** trap, fill out the top sections of the "Sample Traps" datasheet.
   For ***all*** sample traps (Traps #1-60) record the dominate **bottom type** for the area where the trap was set. If it has not changed from the previous trap, just run a line down indicating it is the same. When applicable, make note if the trap size, mesh color, bait type or soak time changed from what you recorded on the top of the datasheet. Other notes of interest should also be recorded (e.g., predation on lobster; berried female; poaching).

For the 1st Trap

2. Record GPS coordinates and water depth on the "Select Traps **Log**" datasheet. Note, for the first trap the information should be recorded on the 'Sample Traps' datasheet.

3a. Pull out and **count** all **legal** (based on your gauge) lobster in the trap and record the total number on the "Sample Traps" datasheet. If you have a large number of lobsters, use a counter to keep track of the total. Set legal size lobster aside.

3b. **Count** all **short** lobster in trap and record the total number on the "Sample Traps" datasheet. If you have a large number of lobsters, use a counter to keep track of the total.

4a. Have the deckhand switch to the "**Lobster Measurements**" datasheet. Record the trap number (highlighted number) from the 'Sample Traps' datasheet. Pull out a **short** lobster from the trap. Using the provided caliper (set on metric – millimeters), measure the carapace length and record the **size**. Be sure to record the entire number provided on the digital readout – do not round the number. Also record the **sex** of the lobster. If the lobster was tagged, record the Lobster/ID number and associated tag color and number in the "Notes" section. Return shorts to the sea as you go through your catch.

4b. Retrieve **legal** lobsters that were set aside. Using the provided caliper (set to metric – millimeters), measure the carapace length and record the **size**. Be sure to record the entire number provided on the digital readout – do not round the number. Also record the **sex** of the lobster. If the lobster was tagged, record the Lobster/ID number and associated tag color and number in the "Notes" section. For the last lobster measured in the trap, record trap number and extend a line down from the first one measured in the trap to the last one measured in the trap, indicating they all came from the same trap.

For the 2nd Trap

5. When there are numerous traps in the area (too many to estimate), record the number of traps fished by other fishermen that are passed while traveling between the 1st and 2nd traps of each group of ten traps. Otherwise, record your estimate at the end of the day.

6a. If you measured **fewer than 20** lobsters in the first trap repeat Steps #2-4 for the second trap.

6b. If you measured **more than 20** lobsters in the first trap complete Step #7 (not Steps 2-4) for the 2nd trap.

For the 3rd – 10th Traps

7. **Count** the number of **legal and short** (based on your gauge) lobster and record the totals on the "Sample Traps" datasheet. Have your deckhand use the counter if there are a large number of lobsters in the trap, recording the total counts once you have finished going through the trap. Return shorts to the sea once counted.

For the Last Trap <u>Sampled</u> (Trap #60)

8. Once you have completed recording data for the last trap (Trap #60), record the **time** and the **GPS coordinates** and **water depth** for that trap at the top of the "Sample Traps" datasheet.

   Also complete the "**Sample Area**" section on the datasheet by estimating and recording the a) **dimensions** (length x width, square mile or other unit you specify) of the area between your first and last sample traps and number of additional traps in the area, including b) your **own** that were sampled AND those not pulled when sampling AND c) those fished by **others** working in the sample area.

For the Last Trap <u>Serviced</u>

9. When you have ***serviced*** the last trap for the day, record the **time** and **GPS coordinates** and **water depth** for the last trap serviced. In addition, fill out the **'End of Day'** section on the 'Sample Traps' datasheet.

Sampling Frequency

Sample **twice** a month, 1½ - 2 weeks apart, in **October** and **November**.
Sample **once** a month, 3-4 weeks apart, in **December** and **January**.
Sampling trips do not have to be to the same area.

Port Sampling

Port sampling will occur for 2 of the 4 sampling trips in November-January.
The **measured** legal catch will need to be **separated** from the rest of the catch on these sampling days.

APPENDIX C.3

Protocols – Season 3
60 Lobster

1. Pull up trap.
   If it is the ***first*** trap, fill out the **general information** at the top portion of the "Sample Traps" datasheet and record **GPS coordinates**, water **depth** and start **time**.
   For ***all traps*** sampled, record the dominate **bottom type** for the area where the trap was set using your bottom finder. If it has not changed from the previous trap, just run a line down indicating it is the same. When applicable, make note if the trap size or soak time changed from what you recorded on the top of the datasheet. Other notes of interest should also be recorded (e.g., berried female; predation on lobster; poached).

2. Pull out and **count** all **legal** (based on your gauge) lobsters in the trap and record the total number on the "Sample Traps" datasheet. If **no legal** lobsters are present, **record zero**. If you have a large number of lobsters, use a counter to keep track of the total. Set legal lobsters aside.

3. **Count** all **short** lobsters in the trap and record the total number on the "Sample Traps" datasheet. If **no short** lobsters are present **record zero**. If you have a large number of lobsters, use a counter to keep track of the total.

4a. Pull out a **short** lobster from the trap. Using the provided caliper (set on metric – millimeters), measure the carapace length and record the **size** on the "Lobster Measurements" datasheet. Be sure to record the entire number provided on the digital readout – do not round the number. Also record the **sex** of the lobster. Record the **trap number** for each measured lobster. If the lobster was tagged, record the Lobster/ID number and associated tag color and number in the "Notes" section. Return shorts to the sea as you go through your catch.

4b. Retrieve **legal** lobsters that were set aside. Using the provided caliper (set to metric – millimeters), measure the carapace length and record the **size** on the "Lobster Measurements" datasheet. Be sure to record the entire number provided on the digital readout – do not round the number. Also record the **sex** of the lobster. Record **the trap number** for each measured lobster. If the lobster was tagged, record the Lobster/ID number and associated tag color and number in the "Notes" section.

5a. If you measure **fewer than 30 lobster within the first 10 traps**, repeat Steps 1-4 until you have measured at least 60 lobster. Measure all lobster in the trap that contains the 60th lobster (do not stop at 60th lobster unless there are no more lobster in the trap).

5b. If you measure **30 or more lobster within the first 10 traps**, do not measure any lobster in the next 10 traps. Instead just count and record the total number of legals and shorts (Steps 2 and 3) for the next 10 traps. After completing counts for 10 traps, record the GPS coordinates and begin measuring again until you have measured at least 60 lobster (follow Steps 1-4). When you hit lobster #60, continue measuring all remaining lobster in the trap (do not stop at 60th lobster unless there are no more lobster in the trap).

5c. When you have reached the **10th , 30th, and 50th lobster measured**, record the **GPS** coordinates and **water depth** on the 'Trap Log' datasheet. After, **count all the lobster traps within 100 ft radius around your boat** and determine if the trap density in this area is low, medium or high compared to the rest of your fishing grounds, circle corresponding estimate on the 'Trap Log' datasheet.

5d. When you have reached the **20th and 40th lobster** record the **GPS** coordinates and **water depth** on the 'Trap Log' datasheet.

6. Once you have measured 60 or more lobsters, record the **time**, and **GPS location** and **water depth** for the **last trap sampled** at the top of the "Sample Traps" datasheet.

7. When you have ***serviced*** the last trap for the day, record the **time** and **GPS location** and **water depth** for the **last trap serviced**. In addition, fill out the **'End of Day'** section on the 'Sample Traps' datasheet. This section includes a rating (low, medium, or high) of the productivity of the area you are sampling both this season and last season as compared to your other fishing grounds.

Sampling Frequency

Sample **twice** a month, 1½ - 2 weeks apart, in **October** and **November**.
Sample **once** a month, 3-4 weeks apart, in **December**
Sampling trips do not have to be to the same area.

Port Sampling

Port sampling will occur for 1 or 2 of the sampling trips in November-December
The **measured** legal catch will need to be **separated** from the rest of the catch on these sampling days.

60 Traps

Sampling is described for 10 traps at a time.
The steps should be repeated six times for a total of 60 traps.

1. Pull up trap.
   If it is the ***first*** trap, fill out the top sections of the "Sample Traps" datasheet.
   For ***all*** sample traps (Traps #1-60) record the dominate **bottom type** for the area where the trap was set using your bottom finder. If it has not changed from the previous trap, just run a line down indicating it is the same. When applicable, make **note if the trap size or soak time changed from what you recorded on the top of the datasheet**. Other notes of interest should also be recorded (e.g., berried female; predation on lobster; poaching).

For the 1st Trap

2. Record GPS coordinates and water depth on the "Select Traps **Log**" datasheet, unless otherwise noted.

3a. Pull out and **count** all **legal** (based on your gauge) lobsters in the trap and record the total number on the "Sample Traps" datasheet. If you have a large number of lobsters, use a counter to keep track of the total. Set legal size lobster aside. Don't forget to record '0' if there are no legal lobster in the trap.

3b. **Count** all **short** lobsters in trap and record the total number on the "Sample Traps" datasheet. If you have a large number of lobsters, use a counter to keep track of the total. Don't forget to record '0' if there are no short lobster in the trap.

4a. Have the deckhand switch to the "**Lobster Measurements**" datasheet. Record the trap number (highlighted number) from the 'Sample Traps' datasheet. Pull out a **short** lobster from the trap. Using the provided caliper (set on metric – millimeters), measure the carapace length and record the **size**. Be sure to record the entire number provided on the digital readout – do not round the number. Also record the **sex** of the lobster. If the lobster was tagged, record the Lobster/ID number and associated tag color and number in the "Notes" section. Return shorts to the sea as you go through your catch.

4b. Retrieve **legal** lobsters that were set aside. Using the provided caliper (set to metric – millimeters), measure the carapace length and record the **size**. Be sure to record the entire number provided on the digital readout – do not round the number. Also record the **sex** of the lobster. If the lobster was tagged, record the Lobster/ID number and associated tag color and number in the "Notes" section. For the last lobster measured in the trap, record trap number and extend a line down from the first lobster measured in that trap to the last one measured in that trap, indicating they all came from the same trap.

For the 2nd Trap

5a. If you measured **fewer than 20** lobsters in the first trap repeat Steps #3-4 for the second trap.

5b. If you measured **more than 20** lobsters in the first trap go to Step #7 (not Steps 3-4) for the 2nd trap.

For the 3rd – 10th Traps

6. **Count** the number of **legal and short** lobster (based on your gauge not caliper) and record the totals on the "Sample Traps" datasheet. Have your deckhand use the counter if there are a large number of lobsters in the trap, recording the total counts once you have finished going through the trap. Return shorts to the sea once counted. Don't forget to record '0' if there are no legal and/or short lobster in the trap.

For Trap Number 11, 31 and 51 (highlighted in orange on datasheet)

7. Repeat steps #2-4, then **count** the number of **traps within** a **100 ft radius** around your boat. Compared to the rest of your fishing grounds, **rate** this **area's density** as **low, medium, or high**. Record the number of traps counted and the relative trap density on the "Trap Log" datasheet.

For the Last Trap <u>Sampled</u> (Trap #60)

7. Once you have completed recording data for the last trap (Trap #60), record the **time** and the **GPS coordinates** and **water depth** for that trap at the top of the "Sample Traps" datasheet.

For the Last Trap <u>Serviced</u>

8. When you have ***serviced*** the last trap for the day, record the **time** and **GPS coordinates** and **water depth** for the last trap serviced. In addition, fill out the **'End of Day'** section on the 'Sample Traps' datasheet. This section includes a rating (low, medium, or high) of the productivity of the area you are sampling compared to your other fishing grounds this season and compared to the same area last season.

Sampling Frequency

Sample **twice** a month, 1½ - 2 weeks apart, in **October** and **November**.
Sample **once** a month, 3-4 weeks apart, in **December**.
Sampling trips do not have to be to the same area.

Port Sampling

Port sampling is required for 1-2 of the sampling trips in November-December.
The **measured** legal catch will need to be **separated** from the rest of the catch on these sampling days.

APPENDIX D.1

New Zealand Rock Lobster Dive Fishery
Collaborative At-Sea Data Collection Program (CASP)
Summary

The Fishery

New Zealand's commercial pot fishery for rock lobster, *Jasus edwardsii*, began in the early 1900s. From 1937 on, the fishery was managed using permits and input controls, with a moratorium on permits in the late 1970s and limited entry in the 1980s. In 1991, an individual Quota Management System was implemented by the New Zealand Ministry for Primary Industries (MPI)[1], and the fishery was divided into nine rock lobster management areas, each with a Total Allowable Commercial Catch (TACC) (Yandle 2008). The government also convened the Rock Lobster Steering Committee to bring user interests into the evolving management of the fishery, and in 1992, established the National Rock Lobster Management Group. In 1996, the New Zealand Rock Lobster Industry Council, an umbrella organization, and nine Crayfish Management Advisory Committees (CRAMACs)[2] consisting of fishermen, buyers and other industry representatives, were formed. In 1999, the role of these organizations in fishery management was formalized with the passage of legislation allowing co-management (New Zealand Fisheries Act 1996 Amendment Act 1999). Currently, management includes individual quotas, minimum sizes, and prohibitions on taking berried females and soft-shelled lobsters, along with some area-specific measures. In 2013, about 270 commercial rock lobster fishermen landed more than 2,800 tons (5.6 million pounds) of rock lobster, 95% of which was exported and had a value of NZ$250 million (about US$205 million).[3]

Motivation for developing the CASP

In the early 1990s, vessel owners became dissatisfied with the stock assessments conducted by government, which reported declining stocks over several years. A lack of time and funds had limited the quality and quantity of data available to set TACC levels. Seeing a need for more and better information and additional management, industry brought stock assessment scientists from elsewhere in to consult with them on ways to meet these needs. One of those scientists told the fishermen, "If you have doubts about the work that [the agency] is doing, then you should collect the data. We'll explain how we use it in our analysis, but you have to live with the results." Industry and scientists (including one from the MPI) then collaborated to establish the voluntary logbook program for the rock lobster fishery described here. They also have collaborated on a number of other data collection and reporting programs with the goals of stabilizing or increasing rock lobster stocks and enhancing long-term revenue from the fishery.

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[1] The MPI was formed in 2011 when the Ministries of Fisheries and of Agriculture and Forestry were merged.

[2] CRA is derived from the Quota Management System designation for rock lobster. CRAMAC membership comprises rock lobster quota owners, processors, exporters, and fishermen in each CRA. Each CRAMAC holds a significant majority mandate of rock lobster quota shares owned in its region and has a two-tiered voting procedure that gives priority to quota share owners on issues affecting TACC decisions, levy-setting, and cost recovery.

[3] http://www.stats.govt.nz/tools_and_services/newsletters/price-index-news/apr-13-article-seafood.aspx, accessed 4/4/14.

CASP outcomes

From its inception in 1993 through the end of the 2010-2011 season, the CASP (i.e., the voluntary logbook) involved 259 participants, logged over 230,000 pot-lifts, and measured more than one million lobsters (Starr 2012; Bentley 2013). The logbook is the primary source of biological information for three of the management regions (2, 5 and 8) and complements traditional observer data in three other management regions (4, 6 and 9). Two management regions (1 and 7) rely on traditional observer data alone. The length-frequency data generated by the rock lobster logbook program (together with more limited observer data) have been used to develop fishery assessment models, resulting in adjustments to the TACC over time.[4] While TACCs in some management regions have been reduced at times, the value of the fishery has grown substantially in recent years, attributed in part to the logbook program and to other industry activities and adherence to management goals.

The CASP

Established in 1993 by the NZ Fishing Industry Board in collaboration with stock assessment scientists, the CASP is a logbook program that has been managed by the Rock Lobster Industry Council and the nine region-based advisory committees (CRAMACs) since 1996 when those organizations were formed (Starr 2012). The goal of the logbook program is to conduct "extensive" low-intensity sampling over a large number of days, as contrasted with "intensive" sampling of a small number of boats by onboard observers (Starr and Vignaux 1997). In this ***voluntary*** program, participating fishermen complete:

- a ***logbook for each trip*** and, once a year
- a ***survey of their fishing patterns***, and
- a ***description of the pots*** they use for sampling

A coordinator hired by each CRAMAC supervises and helps troubleshoot data collection and ensures that data are transmitted to the Rock Lobster Industry Council, which itself is recognized as a the lead government contractor for such work on behalf of the nationwide lobster fishery. The Council then transmits the data to staff at the consulting firm Trophia, Ltd. for quality analysis/quality control, analysis and reporting back to CASP participants and government resource managers.

CASP participants and roles

Fishermen: To meet sampling requirements, the ideal level of participation is 30% of the fleet in each management region. However, activities, experiences and outcomes vary among the nine regions due to differences in stock and fishery conditions, fishery participants, and other circumstances. About 20-40% of the total fleet has participated in the program over time, with 70 fishermen (about 26% of those fishing) participating in 2010-11 (Starr 2012). About half of participants have been involved for at least 5 to 10 years. Participation in three regions (2, 5 and 8) has been the highest and most consistent, with 16 to 18 participants in 2010-11. Participation has been more moderate, with 4 to 9 participants in three other regions (4, 6 and 9), and very low or nonexistent in three regions (1, 3 and 7). The variation in participation among regions is due to differences in fishing conditions, fishing operations (e.g., vessel size, crew size, trip duration), and other factors.

[4] Logbook and observer data measure tail widths, which then are converted to length measurements.

New Zealand Rock Lobster Industry Council (NZRLIC): This is a limited liability corporation that represents the rock lobster industry in New Zealand, and is an umbrella organization for the nine region-based advisory committees ('CRAMACs').[5] The Council is a "commercial stakeholder organization" recognized under New Zealand law as a co-management partner. As the primary contractor for the rock lobster logbook CASP since 1997, the Council subcontracts database management to the National Institute of Water and Atmospheric Research and Trophia, Inc., two government-certified consulting firms (among others). The Council also has oversight over catch sampling (observer programs), lobster tag, release and recapture projects, and other data collection efforts, and participates in consultation meetings, the National Rock Lobster Management Group, seminars, advisory committees, research planning groups, and MPI-led stock assessment working group processes.

Crayfish Management Advisory Committees (CRAMACs): The CRAMACs (which also are government-recognized civil society organization, work with the Rock Lobster Industry Council, its subcontracted consulting research firms, and others to determine data needs, hire and oversee a *CRAMAC* coordinator for their region, and participate in the stock assessment review process (often via the hired coordinator). The CRAMAC coordinator serves as a liaison among the fishermen, the CRAMAC and the research consultants, supervises data collection, collects data sheets, and works with fishermen to ensure data are collected properly and to address any problems. In addition, the CRAMAC coordinator often represents the region's fishery participants at stock assessment meetings, which typically occur in Wellington, far from most of the management regions.

Consultants: Trophia, Ltd. is a government-approved research consulting firm that is contracted by the Rock Lobster Industry Council to manage the logbook database and conduct data analysis and reporting. The firm conveys logbook data and analyses to the MPI annually. (The Industry Council also subcontracts with a separate firm to coordinate the observer program, another fishery-dependent data collection program, and with several other skilled research service providers.)

National Rock Lobster Management Group: This is a multi-sector stakeholder representative group that serves as the primary source of rock lobster TACC and sustainability advice to the Ministry of Fisheries.

Ministry of Primary Industries (MPI): This national agency makes TACC and other management decisions based on stock assessment results, which are peer-reviewed and deliberated through its Stock Assessment Working Group.

CASP procedures and timing

At the beginning of the season, participating fishermen tag four pots that are intended to be representative of the 100 to 150 pots fishermen typically use (New Zealand Rock Lobster Industry Council 2011). Once tagged, these pots are sampled every time they are pulled (usually every trip). Using project-provided datasheets (Fig. D.1.1) and protocols, fishermen record detailed data on the first 25 live lobsters from each tagged pot including sex, reproductive condition, and tail width measured using project-specific calipers. Additional lobsters above and below the size limit are counted and recorded on the datasheet. Fishermen also record the latitude, longitude, depth, soak time, number of predators, and number of dead lobsters in each of the four sample pots.

[5] http://www.nzrocklobster.co.nz/, accessed 8/14/14

Historically, fishermen sent their completed data sheets to the region coordinator or the Rock Lobster Industry Council every two to four weeks. Since the early 2010s, electronic logbooks and related hardware have been adopted in most of management regions, with fishermen typically providing their logbook data to the coordinator on a USB drive. Most recently, the data system has been adapted to work with onboard navigation systems, enabling the provision of real-time data.

In addition to trip data, participating fishermen complete 1) an annual survey with their contact, vessel and quota information, fishing experience and other comments to help the research team better understand their general fishing patterns; and 2) an annual pot description form, indicating pot type, materials, dimensions and other key characteristics. Individuals' logbook data are confidential, that is, not identified or disclosed in raw form to anyone other than the consulting research scientists.

The consulting firm Trophia, Ltd. conducts data quality analysis/quality control using established data validation procedures, then submit the validated data directly into the MPI database for use in stock assessments and annual TACC decision-making by the Stock Assessment Working Group and the MPI. In addition, the consulting firm staff also provide each CASP participant with an annul summary of his own data alongside that for the region as a whole.

Costs, funding and financial management
Major costs associated with this CASP include:

- the region-based CRAMAC coordinator
- consulting firm subcontract for data analysis
- calipers and data forms
- electronic logbook software
- electronic logbook hardware

According to those interviewed, the cost of the CASP is one-third to one-half the cost of observer programs, and affords two to three times as much data. For example, whereas the observer program in one management region had an annual cost of NZ$140,000, the CASP cost was NZ$62,000 when the program was initiated in the early to mid 1990s. (Note that some observer coverage is required in each management region every two to three years to help validate CASP data.) Electronic logbooks, adopted in some regions and of growing interest to others, are variable in cost. One such device requires an initial investment of NZ$1,800 per vessel and NZ$250 per year to maintain, with costs covered by the regional advisory committees (CRAMACs).

Although fishermen historically did not receive financial compensation for participating in the CASP, this has changed somewhat in recent years. In one region, CASP participants receive custom clothing in recognition of their contribution to the fishery, while in another, after losing an especially good region coordinator, the region's advisory committee decided instead to pay each participant a base rate of NZ$2,500 per season, with a bonus payment for each month of logbook data they contribute.

Since 1993, government has required full cost-recovery for fishery management, divided among user groups proportional to their take in the fishery. For example, in one management region (CRA 2), commercial fishermen are responsible for 50% of the cost of managing the fishery. Funding for management costs, including the CASP and other activities, comes from a statutory levy determined by

the NZ-RLIC in consultation with each region's advisory committee.[6] The levy is an amount per ton of quota weight equivalent, not to exceed NZ$2,000 per ton (roughly US$0.68 per pound), and consists of a) a core services levy, to fund the activities of Rock lobster Industry Council, other rock lobster industry-wide services, and the rock lobster industry share of any services provided for the wider benefit of the seafood industry; and b) a stock- or region-specific levy, imposed only at the request of a region's advisory committee to fund region-specific activities. The 2013 Commodity Levy Order for rock lobster specifies a levy of NZ$212-619 (depending on the management region; roughly US$0.07-0.21 per pound) per ton of quota weight equivalent, to be paid to the NZ-RLIC.

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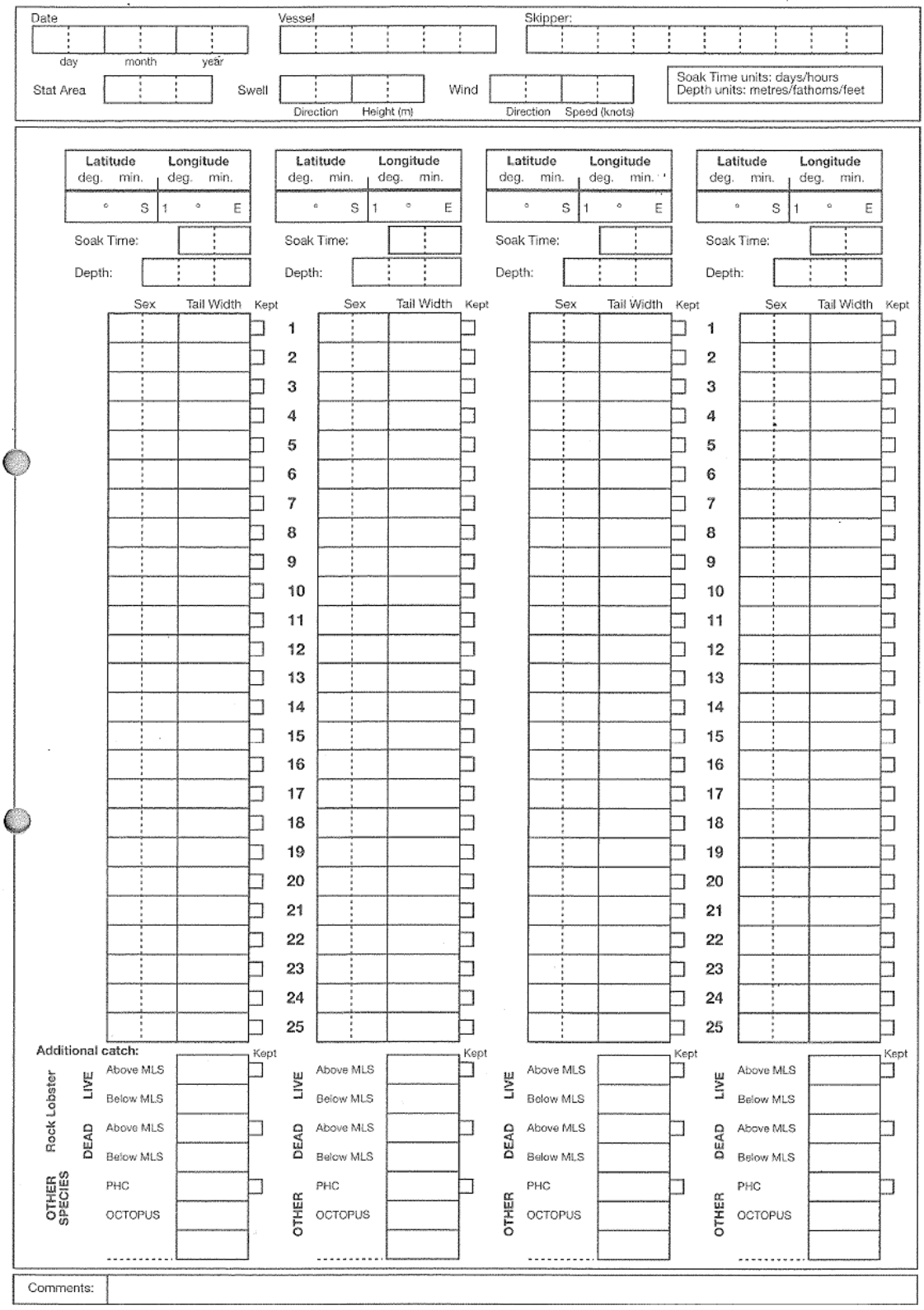
[6] See http://www.nzrocklobster.co.nz/commodity-levies-order.html, accessed 8/15/15.

Figure D.1.1. New Zealand rock lobster fishery logbook program datasheet.



APPENDIX D.2

Southeast Alaska Geoduck Clam Dive Fishery
Collaborative At-Sea Data Collection Program (CASP)
Summary

The Fishery

The Southeast Alaska (SE AK) dive fishery for geoduck clam, *Panopea generosa,* began in 1985 following initial identification of beds for commercial harvesting in the mid 1970s and the development of procedures by the Alaska Department of Environmental Conservation (ADEC) for ensuring safety of the product for human consumption. Initially, fewer than 10 divers participated in the fishery; however, by the early 1990s, interest by resident and nonresident divers increased following Alaska Department of Fish and Game (ADFG) population estimates for new commercial fishing sites. For the 2013-14 season, 69 permitted divers harvested 514,037 pounds of geoduck with an ex-vessel of $4.1 million.[7] The fishery is managed by the state using limited entry, a mandatory logbook, and a nine-month season, during which specific geoduck beds are opened for harvest each week to coordinate with markets and with the region's other dive fisheries happening at the same time. Each bed opening also is contingent on testing for biotoxins to determine whether geoducks from those beds are safe to consume.

Motivation for developing the CASP

In the early 1990s, commercial divers sought to have additional geoduck beds in SE AK identified and opened to the fishery by the ADFG. The agency indicated it did not have the financial or personnel resources to do the stock assessment work required to open new beds. In 1998, following the passage of enabling legislation (Alaska HB 198 1997) industry formed a non-profit economic development organization, the Southeast Alaska Regional Dive Fisheries Association (SARDFA), to develop, expand, and enhance new and existing dive fisheries for abalone, sea cucumber and geoduck.[8] The enabling legislation also established SARDFA's authority to tax its membership - all SE AK commercial divers - to support research and related activities for the region, including the CASP.

CASP outcomes

Major outcomes of this CASP to date include: the opening of new geoduck beds, enabling growth of the fishery; changes in biotoxin sampling procedures to enable live geoduck sales, substantially increasing revenues to the fishery; and other research activities including harvest rate studies and "show factor" studies to improve the accuracy of stock assessments. (The "show factor" is the ratio of the number of geoducks counted to the number actually present in a measured transect, and is used to adjust density estimates to account for geoducks that may not be visible to research divers.)

The CASP

This CASP has two primary data-collection components. Geoduck divers conduct reconnaissance surveys late in the season and summer (off-season) to identify and qualitatively evaluate the commercial viability of beds for the coming season. ADFG uses these survey results to design and conduct focused

[7] http://www.adfg.alaska.gov/index.cfm?adfg=commercialbyareasoutheast.dive_harvest_geoduck, accessed 2/24/16.

[8] http://www.sardfa.org/, accessed 8/4/14.

stock assessments to determine guideline harvest levels for each bed. In addition, divers collect samples for in-season biotoxin testing by ADEC (Scanlan 2012), to determine whether specific beds will be opened for harvest in a given week. In both cases, fishermen collect data separately from rather than during their fishing per se.

CASP participants and roles

Fishermen: Over time, 5 to 10 of the roughly 90 (5.5-11%) permitted geoduck divers have conducted the reconnaissance surveys. The number of surveys has decreased over time because most beds have been identified and assessed at least once, requiring survey or assessment data only for beds where conditions may have changed. Typically, three to six divers participate in the biotoxin testing each year (i.e., one primary and one back-up diver for each of three major fishing areas, to ensure consistency and efficiency). Some divers participate in both the reconnaissance surveys and the biotoxin sampling. For both activities, divers submit applications to SARDFA for a contract to conduct data collection. Contractors are selected by SARDFA based on qualifications such as specific vessel and equipment, computer capacity onboard (for navigation and data entry), computer experience, number of years harvesting geoducks, past reconnaissance survey experience, and other pertinent information.

Southeast Alaska Regional Dive Fisheries Association (SARDFA): SARDFA's mission is to develop, expand, and enhance new and existing dive fisheries in SE AK.[9] The organization is managed by a nine-member Board of Directors elected by commercial fishery divers, with representation from each of five SE AK fishery areas, a Washington-based diver, and an at-large seat. Five committees, including one for each of the region's three major dive fisheries (abalone, geoduck clam, sea cucumber) advise the Board on specific issues. SARDFA employs an executive director to carry out the directives of the Board. For the CASP, SARDFA solicits, issues and manages contracts to divers and coordinates communication between fishery participants and ADFG fishery management and ADEC environmental health personnel about CASP results and subsequent decision-making.

Alaska Department of Fish and Game (ADFG): One to two staff biologists supervise the reconnaissance surveys, conduct the stock assessment surveys, and work with the industry (through SARDFA) to set the opening date for each geoduck bed.

Alaska Department of Environmental Conservation (ADEC): ADEC oversees water quality and biotoxin sampling required to open geoduck beds for fishing over the course of the season, guided by its *Geoduck Clam Biotoxin Monitoring* Plan (Scanlan 2012). As part of that process, ADEC receives samples collected by SARDFA-contracted divers, processes them, and consults with SARDFA and ADFG as part of its decision-making process for approving the opening of each geoduck bed.

CASP procedures and timing

Reconnaissance surveys are coordinated with ADFG stock assessments, with the latter usually occurring within days or weeks after a survey and only for beds that a survey suggests are commercially viable for harvesting. A diver typically is contracted by ADFG through SARDFA for a 4- to 8-day cruise, conducted on his own fishing vessel when he is not fishing. For each reconnaissance survey, the contracted diver generates:

[9] http://www.sardfa.org/, accessed 8/4/14.

- A brief daily narrative of diving and survey activities that includes, for each section surveyed, a brief (1-2 paragraphs) overall description of bottom habitat, vegetation type and presence of other species of interest, and the diver's overall impression of that section's geoduck clam commercial fishery potential.

- A completed data form (Fig. D.2.1) for each survey event (dive) with survey start and stop locations and times, geoduck density (based on a 5-point scale, where 1=commercial high, 2=commercial low, 3=non-commercial high, 4=non-commercial low, 5=no geoducks present), bed depth range and width, habitat, and comments; and

- Electronically annotated NOAA nautical charts that depict the boundaries of the beds surveyed, with each bed rated for its abundance and distribution of geoducks relative to commercial and non-commercial use.

The ADFG project biologist communicates with the diver before, during and after the cruise to provide maps and data collection and entry instructions, and to collect and discuss the resulting data. Fishermen are trained in the use of Excel and ArcView to enable them to enter and transmit the data electronically. Once ADFG has entered the data into its public access data system, fishermen can go to ADFG offices to see the summary results. These data and the stock assessment that follows are included in pre-season discussions between SARDFA's Geoduck Committee and ADFG staff about which beds will be opened when (contingent on biotoxin test results).

Biotoxin testing is required prior to harvest in a given subarea. Prior to such testing, ADEC requires repeated water quality tests (e.g., fecal coliform, consistent with the National Shellfish Sanitation Program) for 6 to 12 months in an area before it can be considered for opening. Once an area is provisionally approved for opening, in-season sampling and testing of geoducks is required, with harvest allowed for up to five to seven days (depending on the region) after sampling (provided test results indicate that the geoducks are safe to consume). Contracted divers collect three sample geoducks from each specified subarea (bed), handle them according to prescribed procedures, and ship them within 24 hours to the state's Environmental Health Laboratory in Anchorage for testing (State of Alaska Environmental Health Laboratory 2011). The lab notifies ADEC, ADFG and SARDFA of the test results within 24 hours of receiving the sample, after which ADFG announces whether or not the subarea will be opened.

Costs, funding and financial management

Major costs associated with this CASP include:

For surveys/stock assessments

- Reconnaissance survey contracts with commercial divers
- ADFG stock assessment biologists' time
- ADFG vessel time
- SARDFA administration costs

For biotoxin sampling

- Biotoxin geoduck sampling contracts with commercial divers
- Biotoxin geoduck sample transport
- ADEC biotoxin testing

From 1998 through 2009, reconnaissance survey contracts and ADFG stock assessment surveys were supported by NOAA Nearshore Project grant funds and funds donated by local municipalities and others to SARDFA (see Pritchett 2010). By then, the fishery had increased substantially (due to the opening of more beds and improved markets), and the 7% assessment that SARDFA collects on the ex-vessel value

of landings was able to entirely fund the CASP and other SARDFA activities. (The state collects a separate 3% tax on all fishery landings.) Revenues and costs vary from year to year (Table D.2.1). SARDFA and ADFG meet annually to review the funds collected, program needs and costs (for CASP and other activities), and collectively develop an annual operating plan for the use of those funds. ADFG retains the funds to support its activities and issues funds to SARDFA to support its functions, both as outlined in the annual operating plan. The Geoduck Reserve and Development Fund is used to support reconnaissance surveys by fishermen and associated stock assessment surveys, and Biotoxin Monitoring Program funds are used to support biotoxin sampling by fishermen and testing by ADEC.

For the reconnaissance surveys, which occur apart from their fishing activities, divers typically are paid $1,000 per day. The amount of compensation is determined by the SARDFA Geoduck Committee, based on estimated time requirements for travel and surveying work, fuel, vessel and equipment use, and related costs, with sufficient funds remaining to compensate the diver and his tender. For the biotoxin sampling, fishermen are paid from $500 to $1,500 per site sampled, depending on the number of sites and distance from port. The payment is increased toward the end of the fishing season, when fewer beds are sampled due to decreased fishing activity, to ensure that sufficient sampling is done to enable productive fishing.

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State of Alaska. 1997. HB 198: SARDFA enacting law. Alaska Statutes: §16.40.240 and §43.76.150-210.

State of Alaska Environmental Health Laboratory. 2011. Geoduck clams PSP sample preparation, packaging and shipping requirements. 2 p.

Table D.2.1. Examples of operating costs related to the SE AK geoduck fishery CASP. Source: Data extracted and compiled from SARDFA reports at http://www.sardfa.org/minutes/.

	FY2008-09		FY2012-13	
Item	**Amount**	**% of budget**	**Amount**	**% of budget**
Assessment revenue	$127,681	n/a	$317,962	n/a
SARDFA Administration*	33,197	26%	41,266	13%
Water Quality Testing*	28,000	22%	15,000	5%
DEC Water Certification Fees*	2,500	2%	3,500	1%
Biotoxin Monitoring Program*	35,000	27%	45,000	14%
ADFG Management	27,653	22%	25,000	8%
Geoduck Harvest Rate Studies	n/a	n/a	16,000	5%
Geoduck Reserve & Development Fund*	1,331	1%	172,196	54%

* Funds to be transferred from ADFG to SARDFA

Figure D.2.1. Sample data form used for geoduck clam reconnaissance surveys in Southeast Alaska.

		Divers:		Subdistrict Comments:					
Lat Start	Lon Start	Lat Stop	Lon Stop	Geoduck density	Depth Start	Depth Stop	Bed Width	Habitat	Comments

APPENDIX D.3

British Columbia Geoduck Dive Fishery
Collaborative At-Sea Data Collection Program (CASP)
Summary

The Fishery

The British Columbia commercial dive fishery for geoduck, *Panopea generosa*, began in 1976. The fishery grew rapidly, and an annual quota was set in 1979; in 1983, a limited entry program capping the number of license at 55 was adopted (James 2008). In 1989, at the request of the Underwater Harvesters Association (UHA) and on the condition that industry cover program management costs, the Canadian Department of Fisheries and Oceans (DFO) implemented an individual vessel quota (IVQ) program with shares allocated evenly among license holders. Additional management measures include dockside catch validation (port sampling), area licensing, and three-year rotations among assessed beds. An "on-grounds monitor" program also was established to help direct and observe the fishing fleet. Fishing occurs year-round, with the total allowable catch (TAC) and effort allocated among specific beds in three major Geoduck Management Areas based on biomass assessment results and with openers timed to optimize market and fishing opportunities. In 2012, 53 licensed divers fished from 40 vessels, landing about 1,500 metric tons (~3.3 million pounds) of geoducks with an ex-vessel value of $46.6 million (DFO 2014).

Motivation for developing the CASP

Through the 1980s, a lack of site-specific biomass estimates and uncertainty about stock conditions hindered expansion of the fishery. DFO managers requested that UHA's research arm conduct additional biomass surveys to address concerns that stocks in certain areas were being overexploited while harvest might be increased in other areas. In 1988, estimates of bed area size from commercial logbook data were used to set the fishery-wide quota. The resulting information, which suggested that bed sizes and geoduck densities had been overestimated, along with more conservative management led to reduced quotas over the next several years (James 2008). Concerns that this broad-scale approach was unnecessarily limiting catch in some areas led license holders, through UHA, to invest in fishery-independent stock assessment as well as fishery-dependent research.[10]

CASP outcomes

Nearly all of the 55 licensees regularly complete the voluntary bed questionnaire (**Error! Reference source not found.**). The resulting data are combined with data from the mandatory logbooks and other UHA-led research activities (e.g., SCUBA surveys, biological and market/dockside sampling) to estimate biomass and provide the basis for calculating bed quotas within each management area. Specifically, quota is set at 1.2-1.8% of estimated current biomass, with a lower rate used for beds that have not been assessed recently and a higher rate used for those beds that have been assessed more recently and determined to have the biomass to support it.

More generally, the UHA, a non-profit organization established to collect fees and hire independent monitors, has assumed more responsibility for managing the fishery, including funding associated DFO science, management and enforcement staff; funding and conducting geoduck stock surveys, sampling and enhancement; and implementing a biotoxin sampling program in selected fishery areas. DFO has played less of a role over time, retaining authority

[10] http://www.geoduck.org/, accessed 2/24/16.

over the issuance of licenses, but relying on UHA for financing and coordination of these and other management-related functions.

The CASP

This CASP consists of a voluntary "bed questionnaire" which was designed and implemented by DFO in 2004 with assistance from the UHA to improve the data used in stock assessments (DFO 2014). In 2008, the questionnaire was integrated with the mandatory Validation & Harvest Logbook, which consists of a single page that is completed by fishermen for each trip (Fig. D.3.1). The bed questionnaire includes six questions with multiple choice response options that provide qualitative information about geoduck density and market quality, observation of juveniles, the need for bed quota adjustment, ease of bed digging, and density of horse clams (managed within the geoduck fishery management plan). In addition, the form includes space for divers to report other observations, with prompts for estimated size of bed, sea otter presence and estimated average clam size.

CASP participants and roles

Fishermen: Most of the 55 licensees complete the voluntary bed questionnaire (along with the mandatory logbook) each time they make a fishing trip. Some licensees also participate as paid subcontractors in SCUBA surveys and other research activities coordinated by UHA.

Underwater Harvesters Association (UHA): A non-profit organization, the UHA was established in 1981 by commercial geoduck harvesters and is funded by membership fees. The UHA provides biological survey data and commercial fishery information to DFO scientists and managers. Since 1988, the UHA has been registered as a contractor with the government to provide monitoring services on behalf of the geoduck license holders. In addition, as the DFO-recognized logbook provider for the fishery, the UHA provides logbooks to fishery participants at the start of each season, and uses a portion of the collected membership fees to support handling and analysis of the resulting data. The organization funds nearly all management functions including the dockside monitoring program (for catch data validation), three on-grounds monitors (one for each geoduck management area, to monitor and coordinate fishing activities and data transmittal), its own and other entities' biomass surveys and other research activities, directed geoduck enforcement activities, enhancement research, biotoxin sampling and other fishery-related costs including a number of contract positions at DFO.

West Coast Geoduck Research Corporation (WCGRC): The WCRGC is the UHA's science subsidiary funded by UHA. Since the mid 1990s, WCGRC has conducted research in partnership with UHA divers, DFO and First Nations to provide fishery-independent data, which DFO uses in its biological assessment and modeling process.

Department of Fisheries and Oceans Canada (DFO): As a condition of the 1989 IVQ program, DFO shares responsibility for managing the fishery with UHA (i.e., requiring a number of items described above), but retains complete authority over the issuance of licenses. However, the agency increasingly relies on the industry and UHA to provide information for and fund many management functions.

Archipelago Marine Research, Ltd.[11]: Contracted by UHA since 1989, Archipelago Marine Research is an accredited service provider for the fishery's dockside monitoring program and related functions. It set up and conducts the program, collecting, entering and maintaining landings and logbook data (including

[11] http://www.archipelago.ca/, accessed 2/24/16.

the voluntary bed questionnaire) and other fishery information in a geoduck fishery database provided to DFO.

On-Grounds Monitors: Funded by the industry through the UHA, three on-grounds monitors – one for each management area – are third party individuals who work with industry to ensure the completeness of the logbook data, help fishermen complete the form, monitor when the beds are open, notify fishermen when and where they can or cannot be fishing, and coordinate sampling for the Marine Biotoxin Monitoring Program. (In some cases this person also is the designated observer, who validates species composition and weight of each fishery landing.)

Geoduck Sectoral Advisory Committee: This 18-member committee provides the main forum for discussion of co-management of the fishery. The committee includes representatives from DFO, commercial vessel owners and fishermen (represented by UHA), processors, First Nations, the Ministry of Agriculture and Lands, and recreational fishermen.

First Nations: Since 1992, several coastal First Nations (aboriginal groups) have worked with DFO and UHA in surveys to estimate geoduck density and help determine geoduck quotas, providing biologists, vessels and divers.

CASP procedures and timing

Each geoduck fishing vessel master (captain) must carry and fill out the Geoduck Validation and Harvest Logbook, which includes the voluntary bed questionnaire, on each trip. Vessel masters are required to notify the on-grounds monitor prior to fishing and before landing geoduck. On landing, divers submit their bed questionnaire responses along with their dive harvest information to the on-grounds monitor or the observer/dockside validator, who then checks the management area, bed number and coordinates for accuracy. The on-grounds monitor or the observer then forwards the combined log and questionnaire to the service provider (Archipelago Marine) for data entry and analysis. The data are entered into a database and submitted to DFO for use in stock assessments. Access to these data is restricted by law to the UHA, fishery participants, the third party service provider and DFO.

Geoduck harvest plans are determined using information from: 1) harvest logbooks, 2) substrate mapping using remote sensing hydro-acoustic backscatter analysis; 3) substrate and depth information from geoduck dive surveys; and 4) comments and feedback on bed locations and sizes from the voluntary bed questionnaire and from on-grounds monitors and fishermen (DFO 2014). In the fall of each year, the Geoduck Sectoral Advisory Committee meets to review this information and provide advice to the DFO regarding management issues and the proposed integrated fishery management plan for the coming year. Area Committees for each of the three commercial fishing areas discuss fish harvesters' observations and advice for the next year's harvest plan, and a Steering Committee comprised of these three Area Committees meets to ensure consensus and coast-wide integration of quota considerations.

Costs, funding and financial management

Major expenses for the CASP include:

- three on-grounds monitors
- dockside observers/data validators
- data entry and analysis by consultants
- four DFO staff
- UHA and Geoduck Management Area meetings

Fishermen are not compensated for their fishery-dependent data collection (mandatory logbook and voluntary bed questionnaire). According to one interviewee, “The idea is that those data contribute to quotas that enable a reasonable and sustainable fishery.”

A condition for the implementation of the IVQ system in the fishery was that industry pay for the incremental costs associated with monitoring catches to ensure quotas were not exceeded (DFO 2014; James 2008). This required that license holders provide the funds to pay for a monitoring program. With the expansion of the fishery and information needs, those costs have increased. Because UHA is responsible for many functions (including but not limited to those identified above), many of which are closely linked, the costs of the CASP (i.e., voluntary bed data collection, analysis and integration) are not easily teased out. Funds to support these activities come from:

1) an annual license fee paid to the government by each quota holder (~CAN $6,000-$7,500; 2014)
2) an annual membership fee paid to UHA by each license holder (~CAN $40,000; 2014)

The amount of funding from each source – and the proportions covered by industry and DFO – have changed substantially over time (James 2008). From 1983 through 1994, licensees paid CAN$10 annually to government; in 1995, license fees were sharply increased to CAN$3,615. Since 1999, the license fee has been based on quota weight, at about CAN$252 per ton of quota, amounting to about CAN $6,000-7,500 per year. Annual UHA membership fees paid by license holders have increased from CAN$50 in the late 1980s (when UHA’s function were much more limited) to CAN$40,000 in recent years. Although membership fees technically are voluntary, license conditions require that landings be monitored by, and reported in logbooks in a format that is only readily available through, the independent port monitoring company hired by the UHA. The license holder pays the fee each season in order to obtain the required logbook. The resulting funds, along with research grants that UHA or its scientific research subsidiary obtains, are also used to pay for UHA’s many other activities.

Historically, the UHA and DFO negotiated specific contracts for the exchange of funds and services. Starting in 2003, the budgeting and assignment of research and management responsibilities were outlined in three- to four-year Joint Service Agreements developed by DFO and UHA. Each year, the DFO and UHA developed an annual work plan specifying the science, management and enforcement activities and financial contributions of both parties. However, no such agreement has been developed since 2012. In both 2012 and 2013 (the most recent years for which data are available), total costs of managing the CAN$47 million ex-vessel valued fishery were about CAN$3.25 million (7% total ex-vessel value of fishery), with DFO covering about 23% (CAN$762,900) and UHA covering 77% (CAN$2.5 million) (DFO 2014).

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Figure D.3.1. Example of British Columbia geoduck and horse clam validation and harvest logbook with voluntary bed questionnaire integrated (questions 1-6 and comments). Source: DFO 2014.