The Economics of Cooperative Fishery Research: A Survey of U.S. West Coast Groundfish Industry and Scientists

John Harms: Northwest Fisheries Science Center, National Marine Fisheries Service, Seattle, WA
Gil Sylvia: Coastal Oregon Marine Experiment Station, Oregon State University, Newport, OR

Abstract. Cooperative research, the active participation of industry in scientific research, is receiving increased attention as an alternative to traditional government-sponsored methods. Its strongest attributes are its potential to improve spatial and temporal collection of fishery data while reducing some research costs. Despite these potential benefits, there are obstacles to adopting cooperative research on a large scale including concerns about biased data, continuity with current data regimes, and the motivations of the participants. Acknowledging these limitations, this research examines the factors that influence industry's willingness to participate in cooperative research with fishery scientists. During summer 1998, scientists and fishermen in the U.S. West Coast groundfish fishery participated in a mail survey that asked respondents to assess several potential cooperative research projects on the basis of their perceived costs and benefits. Scientists and fishermen differed most strongly on "observer programs" and "interviewing fishermen to gather qualitative data." The survey also included hypothetical scenarios where fishing vessels would be chartered for research. Fishermen assigned a "desirability" score and "willingness to supply" their vessel for research as a function of varying levels of compensation, days at sea, consultation into the design and conduct of the research, and other factors. Based on a utility of profit supply model, results were analyzed using ordinary least squares. Compensation and skipper consultation had the largest effect on the charter's desirability and respondents' willingness to supply. Age, education, and gear type also significantly affected fishermen's willingness to participate in the charters. These results suggest significant problems in the manner in which scientists and industry relate. Addressing these problems will require developing institutions with appropriate incentives that emphasize "win-win" scenarios for both groups.

Keywords: cooperative research, fishery management.

1. INTRODUCTION

The Magnuson-Stevens Act requires that U.S. fish stocks be managed to provide the greatest overall benefit to the nation while simultaneously protecting marine ecosystems and ensuring the sustainable use of the resource. However, the National Marine Fisheries Service (NMFS) lacks the equipment, personnel, and funding to collect information of sufficient quality and quantity to assess stocks to the precision the law requires (Gallagher 1987; Stauffer 1997; NRC 1998). In this environment of imperfect information and high uncertainty, the law's mandates to both protect the resource as well as realize maximum benefits from its harvest may be difficult to achieve.

There are significant obstacles that hinder NMFS and state fish and wildlife agencies from addressing these problems. Many commercially important stocks are assessed and managed in a single-species framework where interaction with other species and the surrounding environment are not addressed. Although there are obvious shortcomings with the single-species model, multi-species and ecosystem approaches that aim to take into account ecological interactions require large amounts of data which may be cost-prohibitive to supply (Larkin 1996). Even within single-species research and management systems, there are serious concerns about the accuracy of the data employed in assessment models (Larkin 1996). Discard information may be derived from dated research or may be unavailable for some species. Landings data may suffer from problems with interstate coordination or from difficulty in re-creating species compositions from the general market categories into which fish are often classified on the dock. In addition, industry non-compliance with existing management strategies can be a source of uncertainty that is often overlooked (Rice and Richards 1996).

Amendments to the Magnuson-Stevens Act in 1996 expanded the law to address such issues as bycatch reduction and the identification and conservation of essential fish habitat. These new responsibilities and accompanying fiscal requirements reduce the likelihood that there will be sufficient funding available to significantly improve the current shortfalls in fishery and assessment data (Gay 1998). In order to address the need for an improved fisheries information base, the National Oceanic and Atmospheric Administration (NOAA) has proposed modernizing its fleet of research vessels by acquiring up to six vessels at a cost of approximately $US 50 million each (Dorman 1998).

On the U.S. West Coast, several scientists, managers, and industry leaders have argued that fisheries data methodologies must not only be improved, but also made more efficient and cost-effective (Hosie 1998). Cooperative research efforts between fisheries scientists and the commercial fishing industry are receiving increased attention as one method of supplementing or replacing standard data collection operations and reducing research costs (Gallagher 1987; Dorman 1998; Gay 1998). Several independent reviews of NOAA's fleet modernization plan have supported increased collaboration with industry in research and have suggested that updating the agency's research vessels may not be the most efficient expenditure of public monies (DoC 1996; Dorman 1998; GAO 2000).

There is significant precedent for industry participation in fisheries research, both domestically and abroad. Fishermen have historically provided scientists, museums, and aquariums with specimens for research and exhibits (Gallagher 1987). U.S. federal and state governments have engaged in numerous tag-and-recapture studies with industry (Tiedemann et al. 1990). In Atlantic Canada, scientists and fishermen have established an independent research organization that competes for government research contracts and has completed research projects on local oceanography, spawning behavior of important fish stocks, and tagging studies (King et al. 1994). Several trawlers on the U.S. West Coast participated in a voluntary program to record discard information via logbooks and observers (Saelens 1995).

Vessel charters are also common examples of cooperative research. In the U.S., state and federal fisheries agencies employ commercial fishing vessels and their crew to conduct resource surveys for some stocks (Hannah et al. 1995; NMFS 2000). Australian researchers have collaborated with industry in the design and field testing of bycatch reduction devices (Kennelly and Broadhurst 1996). Cooperative research may also include interview programs where scientists and fishermen discuss perceived anomalies in oceanographic or ecological conditions, changes in fishing behavior, or other issues that might warrant further, more rigorous research.

There are legitimate concerns about the efficacy of certain types of cooperative research. For example, NOAA has maintained that not all of its research duties can be conducted on industry fishing vessels and that information obtained using disparate platforms operating in different environments over varying time periods might present precision, accuracy, and bias problems (Josephson 1996). However, the potential benefits of increasing sampling capacity and reducing research costs suggest it might be worthwhile to develop solutions that address these challenges.

In the West Coast groundfish fishery, cooperative research has become a high profile issue in recent years. Industry, especially the trawl sector, has expressed dissatisfaction with the data used in stock assessments, and some fishermen have offered their vessels, resources, and expertise to NMFS and state agencies to assist in research. Although some scientists and managers have noted a lack of follow-through on some of industry's offers of assistance, agencies have implemented a few programs that involve industry participation including a port interview project, a voluntary discard analysis project, a deepwater trawl survey using chartered vessels, and a pilot electronic logbook program. These efforts have had varying degrees of success and have received mixed reviews by industry. Some have suggested that NMFS is not truly committed to cooperation and that the projects do not go far enough in involving industry in research.

This study was designed to assess the feasibility of cooperative research within the West Coast groundfish fishery. Some of the questions that must be addressed include: What attitudinal, demographic, and institutional factors influence individuals' willingness to participate in a cooperative research project? What projects are viewed favorably or unfavorably by various groups within the fishery? What incentives and contracts are necessary to garner sufficient participation? Answers to these questions can assist scientists, managers, and industry develop cooperative research programs that efficiently and cost-effectively meet research needs and to maximize those projects' chances for success.

2. METHODS

In March and April 1997, six focused discussions were conducted with industry, managers, and scientists in the West Coast groundfish fishery. Two scientist-manager meetings were held in Newport, OR and Tiburon, CA. Four industry meetings were held in Crescent City, CA, Coos Bay, OR, Newport, OR, and Astoria, OR. Eighteen scientists and managers from universities and federal and state agencies and 28 industry members participated and collectively responded to ten questions on cooperative research, working relationships between industry and scientists, important trends in the fishery, and general science and management issues. These discussions were held to define key issues within the fishery related to cooperative research and to provide information for designing a written mail questionnaire.

Results from the focused discussions and other background information were used to design a questionnaire which was mailed to: 1) all owners of limited-entry permits in the U.S. West Coast groundfish fishery; 2) selected owners and managers of groundfish processing plants; 3) all known state, federal, and university scientists and researchers involved in U.S. West Coast groundfish issues; 4) members of the PFMC and its panels; and, 5) Sea Grant extension agents in Washington, Oregon, and California.

A total of 915 surveys were mailed out including 502 to fishermen, 55 to processors, and 348 to scientists, managers, and Sea Grant extension agents. Each of these four major groups received a slightly different version of the questionnaire with changes in question wording appropriate to each respective group. The initial survey mailing occurred in May 1998, reminder cards were mailed to non-respondents in June 1998, and a second mailing was administered in July 1998. The overall response rate for the survey was 55.1%: 43.6% for fishermen, 50.0% for processors, 72.9% for scientists and managers. All individuals received a custom-made groundfish cap for returning a questionnaire.

Survey questions were developed based upon our interpretation of the key themes synthesized from the literature and the six focused discussions. Questions used a four- or five-point ordinal scale to indicate respondents' level of agreement or support of a particular issue. Space was provided for respondents to provide justification for their responses or other comments regarding the question. We also left considerable room at the end of the questionnaire and encouraged respondents to include any comments relevant to the issues raised in the survey.

One-way analysis of variance (ANOVA) was employed to examine differences in responses among groups (e.g., industry and scientists) as well as differences within these groups (e.g., gear type, agency affiliation, type of scientist, state of residence). Ordinary least squares was used to analyze a utility of profit supply model where fishermen respondents evaluated the desirability of a series of scenarios for chartering their fishing vessel for research.

3. RESULTS AND DISCUSSION

3.1 Evaluation of Potential Cooperative Research Projects

In order for a cooperative research project to be successful, both industry and scientist participants should believe it is scientifically and economically justified. If participants believe that a particular project will provide flawed, unnecessary, or redundant information, or that the project's costs outweigh its scientific benefits, that project may not engender the support needed to make it successful. Nine examples of specific cooperative research projects were provided and respondents were asked to indicate for each project its potential to improve fisheries science and their perception of the project's total costs. Respondents rated both "potential to improve fisheries science" and "total costs" on a five-point ordinal scale where 1 = "none" and 5 = "very high" (Table 1).

Scientists and industry largely agreed in their perception of most projects' costs, however there were significant differences in their perceptions of various projects' potential to improve fisheries science. For example, the three projects industry selected as having the most potential for improving fisheries science (industry groups hiring their own scientists, implementing an interview program with industry to provide observational information, and formation of an independent industry-scientist research organization) were the three projects selected by scientists as having the least potential for improving fisheries science. These responses suggest that industry favors those projects that allow them direct involvement and input into the scientific process, while scientists may be hesitant to support greater industry involvement amidst concerns about the potential biases and objectivity of the industry. Industry also displayed significant internal heterogeneity in their evaluation of these projects' potential to improve fisheries science with standard deviations > 1.0 for each project except the comprehensive observer program.

Scientists perceived the highest potential for improving fisheries science in the comprehensive observer program, industry-platform resource surveys, and ad-hoc cooperative experiments. Their support of the observer program reflects the importance they place on obtaining accurate discard information that was displayed in scientists' responses to other portions of this survey. Scientists' favorable opinion of industry-platform surveys and ad-hoc cooperative experiments may stem from their recognition of the decreasing lifespan of current government research vessels and the need to continue collecting survey data and other fishery-independent information for stock assessments.

By dividing the score for potential improvement by the score for total costs, a subjective "cost-efficiency index" was calculated for each project to indicate potential improvement in fisheries science per unit cost (Table 1). Improving the existing logbook program received the highest cost-efficiency index score for both industry and scientist respondents, however, this was mainly due to the perception of low total costs rather than its ability to improve fisheries science. There was significant disparity in scientists' and industry's cost-efficiency indices for the observer program and the interview program. These findings are consistent with comments made during the focus groups where several industry discussants expressed concern over how a comprehensive observer program would be funded, and some scientist discussants expressed skepticism about the usefulness of observational data, despite its potentially low costs.

3.2 Hypothetical Vessel-Charter Scenario

Fishermen respondents were asked to evaluate a series of scenarios for a hypothetical resource survey charter. The scenario consisted of four variable attributes: project setup, compensation, skipper consultation, and days at sea (Table 2). Project setup had two possible levels: "ideal" and "existing." These levels refer to the results of a preceding question where fishermen were asked to design their "ideal" cooperative research project. Fishermen reviewed nine potential characteristics of a vessel charter (e.g., type of contract, bidding process, affiliation of scientists, geographical range of project) and then selected from a list of four or five choices the level of each characteristic they perceived as ideal. They then reviewed the same nine characteristics and selected the level that they believed corresponded with existing cooperative research projects. Compensation is the amount of money the fisherman would receive per day for participating in the charter. Skipper consultation indicates whether the chief scientist consulted with the skipper on issues where his or her expertise might be useful. Days at sea is the number of days the vessel will be at sea during the charter. In addition to these four attributes, key demographic and attitudinal variables were also included in this analysis (Table 2).

Each fisherman was given five versions of the scenario with differing levels of the variable attributes in each version. For each version of the scenario, fishermen selected a desirability level from 1 to 21 (1 = "very undesirable"; 11 = "neutral"; 21 = "very desirable") and indicated whether they would offer their vessel for charter in that version if it required one, three, and six charters per year. The number of charters per year was capped at six to present a reasonable estimate of the upper bound of potential vessel charters in the fishery, however there is the possibility that this may have introduced some bias into the results. There were a total of nine versions of the scenario which were selected using a multifactorial experimental design to ensure orthogonality. The questionnaire was designed so that half of the fishermen would receive versions one through five, and half would receive versions five through nine. Table 3 is an example of one of the nine charter versions.

An individual respondent utility model similar to the main-effects-plus-selected-interactions (MEPSI) model employed in Sylvia and Larkin (1995) was used as the empirical framework for an ordinary least squares regression analysis:

$$U_h = \beta_o + \sum_{j=1}^{J_o} \sum_{i=1}^{I} \beta_{ij} D_{ij}^h + \sum_{j=J_o+1}^{J} \beta_j X_j^h + \sum_{j=1}^{J} \sum_{k=j+1}^{J} \sum_{i=1}^{I} \beta_{ijk} A_{ijk}^h$$

where U_h is the respondent's utility for version h of the scenario. There are a total of J attributes: the J_o subset contains dummy variables, D_{ij}, and the remaining $J - J_o$ variables are continuous, X_j. All attributes are indexed by j. The index i reflects the attribute levels as defined in Table 2. A_{ijk} describes the interactive variable dayssea * boatlength, the product of days at sea for each scenario version and the length of the respondent's vessel. The interaction between these variables is examined because of hypothesized differences in opportunity cost and endurance among smaller and larger vessels. The remaining parameters indicate the relative contribution of each attribute level to overall utility, or desirability of each scenario version h. Two regression analyses were conducted on the vessel-charter scenario: the first analysis examined charter desirability as a function of the charter's attributes and as a function of important attitudinal and demographic variables; the second analysis examined charter supply (i.e., number of times per year the respondent was willing to offer his/her vessel for charter) as a function of the same attributes and variables. Table 4 displays the estimated coefficients and significance for each variable in both regressions.

Amount of compensation paid to the fisherman had the greatest effect on both the desirability of a particular charter scenario and on the number of charters per year in which one would participate. For every dollar increase in compensation, there was a corresponding increase in overall charter desirability of .0021 points and an increase in the preferred number of charters per year of .0008. Therefore increasing daily compensation by $1,000 increases desirability by 2.1 points and increases the number of charters per year in which respondents were willing to participate by 0.8.

Skipper consultation increased desirability by 2.625 points, the second most significant increase. This finding is consistent with comments made by fishermen during the focused discussions indicating their desire to be directly involved in the research and their belief that industry input can improve fisheries research. Skipper consultation also increased respondents' willingness to supply their vessel by 0.5 charters per year.

There was an inverse relationship between days at sea required for the charter and the charter's desirability and the preferred number of charters per year. The variable "dayssea*boatlength" was included to measure interactions between the number of days at sea required in a charter and the length of the respondent's vessel. It is hypothesized that larger boat owners may prefer longer vessel charters in that it reduces economic uncertainty by providing a guaranteed cash flow over a longer period of time. Smaller boat owners may prefer the shorter charters because their vessels do not have the hold capacity or endurance that may be required during longer charters. In the desirability model, the interaction between days at sea and boat length was more significant than either of the component variables by themselves, indicating that large vessel owners prefer longer charters. In the supply model, the interactive variable was also highly significant, but less so than days at sea by itself.

Age produced the second-largest effect in willingness to participate in multiple charters and the third-largest effect in charter desirability. For each additional year in age, charter desirability decreased by .122 points and willingness to supply one's vessel decreased by .088 charters per year. This suggests that younger fishermen may be more open to participating in cooperative research than older fishermen. Given the increasing discussion of this type of research within the last few years, this finding may indicate younger fishermen are more familiar, and hence more open to the concept of research collaboration than older fishermen. Older fishermen may be less willing to participate in multiple charters because they have a higher opportunity cost of participation than younger fishermen in that they require fewer tows or sets to locate and catch fish.

Education was a highly significant variable in both models, and increasing levels of education corresponded with higher charter desirability ratings and increased willingness to participate in multiple charters. This may indicate that better-educated fishermen may be more aware of the need for improved fisheries science or that more educated fishermen may simply have had more exposure to the practice of vessel chartering.

Gear type was an important variable in both regression models. Pot/trap fishermen rated the vessel charter as more desirable and were more willing to participate in multiple charters than any other single gear type as evidenced by the negative coefficients. Compared with trawlers, pot/trap fishermen rated the charter scenario 2.277 points higher in the desirability model and were willing to participate in .81 more charters per year. This suggests a lower opportunity cost to participate in charters among this gear type.

Respondents who fished more frequently in Alaskan waters viewed the charters as less desirable and were willing to participate in fewer charters per year than fishermen who fished less frequently in Alaska. This suggests a higher opportunity cost among those West Coast groundfish fishermen that fish more frequently off Alaska.

4. IMPLICATIONS

There is little disagreement among the various stakeholders in the West Coast groundfish fishery that more and better information is needed to assess and manage the stocks to the high standards required by the Magnuson-Stevens Act. The number of stocks designated as overfished or depleted continues to rise, and the harvest guidelines of most commercially important species steadily decline. Based on these observations, management of the fishery might easily be classified as a failure from both an ecological and an economic standpoint.

While it is unlikely that many would dispute the notion that NMFS uses the best available data in its scientific duties, it is nonetheless appropriate to question how those data might be improved and augmented. Additional mandates concerning bycatch reduction and habitat conservation, the potential for Endangered Species Act listings of salmon and other marine species, and a recent Executive Order requiring NOAA to develop a national system of marine protected areas are likely to offset any increases in the annual budget. These new responsibilities further constrain critical duties such as stock assessment, life history studies, and ecological research which are already underfunded and understaffed.

There are tradeoffs between employing the best possible scientific data and the cost of generating and analyzing those data. For example, designing large resource surveys involves making compromises in sampling frequency, intensity, or geographical extent (Fox and Starr 1996). Given finite research dollars, the goal becomes one of prioritizing research and generating the best, most cost-efficient information and analysis. At least three independent reviews of NOAA/NMFS' data collection practices have advocated increased cooperation with industry in fisheries research based, in part, upon considerations of cost-efficiency.

Recently, NMFS has increasingly employed chartered industry vessels for research, especially for resource surveys. The Northwest Fisheries Science Center has chartered fishing vessels to survey the deepwater slope fishery for the past three years. However, the continuing dearth of information for assessments and other fisheries research suggests there are still considerable opportunities for industry-scientist cooperation. Further, it raises the question of whether cooperation entails more than merely leasing fishing vessels for research platforms.

Industry continues to express an interest and willingness to play a significant and active role in fisheries research. A fundamental issue that needs to be explored is the motivations of the scientists and industry members that would participate in cooperative research. Do we truly believe that cooperation can improve fisheries science and help conduct research for which agencies might not otherwise have the funding and resources? Or is it simply an effort by science and management institutions to placate an angry industry? And are industry participants merely seeking to tap into a guaranteed payday? These are important considerations, as one of the benefits of industry-scientist cooperation is the pooling of the unique insights and expertise that each group provides. A true partnership of scientists and industry will involve participants from both groups in every aspect of the research, from project design to analysis and recommendations. Although there has been much talk recently about cooperative research, Dorman (1996), in his assessment of NMFS' commitment to partnering with industry, noted considerable criticism of research collaboration with industry and observed very little entrepreneurial spirit in developing cooperative solutions.

Under the current research and management institutions, there is little incentive for scientists or industry to seek to improve fisheries science or make it more efficient. In these "traditional" institutional arrangements, government is essentially the sole provider of research and management services and is largely insulated from market forces that might compel it to seek alternative solutions (Kaufmann and Geen 1997). In nations with clearly defined property rights such as Australia and New Zealand, government agencies recover from industry most of the costs associated with research and management. As industry bears more of the financial burden for the prosecution of the fisheries, they demand input into the research and management processes and seek to find ways to improve science and management while reducing costs. In many cases, research contracts are contestable among various service providers helping to ensure cost-effectiveness (Branson 1997).

This project is a first step in identifying the types of research that might best take advantage of a cooperative approach. However, it is important that potential participants be committed to improving fisheries science. There should be frank and honest communication regarding the goals and objectives of the research. Attempts at cooperative research that are guided by superficial or political motives are not only more likely to fail to meet research objectives, but are also apt to further strain the already tenuous industry-scientist working relationship.

Acknowledgements

This project was funded by a grant from the Northwest Fisheries Science Center of the National Marine Fisheries Service to the Coastal Oregon Marine Experiment Station through the Cooperative Institute for Marine Resources Studies (CIMRS NA67FE0324).

5. REFERENCES

Branson, A.R., An industry perspective on New Zealand's Experience with ITQs, in Proceedings of Global Trends: Fisheries Management, E.K. Pikitch, D.D. Huppert, and M.P. Sissenwine eds., American Fisheries Society Symposium 20, June 14-16, 1994, Seattle, 270-274, 1997.

DoC (Department of Commerce, OIG), NOAA should decommission its ships and terminate the recent billion-dollar fleet modernization plan, IPE-7794, 84pp, 1996.

Dorman, C.E., Memorandum to Sarah Laskin (OMB) in re: NOAA NMFS fisheries research vessels (FRVs), 34pp, 1998.

Fox, D.S., and R.M.A. Starr, Comparison of commercial fishery and research catch data, *Canadian Journal of Fisheries and Aquatic Sciences*, *53*, 2681-2694, 1996.

Gallagher, D.W., The commercial fishing industry's involvement in data acquisition and marine biological research, in East Coast Fisheries Law and Policy: Proceedings from June 17-20 Conference on East Coast Fisheries Law and Policy, J.L Bubier and A. Rieser eds., Marine Law Institute, University of Maine School of Law, Portland, 289-311, 1987.

GAO (General Accounting Office), Problems remain with National Marine Fisheries Service's implementation of the Magnuson-Stevens Act, GAO/RCED-00-69, 36pp, 2000.

Gay, J., Truth or consequences, *National Fisherman, 78(3),* 23-24, 1998.

Hannah, R.W., S.A. Jones, and M.R. Long, Fecundity of the ocean shrimp (*Pandalus jordani*), *Canadian Journal of Fisheries and Aquatic Sciences, 52(10),* 2098-2107, 1995.

Hosie, M. (ed.), Proceedings of working together for West Coast groundfish: developing solutions to research needs in 1998, 1999, 2000, and beyond, Portland, 1998.

Josephson, D.H., Memorandum to Frank DeGeorge (OIG) in re: NOAA's response to the OIG draft report IPE-7794, in NOAA should decommission its ships and terminate the recent billion-dollar fleet modernization plan, 24pp, 1996.

Kaufmann, B., and G. Geen, Cost-recovery as a fisheries management tool, *Marine Resource Economics, 12*, 57-66, 1997.

Kennelly, S.J., and M.K. Broadhurst, Fishermen and scientists solving bycatch problems: examples from Australia and possibilities for the Northeastern United States, in Proceedings of Solving Bycatch: Considerations for Today and Tomorrow, E.T. Wray ed., Alaska Sea Grant College Program, Fairbanks, 121-128, 1996.

King, P.A., S.G. Elsworth, and R.F. Baker, Partnerships: the route to better communication, in Proceedings of Coastal Zone Canada '94: Cooperation in the Coastal Zone, P.G. Wells and P.J. Ricketts eds., Coastal Zone Canada Association, Dartmouth, N.S., 596-611, 1994.

Larkin, P.A., The costs of fisheries management information and fisheries research, in Developing and Sustaining World Fisheries Resources: the State of Science and Management, 2nd World Fisheries Congress, D.A. Hancock, D.C. Smith, A. Grant, and J.P. Beumer eds., CSIRO Publishing, Collingwood, VIC, 713-718, 1996.

NMFS (National Marine Fisheries Service), Research plan for West Coast groundfish, 26pp., 2000.

NRC (National Research Council), Improving fish stock assessments, National Academy Press, Washington, DC, 1998.

Rice, J.C. and L.J. Richards, A framework for reducing implementation uncertainty in fisheries management, *North American Journal of Fisheries Management, 16,* 488-494.

Saelens, M.R., Enhanced data collection project – phase I, Oregon Department of Fish and Wildlife, 18pp, 1995.

Stauffer, G.D., Are current data meeting our management needs (for our Northeast Pacific groundfish fisheries)?, in Proceedings of the Workshop on Maintaining Current and Future Fisheries Resource Survey Capabilities, R. Peuser ed., Atlantic States Marine Fisheries Commission, Washington, DC, 36-46, 1997.

Sylvia, G. and S.L. Larkin, Firm-level intermediate demand for Pacific whiting products: a multi-attribute, multi-sector analysis, *Canadian Journal of Agricultural Economics, 43,* 501-518, 1995.

Tiedemann, J., J. Lucy, J. Donnelly, M. Malchoff, B. Doyle, and J. Vaske, An assessment of tag-and-release in the Northeast region: report on a cooperative, multi-state Sea Grant project developing educational materials promoting greater use of best available techniques or enhancing catch-and-release and tag-and-release marine recreational fisheries, 71pp, 1990.

Project	Potential to improve fisheries science (rank in parentheses)			Total costs (rank in parentheses)			Cost-efficiency index[a] (rank in parentheses)		
	Industry	Scientists	*p*	Industry	Scientents	*p*	Industry	Scientists	*p*
Comprehensive observer program	3.263 (4)	4.319 (1)	.000	4.266 (1)	4.200 (1)	.425	0.839 (9)	1.073 (5)	.000
Interview program to provide observational information	3.309 (2)	2.858 (9)	.000	2.777 (8)	2.809 (8)	.695	1.351 (2)	1.094 (4)	.000
Industry groups hiring their own scientists	3.325 (1)	2.949 (8)	.000	3.859 (2)	3.769 (2)	.301	0.942 (7)	0.831 (9)	.004
Industry-platform resource surveys	3.235 (5)	3.543 (2)	.003	3.093 (7)	3.483 (5)	.000	1.179 (3)	1.072 (6)	.024
Improve existing logbooks program	3.023 (8)	3.135 (6)	.205	2.153 (9)	2.297 (9)	.027	1.549 (1)	1.443 (1)	.076
Develop electronic logbook program	2.946 (9)	3.233 (4)	.005	3.650 (3)	3.543 (4)	.265	0.903 (8)	0.971 (7)	.098
Ad-hoc experiments between industry and scientists	3.193 (6)	3.338 (3)	.149	3.116 (6)	3.210 (6)	.264	1.142 (4)	1.010 (3)	.344
Form independent industry-scientist research organization	3.267 (3)	3.117 (7)	.000	3.617 (4)	3.560 (3)	.568	0.997 (6)	0.958 (8)	.389
Use industry vessels to collect oceanographic information	3.108 (7)	3.157 (5)	.615	3.230 (5)	3.085 (7)	.118	1.073 (5)	1.111 (2)	.459

[a]Cost-efficiency indices were computed for each project by dividing response to "Potential to improve fisheries science" by "Total costs." Answer categories for both questions were (1) "none," (2) "low," (3) "moderate," (4) "high," and (5) "very high."

Table 1. Mean scores of potential to improve fisheries science, total costs, and cost-efficiency indices for nine hypothetical cooperative research projects.

Description	Scale
Dependent variables	
Overall desirability of charter scenario	1-21
Number of charters required per year	1, 3, or 6
Project attributes	
Project setup	"ideal" or "existing"
Compensation for participation in the charter	$1,000, $3,000, or $5,000 per day
Skipper consulted during charter?	yes or no
Number of days at sea required per charter	1, 3, or 6
Demographic and attitudinal variables included in model	
Age	Boat Length
Education	Days at sea x Boat length (interactive)
Income from fishing	Expected remaining tenure in fishery
State of residence	Level of involvement in mgmt. process
Gear type	Opinion of cooperative research

Table 2. Description of variables included in vessel-charter scenario

CHARTER SCENARIO

Project Setup:	Your "Ideal"
Compensation:	$3,000 per day
Skipper Consulted:	YES
Days at sea:	One

<u>Very Undesirable</u> **<u>Neutral</u>** **<u>Very Desirable</u>**

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

1) In this scenario, would you offer your vessel for charter if it required 1 charter/year? a. Yes b. No

2) In this scenario, would you offer your vessel for charter if it required 3 charters/year? a. Yes b. No

3) In this scenario, would you offer your vessel for charter if it required 6 charters/year? a. Yes b. No

Table 3. Example of one version of the vessel-charter scenario

Variable/Attribute	Desirability (n=554) Coefficient	t-stat	Supply (n=570) Coefficient	t-stat
Project attributes				
Compensation	.0021***	14.999	.0008***	14.187
Skipper consulted during project?	2.625***	4.536	.493**	2.163
Project setup	.740	1.435	.340*	1.647
Days at sea	-.727***	-1.884	-.323**	-2.100
Demographic and attitudinal variables				
Age	-.122***	-3.434	-.088***	-6.479
Education	.837***	3.354	.386***	3.943
Income from fishing	$-7.69*10^{-7}$	-.567	$5.674*10^{-7}$	1.044
State of residence (AK)[a]	.171	.099	.981	1.412
State of residence (OR)[a]	-.606	-.876	.321	1.187
State of residence (WA)[a]	-.421	-.468	.898***	2.574
Gear type (longline)[b]	-1.179	-1.296	-1.327***	-3.819
Gear type (trawl)[b]	-2.277***	-2.883	-.810***	-2.675
Gear type (miscgear)[b,c]	-1.356	-1.162	.024	.053
Boat length	-.043	-1.491	-.022*	-1.900
Days at sea * Boat length [interactive]	.016**	2.562	.0048*	1.934
Expected remaining tenure in fishery	-.583***	-2.005	-.004	-.035
Degree of involvement in management process	.187	.606	.327***	2.649
Opinion of cooperative research	.641	-1.346	-.251	-1.378
Frequency of fishing in AK[d]	-1.522***	-2.246	-.902***	-3.299
Constant	15.838***	5.643	6.174***	5.442
Adjusted R^2	.373		.358	
F-statistic	18.311***		17.688***	

[a] Each state variable is a dummy variable. California is the intercept term.

[b] Each gear type variable is a dummy variable. Pot/trap gear is the intercept term.

[c] Miscellaneous gear refers to all gear types other than trawl, longline, and pot/trap.

[d] Dummy variable; refers to individuals that selected "frequently" or "rarely" vs. those who selected "occasionally" or "never".

* Significant at the 90% level

** Significant at the 95% level

*** Significant at the 99% level

Table 4. Results of multiple regression analysis for vessel-charter scenario