Minutes of the W2004 Annual Workshop
May 2013, St. Petersburg, Florida

Participants:

Chuck Adams, University of Florida
Sergio Alvarez, University of Florida
Jim Anderson, World Bank
Chris Anderson, University of Washington
Matt Freeman, Mississippi State University
Richard Kazmierczak, Louisiana State University
Gunnar Knapp, University of Alaska Anchorage
Sherry Larkin, University of Florida
Kwamena Quagrainie, Purdue University
Lew Queirolo, NOAA Fisheries, Alaska Region
Andrew Ropicki, University of Florida
Michelle Savolainen, Louisiana State University
Adam Stemle, University of Rhode Island
Gil Sylvia, Oregon State University
Hiro Uchida, University of Rhode Island
Diego Valderrama, University of Florida
Quinn Weninger, Iowa State

Overview: The 2013 research workshop was held in conjunction with the biannual North American Association of Fisheries Economists (NAAFE) meeting in St. Petersburg, Florida from May 21-24. Research results from the project were reported and discussed during sessions of the NAAFE meeting. Abstracts from these presentations are listed below. In addition, a short W2004 business meeting was held immediately after the conclusion of NAAFE. New officers were elected for the coming year and general plans for the group's activities were discussed.

Special Research and Outreach Sessions Organized by W2004 Participants:

Special Session -- Current Status, Future Prospects: Finding, Employment and Relevance of the Fisheries Economics Profession

Session Organizers
Gunnar Knapp, Institute of Social and Economic Research**,** University of Alaska – Anchorage**,** Gunnar.Knapp@uaa.alaska.edu

Cathy Roheim, Department of Agricultural Economics and Rural Sociology**,** University of Idaho**,** Croheim@uidaho.edu

Gil Sylvia, Coastal Oregon Marine Experiment Station**,** Oregon State University**,** Gil.Sylvia@oregonstate.edu

**Session Sponsor: W-2004 '*Marketing, Trade, and Management of Fisheries and Aquaculture Resources'*

Format and Duration
This session is organized into three parts: (1) introductory presentation of data obtained from survey of professionals will be presented during the conference banquet (20 minutes), (2) a special session of two presentations (trends from the NAAFE member database and a literature review of published articles and dissertations) followed by comments from a diverse set of panelists (90 minutes), and (3) a moderated discussion during the closing session (60 minutes).

Abstract
The 2011 NAAFE meetings contained a session developed by Gunnar Knapp and Ann Shriver on teaching fisheries economics. During that session, a spirited discussion ensued in which much was said about the profession's ability to train not only future fisheries economists (broadly defined across a host of areas) but also to educate policy makers, managers and others. In a similar vein, Jim Anderson in his editorial as outgoing editor of *Marine Resource Economics* in 2012 called for the profession to work harder to "get top quality analysis in the hands of policy makers, development organizations and marine resource managers" (p.2, Vol. 27, 2012). Combined, this gives rise to questions about our profession's ability and success in meeting these challenges.

In particular, who will provide expertise on the economics of marine resources - broadly defined to include fisheries and ecosystem management, seafood marketing and trade, and aquaculture - into the future? Will research funding for marine economics be sufficient to incentivize engagement in important research issues by faculty at academic institutions, and thus training of sufficient numbers of high quality new marine economists to meet future needs? Will combined institutional funding and support for marine economic research, education, and extension be coordinated and aggregated within selected academic institutions, or diffused across institutions —and does this matter? What agencies/organizations will provide funding, how will it differ from the past and current situation, and to what end? What are the future needs for marine economists by employers such as academia, governmental agencies, industry and non-governmental organizations? What will the needs be for Ph.D.-trained versus M.S.-trained marine economists? In short, is there sufficient investment (broadly defined) and relevant strategies in training future fisheries economists?

Presentations and Participants
1. Conference banquet (20 minutes):

    Results of NAAFE Membership Survey on Profession
    Presenter: Gunnar Knapp
    • general perceptions about state of fisheries economics and graduate education from recent survey of NAAFE members
    • status of numbers of faculty, graduate students, research funding, and faculty hiring decision-making at academic institutions
    • perceptions of current graduate students and recent graduates regarding motivations underlying their choice of graduate programs and employment prospects
    • perceptions of prospective employers
    • information about the respondents

2. Special Session VII(a) (90 minutes):
    Introduction and Motivation
    Presenter and Moderator: Cathy Roheim

    An Analysis of Trends in the Composition, Location, and Interests in NAAFE Members Using the Membership Database

Presenter: Gunnar Knapp

A Literature/Dissertation Review to Determine Key Trends in Published Literature, Including Institution of Author, Number of Publications on Key Subject Areas Over Time
Gil Sylvia and Janet Webster
Presenter: Gil Sylvia

Remarks by panelists:
- **Susan Capalbo**, Oregon State University
  (Susan.Capalbo@oregonstate.edu)
- **Jim Anderson**, World Bank
  (Andersonuri@gmail.com)
- **Eric Thunberg**, NOAA Fisheries
  (Eric.thunberg@noaa.gov)
- **Vishwanie Maharaj**, World Wildlife Fund, US
  (Vishwanie.Maharaj@wwfus.org)
- **John Connelly**, National Fisheries Institute
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- **David Kling**, UC Davis
  (Dmkling@ucdavis.edu)

3. Special Session VII(b) during Closing Ceremony (60 minute session)

   Presenter and Moderator: Gil Sylvia
   - Brief summary of panel presentations
   - Moderated discussion of panelists' presentations, perspectives, and recommendations. The goal is to answer the following questions: Are the prospects bright for our profession? Who leads in the shared responsibility for training future fisheries and marine economists? Are new investment models needed to support education and training; and if so what are they? What role can or should NAAFE play in supporting investment strategies?

Special Session -- Social Network Analysis in Fisheries

Session Organizer
Sherry Larkin, University of Florida**,** SLarkin@ufl.edu

Format and Duration
One 120-minute session that will begin with an introduction and overview on social network analysis (SNA) and followed by five paper presentations. A moderated discussion of the potential use of SNA in future analysis of fisheries will conclude the session.

Abstract
Social network analysis (SNA) considers social relationships in terms of network theory, which consists of identifying "nodes" (i.e., individual actors or entities within the network) and "ties" or "links" (i.e., the relationships between the nodes). SNA entails measuring mapping the relationships and flows between entities using a social network diagram. SNA provides a visual and a mathematical analysis of the linkages. One use of SNA is to better understand networks and their participants by evaluating the location of actors within the network. For example,

measuring the network location is finding the "centrality" of a node. Such measures provide insight into the various roles and groupings in a network including who are the leaders and who are the isolates (who is in the core of the network versus the periphery) and where are the clusters? According to Dr. Matthew O. Jackson of Stanford University, "Social networks pervade our social and economic lives. They play a central role in the transmission of information about job opportunities and are critical to the trade of many goods and services. They are important in determining which products we buy, which languages we speak, how we vote, as well as whether or not we decide to become criminals, how much education we obtain, and our likelihood of succeeding professionally. The countless ways in which network structures affect our well-being make it critical to understand how social network structures impact behavior, which network structures are likely to emerge in a society, and why we organize ourselves as we do." In fisheries, SNA has most often been used to examine the development of social capital and to describe markets that have developed after rights-based management has been implemented.

Papers and Participants
144. How do Stakeholder Attributes Influence Social Network Capital? Evidence from an Ethnically Diverse Competitive Pelagic Fishery
Michele Barnes-Mauthe, Shawn Arita, Steven Gray, John Lynham and PingSun Leung
Presenter: Michele Barnes-Mauthe, University of Hawaii at Manoa
(Barnesm@hawaii.edu)

127. Fishing Portfolios of Commercial Fishermen in the U.S. South Atlantic Region: A Two-mode Network Approach
Kari MacLauchlin
Presenter: Kari MacLauchlin, South Atlantic Fishery Management Council
(Kari.Maclauchlin@safmc.net)

126. Network Analysis of the Gulf of Mexico Commercial Red Snapper Fishery
Andrew Ropicki
Presenter: Andrew Ropicki, University of Florida
(Aropicki@ufl.edu)
145. A Social Network Analysis of the Australian Coral Reef Fin-Fish Fishery Individual Transferable Quota Market
James Innes, Olivier Thébaud, Ana Norman-López, and Rich Little
Presenter: James Innes, CSIRO
(James.Innes@csiro.au)

155. Network Analysis of the Quota Pounds Market for the West Coast ITQ
Dan Holland and Karma Norman
Presenter: Dan Holland, NOAA Fisheries
(Dan.Holland@noaa.gov)

Special Session -- Perceptions of Sustainability for Seafood

Session Organizer
Chuck Adams, University of Florida**,** Florida Sea Grant**,** Cmadams@ufl.edu

Format and Duration
The session organizer will provide an introduction to the topic and issues. Invited panelists will each provide brief statements, followed by a discussion of future research proposals.

Abstract
This session will address the basic concept of sustainability as applied to fisheries management and seafood marketing. Recent apparent shifts in the support may signal potential changes in user demand for the concept of sustainability as applied to domestic fisheries management and seafood marketing. For example, recent development of alternative approaches to certification other than the traditional, time-honored Marine Stewardship Council (MSC) approach to sustainability, via a third-party certification, as well as changes in the demand for sustainability assurance by the harvesting sector and seafood purveyors in the Gulf of Mexico region, may signal an evolving demand for fisheries and seafood sustainability programs. Issues to be addressed and discussed include: What is the traditional "gold standard" and are there any trends in certification? What are the reasons behind any such changes? Has the concept and process of providing sustainability assurance changed for US domestic fisheries? Do alternatives approaches for sustainability assurance exist? What are the economic cost/benefits associated with sustainability assurance and what are the economic implications associated with a departure from the commonly accepted sustainability assurance approach, such as developed and championed by the current complement of ecolabeling programs. The discussion is expected to generate a set of research questions that will address the economic implications to the harvesting sector, the seafood marketing sector, resource managers, and seafood consumers due to an evolving process of providing seafood sustainability assurance.

Participant Panelists
- **Jay Lugar**, Marine Stewardship Council (MSC)
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- **Damon Morris**, Louisiana Dept. of Wildlife and Fisheries
  (Dmorris@wlf.la.gov)
- **Cathy Roheim**, University of Idaho
  (Croheim@uidaho.edu)
- **Randy Rice**, Alaska Seafood Marketing Institute (ASMI)
  (Rrice@Alaskaseafood.org)

Research and Outreach Paper Presentations by W2004 Participants:

PUTTING A PRICE ON LICE: QUANTIFYING THE BIOLOGICAL AND ECONOMIC IMPACTS OF SEA LICE ON FARMED SALMONIDS

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Atle Guttormsen, Norwegian University of Life Sciences, atle.guttormsen@umb.no

Parasitic sea lice, found naturally on salmonids throughout the world, are known to negatively impact the health, survival and appearance of their hosts. Due to the high stocking levels employed in commercial salmonid farming, along with the permeability of net pens, biophysical nature of lice, and natural oceanographic processes, such impacts may generate significant economic costs to farmers – regardless of the use of chemical treatments and/or biological methods to control lice infestations. Governments regularly monitor average per-fish sea lice counts on salmonid farms, imposing thresholds at which farms must act to control lice infestation (via chemical treatment or culling) in order to protect against ever larger outbreaks and the potentially harmful spillover effects of transmission to nearby wild salmonid populations. On-farm lice therefore impose two types of private economic costs to farmers: a direct economic cost, such that costly control methods must be utilized to mitigate lice infestation; and an indirect economic cost, such that infestation may reduce fish growth (and potentially induce direct fish mortality) leaving farmers with a smaller level of biomass, and therefore revenue, when they choose to harvest their stock.

Utilizing monthly panel data for 1183 unique Norwegian salmonid farms over the seven-year period of 2005-2011, this study estimates the biological and economic impact of the sea louse *Lepeophtheirus salmonis* on stocks of farmed salmon and trout. In doing so, this study looks closely at how such impacts may vary over space and time, and a variety of other factors, such as fish size and lice counts. Fixed effects model results suggest that an additional louse per fish (ceteris paribus) will decrease a typical farm's natural biomass growth in the following month by 4.28% or 8559 kilograms. In terms of elasticities, a 1% increase in lice will on average decrease natural biomass growth in the following month by 0.05%. This result supports the existence of a significant negative lice effect on biomass growth (albeit one that is strongly inelastic for a typical farm) when controlling for important aspects of farm production and fish growth (e.g., quantity of feed, average fish size, total number of fish, average seawater temperature, and spatial-dynamic unobservables). This result implies that an additional louse per fish (in a single month) will on average cost a typical Norwegian farmer approximately $41,410 in lost revenues from the sale of their stock at the time of harvest. This is the first study to our knowledge that attempts to accurately measure the biological impact of lice on farm salmonid biomass growth outside of a laboratory, and to subsequently quantify the economic costs of sea lice infestation to farmers – in other words, "put a price on lice."

FISHERY DISCARDS UNDER HARVEST UNCERTAINTY AND TRADING FRICTIONS

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Growing evidence finds that property rights-based management approaches, such as individual fishing quotas, can address stock conservation goals and improve economic efficiency in marine fisheries. A major concern among resource managers is that fishermen operating under a harvest quota constraint will have difficulty matching random harvests with quotas. Faced with

an overage, i.e., a harvest in excess of the quota, fishermen may be forced to discard fish at sea to avoid regulatory penalty. Harvest randomness and quota constraints may further aggravate the problem of wasteful at-sea discards, which recent estimates put at 7.3 million metric tons of fish per year worldwide, or 8% of the global catch (Kelleher, 2005).

A common element of most quota-based program is restricting and in some cases imposing strict limits on quota transferability. These regulations raise the cost of post-harvest quota trades which, as we show in this paper, can remedy the discard problem.

With this background, our paper has three main objectives. First, we study harvest plans under harvest uncertainty in the absence of quota trade. We explore how ex ante harvest plans and ex post harvest distributions evolve endogenously in response to management quota allocations and exogenous harvest shocks. Second, we show that harvest plans are efficient when quotas can be traded at all stages of fishing operations. Finally, we study policies that can implement efficient plans in the absence of post-harvest quota markets.

Our model considers harvest uncertainty which is idiosyncratic as well as correlated across fishermen. With only idiosyncratic harvest uncertainty, we show that frictionless post-harvest quota trade can eliminate at-sea discards completely. In the absence of such trade, we deduce an ad-valorem tax/subsidy that eliminates discards while delivering a desired harvest target. Alternatively, we identify a hybrid policy, i.e., a combined quota and landings fee, which can implement a manager's target harvest level without discards. When harvest shocks, in addition, have a fishery-wide component, post-harvest quota trading per se cannot eliminate discards; policy intervention in the form of either landing taxes or a hybrid scheme is needed. Given the prevalence of restrictions on quota trade in quota-managed fisheries worldwide, our paper offers important policy advice.

SEA-TURTLE BYCATCH MANAGEMENT IN RIGHTS-BASED FISHERIES UNDER STOCK UNCERTAINTY

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National standard 9 of the Magnusun-Stevens Fisheries Management and Conservation Act requires that U.S. Fisheries Management Plans minimize, to the extent practicable, bycatch and bycatch mortality. Examination of U.S. fisheries suggest, however, that significant bycatch problems remain. A recent U.S. National Bycatch Report estimates that 1,887 marine mammals, 11,772 endangered sea turtles and 7,769 sea birds were intercepted by fishing gear in 2005, the base year of the study. Unintended bycatch and discard of non-target fish species in 2005 was 1.22 billion pounds, or 17% of the total U.S. catch. One often used management approach for reducing the bycatch of non-marketed but socially valuable bycatch species is to curtail fishing. Alternatives that allow benefits from commercial and recreational fishing to continue, while minimizing unintended bycatch, are clearly preferred.

We develop a stochastic general equilibrium framework that facilitates performance evaluation of quota- and non-quota-based management plans in fisheries exposed to socially costly bycatch of non-market species. We examine harvesting behavior, bycatch, and bio-economic performance in a stochastic production environment with and without observability of bycatch, and with and without trade in harvest quotas and bycatch caps.

Our results suggest that a precise implementation of a socially optimal plan is only possible if bycatch is observable and a market for trade in fish quotas and bycatch cap functions costlessly. Non-quota-based regulations, which can be implemented without observability, do

not achieve first-best bycatch avoidance and therefore raise fishing costs. The Gulf of Mexico longline reef fish fishery is examined to demonstrate key policy insights from our model.

COMMERCIAL SCALE AQUAPONICS: PROFITABILITY AND SUSTAINABILITY

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Aquaponics, the symbiotic integration of aquaculture and hydroponics, has been touted as a sustainable farming technology that has a minimal environmental impact. Although existing literature and reports suggest economic feasibility of small-scale or backyard aquaponic system, it is not clear whether commercial scale aquaponics is a viable option. In this project, we assess the economic feasibility of commercial scale aquaponic enterprises based on a survey of several existing aquaponic enterprises in Hawaii. We compare their investment behavior and operational efficacy to the traditional aquaculture and hydroponic system. While previous studies indicate vegetable production as driving force of aquaponics enterprises, our research so far suggest that fish production may play a larger economic role depending on the design of the system. The study also investigates water, energy, and chemical use in the system to assess the environmental impacts of the operation. First we compute life cycle water and energy used in aquaponics system. By comparing the life cycle resource use with aquaculture and hydroponics, we show whether aquaponcs save water and energy. Finally, we combine these results and the economic analysis to show the economic benefits from future resource savings.

INSTITUTIONAL DEPENDENCE OF THE FISHERY PRODUCTION FUNCTION

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The dominant approach to modeling the fishing production process has been to adapt conventional production models used in other industries to a fisheries setting. For example, as agricultural economists hypothesize agricultural yield to be a function of water, soil type, fertilizer, labor hours, etc., fisheries economists hypothesize catch to be a function of inputs such as vessel length, gear type, crew size, and fishing time. The production process of fishing, however, is not easily represented by a simple modification of conventional production models. Fishing production is rather unique because the firm must accommodate its activities to the spatiotemporal dynamics of a fugitive resource. The production process of fishing thus involves the strategic use of inputs over time and space as primary decision variables. As a result, many of the traditionally included inputs in conventional production models of fishing are not direct choice variables for fishermen; rather, they are indirect outcomes of deep structural decisions over the temporal and spatial deployment of fishing gear.

The implications of this idea are important for predicting the outcome of a fishery policy intervention. Conventional models of the fishing production process identify reduced form technical interactions between inputs and outputs that are functions of structural decisions over time and space. If the combination of these structural variables is ultimately shaped by the incentives inherent in management institutions, then there is no reason to expect that the observed a priori relationship between traditional inputs and final outputs should be stable to

interventions in management. Thus, conventional fishing production models do not identify policy invariant parameters. It is therefore naïve to predict the effects of a change in economic policy entirely on the basis of a relationship whose structure alters systematically with a change in policy.

In this paper, we conduct a simulation exercise to investigate the extent to which conventional fishery production models that ignore the primary decision variables of fishermen are institution-dependent. We construct a stylized spatial biological system that captures the complements-in-production relationship between a target and bycatch species that is often seen in capture fisheries. We generate multiple samples of location choices for a representative fisherman, with each sample assembled to represent the location choices that would emerge under different regulatory settings. Using the output production bundles that result from such location choices, we show that fishermen select considerably different portfolios of location choices under different institutions, and this results in output production bundles with vastly different species compositions. We show that estimates of fishery technology using conventional methods are highly dependent on the regulatory setting that generated the production data. Thus, the relationship between traditional inputs and final outputs is not policy invariant, and therefore, conventional models of fishing production are limited in their ability to inform policy makers of fishery policy intervention outcomes. Our findings suggest that accurate assessment of the impacts of a policy intervention requires a description of the production process that is sufficiently structural so as to be invariant to changes in management institutions.

TECHNOLOGY OR INCENTIVES? BYCATCH AVOIDANCE IN THE BSAI GROUNDFISH FISHERY

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Multispecies fisheries add additional complexity for rights-based management implementation. Fundamental to rights-based management in a multispecies fishery is composing a portfolio of total allowable catches (TACs) for both target and non-target species. However, due to imperfectly selective fishing gear, it is difficult to know ex ante a fisherman's catch composition, and thus, fishermen may find it difficult or impossible to conform their catch to match their ex ante portfolio of quota allocations. Possible consequences include extremely high prices for binding species quota, a collapse in the markets for "slack" species, rampant illegal discarding, data fouling, and subverted quota markets.

The appropriateness of rights-based management for multispecies fisheries ultimately depends on a fisherman's ability to "target" their catch. If a fisherman can target accurately, the problem of matching catches and quota allocations declines in importance. In theory, modifying the way in which gear is employed can enhance targeting potential. For instance, modifying the speed, depth, and/or area of tow can potentially enhance the targeting ability of bottom trawlers. Previous ex ante examinations of targeting ability suggest that rights-based systems may face serious challenges due to weak substitution potential between species. In contrast, ex post evidence from multispecies ITQ fisheries suggests that far greater flexibility in outputs is possible than previously thought. These disparate findings suggest that the production technology revealed through empirical work may be heavily dependent on current management policies.

We examine this possibility through an analysis of a fishery undergoing the transition to rights-based management: the Bering Sea/Aleutian Island (BSAI) groundfish fishery. Historically, the BSAI groundfish fishery managed the incidental bycatch of Pacific halibut through a fleet-wide common-pool TAC. Due to the complementary role halibut plays in the catch of targeted species, a binding TAC for halibut often resulted in the premature closure of target fisheries, leaving millions of dollars of unharvested target species quota on the table. In 2008, the North Pacific Fisheries Management Council rationalized the BSAI groundfish fishery under Amendment 80 (A80). Under A80, shares of the TACs for several target and bycatch species are allocated to individual fishermen that are vested in either a cooperative formed by participating members or in a limited access common pool fishery.

We combine an unusually rich panel dataset of vessels with econometric production models to characterize the multi-output production technologies of vessels before and after the policy change. We use multiple measures of substitutability between outputs to investigate the extent to which the incentives prior to rationalization affected targeting ability. In general, we find that fishermen in the BSAI groundfish fishery are remarkably capable of adjusting their behavior to match their desired catch compositions. Furthermore, an investigation of targeting ability using only ex ante data arrives at grossly misleading conclusions—namely that fishermen were limited in their ability to avoid halibut bycatch—indicating that targeting behavior prior to the introduction of A80 was primarily determined by the incentives inherent in the pre-A80 management system.

EXPERIMENTAL ANALYSIS OF WILLINGNESS-TO-PAY FOR VALUE-ADDED PRAWNS

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In order to reach new consumers, food industries and food science departments continue to test new products (or variations of existing products) for acceptability. While acceptability and product differentiability are important marketing concerns, firms will only supply those products which are profitable. New or differentiated product development typically comes at an additional cost. Therefore, consumers must be willing to pay an adequate premium for the firm to respond to consumer demand. With this research project, we examine the consumers' willingness-to-pay for value-added variations to freshwater prawns. Working with the Department of Food Science, Nutrition, and Health Promotion, our research examines the separate effects of (1) salt-acclimation and (2) marination of freshwater prawns on consumers' willingness-to-pay, as compared to the standard untreated freshwater prawns. First, a sensory analysis is conducted to determine the acceptability of the prawn samples, with participants utilizing a hedonic scale. Descriptive analysis attributes included are flavor, odor, texture, and appearance. Following the sensory analysis, subjects will participate in standard nth-price auctions to determine their individual willingness-to-pay for said products. This particular auction mechanism has shown to be advantageous in eliciting consumer demand in laboratory settings (Shogren et al., 2001; List, 2003; Lusk et al., 2004; Umberger and Feuz, 2004). In the auction, subjects are given a monetary allowance from which their willingness to pay is deducted, if their auction bid is at or above a randomly drawn market price for that good. Analysis of the data will determine the impacts of the descriptive analysis attributes on consumers' willingness-to-pay. This applied research will assist prawn producers in identifying value-added products and from which they can determine the profitability of these products (i.e. if the price premium exceeds their added cost).

REFLECTIONS ON SMALL-SCALE FISHERMEN'S RETICENCE TO PARTICIPATE IN THE PUERTO RICAN DEEP-WATER SNAPPER GROUPER CATCH SHARE PROGRAM

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The paper describes the experience of the first attempt to establish a catch share program in the U.S. Caribbean. It also investigates the reasons behind Puerto Rican, small-scale fishermen's reluctance to participate in the deep-water snapper grouper catch share program. Our analysis shows that catch share programs may not be a suitable management tool for the U.S. Caribbean given high transaction costs. High decision-making and operational costs were the main impediments for the establishment of the program. However, the process may have been a positive experience because it encouraged fishermen and managers to work together to find solutions suited for their local circumstances.

AND NOW, SOMETHING COMPLETELY DIFFERENT: A RADICAL SOLUTION TO MANAGEMENT OF PACIFIC HALIBUT RESOURCE APPORTIONMENT IN AND OFF ALASKA

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Commercial Pacific halibut Quota Share (QS) holders believe their economic survival is slipping away, siphoned off by what seems to be an insatiable growth in halibut harvested by charter fishing operations in and off Southeast (SE) and Southcentral Alaska. At the same time, removals of halibut as Prohibited Species Catch (PSC) in commercial groundfish fisheries, as well as halibut mortality incurred in non-groundfish commercial fisheries in the same region, have accounted for halibut removals exceeding the total charter catch off Alaska. Halibut PSC has been regarded as distinctly separate from allocation fights between commercial and charter sectors, and, as such, sacrosanct in North Pacific fishery management. Only recently has there been systemic acknowledgement of the scope of the halibut allocation dilemma; economic incentives forcing movement towards a comprehensive solution; and recognition that the "public process" may be usurped by the courts, if resolution cannot be achieved. The sources of conflict are not unfamiliar … lack of "quasi-property interest"; too many users chasing too few fish; non-selective fishing gear/fishing practices imposing waste; conflicts between market and non-market "users"; U.S. treaty obligations that supersede fishery management regulatory provisions; and sustainability concerns for the Pacific halibut species, itself. In a thought experiment, I ask, "How could the demand for Pacific halibut, within these disparate commercial sectors, be integrated in such a way as to produce a Pareto improvement for society, when compared to the status quo management approach?" I begin by examining "commercial" sources of halibut removal, which have been the recent focus of contention. If one accepts the widely help premise that "each pound of halibut landed by a charter client, fishing SE or Southcentral Alaska, is a pound of halibut removed, without compensation, from commercial halibut IFQ sector's harvest"; and that halibut mortality resulting from groundfish PSC, especially non-pelagic trawling, (but also from halibut discards in non-groundfish fisheries) in and off Alaska reduces the combined catch limit (CCL) available to halibut IFQ and charter operations; and discarding intercepted halibut "wastes" an economically valuable public resource, without compensation; then identifying a cohesive, comprehensive strategy, abandoning convention, may be necessary to realizing a Pareto superior outcome. In this paper, a radical, but technically feasible, approach to facilitating an integrated management and operational solution

to the aforementioned allocation problem is explored. If realized, the solution would enhance inter-sectorial cooperation; reduce PSC waste and diminish the stigma associated with discards; increase high-grade halibut product available to consumers; facilitate stewardship, conservation, and ecological awareness; sustain economically viable commercial fisheries in SE and Southcentral Alaska (and the communities they depend upon and support); and improve the availability and value derived by clientele utilizing Pacific halibut charter fishing purveyors in these areas.

Ancillary benefits may accrue to subsistence, personal-use, unguided sport, and passive-use populations that derive utility from a healthy, sustainably managed, and abundant Pacific halibut resource. Finally, the solution relies upon market-based incentives and internally generated revenues to operate and sustain the program.

AN ECONOMIC MODEL OF SCALLOP AQUACULTURE PRODUCTION IN THE COLOMBIAN CARIBBEAN

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Mollusk aquaculture is of great importance worldwide with production increasing at a very rapid pace over the last 30 years. Although not much development has taken place thus far in the Western Caribbean, *Argopecten nucleus* and *Nodipecten nodosus* have been identified as two scallop species with potential for commercial aquaculture production. Fisheries for these two species failed to develop in the region given the low densities of natural populations; however, captures of wild juveniles in artificial collectors and seed production by public hatcheries have led to the establishment of farmed stocks in the Colombian Caribbean. Nevertheless, factors such as the inconsistent availability of seed, inadequate planning and the lack of information on financial and marketing aspects have prevented the development of an aquaculture industry in Colombia. Preliminary financial analysis suggest that scallop aquaculture is commercially viable due to the high selling price of scallops. In order to assess the true potential of scallop aquaculture in the region, this study developed an economic model for the hatchery and growout phases of an aquaculture operation based on the results of experimental trials conducted by scientists at the Shellfish and Microalgae Lab of the University of Magdalena in Taganga, Colombia. The study examined the economic performance of the proposed operation under a number of assumptions on key production and economic parameters. The study also examined the conditions under which scallop aquaculture could be successfully undertaken by local communities of fishermen affected by declining catches from traditional fisheries. Some policy recommendations were also formulated to promote the development of this form of aquaculture in the country and in the wider Caribbean region.

LONG-TERM HEALTH EFFECTS, RISK PERCEPTIONS, AND CONSUMPTION PATTERNS FOR AQUACULTURED SEAFOOD

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Challenges to the competitiveness of US food industry in both domestic and international markets occur regularly as producers are confronted with consumer concerns over health risks. In the context of US aquaculture, primary factors influencing the competitiveness of the industry are consumers' perceptions of long-term health risks related to domestic farmed seafood

consumption. The public is often particularly sensitive to food risk scares, and can often dominate other considerations in food choice and lead to large impacts on consumption and the viability of aquaculture industry. While recent labeling requirements have aided consumers in determining the seafood production process and the country of origin, it remains difficult for consumers to address health risk in purchasing decisions as there is widespread confusion with respect to riskiness of various species, whether farmed or wild.

This paper analyzes the influences of health risk trade-offs, perceptions, information and attitudes on farmed seafood consumption. Main questions being asked include: (1) How do consumers perceive, process and respond to information regarding mixed, or offsetting, long-term health effects in aquaculture products, and how does this influence purchase behavior relative to competing food products? (2) Does the source and type of risk information matter and how (or why)? (3) Do the answers to the prior two questions vary systematically across population segments? (4) How can policy (including public and/or private actions) encourage more informed consideration of health risks and benefits associated with farmed seafood and promote consumption that reflects informed risk trade-offs? To answer these questions, this paper combines information collected through the usual consumer surveys coupled with experimental auction sessions. Average of 10 participants attended the experimental auction, where they went through six rounds of bidding for each of the three seafood products: one pound of fillet of wild salmon, farmed salmon, and swordfish. Wild versus farmed salmon products are intended to capture the perception towards farmed seafood when the health risk/benefit trade-offs are similar. Swordfish was included because of its relatively high content of mercury compared to salmon, so as to capture whether proper information on mercury risk will have an impact on salmon demand. We chose four publicly available advisories on seafood health benefits and risks with varying sources, and included them as information treatments during the experimental auction. Bids were made without any information ("cold feet"), with the content of information being provided, and then being notified of the source of that information. Collected bidding data will be analyzed econometrically to identify any changes in bidding prices before and after each information treatment, and analyze if and how these observed changes in bid are associated with participant characteristics that we have collected via surveys.

A NASH EQUILIBRIUM APPROACH FOR PREDICTING THE SPATIAL DISTRIBUTION OF FISHING EFFORT IN A MULTI-FLEET, MULTI-AREA GENERALIZED EQUILIBRIUM MODEL

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Many fisheries are characterized by a heterogeneous spatial distribution of fish species. The age-, size-, and sex- distributions of these fish species may also vary spatially. This provides both an opportunity and a problem for fishery managers. On one hand, area-specific catch or effort limits may help to foster desirable stock characteristics, such as an age-structure that makes the stock more resistant to environmental perturbations. On the other hand, the decision made by fishing vessels on the level and spatial distribution of fishing effort can be difficult to predict, and the impact of management regulations uncertain. It is this interaction between size-selective fishing gear and a heterogeneous stock distribution that results in fishing mortality for the area in question. Most bio-economic models of fisheries assume that both fish stocks and fishing effort are distributed homogenously within the fishery, and that fishermen's decisions on effort level and distribution is determined independently of other participants in the fishery. We propose a model that explicitly takes the actions of other fishermen into account in that the marginal revenue function of one vessel depends on the actions of all other vessels in the fishery. We outline a generalized equilibrium model based on this assumption that can

accommodate multiple stocks, fleets, and areas. We discuss the conditions under which a Nash Equilibrium solution to the level and spatial distribution of fishing effort exists. We then introduce constraints on effort and catch and discuss the continued existence of a Nash Equilibrium solution to fishing effort. The solution algorithm that is used to solve for equilibrium effort levels is discussed. Finally, we apply the model to existing fisheries data to illustrate both the shortcomings of such an approach to determining fishing location choice, and the potential that the model has to be used as a tool for examining alternative spatial management strategies.

THE EVOLUTION OF MANAGEMENT: DO INDIVIDUAL RIGHTS EMERGE FROM COLLECTIVE RIGHTS SYSTEMS?

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A trend in fishery management allocates to self-identifying subgroups of harvesters in a fishery, or "sectors," their collective total share of the harvest of each species as a group right that they may manage in any way they wish. This means a single fishery with a single set of overall total allowable catches can be managed by multiple management systems concurrently. We ask whether common pool or individual quota type management systems are more likely to emerge as groups gain experience with their collective rights. In a novel quasi-continuous time experimental environment with a contemporaneous price externality, harvesters can choose to affiliate with a common pool managed group, or an individual quota managed group. We find that the common pool group engages in a fishing derby and receives lower prices, whereas the individual quota group achieves stable harvest levels throughout each season to minimize the price externality. Through successive fishing seasons, the frequency of subjects' choosing individual quota rises from about half to over 85% of subjects. This suggests that the efficiencies associated with strong individual fishing rights may emerge endogenously from the sectorization process, even without imposing them through regulation. We use three supplemental instruments to measure individual preferences to explain which subjects remain in common pool management, and find enjoyment of competition is significant, but risk attitudes and other-regarding preferences are not.

THE FISHERIES PERFORMANCE INDICATORS: RESULTS FROM GLOBAL CASE STUDIES

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The Fisheries Performance Indicators (FPIs) are a rapid assessment instrument for benchmarking and tracking wealth generation from fisheries resources. Applied once to a single fishery, the FPIs provide a snapshot of where fishery-based wealth is accumulating (e.g., with capital owners, with crew or with processors) and of levels of factors thought to affect wealth accumulation. We present results from a cross section of nearly 40 case studies, encompassing artisanal and industrialized fisheries from developing and developed countries around the world, conducted by more than 20 cooperating fisheries economists. The data capture a range of management methods and outcomes, demonstrating that that biological sustainability does not necessarily lead to good economic performance, as represented by wealth accumulation in harvest, post-harvest or fishing community sectors.

A SOURCE DIFFERENTIATED MIXED DEMAND MODEL FOR SHRIMP: AN ANALYSIS OF THE INFLUENCE OF U.S. IMPORTS BY SOURCE ON THE GULF OF MEXICO DOCKSIDE PRICE

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With a 2009 dockside value of $314 million, the shrimp fishery is the largest contributor to the $615 million (2009) Gulf of Mexico commercial fishing sector. The annual production of shrimp from the Gulf of Mexico has, in the long-run, remained relatively stable though year-to-year variations can be significant due to changes in environmental conditions that influence the reproduction, survival, and growth. While the long-run production of Gulf shrimp, in pounds, has remained stable over time, the same cannot be said about the value of landed product; especially when the influence of inflation is removed. The long-run dockside value of the Gulf shrimp harvest has, overall, been declining whether considered on a current or deflated basis. This decline has been particularly pronounced since 2001. On a current dollar basis, the value of Gulf production fell from an average of just over $400 million annually during 1990-94 to about $350 million annually during 2005-09. After adjusting for inflation, the decline was approximately 40%; from $617 million to $367 million (expressed in 2009 dollars). Relatively constant production in association with a declining value implies, of course, a falling price. While there are several reasons for the sharp decline in the Gulf dockside shrimp price beginning in 2001, the overriding one is that of increasing imports. Overall, imports (heads-on equivalent weight) advanced from an average of 850 million pounds annually during 1990-94 to 2.3 billion pounds annually in 2005-09 with much of the increase occurring post-2000. By comparison, Gulf production since 1990 has averaged less than 250 million pounds (heads-on weight) and imports currently account for in excess of 90% of the shrimp consumed in the United States. The source of these imports is from more than forty countries throughout the world with Asian countries accounting for a large proportion of the increase. Thailand dominated exports to the U.S. in 2009; accounting for almost one-half of the Asian exports and more than a third of total exports. Other countries of significance include Indonesia (17% of Asian exports and 13% of total exports to the United States), Ecuador (70% of South American exports and 11% of total exports to the United States), China and Vietnam (each accounting for approximately 10% of Asian exports to the U.S. and 8% of total exports to the United States), and Mexico. The primary objective of this paper is to examine the impact of imports, by country of origin, on the Gulf of Mexico dockside price with a secondary objective of determining whether the Deepwater Horizon Spill influenced consumer perceptions and, hence, the Gulf dockside price. To accomplish this objective, a system of mixed Rotterdam demand equations was estimated based on quarterly data from 1995(1) through 2011(4). Countries considered in the analysis include Thailand, Vietnam, China, India, Indonesia, Ecuador, and Mexico. Demand for Gulf shrimp was specified by size of shrimp with three sizes (large, medium, and small) being considered. U.

THE RETAIL DEMAND AND QUALITY FOR SEAFOOD PRODUCTS IN THE UNITED STATES: A BIVARIATE MODEL

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U.S. consumption of commercial fish and shellfish increased from 12.5 pounds (edible meat weight) per capita in 1980 to 16.6 pounds in 2004 and thereafter declined in successive years to 15.8 pounds in 2010. While seemingly moderate in nature, the increase from 1980 to 2004,

when adjusted for population change, represents an additional source requirement of 2.1 billion pounds annually. Though per capita consumption has fallen since 2004, the increase in population since 2004 has resulted in virtually no change in source requirements. As the socioeconomic characteristics of the "average" U.S. household changes, one can expect changes in seafood consumption. An analysis of household seafood demand can be used to forecast changes in product species and composition that will likely be forthcoming over time. From February 2005 through January 2006, a NOAA Fisheries Seafood Consumption Survey was conducted to gather information about seafood purchases and consumption behavior. The sampling design, which included both cross-sectional samples and longitudinal cohorts, consisted of 10,798 completed interviews, 5,311 of which were fresh cross-sectional interviews. The objective of the study is to estimate expenditure-based household demand functions for seafood consumed at home in aggregate and by primary species. Emphasis will be given to the influence of socioeconomic factors and opportunity costs on the demand for quality. As an outcome of this objective, and based on the hypothesis that demand for quality is proportional to the level of aggregation (i.e., as one moves from a commodity to a good), the study examines whether the demand for quality diminishes in relation to the level of disaggregation. Completion of this objective will build upon the analysis originally proposed by Dong et al. (1998). The bivariate model estimated by Dong et al. (1998) utilized the maximum likelihood method to successfully deal with a truncation problem as well as difficulties of unobserved unit price values. As such, the quality variation and consumer preference could be simultaneously investigated by this bivariate analysis. The quality effect will be analyzed via the quality elasticity which is the distinction between the income elasticity and expenditure elasticity (Cramer, 1973) when the seafood categories were characterized by heterogeneity. Such an analysis will provide relevant information to forecast changes in product species, composition, and demand for quality that are likely to be forthcoming as the U.S. demographics change over time. Cramer J. S., (1973) Interaction of Income and Price in Consumer Demand, International Economic Review, Vol.14, No.2 , pp.351-363 Dong, D., J .S. Shonkwiler And O. Capps, Jr. (1998) Estimation of Demand Functions Using Cross-Sectional Household Data: The Problem Revisited, American Journal of Agriculture Economics. 80(August 1998):466-473

ESTIMATED IMPACTS OF CATCH SHARE MANAGEMENT ON NEW ENGLAND MULTISPECIES GROUNDFISH HARVESTER REVENUES

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To comply with catch limit and stock rebuilding requirements specified in the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006, Amendment 16 to the Northeast Multispecies Fishery Management Plan encouraged groundfishermen to transition from Days-at-Sea (DAS) to sector, or catch share, management. In May of 2010 seventeen self-selecting harvesting sectors representing 432 active vessels and 98% of historical Multispecies landings were issued Allowable Catch Entitlements (ACE), a form of hard TAC, for fourteen stocks of nine groundfish species. This significant change in management coupled with a variety of non-Multispecies targeting options presented incentives for sector vessels to alter harvesting strategies and landings' timing. Prior to Amendment 16 tradable DAS management created a reservation level for expected profitability from a Multispecies trip; landing Multispecies as bycatch in small quantities when targeting low value species (e.g. spiny dogfish and skate) would squander the commodity's value. Amendment 16 provided flexibility in Multispecies landings and led to an increase in the race-to-fish for spiny dogfish while jointly landing Multispecies, skate, whiting, and monkfish. Using fixed effects models of inverse demand at the

ex-vessel level and two hypothetical, or counterfactual, individual landing environments for twenty-five commercially important species, gains of over $30,000,000 in fleet revenues are estimated as a result of Amendment 16.

ESTIMATING POTENTIAL EFFECTS OF SEAFOOD SAFETY AND MERCURY ON THE DEMAND FOR DOMESTIC AND IMPORTED WHITE AND LIGHT MEAT TUNA

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In March 2004, the U.S. Food and Drug Administration (FDA) released a warning about methylmercury accumulation in larger seafood species and the potential for harmful effects, particularly on the health of pregnant women and young children. The notice suggested limiting the consumption of canned white meat tuna, and also notes that this type of tuna contains greater amounts of mercury than light meat tuna. Yellowfin and skipjack tuna are typically sold as "light meat," while albacore tuna is the only species of fish in the U.S. that can be sold as "white meat." Though the majority of tuna consumed in the U.S. is imported, the FDA remains concerned about the safety of imported seafood. Given the FDA's warning and concerns about seafood safety, this study estimated potential effects on the demand for domestic and imported white and light meat tuna using a non-linear almost ideal demand system (AIDS) model. Quarterly domestic landings and imports data from 1996 to 2011 were obtained from the National Marine Fisheries Service.

Four share equations were estimated for the following categories of tuna: domestic white meat, imported white meat, domestic light meat, and imported light meat. Prices between estimated products tend to be correlated, and therefore, the Stone price index was used to account for collinearity. A time trend variable was incorporated into the time series model, and the seasonality of dockside demand was accounted for through the use of dummy variables by quarter. A dummy variable was also used to estimate any permanent shifts in demand for each category of tuna beginning in March 2004. The symmetry, homogeneity, and adding-up restrictions were imposed, and the AIDS model was analyzed in SAS 9.3 using PROC MODEL.

Seasonality in dockside demand was clearly a significant factor for each category of tuna examined. Perhaps more interesting, the parameter for the mercury dummy variable was negative and statistically significant (p=0.081) for imported white meat tuna. This result suggests that there was a statistically significant decrease in demand for imported white meat tuna beginning in March 2004, a change which is not accounted for by any other variable included in the model. Parameter estimates, as well as own- and cross-price elasticities, are presented and discussed.

WILLINGNESS TO PAY FOR STRIPED BASS, A SALINE FISH SPECIES GROWN IN THE US MIDWEST: EVIDENCE FROM AN ONLINE SURVEY

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The US Midwest region has no marine or saltwater resources therefore seafood products produced from saline sources need to be shipped over long distances from the coasts making them relatively expensive. There are plans by some Midwest fish farmers to begin farming striped bass, a marine species. To assist the development of an effective marketing strategy for striped bass products from the Midwest, the study examined the potential market using willingness to pay information from consumers in the Midwest. We found that males relative to females, and consumers who are 29 years of age and younger relative older consumers, are

more likely to pay higher amounts for Midwest striped bass. Other variables found to increase the probability of paying higher amounts for Midwest striped bass include preference for farmed seafood; preference for fresh seafood; seafood purchase frequency of 1 to 3 times per month for home consumption; seafood purchase frequency of once per week for home consumption; eating out 1 to 3 times per month; eating seafood 26 – 50% of the time when eating out; and eating mostly shrimp when eating out. Simulated results from selected variables show that frequent seafood consumers have a higher likelihood to pay more for Midwest striped bass with the magnitude of predicted probability increasing from lower to larger categories of WTP for striped bass. This includes consumers who buy seafood 1 to 3 times per month for home consumption, consumers who buy seafood once per month for home consumption, and consumers who eat seafood 26 - 50% of the time when they eat out. We then took the highest WTP category, i.e., WTP at least $6.00/lb for Midwest striped bass group and simulated for each level of consumers' willing to pay more for Midwest saltwater seafood, (2%, 4%, 6%, 8% and 10% more) against whether or not a consumer buys seafood 1 to 3 times per month for home consumption and whether or not a consumer eats seafood 26 – 50% of the time when eating out. The results show that predicted probabilities increase significantly as the level of willingness to pay more for Midwest saltwater seafood increases.

NOT ALL FISHERY COMANAGEMENT ARE EQUAL: ESTIMATING THE IMPACT OF SELF-IMPOSED RULES CHOICE ON THE PERFORMANCE OF COASTAL SMALL SCALE FISHERY COMANAGEMENT

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This paper investigates deeper into the performance of fishery comanagement, defined as collective resource management by a group of harvesters, with particular focus on the self-imposed rules that these groups employ. Fishery comanagement is garnering attention as potential alternative to command-and-control or individual quota system, and as such a number of studies have been conducted on the topic. However, most of these studies looked at the existence of comanagement scheme, often coded as dichotomous variable that enters the regression models. Others focused on a particular rule—such as the so-called sharing rule—and examined its effect on outcome measures. The reality, however, is that there are many other rules that these groups can employ and each group has its own combination of rules. As such, it is of much interest to know how these rules affect the outcome of fishery comanagement. The challenge is the sheer number of such rules and combinations of rules that exists, which makes the identification almost impossible if one is to treat each rule and attempts to measure its impact individually. In this paper, we collect the data from coastal small scale fishing groups, both who are and are not engaged in comanagement, in South Korea through phone surveys that includes detailed description on the self-imposed rules employed. We then processed this data with factor analysis method to reduce the data dimension, from 25 different rules to 11 factors that are characterized with rules' attributes. The results were then included in the regression models to estimate the effect of these rules (factors) on the total fishing revenue, both in terms of the actual level and the change in total revenue before and after the implementation of comanagement scheme. Preliminary results show that "weak" stock rebuilding effort measures and information sharing had positive effect on the outcome, while other factors are still inconclusive.

DO STAKEHOLDER ATTRIBUTES INFLUENCE SOCIAL NETWORK CAPITAL? EVIDENCE FROM AN ETHNICALLY DIVERSE PELAGIC FISHERY

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Marine fisheries are commonly characterized by a diverse set of stakeholders embedded in social networks, which can influence the flow of information among fishers. By sharing information and building relationships with various stakeholders, fishers can accrue social network capital – an asset that can provide economic and other advantages to those that are better, or strategically connected. Yet little is known concerning who decides to cooperate and share information with others, thereby achieving a greater level of social network capital. Specifically, previous research has not investigated the role of ethnic diversity and other stakeholder attributes on individual levels of social network capital in a marine resource system. In this paper, we first identify social network analysis (SNA) measures which may be appropriate indicators of social network capital. Utilizing a comprehensive social network dataset on Hawaii's longline fishery, we then employ SNA methods, general linear models and other statistical tools to construct these measures and determine the extent to which individual stakeholder attributes can explain the variation within them. We find that ethnicity most strongly correlates with the majority of social network capital measures compared to all other stakeholder attributes, while also being a highly significant predictor of their variation. Results also show that title, or occupation, and fishing experience are also important predictors. This research furthers our understanding of stakeholder diversity and information sharing in competitive marine fisheries, and has important implications for fishery policy and management. Our results are also critically important for empirical studies of social networks in fisheries as they clearly demonstrate that individual determinants of economic behavior, many of which are difficult to observe, are highly correlated with social network characteristics; thus, any attempt to link social network analysis with economic outcomes is likely to suffer from endogenous variables bias.