

**Minutes of the W3004 Annual Workshop
May 2015, Ketchikan, Alaska**

Participants:

Quentin S.W. Fong, University of Alaska Fairbanks
Matthew Freeman, Mississippi State University
Sherry Larkin, University of Florida
Gil Sylvia, Oregon State University
Hirotugu Uchida, University of Rhode Island
Diego Valderrama, University of Florida
Quinn Weninger, Iowa State University

Overview: The 2015 research workshop was held in conjunction with the biannual North American Association of Fisheries Economists (NAAFE) forum in Ketchikan, Alaska from May 20-22. Research results from the project were reported and discussed during sessions of the NAAFE meeting; the abstracts from these presentations are listed below. A list of peer-reviewed publications released over the last year is also provided in this report. In addition, a short W3004 business meeting was held on the first day of the NAAFE forum. General plans for the group's activities were discussed, including attendance at the upcoming CNREP/LSU meeting in 2016 in order to increase participation in the multistate project.

Research Paper Presentations by W3004 Participants at the 2015 NAAFE Forum:

SP008

Economic Feasibility of Producing Oysters Using a Small-Scale Hawaiian Fishpond Model

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Friday, May 22 (9:30-9:45)—Aquaculture

While studies have long examined the economic viability of oyster industries along the Pacific and Atlantic coasts of the mainland United States, Hawai'i has had no industry to speak of in modern times. This may soon change due to the recent establishment of a long-absent water

quality monitoring program required to classify shellfish growing areas. The first oyster farms have been established in traditional Hawaiian fishponds and in one case, clams are being produced in polyculture with shrimp. This potential for a new bivalve market, combined with the twenty-five-year absence of the industry and dearth of literature on the novel use of fishponds for the purpose of oyster farming, provide opportunity for an assessment of economic feasibility of raw oyster production in the state. The State Shellfish Sanitation Plan also differs from those in other states in ways that entail economic costs. For example, in most cases depuration utilizing artificial seawater will be required. In order to address the return to risk, capital, and management, a cost-benefit analysis was conducted with data collected from Hawai'i's only certified oyster farm. Results show that net return is near the breakeven point, and is highly dependent on the optimal levels of three key variables: oyster mortality rate, market price, and quantity of seed planted. The proposed three-fold expansion has costs reflected primarily in materials and supply expenses. Total costs did not increase three-fold, as a linear relationship would imply, thereby suggesting some economy of scale is present.

SP065

Maintaining the Viability of Seafood Processing and Harvesting Industries in Coastal Alaska: Role of Marine Extension

Quentin S.W. Fong

Alaska Sea Grant Marine Advisory Program, Kodiak Seafood and Marine Science Center, University of Alaska Fairbanks, Kodiak AK, USA

Wednesday, May 20 (3:45-4:00)—Fishing and Communities

Alaska is the largest seafood producing state in the US. In 2013, Alaska landed 1.88 billion USD worth of seafood, with a volume of 2.63 million MT. This consists of 34% of the total value and 60% of the total volume landed in the US. Of the top 20 fishing port landing by value, 11 are from Alaska. Alaska's seafood industry directly employs more workers than any other industry sector with more than 60,000. The success of the seafood industry is vital to our coastal communities. In response to employers and stakeholders concern of the graying or increasing age of the workforce, the Alaska Maritime Workforce Development Plan was developed by representatives of the fisheries, seafood, and marine industry sectors, state agencies and the university in Alaska. Aside from workforce development, stakeholders and policy makers also recognize the need for business and entrepreneurship development, including seafood to sustain the economic viability of our fisheries/seafood dependent coastal communities. This presentation illustrates how marine extension, specifically the Alaska Sea Grant Marine Advisory Program and the Kodiak Seafood and Marine Science Center assist Alaska's seafood harvesting and processing sectors to maintain their viability in the global seafood marketplace. Training programs such as the Alaska Seafood Processor Institute, Seafood Processor Quality Control to

address the graying of the workforce, research programs such as co-product development to increase the total value of the catch, and service programs such as one-on-one business and market development consultations will be presented and discussed.

Putting Local Seafood Into the Alaska School System: Seafood Processor's Perspectives

Quentin S. W. Fong

Alaska Sea Grant Marine Advisory Program, University of Alaska Fairbanks, Kodiak AK

Hunger and food insecurity in Alaska are significant and growing problems that are exacerbated by the state's geographic isolation and extreme climate¹⁻². Alaska Native and other rural residents are most severely impacted. In 2008, 19% of Alaska Natives and 22% of rural residents were food insecure. Per capita income is less than half of the national average in rural communities and residents suffer from high energy costs, high unemployment rates and limited local economies. These factors severely limit rural residents' access to healthy and affordable foods. On the other hand, Alaska is the largest seafood producing state in the US. Yet, 76% for various reasons, almost all of Alaska's seafood are exported and does not stay and consumed in the state. In 2012, the University of Alaska Fairbanks received USDA funding to examine and possibly develop a program that connects school cafeterias with locally owned fish businesses. One piece of information needed to achieve the Fish to School program objectives is the capacity and willingness of Alaska based seafood processors to supply local seafood to the school system. The results of a survey with Alaskan seafood processors on their motivation to supply fish to local schools, availability of product forms and species of individual seafood processing plants, willingness to hold inventory and arrange logistics, pricing structure, and advice to Alaskan school food service purchasers on how to best source local seafood will be presented and discussed.

SP048

A Mixed Methods Approach to Analyzing Vietnamese American Fishing Communities on the Gulf of Mexico

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Wednesday, May 20 (2:45-3:00)—Fishing and Communities

As fisheries management becomes more collaborative by seeking input and involvement from stakeholders, it is important to understand and address the diversity of those stakeholders. Gulf Coast fisheries communities include diverse racial and ethnic groups, particularly a large number of Vietnamese Americans involved in all aspects of the seafood industry. Recent disasters, including hurricanes and the BP Macondo oil spill, have exposed a number of communication barriers between state and federal agencies and the Vietnamese American fishing community on the Gulf Coast as well as a lack of reliable socioeconomic data on Vietnamese American fishers and their management and governance priorities. This research focuses on a mixed methods approach to create a database of key baseline socioeconomic data on the Vietnamese American communities affected by fishery management in Mississippi and Alabama and as well as to identify avenues and barriers for communication between Vietnamese American fishers and state and federal fisheries-related agencies in the region. In doing so, we discuss using a combination of 1) face-to-face surveys with Vietnamese Americans in the fishing industry, 2) interviews with representatives of relevant state and federal agencies, 3) interviews with community organizations and key informants, and 4) focus groups with Vietnamese Americans in different aspects of the fishing industry. Collection of this type of data will be used in identifying potential strategies to improve engagement of Vietnamese American stakeholders in the region and be crucial to understand the current and future consequences of management choices for diverse stakeholders.

SP086

Evaluating the impact of the Deepwater Horizon Oil Spill on Red Snapper IFQ Trading Andrew Ropicki¹, Sherry Larkin²

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Wednesday, May 20 (2:45-3:00)—Rights-Based Management

During the first three years (2007-2009) of the Gulf of Mexico red snapper IFQ program most quota lease trades were local, involving fishers that lived in the same communities. In 2010, the red snapper quota lease market changed as more IFQ participants began trading quota with fishers from different regions of the Gulf. One possible cause of the change in trading was the Deepwater Horizon Oil Spill in April 2010, which led to widespread fishing closures in the

northern Gulf of Mexico that lasted for much of the remainder of the year. Fishing closures led to some affected fishers looking to lease out their 2010 quota before it became worthless (non-harvested quota does not carry forward to future years); however, unlike in previous years where they would trade the quota locally they were forced to lease their quota to different areas of the Gulf since their neighbors were subject to the same fishery closures. This research compares IFQ trading data in the years prior to the spill (2007-2009) to 2010 trading data to determine how the oil spill impacted quota trading. Specifically, this analysis compares 2010 quota trading before and after the spill to the same periods in previous years to see if the spill changed the nature of quota trading. In addition, the analysis examines if new trading relationships created in the wake of the oil spill continued into future years.

SP087

Can Fisher Social Networks be used to Explain IFQ Trading?

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Thursday, May 21 (9:45-10:00)—Rights-Based Management

Many of the tangible benefits of catch share programs (e.g., reducing overcapacity) are dependent on the trading of shares. Additional trading-related questions (such as whether landings will change port or be concentrated geographically) are also important to the overall evaluation of a fishery, but are often asked only during post-implementation program reviews. Using both quota trading data and survey data on information sharing among Gulf of Mexico IFQ fishers, this research analyzes the overlap between fisher information sharing networks and quota trading networks to measure the extent to which quota trading is accomplished through social networks. Comparing these two networks will provide information on the role of acquaintanceships in quota trading markets and the value of using fisher survey data on information sharing to a gain a better understanding of trading behavior. The insights of this analysis could provide policy makers with a means of estimating how quota will flow through a fishery prior to implementation of a catch share program by surveying potential participants (commercial, for-hire, and/or recreational) about their information sharing networks. These insights would allow policy makers to predict possible issues related to catch share management in a fishery prior to implementation and design the management program in response to these potential issues.

SP124

An Analysis of the Impacts of the Deepwater Horizon on the Seafood Industry

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Thursday, May 21 (4:30-4:45)—Ecosystem Services

This research was carried out for the Bureau of Ocean and Energy Management to assist them in understanding the economic impacts the Deepwater Horizon Oil spill had on the Gulf of Mexico seafood industry. In addition to an extensive research effort compiling all research pertinent to the Gulf seafood industry structure from vessel to market we have reviewed and compiled available economic impact publications pertinent to the commercial fishing industry. In context to this information and various other economic data and model sources we have developed an input/output impact model that calculates these impacts as they occur down the seafood supply chain. Impacts have been broken down by each Gulf State and key species category, with estimates of direct, induced and indirect impacts on Sales, Value Added, Employment and Income. The primary contribution of this research was laying out the supply chain relationships and market structure to allow for a better understanding how economic impacts occurred during the post spill period.

SP110

Assessing the Value and Role of Seafood Traceability from an Entire Value-Chain Perspective

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Thursday, May 21 (3:30-3:45)—Markets and Trade

The traceability practices of 48 seafood businesses were assessed as part of an evaluation of nine global seafood value chains (from harvest to retail). The research was conducted through direct interviews and written surveys in order to assess the reasons why traceability systems were used

to strengthen business performance. The study was designed to determine which industry, product, or chain characteristics enhanced a seafood business' ability to generate benefits from traceability practices. This included understanding the impacts that traceability information has on commercial performance and the relationships that exist between individual businesses. Using a value chain classification scheme, none of the nine chains were found to be “fragmented”, two were classified as “cooperative”, five were “coordinated”, and two were “collaborative”. Based on twenty seven benefit categories, collaborative chains generated significantly greater traceability related benefits than other chains. Most benefits were more important to upstream as compared to downstream members of a seafood chain. Benefits included enhanced product quality, reduced costs, and improved risk management. Successful firms exhibited greater willingness to share information and considered traceability research to be of value to their future success. Evidence also suggests that traceability information system costs may be scale dependent and relatively higher for smaller firms. Based on these findings, the research concludes with policy and research recommendations for businesses, governments, and NGOs.

SP003

The Effect of Oyster Farm on the Neighboring Housing Value in Rhode Island

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Friday, May 22 (9:00-9:15)—Aquaculture 19

From 2000 onwards, the United States saw an increasing trend for the shellfish aquaculture practices especially along the Northeast coast. Despite the supporting majority of public regarding the shellfish aquaculture operations, these operations are sometimes opposed by local communities claiming the devaluation of housing property due to the construction of oyster farm. Since the uproars against the devaluing of housing property is directly affecting the lives of public, it is critically important to study the effect of construction of oyster farm on its value. A difference-in-difference (DoD) model within hedonic price model (HPM) was used to evaluate the effect of oyster farm on property value. We collected the details of the oyster farms operated in Rhode Island from the Coastal Resource Management Council (CRMC). Our housing sales data lists all the housing transactions in Rhode Island between 2000 and 2013. We used a linear mixed model with lot size as unit level fixed effect and city as random effect. The result showed that the DoD coefficient associated with interaction of distance bands and the construction of oyster farm, was statistically insignificant. The statistical insignificance of the coefficients suggests that there is not much change in housing value due to the construction of oyster farm.

The analysis shows that houses further away from coastline will reduce the value of the property. One of the caveats of this study is lesser housing transactions since the construction of oyster farm happened in recent years.

SP079

How can Community-Based Management Improve an Outcome? The Effects of Revenue Sharing and Social Capital in a Fishery

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Wednesday, May 20 (4:15-4:30)—Fishing and Communities

We empirically disentangle the efficiency mechanism of revenue sharing, in which a group of harvesters shares catch and/or revenue among members of a fishery cooperative, by incorporating the influence of social capital. In addition to each of revenue sharing and social capital influencing a fishery independently we hypothesize social capital potentially affecting the efficiency that revenue sharing brings through strengthening collective fishing efforts performed as a group. This paper provides the first rigorous analysis to measure the effect of revenue sharing and social capital in a co-managed fishery and to identify the mechanism through which revenue sharing and social capital affect the outcome of a fishery. We quantified social capital using controlled economic experiments with fisherman subjects. Using a panel dataset containing 10 fishery groups and random-effects model with wild cluster bootstrap for small sample inference, we find evidence of the long-run positive effect of trust in a community on an economic outcome. The results also show that the fisheries with fishers having similar information network size achieve better stock conditions over time. However, we find no robust evidence of the effect of revenue sharing directly improving an outcome in a fishery or the effect of both revenue sharing and social capital interacting to affect the fishery or its management outcomes.

SP103

Nonlinear Inverse Almost Ideal Demand System for Shellfish in Rhode Island: A Market Study

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Thursday, May 21 (2:15-2:30)—Markets and Trade

The opening and closing of the shellfish harvest area inevitably influences the market, particularly the exvessel prices that harvesters receive. Without a better understanding of shellfish market and its behaviors, it is impractical to determine the impact of management policies on the market as well as the fishery resources. Using Rhode Island data, this study aims to understand and quantify the market interactions of wild harvested shellfish products in Rhode Island. Specifically, we estimated how sensitive are the exvessel prices of shellfish products (three market categories for quahog, scallop, and whelk) with respect to the quantity landed, both of its own and other products. The data were obtained from Statistical Atlantic Fisheries Information System (SAFIS) and analyzed using Nonlinear Inverse Almost Ideal Demand System (NL-IAIDS) to estimate the price sensitivity of shellfish. We found that exvessel prices were inflexible to the variation in quantity landed, however the magnitude of sensitivity varied across products: most sensitive was necks and least sensitive was cherrystone. The study also found that shellfish products included in this study were all substitutes to each other which have a policy implication. The substitutive relationship between the shellfish species would help fishermen to maintain their profit by switching to catch other species/products if catch of one of the species/products is predominant. However, the magnitude of the relation varies with products. Our result showed that the relationship was stronger between necks and cherrystone quahog and least affected between cherrystone and scallops.

SP108

Do Fishermen Benefit from MSC Certification? Analysis of Ex-vessel Prices in Multiple Fisheries

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Thursday, May 21 (4:15-4:30)—Markets and Trade

Fisheries certification programs utilize an ecolabel to create market-based incentives for better management and ecological improvements in ocean fisheries. The Marine Stewardship Council (MSC) ecolabel has the longest and broadest presence in the market relative to other fisheries ecolabels, and represents 10% of seafood the global market, having certified 224 fisheries. A

number of studies have investigated whether consumers are willing to pay a premium for ecolabeled seafood, such as the MSC ecolabel, relative to non-ecolabeled seafood and found evidence that consumers indicate a preference for ecolabeled seafood. However, relatively little literature exists on the economic benefits of ecolabeling programs on fishermen, such as to dockside prices. The focus of this paper is to examine the effect of MSC certification on exvessel prices of three different certified fisheries (e.g., the treatment) relative to exvessel prices from fisheries that are similar yet not certified (e.g., the control). Fisheries included as certified fisheries are Alaskan salmon, Alaskan halibut, and the Kyoto Danish Seine Fishery Federation (KDSFF) flat-head flounder in Japan. The contribution of this paper is thus in providing an analysis of the effect of MSC certification on relative prices between certified and non-certified fisheries for several fisheries. Our models produced results that indicate that different fisheries (and different species for salmon) have experienced different economic effects from certification.

MSC, FIPs, and Everything in Between: Assessment of the Evolving Markets for Certification and Sustainable Seafood

Hirotsugu Uchida

University of Rhode Island

Certification labels for commercially caught fish and crustaceans are a growing trend whose premise is the creation of incentives that will encourage fishing firms to employ more sustainable practices. For the most part, this trend was fueled by the growth of the Marine Stewardship Council (MSC). Moving forward, however, there are several certification programs with varying levels of participation by the retail and producing sector that could give rise to competition to MSC and between these new labels. Another issue that established certification programs face is how to ‘reward’ those fisheries making progress towards certification, but not yet not at conditions necessary to achieve the status. Fisheries Improvement Projects (FIPs) have partially filled that niche.

A critical question, however, is whether the expansion of FIPs may ultimately undermine the environmental benefits generated through certification. With fisheries certification, buyers in the market (from processors, distributors up to the retail sector) reward certified fisheries via increased market access, possible price premiums or other market benefits for the certified fishery. In contrast, FIPs create a scenario where fisheries are rewarded with market access, possibly before significant improvements in the sustainability of the fisheries have occurred. While this may provide an economic incentive for further environmental improvements, studies have shown that a preponderance of FIPs are ‘stuck’ at an early stage of the FIP process. Direct competition in the marketplace between MSC certified and FIPs products may lead to FIP

fisheries explicitly not pursuing MSC certification, given the market opportunities being already presented by engaging in FIPs.

Another important question to be addressed is whether the growing number of certification programs for fisheries, in addition to the MSC, is undermining significant environmental improvements. These include the Responsible Fisheries Management program used by Alaska and others, country-specific certifications, such as those by Japan, Iceland and Norway (and proposed by NMFS for the US), and private certifications such as by the Friends of the Sea. Numerous benchmark studies have shown, for the most part, that MSC is the gold standard in terms of the environmental benefits. However, it is not clear to what extent these programs also undercut the value of MSC certification.

This special session is proposed by a group of researchers (Uchida, Roheim, Frank Asche, and James Sanchirico) working on above issues. Specifically, the group is working on the project to provide insights into the following:

- (1) The consumer, producer, and retail outlets roles in the provision of sustainable seafood;
- (2) The extent seafood products from FIP-engaged fisheries are substitutable with more formal certified sustainable seafood; and
- (3) The perceptions of agents throughout the value chain on the substitutability of seafood across the various certification programs.

Prior to the NAAFE meeting, the group will gather and compile information on these topics through extensive review of academic literature and interviews with industry and FIPs. We anticipate that the literature review will present a series of hypotheses as to what drives demand for sustainable seafood, and what might affect the relative positioning of FIPs versus certification – as well as how the various certifications substitute for one another. Then, in order to place these hypotheses in the context of current behavior and practice within the seafood sector, we will conduct a series of discussions with individuals in the seafood supply chain. Targeted industry experts include, but will not be limited to, Bill DiMento at Highliner Seafoods, Logan Kock at Santa Monica Seafoods.

The proposed special session will first involve the research group's presentation of the preliminary findings. The presentation will be followed by a keynote speech by Jim Anderson, who formally led the fishery program in the World Bank and seafood markets expert, on the role of MSC and FIPs in the context of fisheries in developed and developing countries. After the keynote speech, panelists listed above will be invited onto the stage. Panel discussion on the topic will be moderated by Uchida (lead), Roheim, and Asche.

Thus, the proposed special session will serve two purposes: 1) to raise the profile of the issues identified to members of our disciplinary field, hopefully spurring other researchers to begin

their own investigations of these complex issues; and 2) to obtain feedback from other fisheries economists in academia, regulatory agencies, and environmental NGOs, as well as non-economists from a diverse set of backgrounds.

SP064

Testing the Cost Effectiveness of Manual Removal Strategies for the Containment of Invasive Lionfish Stocks in a Caribbean Reef

Kathryn Ann H. Fields, Diego Valderrama

Food and Resource Economics Department, University of Florida, Gainesville FL, USA

Friday, May 22 (10:45-11:00)—Lagniappe

Two species of the Indo-Pacific lionfish (*Pterois miles* and *P. volitans*) have rapidly expanded throughout the Gulf of Mexico, mid- and south Atlantic and the Caribbean following their introduction to Florida coastal waters during the mid-1980s through releases from marine aquaria. There is overwhelming scientific agreement on the threats that this invasion poses to a wide range of native species, including grunts, snappers, and groupers. Because eradication of lionfish is unfeasible, scientists and conservationists are urging the implementation of lionfish management plans in order to reduce the environmental and economic impacts of the invasion to a manageable scale. Recent studies indicate that persistent removal of lionfish by spearheading does help control lionfish populations and help native fishing rebound. Through mathematical modeling and field tests, researchers have found that reducing lionfish stocks by about 75 to 90 percent leads to the rapid recovery of native fish numbers (Green et al. 2014). Data on prey fish and lionfish densities as well as spearheading catch rates were collected from lionfish derbies held at the Bacalar Chico Marine Reserve, Belize, in 2014. These data were used to estimate reef-specific target lionfish densities leading to the recovery of native prey species in the marine reserve as predicted by the Green et al. (2014) model. The fishing costs involved in reaching the target densities were also estimated to evaluate the overall effectiveness of manual removal techniques as a management strategy for invasive lionfish stocks.

SP051

A Global Game of Capital Divestment in a Quota-Managed Fishery

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² Department of Economics, Iowa State University, Ames IA, USA

Thursday, May 21 (10:30-10:45)—Rights-Based Management

We develop a model where individual fishermen must decide whether to remain active in an ITQ-managed fishery or exit and allocate their capital endowment to an alternative use. Fishermen have private information about their own productivity, which determines the profit potential of their vessel/fishing operation. They however do not observe the productivity of other fishermen. In a game of imperfect information, fishermen choose to remain active or exit based on their own productivity and their beliefs about the distribution of productivity in the fishing population. We prove the existence and uniqueness of this global game equilibrium for a range of parameters. In a unique equilibrium, fishermen follow a threshold strategy: remain active if own productivity exceeds a given threshold; otherwise exit. If the cost of capital remains below an upper bound, a unique threshold equilibrium as described above always exists. Furthermore, the lower the cost of capital, the higher is this threshold productivity. We find that equilibria under imperfect information substantially deviate from that under perfect information because under the former fishermen cannot accurately forecast quota market outcomes. Under imperfect information, they learn about the average productivity only over time, and the fleet's transition to its efficient level only occurs gradually, as observed in practice. Using data from the pacific ground fish trawl fishery which switched to ITQ management in 2012, we calibrate our model by using stochastic frontier econometric methods. We then simulate our model to evaluate of the efficiency and distributional impacts of alternative quota allocations.

SP058

Search and Learning on the Sea

Quinn Weninger

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Thursday, May 21 (1:30-1:45)—Modeling

This paper develops a model of (infinite horizon) sequential location choice facing the captain of a commercial vessel fishing operation. The captain chooses, simply, the next location for the vessel operation. Feasible locations include at sea sites and land-based port locations. Following Marcoul and (2008) the model assumes that the vessel captain faces uncertainty about the true, unobservable spatial distribution of the fish stock. The captain holds prior beliefs about stock conditions and learns as fishing proceeds and catch signals reveal real-time, but noisy, information about stock conditions and payoff possibilities. Upon receiving a catch signal, the captain rationally updates beliefs about stock conditions following Bayes rule, before choosing the next preferred location. The solution to the dynamic stochastic search and learning problem is obtained using numerical collocation methods supplemented by techniques to reduce computational demands in high-dimension state space optimization problems (Smolyak, 1963).

The optimal spatial-search policy, derived numerically, shows how location choices are impacted by key state variables, including the quantity of fuel and supplies on board, the quantity of fish that is onboard, and importantly the current beliefs of the captain regarding the spatial distribution of the fish stock. Optimal movements between at-sea fishing locations are derived as is the decision of when and under what conditions to return to port. Simulated search patterns derived under the optimal dynamic spatial fishing policy differ significantly from patterns predicted by the static random utility model. First and foremost, the model shows how spatial movements are determined by the captains' objective beliefs about stock conditions at available fishing sites. Beliefs, which are key state variable in the decision problem, evolve depending on particular harvest realizations at the sites that have been fished during a trip. A decision to abandon a site currently being fished in favor of another site is driven by the difference in expected catch, as perceived by the skipper, at competing sites, as well as on other model state variables, e.g., the supplies on board and the quantity of fish currently in the vessel hold. Switching incurs an irreversible steaming cost. The decision to move the vessel operation is akin to an optimal stopping problem under uncertainty. Only if the expected catch difference exceeds a particular threshold (which varies with other state variables), will the spatial move be made. The model also characterizes the decision to stop fishing and return to port. As with the site switching decision, factors such as the remaining fuel on board, the quantity of fish on board and the captain's belief about current stock conditions all play a role. The results provide several new insights and important policy guidance for empirical evaluation of spatial fishing behavior.

Peer-Reviewed Publications by W3004 Participants, 2014-2015:

- Aboagye, D.L. and **P.J. Allen**. 2014. Metabolic and locomotor responses of juvenile paddlefish *Polyodon spathula* to hypoxia and temperature. *Comparative Biochemistry and Physiology. Part A, Molecular & Integrative Physiology* 169:51-59.
- Alvarez, S., **S. Larkin**, J.C. Whitehead and T. Haab. 2014. A revealed preference approach to valuing non-market recreational fishing losses from the Deepwater Horizon oil spill. *Journal of Environmental Management* 145:199-209.
- Anderson, J.L., C.M. Anderson, J. Chu, J. Meredith, F. Asche, **G. Sylvia**, M.D. Smith, D. Anggraeni, R. Arthur, A. Guttormsen, J.K. McCluney, T. Ward, W. Akpalu, H. Eggert, J. Flores, **M.A. Freeman**, D.S. Holland, G. Knapp, M. Kobayashi, **S. Larkin**, K. MacLauchlin, K. Schnier, M. Soboil, S. Tveteras, **H. Uchida**, and **D. Valderrama**. The Fishery Performance Indicators: A management tool for triple bottom line outcomes. 2015. *PLoS ONE* 10(5): e0122809. doi:10.1371/journal.pone.0122809.
- Arita, S. and **P.S. Leung**. 2014. A technical efficiency analysis of Hawaii's aquaculture industry. *Journal of the World Aquaculture Society* 45:312-321.

- Asche, F., R.E. Dahl, **D. Valderrama** and D. Zhang. 2014. Price transmission in new supply chains – the case of salmon in France. *Aquaculture Economics and Management* 18:205-219.
- Brown, T.W., **T.R. Hanson**, J.A. Chappell, C.E. Boyd and D.S. Wilson, Jr. 2014. Economic feasibility of an in-pond raceway system for commercial catfish production in West Alabama. *North American Journal of Aquaculture* 76:79-89.
- Carbonetti, B, **R. Pomeroy** and D.L. Richards. 2014. Overcoming the lack of political will in small scale fisheries. *Marine Policy* 44:295-301.
- Danaher, J.J., J.M. Pickens, J.L. Sibley, J.A. Chappell, **T.R. Hanson** and C.E. Boyd. 2014. Growth of tomato seedlings in commercial substrate amended with dewatered aquaculture effluent. *International Journal of Vegetable Science* 20:340-353.
- Evans, K. and **Q. Weninger**. 2014. Information sharing and cooperative search in fisheries. *Environmental and Resource Economics* 58:353-372.
- Fehring, T.R., **R.W. Hardy** and K.D. Cain. 2014. Dietary inclusion of salmon testes meal from Alaskan seafood processing byproducts: Effects on growth and immune function of rainbow trout, *Oncorhynchus mykiss* (Walbaum). *Aquaculture* 433:34-39.
- Fonner, R. and **G. Sylvia**. 2015. Willingness to pay for multiple seafood labels in a niche market. *Marine Resource Economics* 30: 51-70.
- Fox, H.E., J.L. Holtzman, K.M. Haisfield, C.G. McNally, G.A. Cid, M.B. Mascia, J.E. Parks and **R.S. Pomeroy**. 2014. How are our MPAs doing? Challenges in assessing global patterns in marine protected area performance. *Coastal Management* 42:207-226.
- Grimm-Greenblatt, J., **R. Pomeroy**, B. Bravo-Ureta, L.X. Sinh, H. Van Hien, and T. Getchis. 2015. Economic analysis of alternative snakehead *Channa striata* feed. *Aquaculture Economics and Management* 19:192–209.
- Heenan, A., **R. Pomeroy**, J. Bell, P.L. Munday, W. Cheung, C. Logan, R. Brainard, A.Y. Amri, P. Aliño, N. Armada, L. David, R. Rivera-Guieb, S. Green, J. Jompa, T. Leonardo, S. Mamauag, B. Parker, J. Shackeroff and Z. Yasin. 2015. A climate-informed, ecosystem approach to fisheries management. *Marine Policy* 57: 182-192.
- Lee, K.J., S. Rahimnejad, M.S. Powell, F.T. Barrows, S. Smiley, P.J. Bechtel and **R.W. Hardy**. 2015. Salmon testes meal as a functional feed additive in fish meal and plant protein-based diets for rainbow trout (*Oncorhynchus mykiss* Walbaum) and Nile tilapia (*Oreochromis niloticus* L.) fry. *Aquaculture Research* 46:1590-1596.
- Omar-Ali, A., C. Hohn, **P.J. Allen**, J. Rodríguez and L. Petrie-Hanson. 2015. Tissue PAH, blood cell and tissue changes following exposure to water accommodated fractions of crude oil in alligator gar, *Atractosteus spatula*. *Marine Environmental Research* 108:33-44.
- Paine, N., **F.R. Homans**, M. Pollak, J.M. Bielicki and E.J. Wilson. 2014. Why market rules matter: Optimizing pumped hydroelectric storage when compensation rules differ. *Energy Economics* 46:10-19.

- Pomeroy, R.**, K. Baldwin and P. McConney. 2014. Marine spatial planning in Asia and the Caribbean: Application and implications for fisheries and marine resource management. *Desenvolvimento e Meio Ambiente* 32:151-164.
- Pomeroy, R.**, M.M. Dey, and N. Plesha. 2014. The social and economic impacts of semi-intensive aquaculture on biodiversity. *Aquaculture Economics and Management* 18:303-324.
- Pomeroy, R.**, K. Hiew, K. Ramdass, J.M. Saad, P. Lokani; M. Grizelda, E. Lorenzo, G. Manero, Z. Maguad, M. Pido and G. Goby. 2015. Moving towards an ecosystem approach to fisheries management in the Coral Triangle region. *Marine Policy* 51:211-219.
- Pomeroy, R.**, J. Parks, K. Reaugh-Flower, M. Guidote, H. Govan and S. Atkinson. 2015. Status and priority capacity needs for local compliance and community-supported enforcement of marine resource rules and regulations in the Coral Triangle region. *Coastal Management* 43:1-28.
- Purcell, S. and **R. Pomeroy**. 2015. Driving small-scale fisheries in developing countries. *Frontiers in Marine Science* 2:44. doi: 10.3389/fmars.2015.00044
- Ropicki, A.J. and **S.L. Larkin**. 2014. Social network analysis of price dispersion in fishing quota lease markets. *Marine Resource Economics* 29:157-176.
- Sale, P.F., T. Agardy, C.H. Ainsworth, B.E. Feist, J.D. Bell, P. Christie, O. Hoegh-Guldberg, P.J. Mumby, D.A. Feary, M.I. Saunders, T.M. Daw, S.J. Foale, P.S. Levin, K.C. Lindeman, K. Lorenzen, **R.S. Pomeroy**, E.H. Allison, R.H. Bradbury, J. Corrin, A.J. Edwards, D.O. Obura, Y.J. Sadovy de Mitcheson, M.A. Samoilys and C.R.C. Sheppard. 2014. Transforming management of tropical coastal seas to cope with challenges of the 21st Century. *Marine Pollution Bulletin* 85:8-23.
- Schwarz, D.E. and **P.J. Allen**. 2014. Effects of salinity on growth and ion regulation of juvenile alligator gar *Atractosteus spatula*. *Comparative Biochemistry and Physiology. Part A, Molecular & Integrative Physiology* 169:44-50.
- Singh, R. and **Q. Weninger**. 2015. Harvest efficiency and fishery discards under harvest uncertainty and trading restrictions. *Journal of Environmental Economics and Management* 70:72-91.
- Singh, R. and **Q. Weninger**. 2015. Cap-and-trade bycatch management with costly avoidance and stock uncertainty. *Marine Resource Economics* 30:97-119.
- Sinh, L.X., H. Navy and **R. Pomeroy**. 2014. Value chain of snakehead fish in the Lower Mekong Basin of Cambodia and Vietnam. *Aquaculture Economics and Management* 18:76-96.
- Sterling, B., M. Gooch, B. Dent, N. Maernick, A. Miller and **G. Sylvia**. 2015. Assessing the value and role of seafood traceability from an entire value-chain perspective. *Comprehensive Reviews in Food Science and Food Safety* 14:2015-2068.
- Stewart, H.A. and **P.J. Allen**. 2014. Critical thermal maxima of two geographic strains of channel and hybrid catfish. *North American Journal of Aquaculture* 76:104-111.
- Tokunaga, K, C. Tamaru, H. Ako and **P.S. Leung**. 2015. Economics of small-scale commercial aquaponics in Hawai'i. *Journal of the World Aquaculture Society* 46:20-32.

- Uchida, H.**, Y. Onozaka, T. Morita and S. Managi. 2014. Demand for ecolabeled seafood in the Japanese market: A conjoint analysis of the impact of information and interaction with other labels. *Food Policy* 44:68-76.
- Uchida, H.**, C.A. Roheim, H. Wakamatsu and C.M. Anderson. 2014. Do Japanese consumers care about sustainable fisheries? Evidence from an auction of ecolabelled seafood. *Australian Journal of Agricultural and Resource Economics* 58:263-280.
- Valderrama, D.**, J. Cai, N. Hishamunda, N. Reidler, I.C. Neish, A.Q. Hurtado, F.E. Msuya, M. Krishnan, R. Narayanakumar, M. Kronen, D. Robledo, E. Gasca-Leyva and J. Fraga. 2015. The economics of *Kappaphycus* seaweed cultivation in developing countries: a comparative analysis of farming systems. *Aquaculture Economics and Management* 19:251-277.
- Valderrama, D.**, S. Iyemperumal and M. Krishnan. 2014. Building consensus for sustainable development in aquaculture: a Delphi study of Better Management Practices for shrimp farming in India. *Aquaculture Economics and Management* 18:369-394.
- Xu, P., **Q. Fong**, A. Bersamin and B. Izumi. 2015. Fisheries-to-school in Alaska: A food service directors' perspective. *International Journal of Economics and Finance* 7:142-149.