Research and Data Collection Project Summaries and Updates, 2008
Crab SAFE Report

Markets and Trade

Alaska Fisheries and Global Trade

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International trade is an important component of several Alaska fisheries (Quarterly Report, Oct.-Dec. 2006). This project is aimed at integrating international trade data that are associated with Alaska fisheries into a global economic growth model that represents international trade (see Quarterly Report, Jan.-March 2007). In particular, this project involves the continued development of a global Population-Environment-Technology (PET) Model for scenario-based (e.g. IPCC) analyses of trade, ocean acidification, and climate change. An application of these scenarios is described in the AFSC Ocean Acidification Research Plan.

PET Model and Data
Work on the PET model is ongoing and currently involves an international and multidisciplinary team of economists, demographers, biophysical scientists, and a mathematician, from the U.S., China, India, Japan, Russia, and Slovakia. Collaborating institutions are NOAA, U.S. National Center for Atmospheric Research (NCAR), International Institute for Applied Systems Analysis (IIASA), University of Illinois at Urbana-Champaign, Brown University, and Moscow State University.

The PET model has a dynamic computable general equilibrium structure. Its focus is on the effects of demographic change (e.g. population aging, urbanization, changes in household size) and economic growth on demand for food, energy, and emissions. Two versions of the PET model, pertaining to the effects of demographic trends on future demand in the U.S. and China under the Intergovernmental Panel on Climate Change (IPCC) scenarios, were cited in a feature article "The Population Problem" that appeared in the June 2008 issue of *Nature Reports Climate Change* (http://www.nature.com/climate/2008/0806/full/climate.2008.44.html).

In addition, the PET model is being coupled with the Integrated Science Assessment Model (ISAM), a global biogeochemical cycles model of moderate complexity, under a grant from the U.S. Department of Energy to the Department of Atmospheric Sciences at the University of Illinois. The coupled PET-ISAM will be used to analyze effects of emissions scenarios on climate change and ocean acidification.

Trade and production data for the PET model are from the Global Trade Analysis Project (GTAP). Preparation of these data is a major task that is being performed by researchers at NCAR and IIASA. Eventually the PET model will represent 24 different countries and regions:

1. USA
2. EU27+
3. Transition Countries (TCs)
    a. Russia
    b. Other Transition Countries (OTCs)
4. Other Industrialized Countries (OICs)
    a. Japan
    b. Rest of Other Industrialized Countries (ROICs)
        i. S. Korea

            ii. Canada
            iii. Australia & New Zealand (ANZ)
            iv. Other Pacific Industrialized Countries (OPICs) [Singapore, Taiwan]
            v. Israel & S. Africa (ISA)
5. China (incl. Hong Kong)
6. India
7. Latin America and Caribbean (LAC)
    a. Mexico
    b. Brazil
    c. Other LAC (OLAC)
        i. Pacific South America (PSA) [Chile, Ecuador, Peru]
        ii. Rest of Other LAC (ROLAC)
8. Sub-Saharan Africa (SSA)
9. Other Asia
    a. Turkey
    b. Middle East and North Africa (MENA)
    c. Southeast Asia
        i. Indonesia
        ii. Vietnam
        iii. Malaysia & Philippines (MP)
        iv. Other Southeast Asia (OSEA)

IPCC emissions scenarios provide assumptions about future rates of technical change and other variables. Future work will embed a regional economic model of Alaska, which includes a detailed fisheries sector, in the PET model framework.

Estimating Global Trade from Pacific Fisheries for Regional Economic Models
Products from Alaska fisheries are consumed around the world. Global demand for these products is an important source of income to Alaska fishermen, processors, and traders. The U.S. regional economic accounts (i.e. IMPLAN) distinguish between domestic versus foreign trade, but do not identify bilateral trade flows between partners. However, information about the volume and value of trade between partners is important for understanding the current, and historic, economic status of a fishery, and thus, for making reasonable projections about future economic conditions. A case in point is the recent surge in U.S. imports of Russian king crab. A weakness of GTAP data, which do include bilateral trade flows, is a lack of detail in the fisheries sectors. The goal in this part of the project is to fill gaps in the U.S. regional economic accounts with a set of consistent benchmark data on bilateral trade in select fish products among countries along the North Pacific Rim, including the U.S., Canada, Mexico, Japan, China, South Korea, Russia, and Vietnam. Estimating these benchmark, bilateral trade flows is a necessary step in linking a regional economic model for Alaska to the PET model. These benchmark data were obtained or estimated using international trade data from 3 sources: i) U.S. Merchandise Trade Statistics, ii) U.N. Merchandise Trade Statistics, and iii) U.N. FAO Fisheries Statistics for Commodity Production and Trade.

The U.S. and U.N. merchandise trade accounts are classified according to the Harmonized Commodity Description and Coding System (HS), administered by the World Customs Organization in Brussels. The U.S. data are managed by the Foreign Trade Statistics Division of the U.S. Census Bureau. The U.S. data subdivide the 4 and 6 digit HS codes into 10-digit statistical reporting categories. The 10-digit categories (http://www.census.gov/foreign-trade/reference/codes/index.html#concordance) contain many specific categories for U.S. and Alaska fisheries, such as pollock roe and fillets; frozen king, snow, and other crabs; yellowfin sole, Pacific Ocean perch, sablefish, lingcod, several types of salmon, and others. In particular, the U.S. data have the volume and value of exports and imports, over time, from each U.S. customs district to each country that is a U.S. trade partner. The FAO data have a similar, or in some instances, a more refined level of detail for fish commodities, and contain information on production and trade for all of the world's fisheries over time. However, the FAO data only give volume and value of aggregate exports and imports for each country, and thus, do not identify bilateral trade flows.

The U.N. Merchandise data are the global source for identifying bilateral trade flows, but these are available only at the HS 6-digit level. For example, a HS 6-digit code identifies frozen crabs, but not the species composition that is identified in the U.S. In addition, while the FAO and U.S. trade data appear to be fairly consistent, the U.N. Merchandise data do not always match well with the other sources. They also appear in some cases to be internally inconsistent in some cases with large differences between exports reported by one country, and corresponding imports reported by another. This type of consistency problem is almost always encountered with input-output (IO) data, and resolving inconsistencies in the international trade data was the primary analytical task in this project.

This part of the project used HS 10-digit U.S. Merchandise data to quantify trade volume and value between the U.S. and each of its trade partners, with emphasis given to other countries along the North Pacific Rim: Canada, China, Japan, South Korea, Mexico, Russia, and the emerging markets of Vietnam. The 6-digit U.N. Merchandise data was used to construct a set of initial IO matrices of trade flows (with columns of exporting countries and rows of importing countries). A tested and appropriate numerical procedure was then applied to 'balance' these matrices, thus estimating a set of consistent bilateral trade flows from the initial IO matrices using the FAO export/import data as constraints.

A set of benchmark tables with estimates of the bilateral trade flows for a subset of the species listed above was recently completed. These tables are based on the United Nations Commercial Trade Statistics Database (http://comtrade.un.org) and were adjusted to U.S. exports and imports using an estimation procedure for updating a transaction matrix. This adjustment procedure is an example of a bi-proportional technique in input-output analysis that has some desirable properties. In particular, it minimizes the sum of squared residuals in bilateral trade flows for a certain metric. Adjustments are necessary to reconcile the U.N. trade data with data from the U.S. Merchandise Trade Statistics. For example, U.N. data reported by Russia for its exports of King Crab to the United States are severely underestimated in 2005. U.S. trade data provides detailed information on the amount, in both kilograms and dollars, of important commodity groups that are directly related to Alaska fisheries. Trade statistics that were used to produce the bilateral trade flow estimates are available to AFSC economists through the U.S. Department of Commerce International Trade Administration's Trade Policy Information System (http://trade.gov).

Work on estimating bilateral trade flows and recent results with the PET model were presented in July 2008 at the International Institute for Fisheries Economics and Trade (IIFET) conference in Nha Trang, Vietnam.

Data Collection and Synthesis

BSAI Crab EDR Documentation and Data Quality Review

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As directed by NPFMC motions from February 2003 and December 2006, a rigorous set of procedures for assessing and documenting data quality of the BSAI Crab EDR database have been developed and implemented by ESSRP staff and contractors. Following presentation of EDR data quality documentation to the Council in February 2008 by AFSC economists, the Council issued a motion directing the Pacific Northwest Crab Industry Advisory Committee (PNCIAC) to participate in a formal review of EDR data quality and documentation.

Dataset documentation (metadata) includes extensive details, including table and field descriptions, source tracking to identify EDR form tables across versions and data collection years, data field use guidelines and data quality results. Data quality information is derived from annual third party validation audits conducted by the accounting firm Aldrich, Kilbride and Tatone, LLC (AKT) and extensive submitter feedback. To facilitate improved database integrity and documentation, ESSRP staff have collaborated with PSMFC to complete migration of the database from MS Access into the Oracle relational database environment. The result has been improved database structure and usability, and the ability to complete formal database logic checks. The database has also been integrated with secondary datasets, including eLandings catch and landings data and Commercial Operators Annual Report processor output and sales data.

The validation audit process includes both random audits, based on a statistical sample of the EDR population, and non-random audits of EDRs identified on the basis of missing variables or outliers in reported information. AKT annually selects vessels or processors for audit based upon a statistical sample; for each vessel or processor selected for audit, detailed support is requested and examined by AKT staff. Variables for audit are selected from those that can be validated by documented support. For each data variable requested, AKT critically evaluates the support provided against third party support, such as invoices or fish tickets; internally-generated information, such as crew settlement sheets, general ledger details, detailed internal reports, or financial statements; and estimates made, including the reasonableness of assumptions. Results of the audits conducted to-date have indicated that documentation of support and accuracy of reported data have improved in 2006 and 2007 from the initial historical data conducted in 2005, in which data were reported for 1998, 2001, and 2004. However, despite improvements in definitions included in the EDRs, there is still variability in how information is reported based upon the ability to break down information in the manner requested in EDR forms and changing conditions and markets within the fishery. Variability in the quality of supporting documentation to information submitted in the EDRs has improved for the 2006 reporting year. In addition to providing quantitative information on data quality, the annual validation audit provides additional information on which to improve data collection forms to improve accuracy of reported data. Data collection for the 2007 calendar year was completed in 3rd Quarter of 2008 and the validation audit by AKT for these data is ongoing.

In addition to validation audits, ongoing dialogue between ESSRP and Council economists and industry data providers have produced important documentation of data quality concerns and guidance for interpretation of individual EDR data fields. This dialogue has continued more formally as part of the Council review process between ESSRP staff and the PNCIAC membership. AFSC economists met with PNCIAC during 3rd Quarter 2008 and presented the draft metadata document for formal comments. The comment period ended June 28, and replies to comments are being drafted and incorporated into the metadata document for presentation to the committee in September, 2008. PNCIAC will report findings to the Council in October 2008, for Council deliberation regarding use of EDR data fields in analysis of effects of crab rationalization and potential management changes. In addition to providing the documentation required for formal industry review of the database, detailed metadata will ensure long term integrity of the database and access the information in the EDR database by authorized data users.

Models of Fishermen Behavior, Management and Economic Performance

Cooperative Formation and Productivity Change in the Alaskan Crab Fisheries: Measuring the Impacts of the BSAI Crab Rationalization Program

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Although the impacts of exclusive property rights, or Limited Access Privilege Programs (LAPPs), on fleet wide measures of efficiency, productivity, and capacity utilization in fisheries have been investigated (Felthoven 2002, Felthoven and Morrison-Paul 2005, and Felthoven, Morrison-Paul and Torres 2008), to date there has not been an empirical study of the way in which improvements in economic performance have been generated through cooperative behavior among vessel owners to stack quota and achieve economies of scale. Under the Bering Sea and Aleutian Island (BSAI) Crab Rationalization Program of 2005, the fishermen awarded property rights within these fisheries formed voluntary cooperatives in order to pool their individual fishing quotas (IFQs) and collectively manage and execute fishing operations. The set of vessels included within each cooperative was decided upon by the fishermen within the fleet and reflects strategic decisions (e.g., smaller boats are often idle while larger boats can be used to stack the others' quota) and pragmatic factors such as having established, trusting relationship with each other. To date the formation of these cooperatives have not been studied. This research will investigate the formation of cooperatives under the BSAI Crab Rationalization Program of 2005 as well as conduct an analysis of the changes in efficiency, capacity, and productivity which have resulted from the enactment of this policy.

One of the fundamental arguments for the creation of LAPPs is to reduce the "race for fish" inherent in many of these fisheries. As a byproduct of this change, the number of vessels utilized within the fishery has been reduced drastically. For instance, from 2000-2004 there were an average of 258 and 261 permit holders within the Alaskan red king crab and snow crab fisheries, respectively.[1] Following the implementation of the LAPP these numbers have substantially decreased. Over the past few years there have been roughly 120 permitted vessels within the Alaskan crab fishery and it has recently been noted that less than 80 of these vessels are actively participating in these two crab fisheries. The reduction in the number of vessels utilized is a direct result of the cooperatives, which have consolidated fishing quota among selected vessels. At present there are nearly 20 crab cooperatives. This research will investigate the way in which

[1] This information was obtained from the Alaska Department of Fish and Games website: http://www.cf.adfg.state.ak.us/geninfo/shellfsh/crabs/crab_harvest.php

quota has been pooled aboard vessels within these coops and systematically analyze the cost structure of the vessels to better understand the gains associated with the quota pooling.

To investigate the formation of cooperatives as well as the changes in productivity, efficiency and capacity resulting from the formation of cooperatives, pre- and post- rationalization measures of cost efficiency and productivity will be estimated for each vessel within the Alaskan crab fishery. The pre- and post-rationalization measures will be utilized to estimate the impacts of the LAPP within the fisheries whereas the pre- rationalization measures will be used to determine the characteristics of cooperative formation. A number of testable hypotheses can be investigated within the analysis: (1) the BSAI Crab Rationalization Program has increased the mean cost efficiency (CE) and reduced the excess capacity of vessels operating within the fishery, (2) changes in cost efficiency within the crab fisheries are predominately due to economies of scale, and (3) fishermen cooperatives were formed by combining high productivity (or capacity) vessels with lower productivity (or capacity) vessels in an effort to enhance the benefits from pooling IFQs within the cooperative.

There are two primary objectives of this research. The first objective is to determine the effect that estimated levels of pre-rationalization efficiency and productivity had on cooperative formation in the years following rationalization. The primary focus will be whether or not cooperative formation is consistent with an effort to maximize the potential aggregate gains from pooling IFQs. The second objective is to investigate the presence of productivity change (PC) resulting from the BSAI Crab Rationalization Program and to decompose cost efficiency changes into technical change (TC), allocative efficiency (AE) and technical efficiency (TE) components.

To estimate vessel level measures of TE, AE and PC, an empirical framework such as that proposed Kumbhakar and Lovell (2000) can be used. A stochastic cost frontier function can be estimated which incorporates time specific dummy variables as well as a LAPP dummy variable. Using this specification one can estimate TC, AE and TE, which comprise the estimated changes in cost efficiency. Following the estimation of the vessel-level cost frontier the researchers will investigate the properties of the cooperatives formed following the BSAI Crab Rationalization Program in an effort to determine the extent to which estimated measures of vessel-specific cost efficiency appear to have influenced the structure of the cooperative formations.

Dynamic Search Behavior and the Alaskan Crab Rationalization Program

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Economists have long extolled the virtues of fishery rationalization programs. Theoretical and empirical studies have produced a long list of potential benefits from individually transferable quotas, including reduced costs by allowing captains to select an optimal input mix, improved safety conditions, increased revenues from spreading fresh product over a longer season or a heightened ability to focus on quality, and decreased overcapacity as less profitable vessels sell quota to more profitable vessels and exit the fishery. What is missing from this litany is an understanding of how an individual fishing quota (IFQ) system affects micro-behavioral decisions about where, when, and how often to fish. We are interested in whether, and to what extent, enhanced profitability stemming from an IFQ program is attributable to changes in vessel search behavior and location choices.

The Alaskan crab rationalization program implemented in 2005 provides a "laboratory" in which to study the behavioral effects of an IFQ system. Vessel-level information about fishing locations, frequency, and input use (e.g., crew, fuel, bait, and gear) is available before and after the policy change, allowing one to examine a broad range of research questions about the way that a secure right to a portion of the harvest affects fishermen's operational strategies. Moreover, extensive fishery-specific cost data are available which will facilitate more realistic and detailed models of fisherman behavior, as well as computation of the resulting quasi-rents associated with observed decisions regarding location choice and searching propensity.

Specifically, we are particularly interested in examining the extent to which rationalization heightened the incentives to search for crab. Our hypothesis is that, prior to rationalization, the race for fish undermined the incentive to engage in optimal search behavior. As a consequence, vessels were forced to fish opportunistically and sacrificed information gathering through searching that could have been beneficial for future use. Of course, some search was always necessary prior to rationalization. However, we hypothesize that vessels had little incentive to forego immediate fishing opportunities in order to gather information for future use about abundances over space. After rationalization, these incentives changed, perhaps dramatically.

Researchers have observed that fishing location choices are correlated over time (Holland and Sutinen 2000; Smith 2005). That is, knowing a fishermen's past sequence of fishing ground choices has explanatory power in future choices. A potentially important explanation for correlated choices is that visiting a site produces individual-specific information about that site. But the presence of an information effect alone does not necessarily point to a particular search strategy. Whether temporal correlation in choices reflects a forward-looking search strategy or simply a passive updating of information is an open question and, we argue, will likely depend on the institutional setting of the fishery.

To study search behavior before and after rationalization in the crab fishery, we will use discrete choice dynamic programming (DCDP). First developed by Rust (1987), DCDP has been used in natural resource economics to study forest rotations (Provencher 1995) and recreation demand (Provencher and Bishop 1997), and it was first proposed for studying fishing micro-behavior by Smith (2000). The idea is that individual fishing vessels choose a discrete fishing location in each period, and in doing so, they obtain both an instantaneous payoff (in fishing revenue) and the possibility of a future payoff in the value of information about abundance at that site. A systematic consideration of the value of information alters the static discrete choice framework such that fishing vessels may forego current fishing opportunities in order to gather information purposefully. Estimating a DCDP problem in this case involves nesting a stochastic dynamic program within a maximum likelihood routine to estimate the parameters of the discrete choice model. What distinguishes DCDP from traditional discrete choice modeling is that the dynamic programming component solves for the optimal future trajectory of spatial decisions conditional on the current state of information. The dynamic program must be solved at each iteration of the maximum likelihood routine, introducing substantial computational burden.

To our knowledge, only Smith and Provencher (2003) have applied DCDP to the fishing search problem. In their case of analyzing sea urchin divers, the search motive did not appear large enough for individuals to forego immediate profits to gather information. However, the results were largely inconclusive because computational burden limited the state space to just four fishing locations. The information content of a fishing location choice is simply too small when the choice set is a partition of an entire fishery into just four zones. In general, what prevents the estimation of DCDP problems with many more choices is the "curse of dimensionality" (Wolpin). Essentially, as the state space (number of possible discrete choices) grows linearly, the computational burden increases geometrically. A recent study of surf clams in a rationalized fishery finds some evidence of search behavior (Marcoul and Weninger 2007). However, this study does not use DCDP and does not formally model the dynamics empirically such that results are only suggestive of a search motive. Hicks and Schnier (2006, 2007) model within-trip dynamic location choices by modifying the DCDP problem to eliminate the stochastic element. Their approach is useful in reducing the computational burden of DCDP but does not allow for formal modeling of information sets and thus is not able to study the search problem that we propose.

Fortunately, recent developments in micro-econometrics within both labor economics and industrial organization have found ways around the curse of dimensionality in DCDP. In this project, we will employ Conditional Choice Probability (CCP) methods (Hotz and Miller 1993; Arcidiacono and Miller 2007). These methods rely on a correspondence between the value function and the probability of observing a current choice to approximate the more computationally intensive full solution of a DCDP. As such, these methods open up opportunities for studying discrete dynamic decisions with a far greater state space than would otherwise be possible.

There are three primary expected benefits of this project. First, the analysis will improve our understanding of the effects of the current crab rationalization program on individual decision making and identify elements of the program that have allowed fishermen to adjust their behavior in order to increase net benefits derived from the resource. Second, the project will provide a novel analysis of the way in which rationalization programs in general may impact the distribution of effort and the resulting changes in catch-per-unit-effort and travel costs; no prior study has analyzed the dynamic micro-behavior of a fishery both before and after rationalization. Third, the project will contribute broadly to the economics literature on micro-econometrics and attract attention of other leading researchers. The available data on daily commercial fishing choices and the associated costs and benefits provide a virtually unprecedented opportunity to study economically important micro-behavioral decisions of individuals over time.

Measuring the Value of a Statistical Life in the BSAI Crab Fisheries

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The value of a statistical life (VSL) is revealed by one's choices regarding monetary returns and fatality risk. Estimates of the VSL have been extensively used to inform public policy and quantify preferences for environmental quality, health and safety. To date little attention has been paid to investigate the tradeoffs associated with the returns from natural resource extraction activities and the risks incurred, and the effect that changes in safety regulations and the utilization of property rights management has had on the VSL. In this research we model fishing captains' discrete choices to fish on a given day or not, conditional on the observed risk present, in the Bering Sea and Aleutian Islands crab fisheries. We instrument for risk using fatality data from crab and non-crab fisheries, as well information on wave height, wind speed, air temperature, and sea temperature (to capture ice risk propensity). We examine how the VSL and fatality risk have changed since the inception of both the United States Coast Guard (USCG) pre-season boarding program and the BSAI crab rationalization program.

Notably, our estimation framework controls for the inherent sample selection bias present in many VSL estimates and when compared to those estimates which do not control for sample selection, illustrate the substantially upward biases which may arise. In addition, these estimates are robust to heterogeneous preferences which can bias homogeneous estimates of the VSL. By expanding our utility theoretic model to reflect captains' preferences for others' well-being we may be able to recover the value of an altruistic life via the unique data generating process present within these fisheries. Preliminary empirical estimates provide a measure of the captain's value for crew lives, and decomposing our estimated VSL (which includes the value of an altruistic life); we were also able to recover the captain's implicit value of his own life.

These estimates may be used to benefit contemporary fisheries policy. For instance, recently the New York Times reported that the fatality rates within the Pacific Northwest Dungeness crab fisheries possessed fatality risk rates that were 60 times greater than the average American worker. This article pointed out that the dockside safety program does not check every vessel participating in this fishery, whereas in Alaska the USCG Pre-Season boarding program does. Presumably the cost of the program may be one of the reasons why this dockside boarding program is not perfectly executed. However, given our range of estimates for the VSL and our estimated reductions in the fatality risk resulting from the complete coverage of the USCG Pre-Season boarding program, our model predicts that the annual benefits derived from this policy within the BSAI crab fishery range are quite substantial.

The Effects of Rationalization on Processor Competition

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A vital step in predicting how communities will be impacted by fishery rationalization is to understand how rationalization will affect the landing port selection decision of fishers. To accomplish this one must first know how the competitive balance between spatially differentiated processors will change under rationalization. While spatial impacts on competition have been examined in the economics literature from both theoretical (e.g. Hotelling (1929), Salop (1979), and Gabszewicz and Thisse (1979)) and empirical (e.g. Davis (1997), Pinske, Slade, and Brett (2002) and McMillen, Singell, and Waddell (2007)) perspectives for a variety of industries, the issue has remained largely untouched with respect to the fish processing industry.

There are two central questions that will be examined with this research. One, we want to determine how spatial competition of processors, in terms of timing and intensity of price responses, has changed as a result of rationalization. Two, we want to determine how distance costs of fishers, and thus spatial effort and port delivery decisions, has changed as a result of rationalization. To achieve these research objectives a three-step approach will be employed. First, we will develop a theoretical model of spatial competition for a fish processing sector and, through the use of simulation analysis, examine how rationalization is expected to impact the competitive behavior of processors under different assumed market and cost structures. Second, using the results of the theoretical model for guidance, we will econometrically examine how rationalization has impacted competition in processing sectors for fisheries that have changed management from regulated open-access to individual fishing quota (IFQ) management. The likely candidates for fisheries to use in this empirical section are the Alaska sablefish fishery and the Alaska halibut fishery, and potentially the Bering Sea and Aleutian Islands crab fisheries. These fisheries seem well suited for this analysis because the fish are caught and processed over a large geographic area and key to this study will be examining the spatial distribution of fishers' effort and the spatial distribution of the processors themselves. Finally, and related to the second step, we will empirically test how rationalization has changed fishers' distance traveled cost. This is important with respect to competition aspects of the processing sector, because if it is found that the distance cost for fishers has decreased in response to rationalization, then presumably processor competition would increase as processors vie for fishers distributed across a larger geographic area.

Monte Carlo simulations will be conducted to identify pricing paths under different model parameter values. In particular the research will focus on different assumptions about the degree of competition in the processing sector, different time costs for fishers, and different information assumptions of both fishers and processors. Using these simulations we hope to be able to assess how model results are affected by assumed spatial abundance of resources, changes in climate, or area closures. Based on these results we should also be able to form some solid comparative static results which can then be used to form an empirical strategy.

In terms of empirically modeling pricing competition among processors in a spatial sense, it is important to remember that ex-vessel pricing introduces interesting market features that are not encountered in more traditional location models. First, location models are often framed as a competitive monopolist situation with no quantity constraints. Ex-vessel markets are often better characterized as monopsonistic markets and the markets are quantity-constrained by total allowable catch measures (TAC). Second, where more traditional location models consider the situation to be one of optimal location choice by competing monopolists, ex-vessel markets present situations where the competing monopsonists (processors) are stationary while the fishers are mobile. Therefore, one key to understanding competition among processors will be to understand fishing site selection and distance cost estimates. The empirical methodology that will be utilized here will most likely need to be a combination of semiparametric approaches such as those described in Pinkse, Slade, and Brett (2002) and more traditional panel methods as used in McMillen, Singell, and Waddell (2007).

To determine how distance costs for fishers have changed as a result of rationalization, we will use the latest in dynamic random utility modeling. An aim of this research will be to extend this literature by including landing ports into the fishers' decision problem to see if fish location is also affected by price differentials across ports.

<u>Regional Economic Modeling</u>

Estimating Regional Economic Impacts of Alaska Crab Rationalization

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In the time since the Bering Sea and Aleutian Islands (BSAI) crab fisheries were rationalized in 2005, there have been rapid and dramatic changes within the industry. While total harvest in the Bristol Bay Red King Crab and Bering Sea Opilio Crab fisheries increased in 2005 relative to 2004, the number of vessels and crew members participating in both fisheries fell markedly. The effects of this consolidation have not been formally evaluated, nor have the complex changes that occurred with the timing and location of crab processing. Fishery managers and the public at large have expressed an interest in knowing how and by how much crab rationalization has affected employment and earnings of vessels and processors and the economic well-being of communities dependent on crab fisheries. This project will investigate these economic impacts by developing a regional economic model for Alaska and Washington that will provide fishery managers with the information on how the economic returns of stakeholders changed under crab rationalization. The model may also be used to estimate how alternative crab individual processor quota (IPQ) allocations will affect stakeholders and their communities. By estimating economic impacts of crab rationalization on fishery-dependent communities, this project will help address National Standard 8 of the Magnuson-Stevens Act National Standard Guidelines and other federal mandates. The results of this project will also assist managers in considering and formulating modifications to BSAI crab fishery policies.

To date, the following tasks have been conducted for this project:

1. The principal investigator (PI, Chang Seung) identified the type of regional economic models to use for estimating the impacts of crab rationalization.
2. The PI obtained crab EDR data, and conducted a preliminary data analysis including (a) mapping the input costs from open-ended questions into IMPLAN sectors; (b) summarizing both pre- (2004) and post-rationalization (2005, 2006) total revenue, factor incomes, and total cost for crab harvesting vessels and processors; and (c) developing ratios for prorating crab activity using days at sea (or days processing), volume of raw fish and/or finished products, and revenue.
3. During the process of conducting the above tasks, identified and investigated potential data problems.
4. Obtained data on sales and leases of crab ITQs.
5. Obtained IMPLAN data for Alaska and Washington.
6. Wrote programs to automate the data aggregation / mapping process, especially the open ended cost data.

When the EDR data inquiries are finalized and the data automation task is completed, the PI will use the final, corrected data to conduct the following tasks:

1. Generate pre- and post-rationalization production functions for different sectors (catcher vessel, catcher processor, floating processor, and shorebased processor).
2. Prorate the annual costs to crab-related activities and estimate the input costs incurred by location of purchase (Alaska or Washington).
3. Generate total revenue and value added components (labor income, capital income, and taxes) for the different sectors.
4. Embed these crab data within a 2004 Alaska social accounting matrix (SAM) developed by Dr. Edward Waters (for an Alaska computable general equilibrium modeling project), and balance the SAM.
5. Develop the Alaska SAM model for calculating the impacts of crab rationalization on Alaska.
6. Examine data on the sale and lease of crab ITQs and estimate the changes in income to Washington-resident vessel owners from their sales of ITQs.
7. Conduct state of Washington impact analysis using IMPLAN.
8. Summarize the results, and write a journal paper.

<u>Socioeconomic, Cultural and Community Analyses</u>

Post-Rationalization Restructuring of Alaska Crab Fishery Crew Opportunities

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Rationalization of the Bering Sea crab fishery in 2005 resulted in swift consolidation of the fleet from over 250 vessels to just 89. A large reduction in the ex-vessel prices paid for crab also occurred at this time. Among the most important impacts on communities has been the loss of crew jobs, estimated in a University of Alaska study to be approximately 1350 positions.

As the initial effects of the rationalization program begin to stabilize, it is important to understand the actual impacts of this program on crewmembers. Loss of crew jobs was a predicted effect, but the specifics of crew impacts are not understood in great detail. Beginning in the fall of 2007, this project used ethnographic interview techniques to study current and former crewmembers, how they have been affected, and how their jobs have been affected. Field sites have included Akutan, Kodiak, Old Harbor, Seattle, Unalaska/Dutch Harbor, and Astoria, Oregon. Interviews have focused on issues of employment opportunities and job characteristics that may be useful in understanding how crewmembers might be affected in other rationalization initiatives. Decision theory and occupational communities theory provide the preliminary analytical framework for this research. A report detailing this research will be presented to the North Pacific Fishery Management Council at the October 2008 meeting in Anchorage.