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NOAA FISHERIES

Indicators of Fishing Engagement and Reliance of Alaskan Fishing Communities

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Alaska FISHERIES SCIENCE CENTER

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Cover image. Small boat harbor in Kodiak, AK. Photo by Amber Himes-Cornell

NOAA FISHERIES

Indicators of Fishing Engagement and Reliance of Alaskan Fishing Communities

By Stephen Kasperski and Amber Himes-Cornell

Processing plant in Kenai, AK.
Photo by Kristin Hoelting

Introduction

The Magnuson-Stevens Fishery Conservation and Management Reauthorization Act (MSA) of 2006 requires fishery management actions to provide the optimum yield from a fishery in a fair and equitable manner to all fishermen while providing for the sustained participation of fishing communities and, to the extent practical, minimizing adverse economic impacts on such communities [MSA §301]. National Standard 8 of the MSA specifically states that communities need to be considered when changes in fishing regulations are made, requiring that we "take into account the importance of fishery resources to communities."

If policymakers and regulatory agencies such as the National Marine Fisheries Service (NMFS) are to effectively regulate and protect marine resources while also supporting local communities as mandated by the MSA, there remain several key questions that must be answered about how involved communities are in fisheries; how these communities may be differentially affected by changes in fisheries management; how they are physically, socially, and culturally impacted by fisheries management decisions; and finally, how they adapt to those impacts in a shifting context of environmental, social, and political change.

In response to the first two questions above, the AFSC's Economic and Social Sciences Research program has developed a set of fisheries engagement and reliance indices using secondary data for 89 communities in Alaska that participate in commercial and recreational fisheries in the North Pacific. The purpose of the study is to explore the degree to which communities are engaged in fisheries in Alaska and how reliant they are on these fisheries, and which communities may be impacted by changes in fisheries management. We consider three main types of fisheries involvement—commercial processing, commercial harvesting, and recreational fishing— and create numerical indices of engagement and reliance for each category of fisheries involvement. Engagement represents the scale of the industry in the community while reliance represents the importance to the community of the industry in terms of numbers per resident.

These statewide indices are a first step toward assessing fisheries involvement by communities across Alaska. Additional indices are necessary to assess the importance of a particular fishery to communities, the importance of certain communities to a fishery, or the relative fisheries engagement and reliance of communities within a specific region of the state. Here we define engagement as a community's participation in fisheries as a whole and reliance as a per capita measurement of fisheries participation. By separating commercial processing from commercial harvesting, the indices presented here show the importance for those communities that may not show up in the NMFS report "Fisheries of the United States" because they have a small amount of commercial landings, but have a large number of fishermen and vessel owners in the community. Additionally, by separating engagement from reliance, these indices highlight communities with relatively small-scale fisheries, but with a large proportion of residents that participate in the fishing industry that may otherwise be overlooked by policy makers given their relatively small scale of fisheries. These indicators give policy makers and communities themselves a quantitative measure of community involvement in a variety of different aspects of fisheries which will help provide information about which communities will likely be the most affected by changes in fisheries management.

These indices are intended to improve the analytical rigor of fisheries Social Impact Assessments through analysis of adherence to National Standard 8 of the MSA and Executive Order 12898 on Environmental Justice in components of Environmental Impact Statements. An advantage to this approach, especially given the short time frame in which these analyses are conducted, is that the data used to construct these indices are readily accessible via the AFSC's Community Profiles of the North Pacific project, do not require time intensive in-person interviews, and can be compiled quickly to create measures of community engagement and reliance and to update community profiles. A summary of data available for this project can be viewed on the AFSC's Community Profiles of the North Pacific: Alaska website.

Methods

Data were collected from state and federal sources for 89 communities across the state of Alaska. Communities were selected for inclusion in our study population if commercial fisheries landings were made in the community or if there was a charter business located in the community. We use mean values from 2005 to 2009 for all variables, and separate them into three different categories of fisheries involvement: commercial processing, commercial harvesting, and recreational fishing. For the commercial processing category, we include the amount of commercial landings, commercial revenue, and the number of processors in each community. For the commercial harvesting category, we include the number of permits, vessels, and crew members in each community. Finally, the recreational fishing category includes the number of charter businesses, sportfish guide businesses, sportfish guide licenses, and sportfishing licenses in each community. For each community, we estimate their engagement in and reliance upon commercial processing, commercial harvesting, and recreational fishing. Community engagement is represented by their actual values of a variable and the reliance is represented by their per capita (divided by population) equivalent.

To examine the relative engagement and reliance of each community to the three categories of fisheries involvement, we conducted two separate principal components analyses (a statistical procedure) for each category to determine a community's relative engagement and relative reliance for each category of fisheries involvement. Principal component analysis was used to create quantitative indices that bring together information from several variables that can help represent specific concepts of fisheries involvement. We used the six principal components analyses included in this study to create six indices of fisheries involvement for each community: commercial processing engagement, commercial processing reliance, commercial harvesting engagement, commercial harvesting reliance, recreational engagement, and recreational reliance.

Results

Our six principal component analyses were designed to each result in a single factor solution, such that all the variables included in each principal components analysis can be summarized by a single index and represent a single concept of fisheries involvement. These indices describe the engagement or reliance of each community to each category of fisheries involvement in a robust and statistically meaningful way.

Below we define the various indices we computed for the 89 included communities in various dimensions, including commercial processing and harvesting engagement and reliance, and recreational engagement and reliance. Table 1 presents the rotated factor loadings and total variance explained for all of the variables included in each of the six principal components analyses. To provide a summary of the community engagement and reliance indices of fisheries involvement for each of the six indices described above, communities were each defined as being minimally engaged in commercial or recreational fisheries if they fell in the bottom 10% of index scores, moderately engaged with an index score in the middle 80%, and the highly engaged with index scores in the top 10% (Figs. 1-6).

The results of the highly engaged communities are presented in Table 2 using a binary scale of 1 or 0 for each index. A community receives a value of 1 in the table for a given index if they are in the top 10% of included Alaskan communities with the final column representing a sum of all other columns. Of the 89 communities included in this analysis, there were 5 communities that have a total index score of 3, 12 communities with a total index score of 2, 9 communities with a total index score of 1, and the other 63 communities have a total index score of zero. Four of the five communities with a total index score of 3, Juneau, Ketchikan, Kodiak, and Sitka, are in the top 10% of communities for commercial processing engagement, commercial harvesting engagement, and recreational engagement. The other community with a total index score of 3, Elfin Cove, was in the top 10% of communities for commercial processing reliance, commercial harvesting reliance, and recreational reliance, largely because Elfin Cove had a small population of 36 residents during the survey period.

Commercial Processing Engagement and Reliance Indices

Commercial processing engagement represents the scale of the commercial fishing and processing industry in the community. The commercial processing engagement index contains commercial revenues, commercial pounds landed, and the number of processors in the community and explains 71% of the variance in the variables. Commercial processing reliance represents the importance to the community of the commercial fishing and processing industry in terms of values per person. The commercial processing reliance index contains commercial revenues per capita, commercial pounds landed per capita, and the number of processors per capita in the community and explains 94% of the variance in the variables.

Commercial Harvesting Engagement and Reliance Indices

Commercial harvesting engagement represents the number of fishermen and commercial fishing vessel owners in the community. The commercial harvesting engagement index contains the number of commercial fishing permits, the number of vessels owned by residents of the community, and the number of crew licenses in the community and explains 95% of the variance in the variables. Commercial harvesting reliance represents the importance to the community of the fishermen and vessel owners in the community. The commercial harvesting reliance index contains the number of commercial fishing permits per capita, number of vessels owned per capita, and the number of crew licenses in the community and explains 92% of the variance in the variables.

Recreational Engagement and Reliance Indices

Recreational engagement represents the scale of the recreational, charter, and guide industry in the community. The recreational engagement index contains the number of charter businesses, sportfish licenses, sportfish guide businesses, and sportfish guide licenses in the community and explains 79% of the variance in the variables. Recreational reliance represents the importance to the community of the recreational, charter, and guide industry. The recreational reliance index contains the number of charter businesses per capita, the number of sportfish licenses per capita, the number of sportfish guide businesses per capita, and the number of sportfish guide licenses per capita in the community and explains 77% of the variance in the variables.

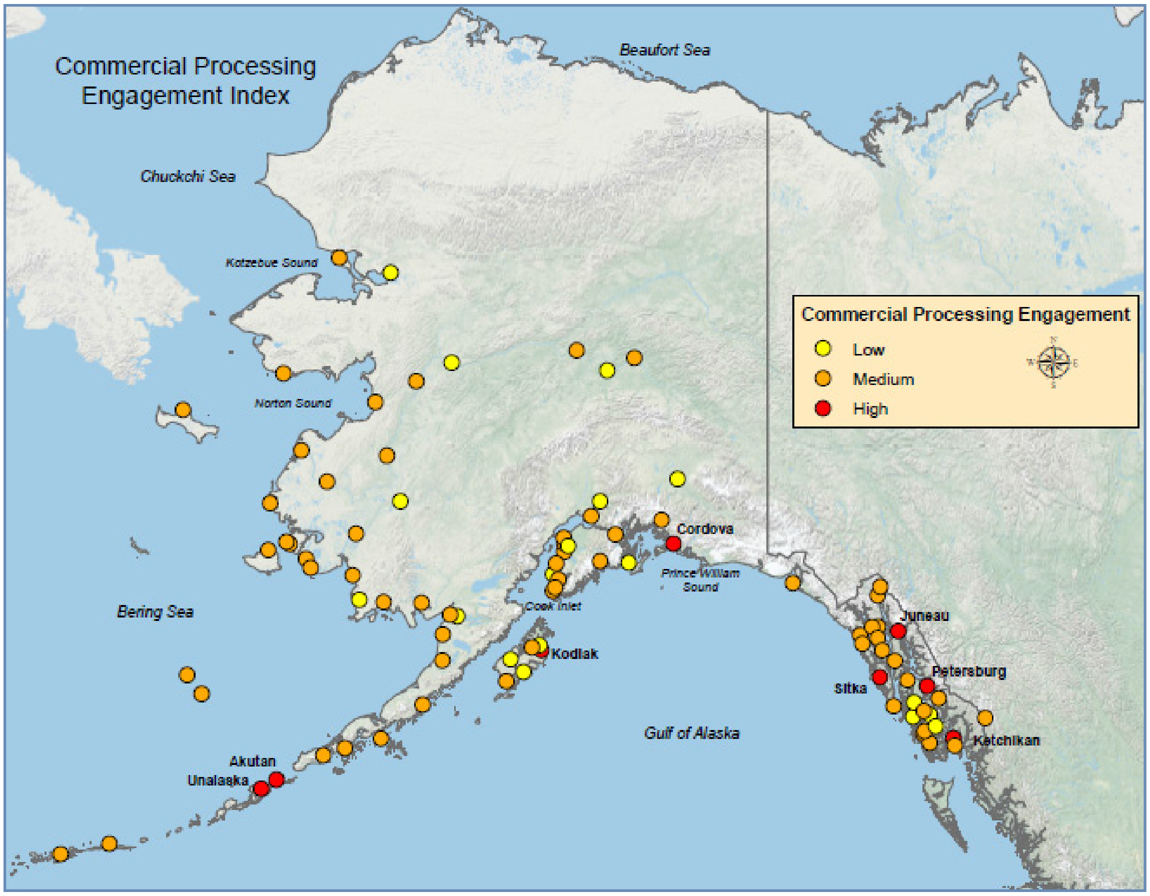


Figure 1: Distribution of commercial processing engagement for 89 Alaskan fishing communities. All communities that rank in the top 10% are considered high and are labeled and in red.

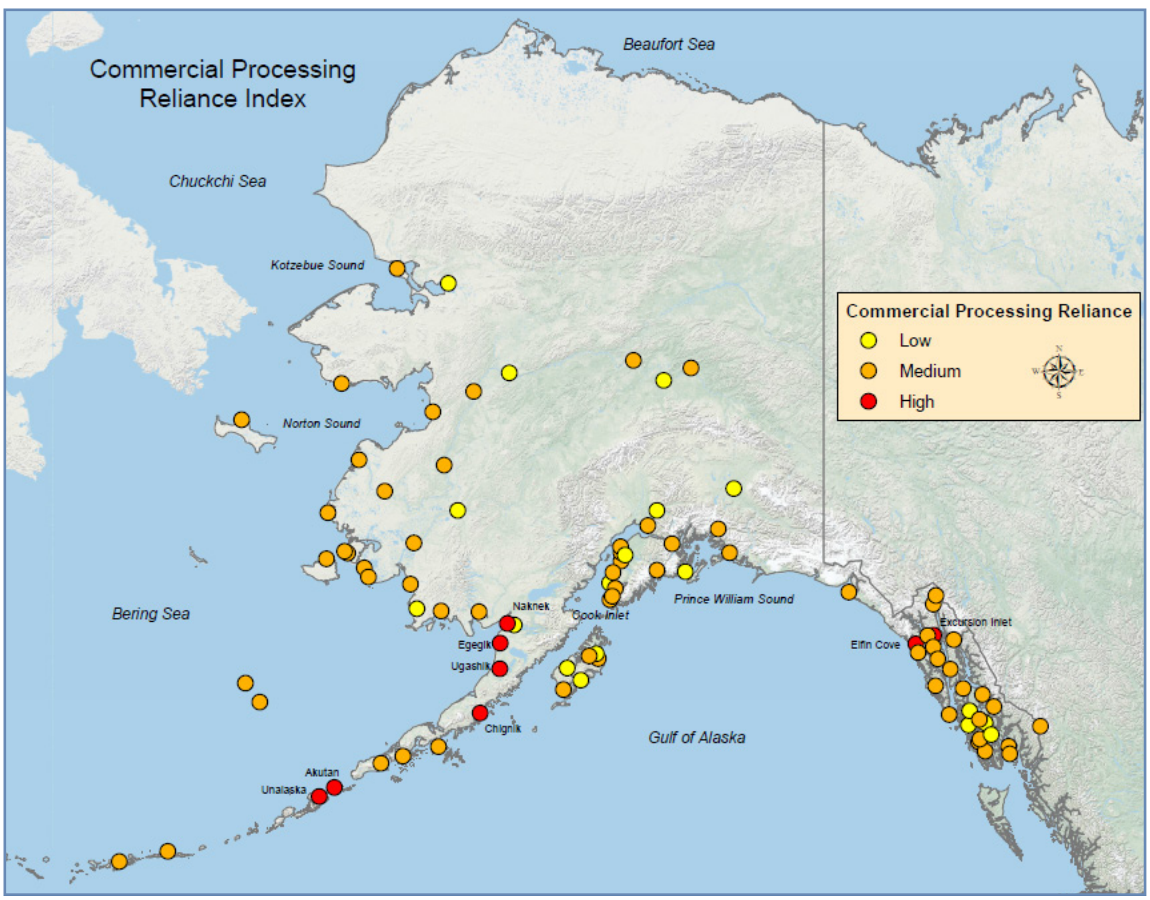


Figure 2: Distribution of commercial processing reliance for 89 Alaskan fishing communities. All communities that rank in the top 10% are considered "high" and are labeled and in red.

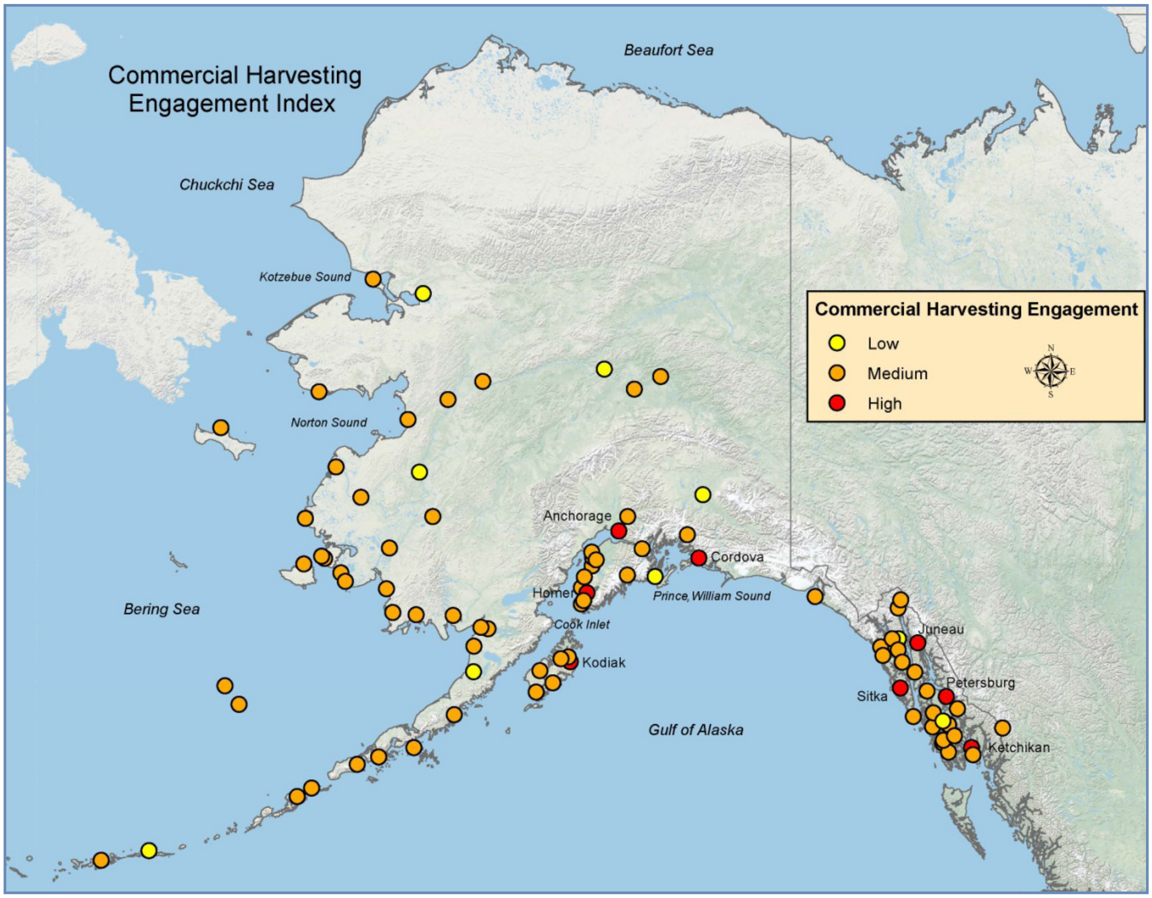


Figure 3: Distribution of commercial harvesting engagement for 89 Alaskan fishing communities. All communities that rank in the top 10% are considered "high" and are labeled and in red.

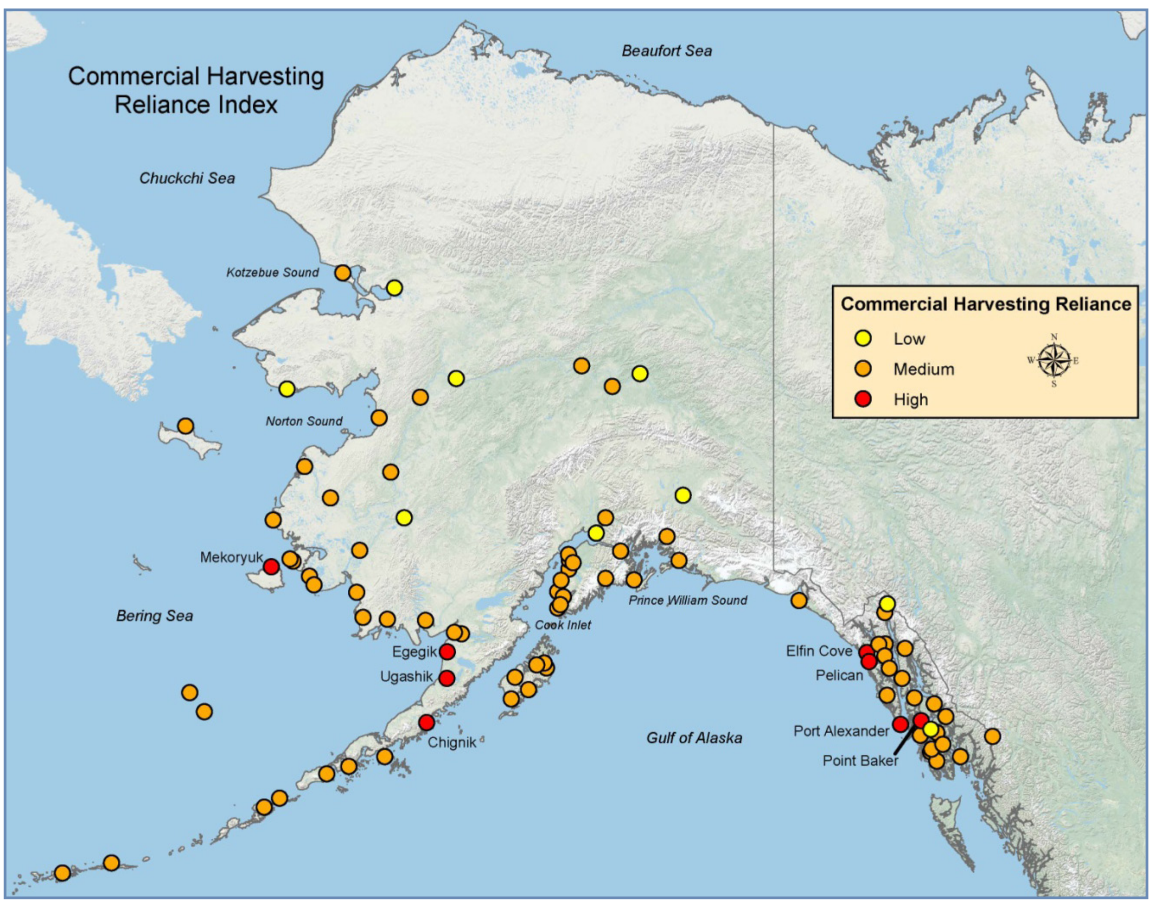


Figure 4: Distribution of commercial harvesting reliance for 89 Alaskan fishing communities. All communities that rank in the top 10% are considered "high" and are labeled and in red.

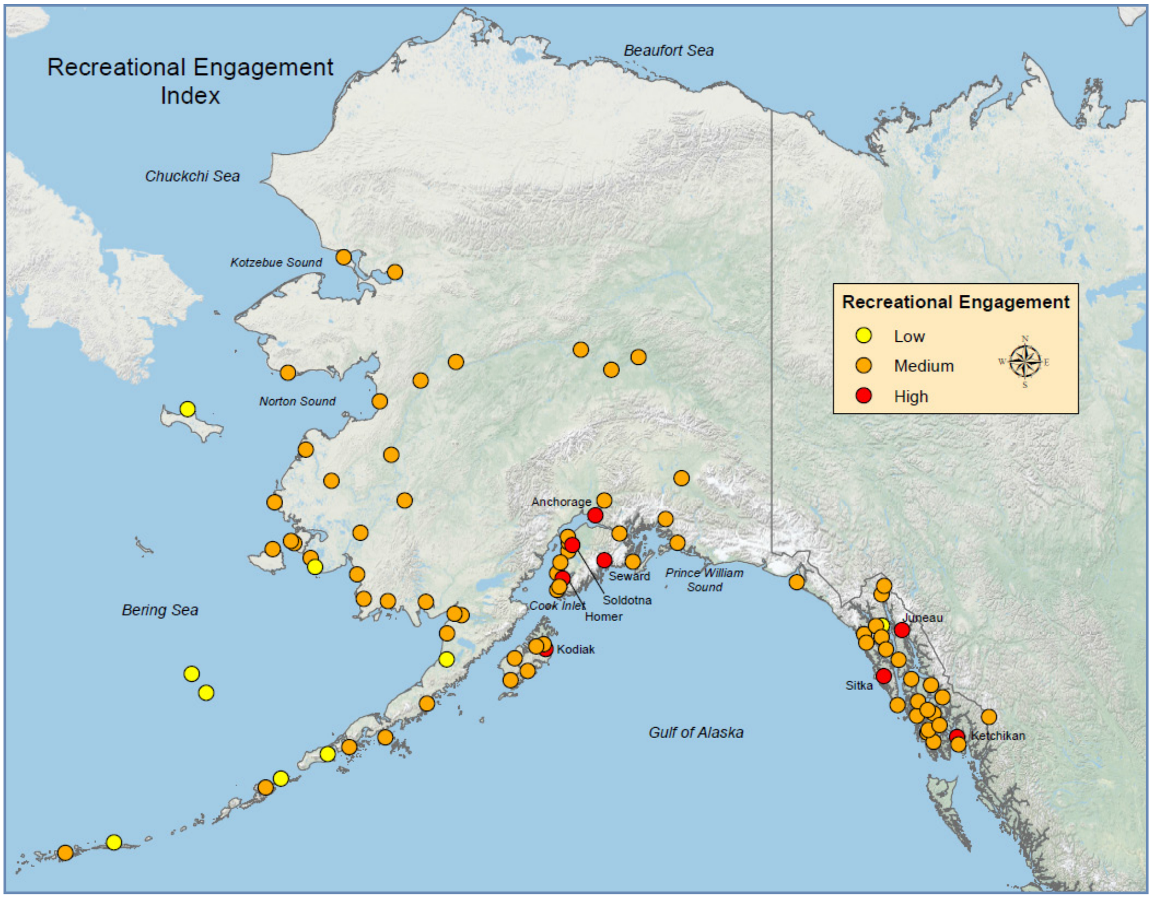


Figure 5: Distribution of Recreational Engagement for 89 Alaskan fishing communities. All communities that rank in the top 10% are considered "high" and are labeled and in red.

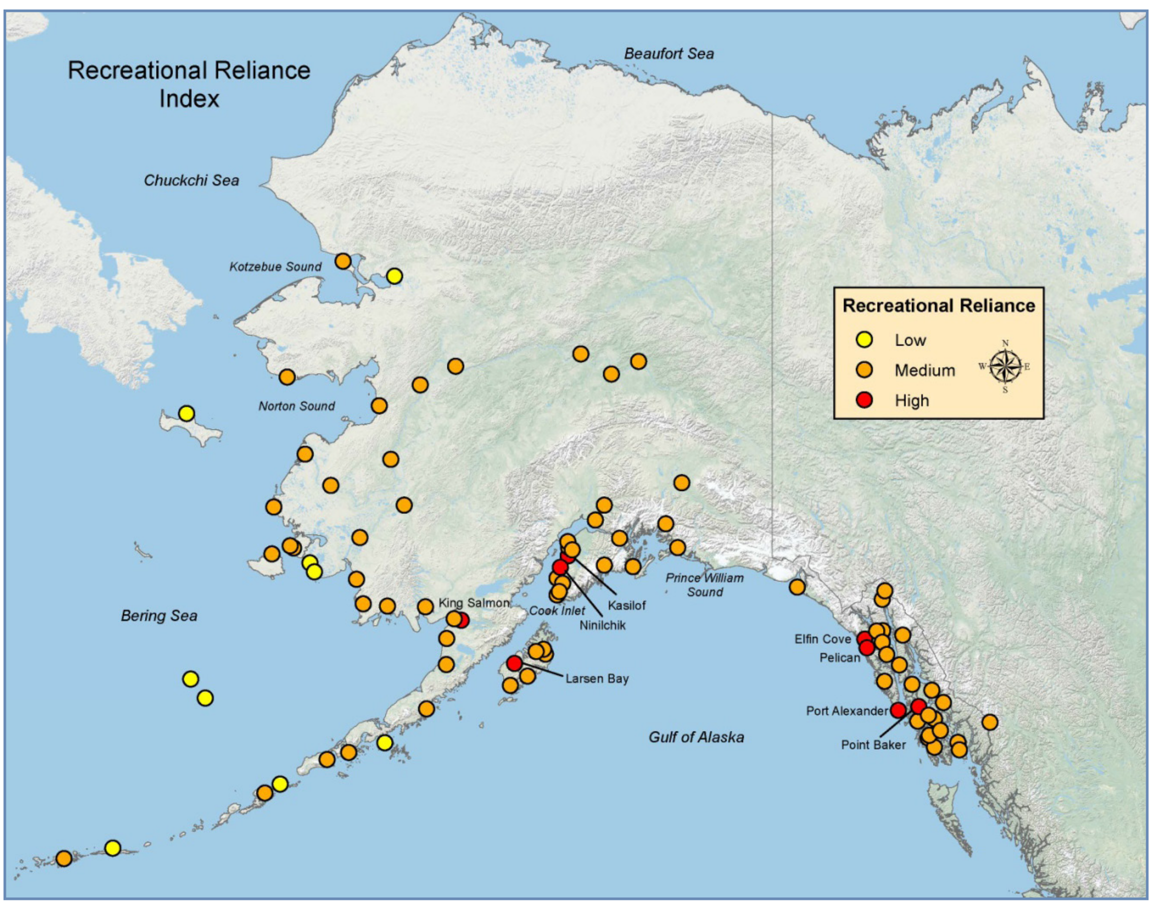


Figure 6: Distribution of recreational reliance for 89 Alaskan fishing communities. All communities that rank in the top 10% are considered "high" and are labeled and in red.

Beach landing site in Aleknagik, AK.
Photo by Kristin Hoelting

Discussion

The results of this analysis show a number of interesting trends in commercial and recreational fisheries participation around the state. As seen in Figures 1-4, regarding commercial fisheries, all of the highly reliant and engaged communities are located in the southern half of the state between the Aleutian Islands, Alaska Peninsula, Gulf of Alaska and Southeast Alaska. Similarly, Figure 5 and 6 show that recreational fishing is most prominent in Southeast Alaska, on Kodiak Island, on the Kenai Peninsula, and in Bristol Bay. However, communities that rank highly in engagement do not generally also rank highly in reliance for the same category of fisheries involvement. This is often a result of communities with a high degree of engagement have a larger population than some smaller communities that have more involvement per resident. The two exceptions are the communities of Akutan and Unalaska which both rate highly in the commercial processing engagement as well as the commercial processing reliance.

As noted previously, Table 2 summarizes the top communities for each of the six indices, where a community receives a score of 1 for each index for which it falls into the top 10% of communities. Of the six potential indices, only five communities had a total index score of 3. One of these communities scored a 1 in all three reliance categories, while the other four communities scored a 1 in all three engagement categories. Of the 12 communities that scored a total of 2, 6 communities have a 1 in both commercial engagement categories, 4 communities have a 1 in both commercial reliance categories, and 2 have a 1 in both commercial processing engagement and reliance. No communities have a 1 in both recreational engagement and recreational reliance. These results show the variety of fishing community types that exist in Alaska and to some extent highlight the diversity in commercial and recreational fisheries involvement seen across the state.

In this study we have chosen to group communities as the highest 10%, the middle 80%, and the lowest 10% for each of these indices, which equates to 8 high communities, 73 middle communities, and 8 low communities. This does not mean that the 9th most engaged or reliant community is not engaged or reliant on fisheries, but rather that there are other communities that are relatively more engaged or reliant. However, in this study we are focusing only on a small number of communities to highlight those areas in which they have a very high involvement in commercial and recreational fisheries relative to the rest of the state.

We created these indices to comport with NOAA's Next Generation Strategic Plan and they will be a significant contribution to the assessment of community well-being in the context of catch share management regimes that govern the majority of Alaska's federal fisheries. Our intent is that these indices will be useful for both fisheries managers and communities themselves to assess and predict community level impacts from fisheries management changes. To further improve these indices, we completed fieldwork in 2013 in 12 communities across the state to groundthruth the results and validate the indices' ability to measure community engagement and reliance on fishing. We are currently using the results of this fieldwork to test the indices and make modifications to the methodology where appropriate.

Table 1: Fisheries involvement indices with factor loadings and total variance explained.

	Rotated Factor Loading	Total Variance Explained
Commercial Processing Engagement		
Commercial revenue	0.983	71%
Commercial pounds landed	0.927	
Number of processors	0.544	
Commercial Processing Reliance		
Commercial revenue per capita	0.988	94%
Commercial pounds landed per capita	0.970	
Number of processors per capita	0.947	
Commercial Harvesting Engagement		
Number of commercial fishing permits	0.990	95%
Number of vessels owned	0.975	
Crew licenses	0.957	
Commercial Harvesting Reliance		
Number of commercial fishing permits per capita	0.972	92%
Number of vessels owned per capita	0.982	
Crew licenses per capita	0.917	
Recreational Engagement		
Number of charter businesses	0.718	79%
Number of sportfish licenses	0.865	
Number of sportfish guide businesses	0.981	
Number of sportfish guide licenses	0.975	
Recreational Reliance		
Number of charter businesses per capita	0.940	77%
Number of sportfish licenses per capita	0.562	
Number of sportfish guide businesses per capita	0.980	
Number of sportfish guide licenses per capita	0.969	

Table 2: Community engagement and reliance indices of fisheries involvement for all Alaskan communities that rank in the top 10% of communities and are therefore considered "high" for at least one index.

Community	Comm. Processing Engagement	Comm. Fishermen Engagement	Comm. Processing Reliance	Comm. Fishermen Reliance	Rec. Engagement	Rec. Reliance	Total
Elfin Cove	0	0	1	1	0	1	3
Juneau	1	1	0	0	1	0	3
Ketchikan	1	1	0	0	1	0	3
Kodiak	1	1	0	0	1	0	3
Sitka	1	1	0	0	1	0	3
Akutan	1	0	1	0	0	0	2
Anchorage	0	1	0	0	1	0	2
Chignik	0	0	1	1	0	0	2
Cordova	1	1	0	0	0	0	2
Egegik	0	0	1	1	0	0	2
Homer	0	1	0	0	1	0	2
Pelican	0	0	0	1	0	1	2
Petersburg	1	1	0	0	0	0	2
Point Baker	0	0	0	1	0	1	2
Port Alexander	0	0	0	1	0	1	2
Ugashik	0	0	1	1	0	0	2
Unalaska	1	0	1	0	0	0	2
Excursion Inlet	0	0	1	0	0	0	1
Kasilof	0	0	0	0	0	1	1
King Salmon	0	0	0	0	0	1	1
Larsen Bay	0	0	0	0	0	1	1
Mekoryuk	0	0	0	1	0	0	1
Naknek	0	0	1	0	0	0	1
Ninilchik	0	0	0	0	0	1	1
Seward	0	0	0	0	1	0	1
Soldotna	0	0	0	0	1	0	1

Conclusion

Through this project we have developed a novel way for fisheries managers to look at the potential community impacts associated with fisheries management changes. The approach presented here represents a quantitative method for incorporating multiple data sources across commercial processing, commercial harvesting, and recreational fishing involvement into measurable concepts of fishing engagement and reliance at the community level. We are currently expanding this methodology to create other types of indices, including a set of Alaskan social vulnerability and resilience indices that include information about the labor force, housing characteristics, poverty, population composition, personal disruption, housing disruption, subsistence fishing, and species-specific dependence. Socio-economics researchers at the Northeast Fisheries Science Center and Southeast Regional Office have developed a website where one can explore a set of similar social indices for the East Coast of the United States. The data for Alaskan communities will be available for exploration on this website in spring 2014.

The main advantage of this methodology is the ability to assimilate large amounts of information by combining a large number of correlated variables into a single index. A second advantage is the ability to rely on secondary data sources to analyze community impacts rather than having to undertake primary data collection (in-person interviews). Primary data collection inevitably takes considerably more time and resources, and ultimately may not fit within the short timeframes in which social impact assessments must often be written in the fisheries management process.

This research represents a glimpse into a larger research project where we are looking at many different indicators of community vulnerability, resilience, and well-being. Some of the additional concepts for which we are developing indices include climate change vulnerability (e.g., changes in sea ice extent, sea level rise, erosion risk), and vulnerability to specific fisheries management actions (e.g., the potential Gulf of Alaska bycatch management program). We are also creating a time series of engagement and reliance indices to facilitate retrospective comparisons of engagement and reliance before and after fisheries management regulations are implemented.

Additional Resources

Himes-Cornell, A., Hoelting, K., Maguire, C., Munger-Little, L., Lee, J., Fisk, J., Felthoven, R., Geller, C., Little, P., 2013. Community profiles for North Pacific Fisheries - Alaska. U. S. Dep. Commer., NOAA Tech. Memo. National Marine Fisheries Service-AFSC-259, Volumes 1-12.

National Marine Fisheries Service (NMFS), 2013. Fisheries of the United States 2012. Silver Spring, MD.

Main harbor and processing plant in Sand Point, AK.
Photo by Conor Maguire

Habitat and Ecological Processes Research

Ocean Acidification and EFH Research Funding for FY 2014

The AFSC will receive about $376,450 for ocean acidification research in FY 2014. The new funds primarily will be used to conduct species-specific physiological research. The species-specific physiological response to ocean acidification is unknown for most marine species. Lacking basic knowledge, research will be directed toward several crab, fish, and coral taxa. The research will be conducted at the AFSC's Kodiak and Newport Laboratories. The king crab results also will be incorporated into a king crab bioeconomic model; this work will be completed by the Socioeconomics Assessment program in Seattle.

Principal Investigators	Abbreviated Titles	Funding
Foy	Alaska crab growth and survival	$195,950
Dalton	Alaska crab abundance forecast	$46,200
Hurst	Growth and survival of finfish	$52,300
Foy, Hurst, Mathis	Water chemistry	$52,649
Stone	Calcium carbonate mineralogy of Alaskan corals	$29,351
Total		$376,450

Essential Fish Habitat Funding

The AFSC will receive about $494,100 for essential fish habitat (EFH) research in FY 2014. Project selection for EFH research is based on research priorities from the Alaska Essential Fish Habitat Research Plan. Research priorities are

1. Characterize habitat utilization and productivity; increase the level of information available to describe and identify EFH; apply information from EFH studies at regional scales.
2. Assess sensitivity, impact, and recovery of disturbed benthic habitat.
3. Validate and improve habitat impacts model; begin to develop geographic-based database for off-shore habitat data.
4. Map the seafloor.
5. Assess coastal and marine habitats facing development.

Principal Investigators	Titles	Funding
Rooper, Sigler, Hoff	Ground truth the presence and abundance of coral habitat on the eastern Bering Sea slope both inside and outside canyon areas	$138,420
Zimmermann	Bathymetry and substrate compilation from smooth sheets: Gulf of Alaska and Norton Sound	$72,572
Laurel, Ryer, Copeman	Optimal thermal habitats of gadids in Alaskan waters	$68,000
Olson, Foy, Harris	Examining the effects of offshore marine mining activities on Norton Sound red king crab habitat	$77,330
Yeung, Yang, Cooper	High prey availability defines juvenile flatfish habitat quality in the eastern Bering Sea	$50,730
Malecha, Shotwell, Ammann	Recruitment and response to damage of an Alaskan gorgonian coral	$17,700
Hoff, Stone	Coral and Sponge diversity along the EBS slope with a focus on Pribilof and Zhemchug Canyons	$20,750
Stone, Waller	Matching pieces of the puzzle: validating the reproductive ecology of red tree corals in Gulf of Alaska habitats with extensive studies in shallow water	$48,575
Total		$494,100

By Mike Sigler

The Bering Sea Project

In conjunction with the 2014 Ocean Sciences Meeting (23-28 February 2014 at the Hawaii Convention Center in Honolulu, Hawaii) the Bering Sea Project hosted a session, Climate-mediated oceanographic drivers and trophic interactions in high latitude marginal seas: observations, modeling, and syntheses and consequences for commercial fisheries (24 Feburary). There also was a Bering Sea Open Science Meeting which took place on Sunday, 23 Febuary. The Bering Sea Open Science Meeting (BSOSM) aimed to

1. Communicate research knowledge derived from the 2007-13 Bering Sea Project, and
2. Engage the community working in related disciplines and regions.

This BSOSM welcomed topics within the broad scope of the Bering Sea Project - to "understand the impacts of climate change and dynamic sea ice cover on the eastern Bering Sea ecosystem" - as well as related work from other research programs or other subarctic regions. A key theme for the BSOSM was integration and synthesis: cross-discipline work and novel collaborations have been central to the Bering Sea Project and that theme was extended through the BSOSM.

By Mike Sigler

The titles and presenters follow.

Henry P. Huntington	It's not all about the ecosystem: Results and collaborations of the Local and Traditional Knowledge component of the Bering Sea Project
Calvin Mordy	Mechanisms that influence the magnitude, distribution and fate of primary production on the Bering Sea Shelf
Rolf Gradinger	Contribution of sea ice biological processes to Bering Sea winter/spring carbon cycle
Neil S. Banas	Temperature and ice influences on large zooplankton on interannual and multidecadal scales: Ecosystem and life-history modeling approaches
George L. Hunt, Jr.	What controls the distribution and abundance of euphausiids over the southeastern Bering Sea shelf?
Colleen M. Petrik	The effect of eastern Bering Sea climate variability on the distribution of walleye pollock early life stages during the BSIERP/BEST years
Anne B. Hollowed	Fish distributions and ocean conditions
Alan Haynie	Not just a march to the north: How climate variation affects the Bering Sea pollock trawl and Pacific cod longline fisheries
Alexandre N. Zerbini	Baleen whale abundance and distribution in relation to environmental variables and prey abundance in the eastern Bering Sea
Kathy Kuletz	Spatial and seasonal aspects of seabird diet and predator-prey relations across the Bering Sea shelf
Andrew W. Trites	What drives the abundance of top predators? A comparative analysis of increasing and decreasing populations of fur seals and sea birds in the eastern Bering Sea
Ivonne Ortiz	The benefits of hindsight: Examining results of the Bering Sea Project's vertically-integrated modeling effort from physics to fish
Lee W. Cooper	A review of new insights on functioning and dynamics of the northern Bering Sea ecosystem
Michael F. Sigler	An organism-centric view of subarctic productivity: Gas tanks, location matters and historical context

Figure 1. Belugas whales in the Arctic. Photo by Laura Morse (NMFS research permit 782-1719).

Cetacean Assessment & Ecology Program

Spatio-Temporal Movement Patterns of Two Alaskan Beluga Whale Stocks Based on Acoustic Detections

Passive acoustic monitoring using bottom-mounted recorders is a reliable and cost-effective method for monitoring the presence of some marine mammals year-round in the extreme environmental conditions present in the Arctic (extensive darkness, cold, and winter ice coverage; e.g., Delarue et al. 2011, Moore et al. 2012, MacIntyre et al. 2013). Beluga whales (Delphinapterus leucas; Fig. 1) are commonly referred to as the canaries of the sea due to their highly vocal nature. They produce a wide variety of vocalizations that can be classified as whistles, pulsed calls, noisy calls, combined calls, and echolocation clicks (Sjare and Smith 1986). These vocalizations range in frequency from approximately 200 Hz to 20 kHz, with echolocation clicks extending upwards of 120 kHz. Thus, belugas are an ideal candidate species for passive acoustic monitoring over their vast migratory range.

Within the Alaskan region (Fig. 2), five stocks or populations of belugas are recognized based on their defined summering locations or year-round residence (Allen and Angliss 2013). These are the migratory stocks of the eastern Beaufort Sea, the eastern Chukchi Sea, and the eastern Bering Sea (Norton Sound), which have distinct summering and wintering grounds, and the resident populations of Bristol Bay and Cook Inlet, which are not migratory. Genetic data suggest each population is demographically distinct (O'Corry-Crowe et al. 1997).

The aim of this study was to identify peaks in beluga vocal activity from four passive acoustic moorings, located in the northern Bering, northeastern Chukchi, and western Beaufort Seas, over a single year to understand the migratory movements and fine-scale timing of the eastern Beaufort Sea and eastern Chukchi Sea stocks as they undertake their extended migrations in the Alaskan Arctic and Subarctic. The large, eastern Beaufort Sea (EBS) stock (~40,000 individuals; Allen and Angliss 2013) migrates through the eastern Chukchi Sea, utilizing pathways such as the open-water lead that develops near the coast between Point Hope and Point Barrow (Moore et al. 2000) to summer in the Mackenzie Delta and Amundsen Gulf in the Canadian Beaufort Sea region

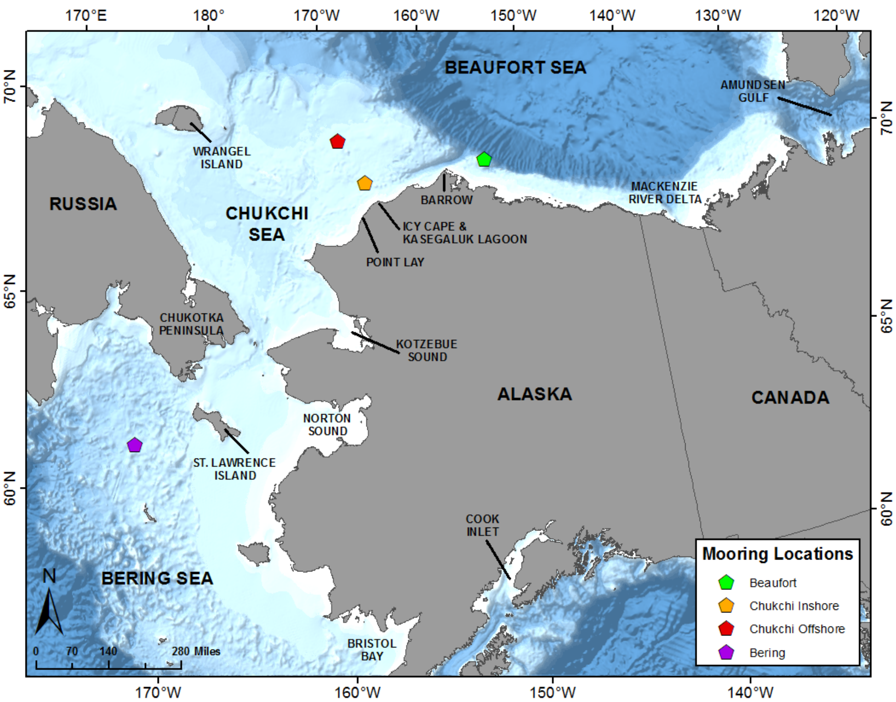


Figure 2. Map of the Alaskan Arctic region, including locations mentioned in the text and each recorder location. Mooring icons cover the approximate call detection range.

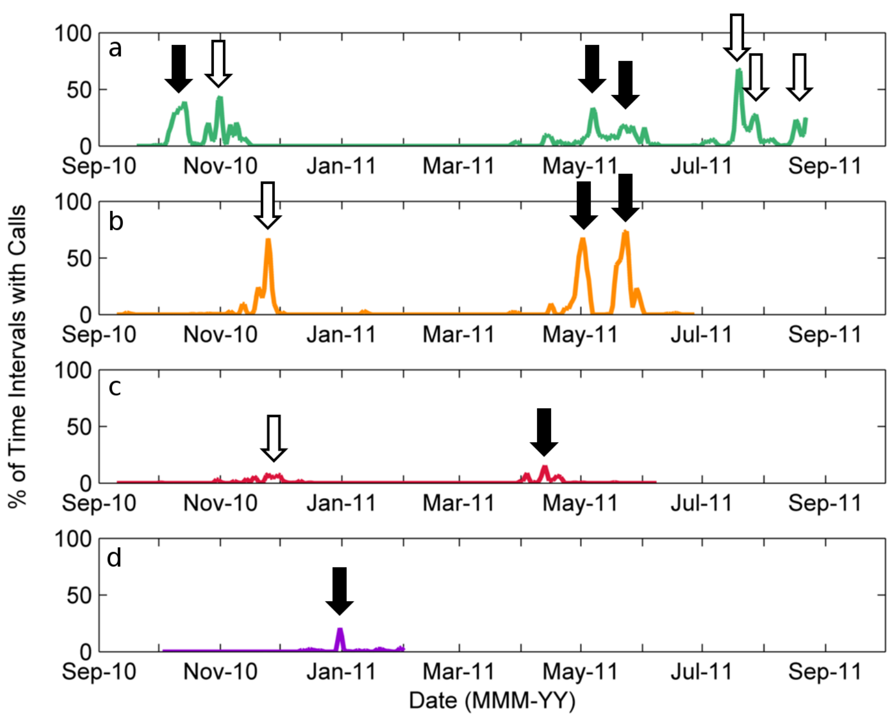


Figure. 3. Beluga acoustic detections from September 2010 to September 2011 on the four recorders located in the western Beaufort, northeastern Chukchi, and northern Bering Seas. Arrows indicate the stock/population origin(s) of acoustic detections from the current study based on satellite-tagging studies of the eastern Chukchi Sea (ECS) stock (white arrows) and the eastern Beaufort Sea (EBS) stock (black arrows) in the a) Beaufort Sea, b) "inshore" northeastern Chukchi Sea, c) "offshore" northeastern Chukchi Sea, and d) Bering Sea. Colors indicate mooring locations shown in Figure 2.

(Harwood et al. 1996). In summer, satellite-monitored individuals from this stock moved hundreds of kilometers to the north and west, including into dense areas of pack ice (Richard et al. 2001, Hauser et al. 2014). In autumn, these individuals migrated west through the Beaufort Sea and then south through the Chukchi Sea (particularly on the western side) before crossing the Bering Strait and entering the Bering Sea at the end of November (Richard et al. 2001, Hauser et al. 2014). The smaller, eastern Chukchi Sea (ECS) stock (~3,700 individuals; Allen and Angliss 2013) spends early summer (June) along the coast of the eastern Chukchi Sea, particularly near Kasegaluk Lagoon and Kotzebue Sound (Frost and Lowry 1990). Anecdotal evidence suggests the ECS stock spends winter and spring in the northern Bering Sea, north of St. Lawrence Island (D. Hauser, pers. comm.). In summer and autumn, satellite-monitored individuals from this stock moved from the eastern Chukchi Sea into the Arctic basin and western Beaufort Sea, where some individuals roamed widely (Suydam et al. 2001, 2005; Hauser et al. 2014). Therefore, there is seasonal overlap between the ECS and EBS stocks. (Hauser et al. 2014). In this study, we investigated the spatio-temporal movement patterns of two Alaskan beluga stocks, using long-term passive acoustic recorders to capture temporal peaks in vocal activity, to improve our understanding of the fine-scale migratory timing of these stocks for management and conservation purposes. (continued)

Four moorings that included acoustic recorders (AURALs), deployed in autumn 2010 and retrieved the following year, were chosen as representatives for each region (Fig. 2, Table 1). Image files (.png) of spectrograms were pre-generated from recordings, then analyzed using an in-house MATLAB-based program. Data are presented as the percentage of time intervals (standardized to 180 sec) with calls for each day by comparing the number of image files with calls to the number of available image files for each mooring. Data were then averaged using a zero-phase 2-day moving average in MATLAB. The population origin of each peak is inferred using the current understanding of beluga movements from satellite-tagging studies (summarized in Hauser et al. 2014) and aerial surveys (Clarke et al. 1993, 2012; Moore et al. 1993, 2000).

In total, 1,020 days of data were analyzed (~280,000 image files). Due to the recording settings (Table 1), echolocation clicks were not recorded, and all detections were based on beluga social communication signals (whistles, pulsed, noisy, and combined calls). Belugas were detected on 267 days (26% of days analyzed contained one or more beluga calls). Detections were recorded sporadically throughout the region, together with distinct vocal peaks (defined as >20% of time intervals with calls for each day due to the sporadic nature of beluga calls in time, but prolific production per individual) when seasonal migrations transited an area.

In the western Beaufort Sea, two peaks of detections occurred in autumn; the first occurred from 5 to 16 October and the second from 30 October to 2 November. Due to the seasonal timing of detections, the first peak was likely from the EBS stock leaving the Beaufort Sea followed by the ECS stock (second peak; Fig. 3a). A spring peak in detections occurred from 2 until 15 May, with a series of smaller peaks spread from 21 May into the start of June. Both early- and late-May peaks corresponded with similar, slightly earlier peaks in the northeastern Chukchi Sea (Figs. 3a, b). Therefore, the EBS stock, first detected in the northeastern Chukchi Sea (Fig. 3b), continued moving northeast and then east into the western Beaufort Sea in two “groups” en route to the eastern Beaufort Sea (Fig. 3a). Over summer, belugas were detected from 2 July until 22 August and were likely from the ECS stock, as the EBS stock is located in the Canadian Beaufort Sea at this time of year (Fig. 3a). At the inshore, northeastern Chukchi Sea recorder, a strong autumn peak with a high percentage of time intervals with call detections occurred from 19 to 29 November. This peak was likely caused by the ECS stock leaving the northeastern Chukchi Sea (Fig. 3b). Two strong spring peaks with a high percentage of beluga detections were evident; the first spring peak occurred from 23 April to 6 May, and the second spring peak occurred from 18 May to 1 June. Both early- and late-May peaks were likely caused by the EBS stock moving north through the northeastern Chukchi Sea en route to their eastern Beaufort Sea summering grounds (Fig. 3b). On the offshore recorder, the highest percentage of time intervals with calls occurred from 17 November to 1 December. This latter period of detections is consistent with the slightly later movement of the ECS stock out of the northeastern Chukchi Sea (Fig. 3c). No peak in detections occurred in spring on this mooring, but the highest percentage of calls was identified from 11 to 21 April. Due to the seasonal timing of detections, these were likely caused by the EBS stock (Fig. 3c). In the Bering Sea, there was a single peak in detections over winter from 30 December to 1 January, with lower levels of calls detected outside of this peak. This peak was likely caused by the EBS stock, due to their disposition to overwinter in a more southwesterly location than the ECS stock (Fig. 3d).

The peaks in beluga call detections from passive acoustic monitoring presented here agree with the overall understanding of the seasonal migration of two beluga populations in Alaskan Arctic waters (e.g., Hauser et al. 2014). However, our data provide a finer scale of temporal detail to allow investigation of the population origin of each peak. After overwintering in the Bering Sea, belugas from the EBS and ECS stocks migrated north through the northeastern Chukchi and western Beaufort Seas in multiple waves, which were temporally distinct. Inclusion of all data (100%) into analyses has provided a robust assessment of the fine-scale timing of movements. These results suggest peaks in vocal activity are able to capture fine-scale temporal movements of populations when temporal or spatial differences between detection peaks are large enough to be identified as independent events. Additional studies are already underway to investigate the vocal repertoire of each population to evaluate the feasibility of using differences in dialects to identify each population.

By Ellen C. Garland

Table 1. Location of each long-term recorder and deployment information.

Location	Latitude (N)	Longitude (W)	Depth (m)	Recording date Start	Recording date End	Length (days)	Sampling rate (Hz)	Duty cycle
Bering Sea	62.1960000	174.6588333	70	10/03/2010	02/01/2011	120	8,192	8 min/20 min
“Inshore” Chukchi Sea	70.7983833	163.0811167	43	09/10/2010	06/27/2011	291	16,384	95 min/300 min
“Offshore” Chukchi Sea	71.8339500	165.9033000	44	09/10/2010	06/08/2011	272	16,384	95 min/300 min
Western Beaufort Sea	71.6880333	153.1739833	105	09/20/2010	08/22/2011	337	8,192	9 min/20 min

Figure 1. Zapadni Reef rookery site, with new observation blinds, on St. Paul Island.

Alaska Ecosystems Program

Demography of Northern Fur Seals on the Pribilof Islands

In response to the recent decline of northern fur seals (Callorhinus ursinus) on the Pribilof Islands, the Alaska Ecosystems Program began a long-term demographics research program, on St. Paul Island in 2007 and on St. George Island in 2009, based primarily on the tagging and re-sighting of fur seals at a few rookeries where it was deemed feasible. The objectives were to estimate age-specific survival and reproductive rates of female northern fur seals to compare with historic rates in order to determine which life-history stage or stages were driving the decline.

Only two or three rookery sites offered adequate vantages to obtain re-sightings of tagged seals. We chose the northern end of the Polovina Cliffs rookery on the northeast side of St. Paul Island to begin the tagging program in 2007, and we added the South rookery on St. George Island in 2009. With the addition of elevated blinds, re-sighting became possible at Zapadni Reef rookery on southern St. Paul Island (Fig. 1) and pup tagging was initiated there in 2010. Tagging takes place each fall, and re-sighting with high-powered optics and photography occurs during the first 2 months of pupping season each summer (July-August). Re-sighting effort was recently extended into September, when many juveniles tagged as pups reappear at the rookeries.

Reproductive rates were estimated as the proportion of fur seals with a pup among the non-pup tagged sample. The mean annual reproductive rate at both islands was 0.84 (SE=0.01, range=0.79-0.89). With such high rates, low adult reproduction is unlikely to be the cause of the current population decline. Reproductive rates are within the range expected for population stability, and the potential biases in these estimates are small due to the very high probability of re-sighting each year.

Survival and probability of sighting were estimated with the package "marked" in R statistical software, using Akaike's Information Criteria for model selection. From 2008 to 2012, estimated adult female survival at St. Paul was 0.77 (SE=0.014) and from 2009 to 2012 it was 0.79 (SE=0.015) at St. George. Annual probability of sighting ranged from 0.86 to 0.97 at St. Paul and has been close to 0.99 at St. George since 2011. Apparent adult survival is lower than needed for population stability but is confounded with permanent emigration, which has not yet been estimated. Tagged pup cohorts have not reached recruitment age (4-8 years), so preliminary estimates of juvenile survival are not considered reliable, as yet.

Figure 2a. Tag types applied to northern fur seals on the Pribilof Islands. Pictured above: Allflex "narrow" sheep tag (AN).

Figure 2c. Monel metal tag (M), National Band and Tag Co.

Figure 2b. Allflex large tag (AL).

Figure 2d. Dalton Superflexitag (DS).

Good survival estimates are notoriously difficult to obtain in marine mammal studies. At the outset, we recognized two important uncertainties: tag loss and permanent emigration. Little information was available on the retention and readability of flipper tags on northern fur seals, so many types had to be tried and evaluated (Fig. 2). Tables 1 and 2 describe tag retention by adults at the Polovina Cliffs rookery and by pups tagged at the South rookery in 2009. Of the tags tried, Allflex "narrow" sheep tags (AN) (Fig. 2a) performed the best and Dalton Superflexitags (DS) (Fig. 2d) the worst, but the probability of losing both tags was relatively low even in the worst case (pups with DS tags). Differences in estimated tag-loss rates and patterns between sites suggest that rookery substrate is a key factor causing tag loss; AN tags present the lowest under-flipper profile with less chance of catching on rocks. DS tags also begin to become unreadable after approximately 5 years. We now tag exclusively with AN tags.

Table 1. Annual tag loss from tag transitions (2 tags to 1 tag) for adult female northern fur seals on St. Paul Island.

Tag types and ages	n2	n1	single loss rate	SE	double loss rate	SE
Dalton Superflexitag (DS)-new	103	9	0.042	0.014	0.002	0.001
DS-2nd yr	61	7	0.054	0.020	0.003	0.002
DS-2+ yrs	101	4	0.019	0.010	0.000	0.000
Allflex "narrow" (AN)	83	0	0		0.000	
AN w/metal-new	103	0	0			
metal w/AN-new	99	5	0.048	0.021	0	
AN w/metal-old	239	2	0.008	0.006		
metal w/AN-old	239	1	0.004	0.004	0.000	0.000
Allflex large (AL)-old	27	2	0.036	0.025	0.001	0.001
AL w/radio-tag (TX)-new	71	2	0.027	0.019		
AL w/TX old	109	0	0			

Estimating permanent emigration of adults remains problematic. Surveys outside our intensive study sites suggest the rate is low, but even low rates can represent an important bias and have a large influence on population growth when survival rates are high, as is the case with large mammals. We are evaluating the degree to which permanent emigration may affect survival estimates by expanding our surveys of other rookeries and examining patterns of temporary emigration in our re-sighting data that may give insight to the movements of fur seals among the various rookeries. These longitudinal re-sighting records may also allow us to estimate foraging trip durations of females with pups, a potential indicator of foraging conditions for northern fur seals.

Table 2. Cumulative tag loss after initial tagging as pups, with Dalton Superflexitags (DS), for the 2009 pup cohort on St. George Island.

Tag types and ages	n2	n1	single loss rate	SE	double loss rate	SE
DS(left)-2 yrs	34	29	0.460	0.063		
DS(right)-2 yrs	34	15	0.306	0.066	0.141	0.036
DS(left)-3 yrs	61	42	0.408	0.048		
DS(right)-3 yrs	61	26	0.299	0.049	0.122	0.025
DS(left)-4 yrs	67	60	0.472	0.044		
DS(right)-4 yrs	67	43	0.391	0.047	0.185	0.028

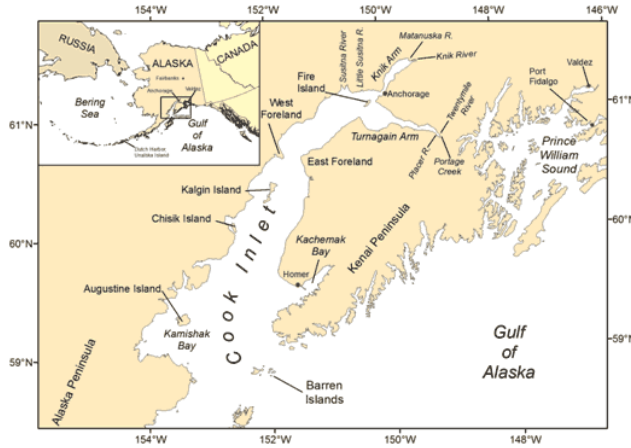
Groundfish Assessment Program

Smooth Sheet Bathymetry of Cook Inlet, Alaska

Scientists with the AFSC's Groundfish Asessment Program have expanded their mapping study of the Aleutian Islands to include Cook Inlet, Alaska. This work is part of a project using smooth sheets to provide better seafloor information for fisheries research. The Cook Inlet project includes the same smooth sheet bathymetry editing and sediment digitizing as the Aleutian Islands effort, but also includes:

- digitizing the inshore features, such as rocks, islets, rocky reefs, and kelp beds;
- digitizing the shoreline; and
- replacing some areas of older, lower resolution smooth sheet bathymetry data with more modern, higher resolution multibeam bathmetry data.

The smaller area of Cook Inlet, greater amount of project time, and higher quality of smooth sheets than in the Aleutian Islands made these additions possible. The NMFS Alaska Regional Office's Essential Fish Habitat funding made much of this work possible.

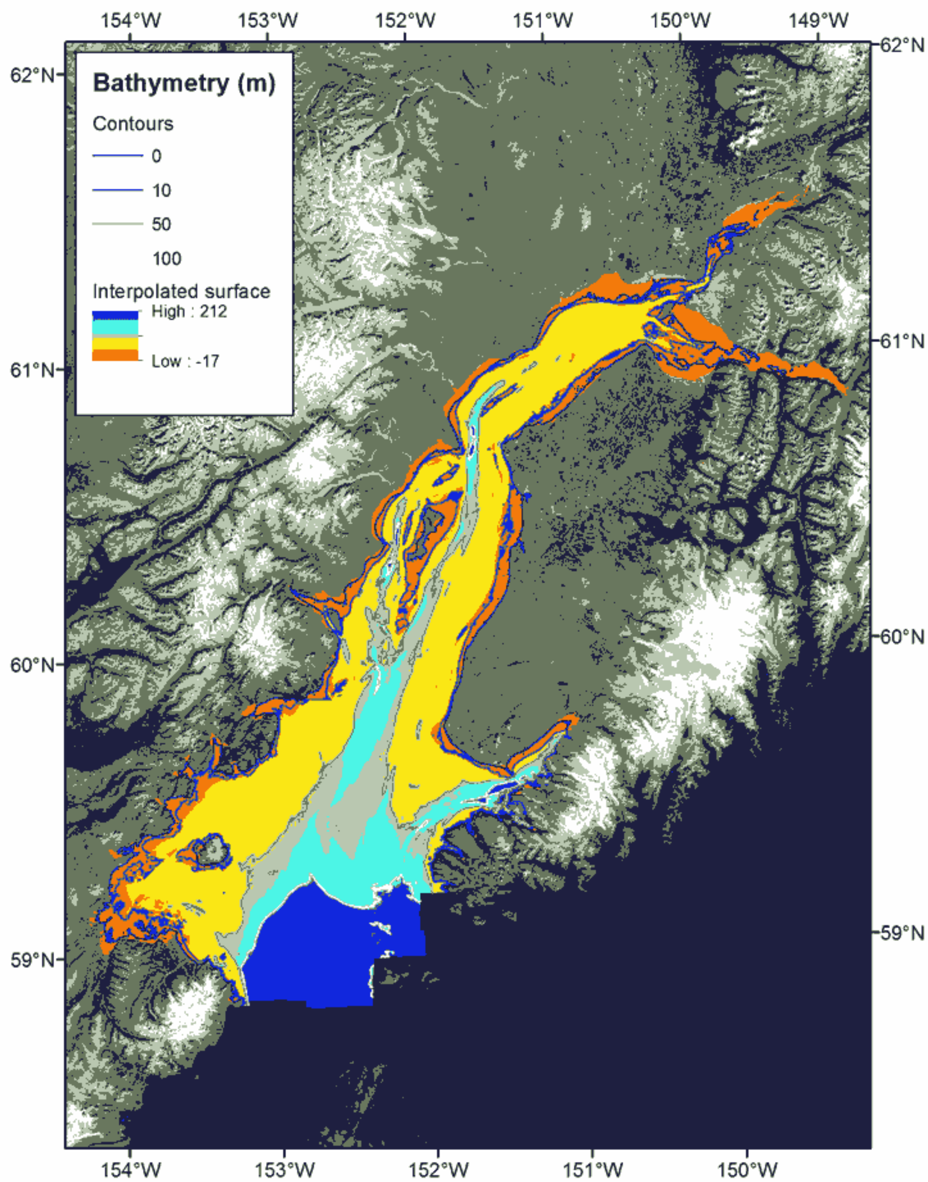


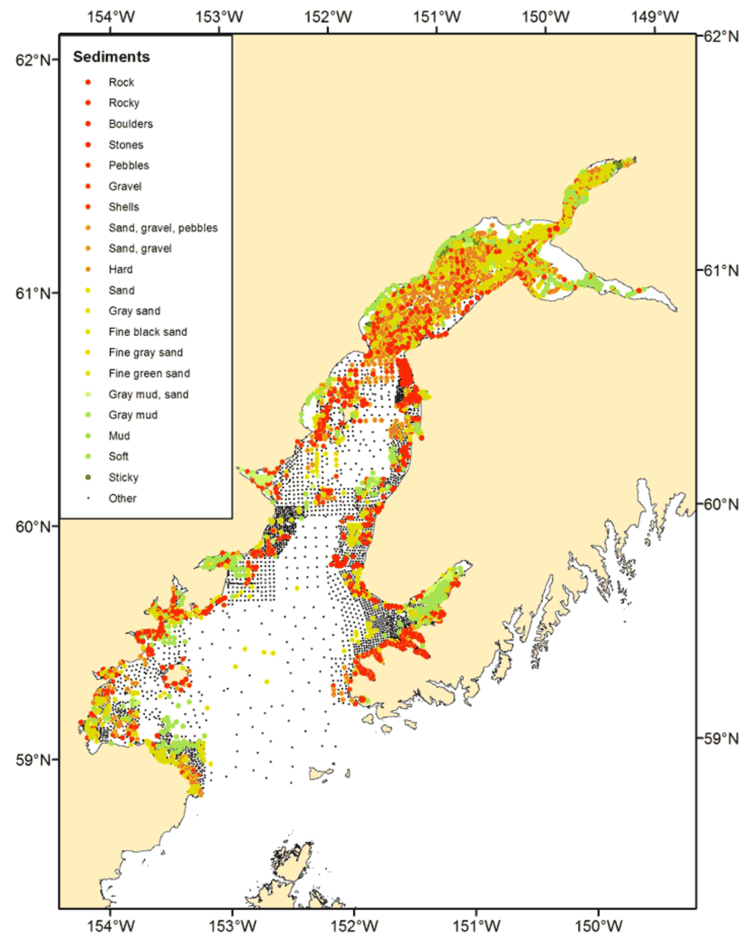
Bathymetry of Cook Inlet

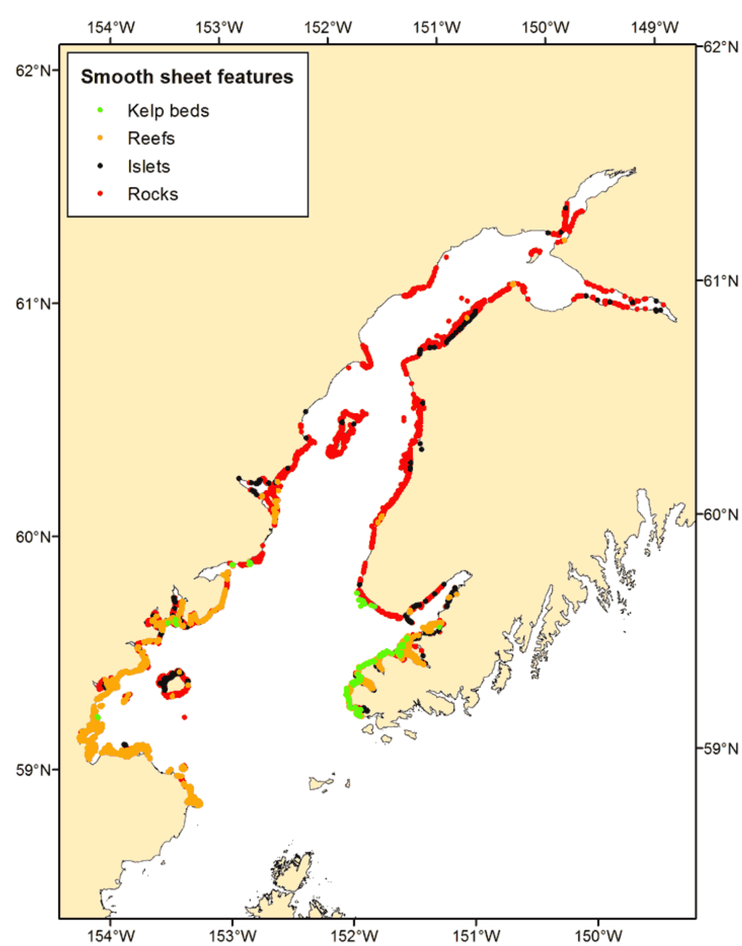
A total of 1.4 million National Ocean Service (NOS) bathymetric soundings from 98 hydrographic surveys represented by smooth sheets in Cook Inlet were corrected, digitized, and assembled.

Overall, the inlet is shallow, with an area-weighted mean depth of 44.7 m, but is as deep as 212 m at the south end near the Barren Islands.

The original, uncorrected smooth sheet bathymetry data sets are available from the National Geophysical Data Center (NGDC), which archives and distributes data that were originally collected by the NOS and others.







Sediments of Cook Inlet

A total of 9,000 verbal surficial sediment descriptions from 96 smooth sheets were digitized, providing the largest single source of sediment information for Cook Inlet.

There were 1,172 unique verbal descriptions, with most of the sediment description categories (58%) only having a single occurrence. That means that most descriptions were fairly lengthy and specific.

Of the sediment descriptions which occurred more than once, Hard (n = 1335), Sand (n = 721), Rocky (n = 608), and Mud (n = 365) were the most common, which ranged from Rock to Clay, Sand ridges to Mud flats, Weeds to Stumps, and Mud to Coral.

The 20 most common sediment categories are depicted along a color gradient in the Figure, where red shows larger/harder sediments such as Rock, Rocky, and Boulders, and green shows smaller/softer sediments such as Mud, Soft, and Sticky.

Smooth Sheet Features of Cook Inlet

A total of 12,000 features such as rocky reefs, kelp beds, rocks, and islets were digitized from the smooth sheets and added to the original files from NGDC, resulting in a total of 18,000 features.

Almost 10,000 of these points indicated the edge of rocky reefs, covering much of the shore in Kamishak Bay, the southern shore of Kachemak Bay, and near Chisik Island, but reefs were rare north of there.

More than 7,000 rocks and more than 800 islets were found along most of the Cook Inlet shore. There were less than 300 kelp beds, almost all of which occurred in outer Kachemak Bay.

Altogether there were almost 18,000 rocks or rock ally features such as rocky reefs, kelp beds, and islets, which were added to the sediment data set.

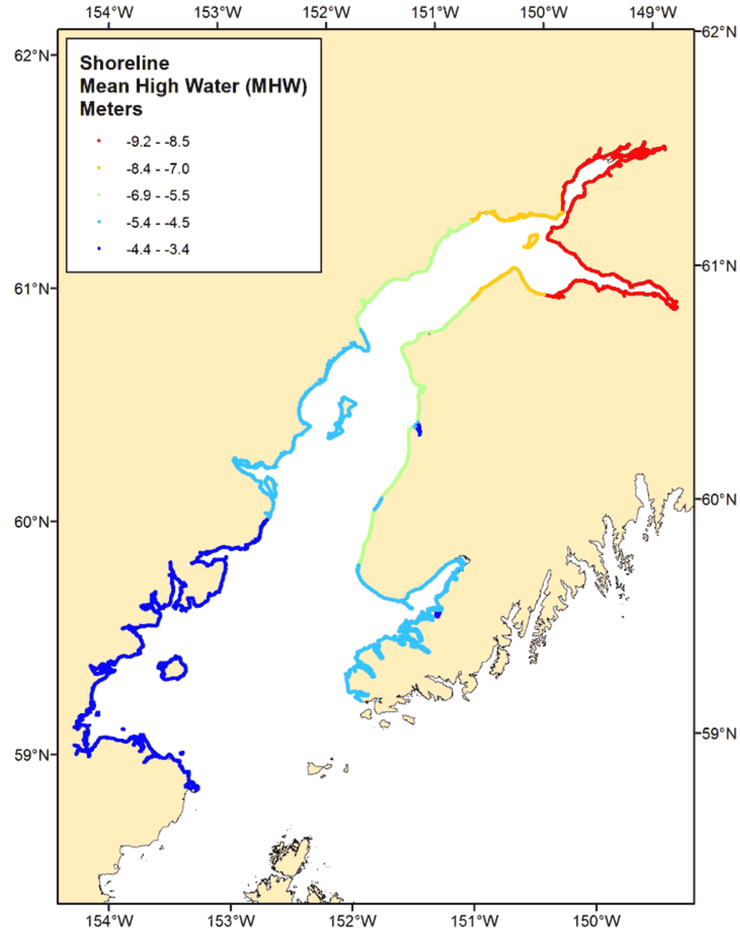
Shoreline of Cook Inlet

A total of 95,000 individual shoreline points were also digitized, describing 2,418.3 km of mainland shoreline and 528.9 km of island shoreline from 507 individual islands, providing the most detailed shoreline of Cook Inlet.

The shoreline is defined on the smooth sheets as MHW (Mean High Water), the same vertical tidal datum as the bathymetry, which typically ranges only as shallow as MLLW (Mean Lower Low Water), defined as zero meters depth.

The MHW shoreline was highest in the northern end of Cook Inlet, ranging up to -9.2 m in Turnagain Arm, and -9.1 m in Knik Arm, and lowest at Augustine Island and Kamishak Bay (-4.4 to -3.4 m, respectively).

By adding the digitized shoreline to the digitized bathymetry, a complete bathymetry map for Cook Inlet was assembled without the typical gaps between the shallowest soundings and the shoreline. Thus, researchers were able to determine that at high tide (MHW) the total volume of the inlet is 1,024.1 km3 and the total surface area is 20,540 km^2. When the tide drops from MHW to MLLW, the Inlet loses 99.7 km^3 of water, or 9.7% of its volume, and exposes 1,616 km^2 of seabed, or 7.9% of its surface area.



Conclusion

While the Alaska Fisheries Science Center has been conducting marine research for decades in Alaskan waters, a lot of basic information about the seafloor, such as depth, is generally not known beyond what is depicted on small scale (1:100,000) NOS Navigational Charts. Therefore, AFSC scientists have been creating more detailed bathymetry and sediment maps in order to provide a better understanding of how studied animals interact with their environment. This information is being used by NOAA's Deep Sea Coral Research and Technology Program to predict the presence/absence and abundance of corals and sponges. More information on these studies is featured in the AFSC research report Determining the Distributions of Deep-sea Corals and Sponges Throughout Alaska.

Scientists who conduct AFSC stock assessment bottom trawl surveys are also using the information to delimit areas that cannot be sampled effectively with bottom trawls. The results from the AFSC mapping project may result in an alternative survey method such as underwater cameras or acoustics to assess the abundance of fish in untrawlable areas.

An inter-agency collaboration, the Gulf of Alaska Integrated Ecosystem Research Program (GOA-IERP), sponsored by the North Pacific Research Board, is using the detailed bathymetry and sediment information to predict the preferred settlement habitat juveniles of five important groundfish species. Results from GOA-IERP will be used towards developing a better understanding of the ecosystem processes that regulate stock recruitment.

The Alaska Regional Office will investigate use of the bathymetry and sediment information to oversee sustainable fisheries, conduct Essential Fish Habitat (EFH) reviews, and manage protected species. The Bureau of Ocean Energy Management may use the information for preparing National Environmental Policy Act (NEPA), Essential Fish Habitat (EFH), and Endangered Species Act (ESA) documents for the possibility of a federal lease sale in lower Cook Inlet.

Details of the processing methods for the smooth sheet data for Cook Inlet are published in " Smooth sheet bathymetry of Cook Inlet, Alaska" NOAA Tech. Memo. NMFS-AFSC-275.

By Mark Zimmermann
and Megan Prescott

Resource Ecology and Ecosystem Modeling Program

Fish Stomach Collection and Lab Analysis

During the first quarter of 2014, Resource Ecology and Ecosystem Modeling (REEM) staff analyzed the contents of 3,647 groundfish stomachs. Laboratory analysis was completed and the resulting data error-checked and loaded into the AFSC's Groundfish Food Habits database, resulting in 11,626 added records. The majority of the samples analyzed during the quarter were Pacific halibut and gadids from the eastern Bering Sea. Pacific halibut and rockfishes from the Gulf of Alaska region were also analyzed. Other REEM program highlights include:

- Angela Dillon, a University of Washington School of Fisheries and Aquatic Sciences undergraduate, completed the stomach content analysis for her Capstone student project "Food Habits of Pacific Cod, Pacific Halibut, and Flathead Sole in Marmot Bay, Alaska." She is now beginning her analysis of the resulting data.
- A scientist visiting from the Northwest Fisheries Science Center, Jessica Randall, is conducting stomach content analysis on juvenile salmon from Puget Sound, and Food Habits Lab personnel are assisting her to identify some of the zooplankton in the samples.
- Forty-eight stomach sampling kits for fisheries observers were assembled and delivered to vessels in the Seattle-Tacoma area before their departure to Alaskan fishing grounds. Stomach sampling was performed by fisheries observers on 576 walleye pollock and 99 Pacific cod from the eastern Bering Sea and Aleutian Islands regions.
- REEM program outreach activities included a laboratory and program tour for Bob Lauth and Jenna Keeton (a senior at University of Washington), and school presentations for Jane Addams K-8 School in Seattle during their Science Career Day and for an East High School science class in Anchorage.
- The REEM program educational display and the fish food habits hands-on activity were presented during the Polar Science Weekend event at the Pacific Science Center.

By Troy Buckley, Geoff Lang, Mei-Sun Yang, Richard Hibpshman, Kimberly Sawyer, Caroline Robinson and Sean Rohan

National Ecosystem Modeling Workshop

The NMFS National Ecosystem Modeling Workshop (NEMOW) took place in Seattle (18-20 March 2014). REEM program staff member Kerim Aydin served on the steering committee for the meeting, which included 50 NOAA scientists and team members; several AFSC scientists participated. The theme of the meeting was developing multi-model inference techniques for ecosystem predictions. Kerim presented a summary of ecosystem modeling activities at the AFSC.

By Kerim Aydin

Seabird Research

Stephani Zador and Shannon Fitzgerald attended the Pacific Seabird Group's 41st Annual Meeting, held this year in Juneau, Alaska, 20-22 February 2014. Zador presented a plenary talk titled "Ecosystem based management in Alaska: the role of seabirds as ecosystem indicators." Zador's plenary talk noted how the Ecosystem Chapter of the annual Stock Assessment and Fishery Evaluation (SAFE) report was used in the annual North Pacific Fisheries Management Council Process (NPFMC) and provided several examples of how seabird data are currently being used in management processes. She also noted how important the many sources of data were that supplied information for the report's Ecosystem Chapter and the current state of how this wide variety of information was being collated and "boiled down" into ecosystem indicators.

Fitzgerald presented the talk "Preliminary estimates of seabird bycatch in the Alaskan halibut longline fishery in 2013" and also presented a talk on behalf of William Walker titled "The diet of northern fulmars (*Fulmaris glacialis*) in the eastern Bering sea and Aleutian Islands Region: an exercise in the use of bycaught marine birds in investigations of natural feeding strategy." Fitzgerald also participated in the Japanese Seabird Conservation Committee, reporting on bycatch monitoring and reduction efforts in Alaskan waters, and he participated in the North Pacific Albatross Working Group Meeting, which discussed various aspects of North Pacific albatross conservation and management.

The plenary was very well received and referred to throughout the remainder of the meeting by other presenters. During a final day summary session, seabird biologist Dr. David Ainley noted that NOAA/Alaska Fisheries Science Center and the Council process seemed to have set a gold standard for work incorporating seabird data into a management process.

Abstracts and co-authors can be found on the Pacific Seabird Group website .

By Shannon Fitzgerald

Scientific and Statistical Committee Workshop

In February, the NPFMC's Scientific and Statistical Committee held a half-day workshop on the modeling efforts for the Bering Sea and Gulf of Alaska Integrated Ecosystem Research Programs. Kerim Aydin coordinated the workshop and presented, with Ivonne Ortiz, the results of physical, plankton, and fish modeling as part of the Bering Sea project, focusing on the current status of predicting recruitment for Bering Sea stocks and further presented the results of individual-based fish models for the Gulf of Alaska.

By Kerim Aydin

Bering Sea Project Open Science Meeting/ASLO Ocean Science Meeting

North Pacific Research Board (NPRB) scientists and researchers involved in the Bering Sea Integrated Ecosystem Research Project (BSIERP) met 22-23 February 2014 prior to the Association for the Sciences of Limnology and Oceanography (ASLO) Ocean Science Meeting in Honolulu, Hawaii, to present results from the BEST-BSIERP project as well as related work from other research programs and disciplines not specifically included in the program. REEM program scientists were well represented at this meeting. Kerim Aydin presented results from the vertically integrated spatially-explicit ecosystem model FEAST and discussed future applications for evaluation of climate change and fishery effects on the Bering Sea ecosystem. Kirstin Holsman presented a poster reviewing results of temperature and size-specific patterns in foraging rates of three groundfish species (walleye pollock, Pacific cod, and arrowtooth flounder) in the Bering Sea, Gulf of Alaska, and Aleutian Islands and presented a talk during the subsequent ASLO Ocean Science Meeting that reviewed results from a climate specific multi-species model under three future climate scenarios. Stephani Zador presented a talk discussing the role of qualitative synthesis of ecosystem indicators in understanding and predicting short- and long-term climate and ecosystem shifts that can impact multiple marine species in a food web, and Ivonne Ortiz presented a talk summarizing main findings of the FEAST model.

By Kirstin Holsman

Economics & Social Sciences Research Program

Research Related to the Halibut Catch Sharing Plan

To address long-standing allocation conflicts between the Pacific halibut commercial fishing sector and the recreational charter (for-hire) sector in Alaska, an Alaska halibut catch sharing plan (CSP) is being implemented in 2014 that has a provision allowing the leasing of commercial individual fishing quota (IFQ) to recreational charter businesses (see 78 FR 75844). This one-way inter-sectoral trading allows for the charter sector to increase its share of the total allowable catch while compensating commercial fishermen. This type of catch shares program is novel in fisheries.

In recent work, economist Dan Lew with the Economics & Social Sciences Research (ESSR) program and Isabel Call (UC Davis Ph.D. candidate) examine the literature on non-fisheries tradable permit programs (TPPs) that have similarities to the IFQ leasing component of the Alaska halibut CSP program. To this end, they examine several successful TPPs, drawing from emissions trading programs, water quality trading programs, and transferable development rights programs. These programs are evaluated in terms of their similarities and differences to the Alaska CSP program. Several characteristics not part of the current CSP that other TPPs have used that may increase the likelihood for the CSP to be effective in achieving its primary goals (if implemented) are identified.

In complementary work, and to help inform potential future policy discussions about the CSP, Dan Lew is developing a survey that will collect information on general attitudes toward the CSP and the guided angler fish leasing program from International Pacific Halibut Commission Area 2C and Area 3A charter boat businesses (Charter Halibut Permit holders), and ask them to indicate their preferences for hypothetically relaxing specific features of the angler leasing program along the lines identified in the work describe above. This information could provide valuable information to the NPFMC in its evaluation of the current features of the CSP and provide information that may help it evaluate adjustments to the CSP. The survey will also provide a broad gauge of attitudes toward the program and its impacts on the charter sector and anglers. It is anticipated to be fielded in 2015.

By Dan Lew

Untangling Economic Impacts for Alaska Fisheries: A Structural Path Analysis

Fishery managers are often provided with economic impact multipliers calculated based on input-output (IO) or social accounting matrix (SAM) models. Most often, however, the economic impact multipliers for fisheries measure only the total economic impacts, and do not provide information on how and through what channels the fishery management actions or exogenous shocks generate the impacts.

A structural path analysis (SPA) is a useful tool that has been used to unravel the aggregate multipliers in economic impact analysis. The tool is used to investigate the channels through which the initial policy shocks or exogenous shocks to a sector (origin) are transmitted to and generate effects on other sectors (destination sectors) of an economy. This type of analysis examines the concentration, strength, and speed of various transmission channels or paths. First, concentration refers to the share of total economic impact of a shock that travels through one or more paths that link different economic sectors (or accounts) in a SAM. Second, strength is measured by the size of the contribution of a path to the total multiplier effect. Finally, speed relates to the share of the contribution of the path that travels directly from the origin to the destination sectors without going through any sector (account) more than once. The transmission of effects along paths of higher lengths will typically take more time to materialize because a larger number of transactions need to take place.

None of the previous studies have utilized this tool for analysis of economic impacts of fisheries. This study uses an SPA to show how the initial shocks to the fishery sector generate the impacts through various channels in a regional economy and to what extent these impacts are amplified while passing through the various channels. The SPA analysis is conducted within a SAM framework for the fisheries of Southeast Alaska, as an example. Recently, an industry-by-industry SAM for Southeast Alaska has been generated. Preliminary results from the analysis are being examined. Once completed, this study will provide the fishery managers a better understanding of how the regional economic impacts are generated and serve as a useful tool that is complementary to the traditional economic impacts analysis which calculated only the aggregate economic multipliers.

By Chang Seung

Ocean Acidification Planning for 2015-17

The AFSC is planning research for 2015-17 to evaluate impacts of ocean acidification on commercially important species in the Bering Sea and Gulf of Alaska. The research plan for 2012-14 covered red king crab, Tanner crab, and golden king crab. A paper with results from a bioeconomic model for the valuable Bristol Bay red king crab (BBRKC) fishery was recently accepted for publication at the journal Ecological Modelling. Population dynamics in the BBRKC bioeconomic model included a stage-structured “pre-recruit” model for vulnerable juvenile crab. This pre-recruit model was estimated using data from ocean acidification exposure experiments conducted on juvenile red king crab at the AFSC’s Kodiak Laboratory. Otherwise, population dynamics in the BBRKC bioeconomic model was based on a simplified version of the full BBRKC stock assessment model. The BBRKC bioeconomic model is being used as a template for other crab fisheries. Estimated effects of ocean acidification on juvenile Tanner crab will be implemented for Tanner crab. This pre-recruit model will be linked to a post-recruit model for Tanner, and because Tanner are mainly bycatch in the snow crab fishery, the linked Tanner crab model will also be linked to a post-recruit model for eastern Bering Sea (EBS) snow crab to analyze impacts of different harvest strategies.

Looking ahead to 2015-17, research projects are planned to develop a prerecruit model for snow crab to forecast impacts of ocean acidification on the valuable EBS snow crab fishery to incorporate effects of temperature and climate change on juvenile red king crab, and in addition, to develop bioeconomic models with ocean acidification effects for walleye pollock. Based on results from exposure experiments, direct effects of ocean acidification on growth and survival of juvenile pollock are not expected to be significant. Consequently, the strategy for modeling bioeconomic effects of ocean acidification for finfish will be different from those for crab. Recent work has demonstrated that ocean acidification disrupts the sensory physiology and behavioral responsiveness to critical environmental stimuli in some fishes. The AFSC’s Newport Lab is planning experiments to examine the effects of ocean acidification on the behavior of larval and juvenile walleye pollock. In addition, ocean acidification may have indirect effects on growth of juvenile pollock through changes in prey availability and quality. Results to date on direct effects of pH suggest that growth of walleye pollock is relatively resilient to the direct physiological effects of ocean acidification under optimal foraging conditions. However, it is essential to investigate how the direct effects of pH are manifested in walleye pollock of different or compromised nutritional status as future marine condition will likely be characterized by both food limitation and increasing acidification. To forecast effects of ocean acidification on finfish, we are planning the development of bioeconomic models linked to individual-based or bioenergetics models to make predictions related to growth, fecundity, and survival through the factors of behavior and prey.

By Mike Dalton, André Punt (UW), and Tom Hurst

Status of Stocks & Multispecies
Assessment Program

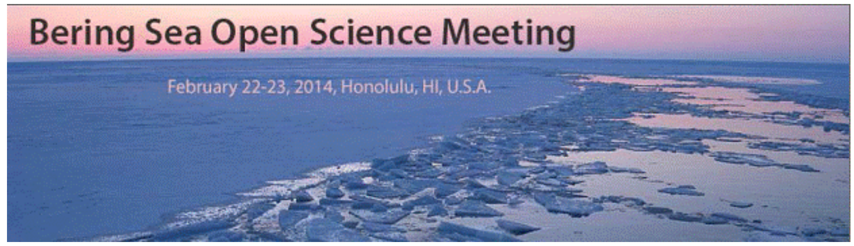
Second International Symposium on Fishery-Dependent Information

The Food and Agricultural Organization (FAO) hosted the second international conference on the collection and interpretation of traditional and non-traditional fishery dependent data at FAO Headquarters in Rome, Italy (3-6 March 2014). This second symposium in the series of Fishery Dependent Information symposia focused on the changing face of fisheries management and the related data and knowledge needs. The conference explored the role of fishers in collecting data, the incorporation of fisher-collected data and knowledge in science, management and policy-making, and the broader role of stakeholders in this process.

Four AFSC staff attended the Second International Symposium on Fishery-Dependent Information with broad participation from international agencies and fisheries agency scientists from around the world. Topics covered everything from “Involving Stakeholders in Participatory Management and Data Collection” to “Information Needs for an Ecosystem Approach to Fisheries” and “Participatory Data Collection in Small Scale fisheries.” There was a focus on how to best leverage scientifically defensible information from those who already spend the most time on the fishing grounds. Participants included representatives from active resource managers, scientists and the fishing sector on the collection and interpretation of information in the context of the ecosystem approach.

Steve Barbeaux presented results of his study titled: “Developing real-time local fishery management through cooperative acoustic surveys in the Aleutian Islands.” This work featured an innovative near-real time cooperative survey of fish abundance prior to allowing directed fishing in areas considered to be sensitive Steller sea lion habitat and foraging area. Jim Ianelli provided a presentation titled “Estimating impacts of the pollock fishery on selected runs of Chinook salmon from Alaska” which covered how extensive observer data on the biological attributes of the bycatch (size and age composition) was used to estimate the impact on specific regional salmon stock groups as defined given available genetic information. This model shows that since 2008, the impact of the bycatch on Alaskan Chinook salmon stocks was reduced due to heightened awareness and regulatory changes (on the EBS pollock fishery) that went into effect in 2011. Ianelli also contributed as a co-author on a companion study that evaluates the efficacy of the new management regulations. Other contributions from the AFSC included the new observer program for precisely counting salmon bycatch in other fisheries (by Craig Faunce, FMA Division) and an evaluation of the electronic monitoring program in Alaska (by Farron Wallace, FMA Division). By Jim Ianelli and Steve Barbeaux

By Jim Ianelli
and Steve Barbeaux



Bering Sea Open Science Meeting

Anne Hollowed gave an oral presentation at the Bering Sea Project Open Science Meeting in Honolulu, Hawaii, 23 February 2014. Her talk, titled "Fish distribution and ocean conditions," summarized the key findings of the Fish Component of the Bering Sea Project and highlighted the research of the following investigators: Anne B. Hollowed, Matt Baker, Steve Barbeaux, Troy Buckley, Lorenzo Ciannelli, Edward D. Cokelet, John Horne, Stan Kotwicki, Robert R. Lauth, Sandra Parker-Stetter, and Patrick H. Ressler. Investigators designed, tested and implemented innovative new methods to collect oceanographic and biological data in the eastern Bering Sea. Water column profiles revealed a latitudinal gradient in the upper to lower density difference with stronger stratification north of lat. 59° N. In spring, near-surface Chlorophyll a, oxygen, and nutrient data exhibited relationships consistent with the classical Redfield ratios. Oceanographic conditions were cold throughout the study period which inhibited the group's ability to compare the strength of density gradients across the shelf in warm and cold years; however, they were able to show that the boundary of the well-mixed, inner shelf was not always located at the 50-m isobath. Statistical analysis showed strong evidence of environmental influence on vertical and horizontal niche partitioning amongst forage fish and juvenile and adult groundfish. Depth alone was not sufficient to explain observed spatial distributions; light, bottom temperature, prey availability (euphausiids), and predator abundance were also selected as explanatory variables. Comparison of acoustic estimates of euphausiid and pollock biomass showed pollock predation could be substantial, but overall water temperature was a much stronger predictor of euphausiid biomass than pollock biomass (a proxy for predation pressure), implying bottom-up control dominated. Frameworks for projecting future impacts of climate change on the spatial distribution and abundance allowed a first order glimpse of future conditions under a changing climate.

Green Technology Forum of Ocean Strategy on Climate Change

Anne Hollowed was an invited speaker at the Green Technology Forum of Ocean Strategy on Climate Change, 7 March 2014 in Seoul, Korea. Highlights of Anne's talk were that climate change is expected to impact the physics, chemistry, and lower trophic level production of the Bering Sea and Arctic Ocean. These changes will impact the distribution, phenology, and abundance of commercial fish and crabs in the Bering Sea and Arctic Ocean through direct and indirect pathways. She compared the mechanisms through which climate change is expected to alter the fish and crab populations in the Bering Sea and Arctic Ocean. Results from qualitative and quantitative modeling approaches were considered. She discussed the challenges that climate change presents for sustainable management of living marine resources in high latitude regions and introduced a framework for adjusting current harvest strategies to accommodate for projected climate change impacts on marine species.

Ocean Sciences Meeting 2014

Anne Hollowed gave an oral presentation in at the Ocean Sciences Meeting February 26, 2014. Anne's session focused on Climate Impacts on Living Marine Resources. Anne's talk focused on projected impacts of climate change on Arctic and sub-Arctic fish and fisheries. She discussed the types of changes that are projected to occur under a changing climate and the implications of these changes on key biological processes governing marine fish production.

By Anne Hollowed.

REFM Scientists Attend 2014 Alaska Marine Science Symposium

Several researchers from the REFM division presented their work at the Alaska Marine Science Symposium (AMSS) held in Anchorage, Alaska, during January 2014. The AMSS is an annual event that brings together marine scientists from a wide variety of disciplines working across marine Alaska. Symposium events are structured around different Alaska marine ecosystems, with one day each devoted to Arctic, Bering Sea/ Aleutian Islands, and Gulf of Alaska issues. The meeting kicks off with an afternoon of keynote addresses, which this year included revisiting the Exxon Valdez oil spill and a discussion of cooperative industry/government design of fishing gears that reduce bycatch. Below is a brief summary of the work presented by REFM personnel; the full abstracts for all of the AMSS presentations can be found at http://www.alaskamarinescience.org/.

Kirstin Holsman presented a poster (.pdf, 1.35 mb) that described her studies of potential climate-change effects on ecosystem dynamics in the Bering Sea. Her presented work was a subset of a larger modeling effort that involves applying scaled-down climate projections from global models to ecosystem models of the Bering Sea. Her model estimates of changes in prey demand by key groundfish predators are consistent with observed diet patterns and demonstrate how future changes in physical properties such as water temperature may be transmitted through the ecosystem and influence the ecology of commercial fish species.

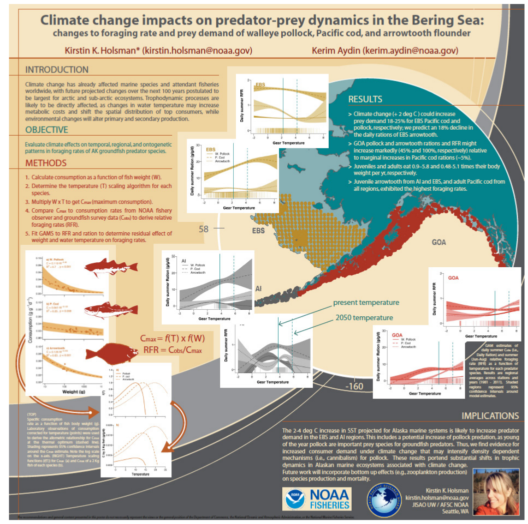
The poster (.pdf, 14.8 mb) presented by **Matt Baker** focused on patterns of marine species distribution and abundance in the eastern Bering Sea, Gulf of Alaska, and Aleutian Islands. Matt's research is designed to understand how communities of marine organisms are arranged spatially, the key physical and biological drivers of those patterns, and how communities change over time. Random forest statistical approaches were used to explore the effects of physical drivers on biological communities, while dynamic factor analysis was used to distinguish common underlying trends of species.

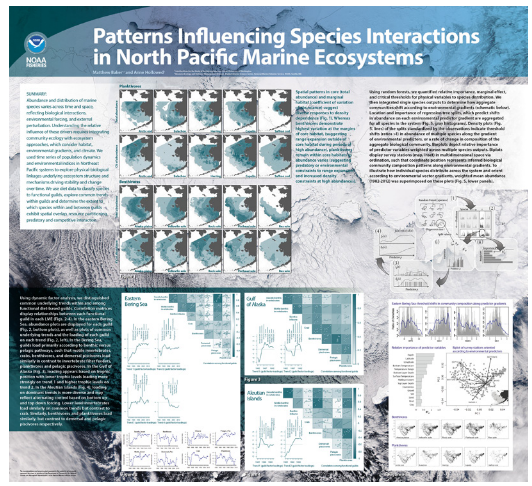
Susanne McDermott's poster (.pdf, 3.87 mb) described the latest component of a long-term tagging study of Atka mackerel in the Aleutian Islands. This effort focused on the central Aleutians and suggests limited spatial movement by individuals. This project is providing insight into Atka mackerel population dynamics as well as the availability of mackerel as prey for Steller sea lions.

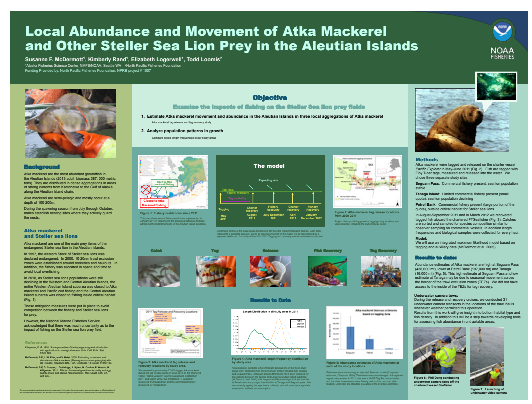
The poster (.pdf, 362 kb) by **Todd TenBrink** and **Tom Wilderbuer** presented the results of maturity research on commercially-important flatfishes. Maturity ogives (that describe the portion of a population that is sexually mature at a given age) are an important element of fish population dynamics and stock assessment. This work provided data that will be used to improve the assessments of yellowfin sole, Alaska plaice, and flathead sole.

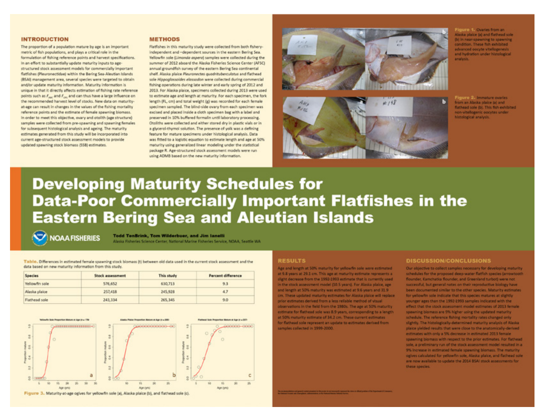
Olav Ormseth made several presentations related to his work on the Gulf of Alaska Integrated Ecosystem Research Program (GOAIERP). He gave an overview talk about the GOAIERP, which wrapped up its last field year in 2013 and will be analyzing and synthesizing data over the next few years. He also presented a poster describing two small-scale oceanographic moorings he placed in nearshore waters during 2013.

By Olav Ormseth









International Council for Exploration of the Sea Benchmark Workshop on Northern Haddock Stocks

Status of Stocks & Multispecies Assessment program staff member Dr. Paul Spencer served as an external reviewer at the International Council for Exploration of the Sea (ICES) Benchmark Workshop on Northern Haddock Stocks, which was held in Copenhagen, Denmark 24-28 February 2014. The external review panel was chaired by Dr. Noel Cadigan (Memorial University, Canada) and also included Dr. Kristin Kleisner (NOAA/NEFSC, USA).

Key issues discussed included an evaluation of genetic and non-genetic evidence for stock separation between the current North Sea and west of Scotland stocks, choice of assessment methodology, and inference of population density in untrawlable areas. Key recommendations included combining the North Sea and West of Scotland stocks into a single assessment (due to fish movement between areas at early life stages) but partitioning of harvest between areas in proportion to survey biomass (due to limited movement at the adult stages). Additionally, the TSA (Time Series Analysis) model (an age-structured state-space model) was recommended for the assessment methodology.

The workshop was relevant to AFSC assessments, as the topics of stock structure, untrawlable grounds, and state-space models have also been topics discussed during recent meetings of the NPFMC groundfish plan teams.

By Paul Spencer

AFSC Scientists Present Research at Western Groundfish Conference

The 18th semi-annual meeting of the Western Groundfish Conference was held in Victoria, British Columbia, 10-14 February 2014. The meeting was well attended by scientists the AFSC and the NMFS Alaska Regional Office. All AFSC attendees shared recent research in either poster or oral presentation format. The meeting was smaller than in past years, but still provided 137 scientists a chance to see new research results, get new ideas, and have face-to-face contact with collaborators and colleagues from the west coast of the United States and Canada. Attendees came from 5 countries and represented 10 universities, 7 regulatory agencies, 3 non-governmental organizations, and the fishing industry. As is usual for this conference, many of the talks focused on rockfish, sablefish, and ling cod, but other taxa from pollock to octopus also were included. The effectiveness of marine protected areas was discussed in several talks, and there were a number of presentations on modeling of data-poor stocks from students and faculty at Oregon State University. Other popular topics included ageing methods and otolith chemistry; the use of underwater cameras and ROVs for groundfish assessment; and bycatch control for halibut and seabirds. The keynote speaker, Dr. Verena Tunnicliffe from the University of Victoria, showed astounding pictures from her years of deep underwater research with submersibles and ROVs as well as data from development of the world's first cabled seafloor observatory in the Strait of Georgia. Socials, a poster session, and catered lunches each day of the meeting provided lots of opportunity for networking and sharing of ideas. The full schedule from the meeting and many of the presentations may be viewed at www.westerngc.org/program/.

By Elizabeth Conners

Age and Growth Program

Production Numbers

Estimated production figures for 1 January – 31 March 2014.

Species	Specimens Aged
Arctic cod	598
Dusky rockfish	73
Harlequin rockfish	255
Northern rockfish	303
Walleye pollock	2,093

Total production figures were were 3,322 with 813 test ages and 14 examined and determined to be unageable.

By Jon Short

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Main harbor and processing plant in Sand Point, AK.
Photo by Conor Maguire

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of the U.S. Department of Commerce

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