UNDERSTANDING PLACE IN FISHERIES MANAGEMENT:

AN EXAMINATION OF ECOLOGICAL AND SOCIAL COMMUNITIES IN THE

PRIBILOF ISLANDS, ALASKA

By

Courtney Lyons

RECOMMENDED:

Dr. Christopher Siddon

Dr. Katherine Reedy

Dr. Ginny Eckert
Advisory Committee Co-Chair

Dr. Courtney Carothers
Advisory Committee Co-Chair

Dr. Shannon Atkinson
Chair, Graduate Program in Fisheries

APPROVED:

Dr. Joan Braddock
Interim Dean, School of Fisheries and Ocean Sciences

Dr. John Eichelberger
Dean of the Graduate School

14 July 2015
Date

UNDERSTANDING PLACE IN FISHERIES MANAGEMENT: AN EXAMINATION OF ECOLOGICAL AND SOCIAL COMMUNITIES IN THE PRIBILOF ISLANDS, ALASKA

A

DISSERTATION

Presented to the Faculty

of the University of Alaska Fairbanks

in Partial Fulfillment of the Requirements

for the Degree of

DOCTOR OF PHILOSOPHY

By

Courtney Lyons, B.S., M.S.

Fairbanks, Alaska

August 2015

Abstract

Holistic approaches toward fisheries management are widely considered a more sustainable option than standard single-species frameworks. This project uses the holistic frameworks of ecosystem-based fisheries management (EBFM) and place-making to examine the ecological and social systems of the Pribilof Islands and the ways in which fisheries management decisions have structured these systems. In Chapter 1, we sought to understand potential ecological constraints of temperature, fish predation, and interactions with a congener (red king crab; *Paralithodes camtschaticus*) on blue king crab (*Paralithodes platypus*) recovery. These examinations suggest that blue king crab juveniles switch strategies from predator avoidance to a strategy of predator deterrence in situations where predation is more likely. In addition, this research suggests that predatory interactions between crab congeners may be more likely than fish predation to inhibit blue king crab recovery. In Chapter 2, we sought to understand local place-making efforts and how they differed between the two Pribilof Island villages, as well as, how these place-making efforts articulated with development programs. We found that place-making efforts in both communities were based on maintaining residence in the islands and an appreciation of the way-of-life that residence provided. The way place-making efforts articulated with development programs, however, differed between the communities. In St. George, Alaska, residents selectively embraced development, only supporting initiatives that would help realize the goal of maintaining residence in the community, as opposed to integrating into a regional economy. Residents of St. Paul, Alaska, in contrast, had more autonomy and were able to control development projects in their community to support local place-making efforts. In Chapter 3 we used these data to develop a framework for assessing the vulnerability of fishing communities based on holistic, ethnographic understandings of local social systems. This framework showed

St. George to be a highly vulnerable community, while St. Paul was only moderately vulnerable. These assessments challenged previously published, quantitative vulnerability assessments. The results of our investigations into the social and ecological systems of the Pribilof Islands support the idea that holistic perspectives provide important information that can drastically alter management understandings of both fish resources and the people who depend upon them.

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Acknowledgements

This project would not have been possible without the help of numerous people. These include of course, my co-advisors, Dr. Courtney Carothers and Dr. Ginny Eckert, and my committee members, Dr. Katherine Reedy and Dr. Christopher Siddon. I benefited greatly from their advice, technical expertise, support, and patience. I am also indebted to the wonderful people at the Fisheries Behavioral Ecology Program lab in Newport, Oregon: Allan Stoner, Michelle Ottmar, Scott Haines, and Courtney Danly. They taught me how to use a table saw, provided invaluable advice on experimental set up, and spent hours sifting through shell hash one piece at a time with me, and they did so with grace and good humor. I wish to thank Anna Kerttula of the National Science Foundation Arctic Social Sciences Program, for advice and encouragement, the residents of St. Paul and St. George for sharing their time and stories, and my friends and family for their continual words of support and encouragement. In particular, I would like to recognize my husband who went above and beyond to help me succeed at this project. Not only did he agree to quit his job and come out on a six-month research trip with me, but he suffered through the discomfort and indignity of being horribly sea sick on a small boat in the middle of the Bering Sea, as well as, the pain of learning how to ride a four-wheeler over the kidney-bruising tundra, all so that he could feel like he was contributing. Thanks for the adventures, Mr. Smoker.

General Introduction

Much of fisheries management still takes a single-species approach, despite awareness that ecosystems and, more broadly, social systems, greatly affect resource abundance. While managers are often interested in integrating these kinds of data, they have limited time and budgets with which to explore such topics. This project was, therefore, borne out of recognition of these shortcomings and a desire to better document the ways in which social and ecological systems affect resources and their sustainability in Alaskan fisheries. While numerous potential social-ecological systems exist in which such an examination could be conducted, I chose to focus on those present in the Pribilof Islands.

The Pribilof Islands are a group of four islands near the Bering Sea shelf break, off the western coast of Alaska. Influenced by the shelf break and upwelling currents, the Pribilof Island marine ecosystem is highly productive (Springer et al. 1996), supporting large populations of commercially valuable fish and shellfish species. In particular, the islands support a declining population of blue king crab (*Paralithodes platypus*) that has failed to rebuild after 10 years of closure to directed fishing efforts (Foy 2010). Management interest in this declining stock initially drew my attention to the islands.

The social system present in the Pribilof Islands consists of two, largely Native (Aleut or Unangan), communities: St. Paul and St. George, Alaska. Located on islands 40 miles apart, residents of these communities were originally sealers who harvested Northern fur seals as part of the fur trade (Torrey 1978). Declines in the local fur seal population throughout the twentieth century, however, eventually led to a closure of this fishery. This closure decimated the local economies and forced residents to diversify into other Bering Sea fisheries. Today the Pribilof Island economies are based on crab processing and participation in a local halibut long-line

fishery (EDAW 2008). With human communities heavily dependent upon marine resources, and fish resources in decline, the Pribilof Islands provide an ideal system in which to examine social and ecological relationships to marine resources.

Initially, the interdisciplinary framework chosen for this project was that of ecosystem-based fisheries management (EBFM). EBFM has been variously defined, but, in general, refers to a more holistic approach toward resource management. In this approach, fisheries are emphasized, but explained and examined in terms of relationships with other species, such as marine mammals, non-target species (Link 2010), and humans (McLeod and Leslie 2009). EBFM approaches are critical of management, but seek to adapt, rather than replace, current programs (Link 2010). Additionally, EBFM efforts are known for drawing upon resilience theory, working to assess ecosystem values, and integrating humans and human use into ecosystem understandings (McLeod and Leslie 2009).

While a powerful tool, the EBFM framework is limited in its ability to engage with the complexity of social systems. EBFM restricts discussions of social systems to their direct relationships with fisheries resources, making these interactions seem inevitable and natural. However, both direct (*e.g.,* fishing, bycatch) and indirect (*e.g.*, runoff, pollution, human-induced climate change) interactions with fish resources are driven by a suite of political, economic, and cultural relationships that are in constant flux (Breslow 2015). Changes in these social drivers, though largely invisible in EBFM approaches, can drastically alter interactions with fish resources (Breslow 2015). As a result, to better engage with the complexities of social data, I chose to draw upon critical social science theory, shifting my examination of Pribilof Island social systems from an EBFM framework to a place-making framework.

While *space* is vast, general, and encompassing (Tuan 1977), *place* is local and specific, connoting a constantly changing meaning to residents (Thornton 2008). Thus, place is a social construct and place-making the method in which place is constructed out of space. These meanings are mediated by many factors, including: local history and landscape (Marsh 1987), the physical senses (Tuan 1977), ties to regional and global politics (Escobar 2001), and economic utility (Dirlik 1999). Taken together, these meanings form a sense of place that can encompass a variety of social drivers structuring human interactions with fisheries resources.

Place-making, furthermore, represents an alternative to the "natural/social capital" framework often used by natural science practitioners of EBFM to describe human relationships and interactions with resource. While proponents of these capital-based approaches have admirable goals of diversifying the kinds of values incorporated into management decisions, such frameworks have the unfortunate side effect of reifying the idea of markets as a natural and acceptable framework for all decision-making. Critical social science recognizes that markets are not the only way to express value, nor are they the best way to do so. Markets view nature and society as commodities, they cause people and firms to discount the future in pursuit of profits that can be realized today, and they encourage thinking in terms of "substitution" or mitigation (e.g., Escobar 1995), whether or not such substitutions are feasible or desirable. Finally, market frameworks frequently differ greatly from indigenous or alternative value systems about resources, management, and relationship to place (Thornton 2008).

The following three chapters, therefore, draw upon the frameworks of EBFM and place-making to achieve two goals: 1.) to gain a more holistic understanding of the social and ecological communities of the Pribilof Islands, and 2.) to provide me with skills in conducting and communication interdisciplinary research. In Chapter 1, I therefore draw upon an EBFM

framework to examine the potential role of ecosystem interactions in the recovery failure of the Pribilof Island blue king crab population. In Chapters 2 and 3 I shift to a place-making framework. Specifically, in Chapter 2 I use place-making theories to examine the influence of fisheries related development projects on the Pribilof Island communities of St. Paul and St. George, Alaska. Then in Chapter 3, I build upon the findings of Chapter 2, demonstrating how these insights might be better integrated into the fisheries management decision-making process.

Chapter 1: Influence of temperature and congener presence on blue (*Paralithodes platypus*) and red (*Paralithodes camtschaticus*) king crab habitat preference and fish predation[1]

Abstract

Rebuilding fisheries is a difficult process and many stocks that are declared overfished fail to recover even in the absence of fishing pressure. The Pribilof Islands blue king crab stock, in Alaska, USA is one of these recovery failures. To explore how environmental and ecological factors might interact to suppress this stock, we conducted a suite of laboratory experiments to assess the effects of temperature changes and the presence of red king crab on blue king crab habitat preference and fish predation survival. Age-0 blue king crabs exhibited plasticity in habitat preference mediated by changes in water temperature, as well as the presence and density of juvenile red king crabs. While blue king crabs are often associated with shell hash habitat, increases in water temperature, as well as the presence of red king crab at high densities, caused blue king crab juveniles to shift into habitats with more vertical structure present, a habitat type shown to reduce the predation efficacy of red king crabs. In addition, while red king crabs typically prefer habitats with more vertical structure, they were more likely to use shell hash habitat in the presence of blue king crabs, perhaps drawn by predation opportunities. Thus blue king crabs are behaviorally plastic, switching from strategies of predator avoidance when predator encounter rates are likely low, to predator deterrence strategies when encounter rates are higher. Fish predation trials further support the idea that blue king crabs are more focused on

[1]Lyons, C., G.L. Eckert, and A.W. Stoner. Influence of temperature and congener presence on blue (*Paralithodes platypus*) and red (*Paralithodes camtschaticus*) king crab habitat preference and fish predation. Prepared for submission in the *Journal of Crustacean Biology*.

predator avoidance than are red king crabs. Blue king crabs had higher survival (60%) than red king crabs (33%) when exposed to fish predators in trials run separately for the two crab species. A similar pattern was observed when the two species were mixed and then exposed to fish predators (71% and 12% survival for blue and red king crabs, respectively). Fish predators were most efficient on red king crab prey, with a higher ratio of crabs eaten per strike and target as well as a lower ratio of strikes per target. Our results indicate that age-0 blue king crabs may be less vulnerable to fish predation than red king crabs. Future research should assess how fish predation rates change when presented with higher densities of red and blue king crab in mixed assemblages, as the habitat shifts we observed in our study could affect predation survival.

1.1 Introduction

Rebuilding overfished and depressed stocks is a difficult process. In the US alone, 50 (out of 478) fish stocks are managed under rebuilding plans (NMFS, 2013). These rebuilding plans are designed to recover stocks to abundances able to support maximum sustainable yield within 10 years (NMFS, 2013); when that goal is not met, the stock is considered a rebuilding failure. Numerous reasons are suggested for such failures, including inability to adequately reduce fishing pressure due to lack of political will, depensatory population dynamics at low stock sizes, changes in environmental conditions, poor productivity of cold water stocks, lack of scientific understanding, and over-optimistic model projections (Lambert, 2011; Murawski, 2010; Punt, 2011). Furthermore, rebuilding efforts may be slowed due to factors such as reduced spawning biomass, removal of older individuals from the population, a loss of genetic diversity, and habitat destruction due to bottom trawling (Kruse et al., 2009). In the face of such a plurality of factors,

designing successful rebuilding strategies is necessarily difficult, even in places known for well-managed fish stocks, such as Alaska.

The Pribilof Island blue king crab stock in the Bering Sea provides an excellent example of these rebuilding difficulties. This stock at one time supported a commercial fishery worth up to $13 million per year, with a maximum annual harvest of nearly 5000 metric tons (Bowers et al., 2010). After peaking in 1980, harvests declined sharply until the fishery was closed in 1999 (Fig. 1) and placed under a rebuilding plan in 2003 (Zheng and Pengilly, 2003). This plan included a prohibition on trawling around the islands to protect habitat and reduce bycatch, as well as closure of the directed fishery (NPFMC, 2010), but the stock has so far failed to recover, even in the absence of fishing. Thus ecological and environmental factors likely contribute to the Pribilof Island blue king crab rebuilding failure.

The Bering Sea experienced a regime shift in the mid 1970s (Francis et al., 1998), causing several ecological changes that may have affected Pribilof Island blue king crab. One major difference observed in the Pribilof Island region was an increase in bottom temperature as the Bering Sea cold pool moved farther north (Mueter and Litzow, 2008). Average benthic temperature in the Pribilof Island region measured during summer trawl surveys from 1982-2009 was 2.7°C (±SE= 0.1°C). However, the period from 2002-2006 was much warmer, closer to 4°C (Mueter and Litzow, 2008), with temperatures as high as 8°C observed at a nearby mooring buoy (M2; NOAA, 2005). While blue king crabs are often described as a cold-water adapted species, growth rates increase exponentially up to 8°C, and they can tolerate a wide range of temperatures (Stoner et al., 2013). Furthermore, increased temperature does not appear to cause physiological damage to blue king crabs until around 21°C (Stoner et al., 2013), though it could cause ecological changes, modifying interactions with competitors and predators.

In particular, agonistic interactions between red and blue king crab may be increased at higher temperatures. Red king crab are cannibalistic and aggressive congeners (Stoner et al., 2010) and after the 1970s Bering Sea regime shift, red king crab abundance increased in Pribilof Island waters, resulting in more frequent interactions between these two species. Recent research supports the hypothesis that age-1 and age-0 red king crab may exert substantial predation pressure on age-0 blue king crab (Long et al., 2015) in the Pribilof Island region, and that these interactions may peak during the winter and spring when both species migrate to nearshore waters to spawn and mate. As a result, age-0 crabs of both species are often in close proximity, though differences in habitat preference may help reduce interactions.

Juvenile red king crab prefer areas with complex, biogenic structure (Pirtle and Stoner, 2010), while juvenile blue king crab prefer areas with a shell hash substrate (Tapella et al., 2009). These preferences are likely driven by different needs. Red king crab habitat preference is thought to reflect a desire to maximize foraging opportunities (Pirtle and Stoner, 2010), while blue king crab preferences may reflect a predator avoidance strategy (Daly and Long, 2014b). Interstitial space in shell hash habitat provides refuge for blue king crab and their dull, mottled color makes them highly cryptic in this substrate, providing effective protection from larger congener predators (Daly and Long, 2014b). At warmer temperatures, however, energetic demands increase and blue king crab may need to balance foraging requirements against the strategy of remaining still and cryptic.

In addition to influxes of crab, groundfish biomass increased substantially after the mid-1970s regime shift and these increases have often been posited as a causal factor in declines of red king crab throughout Alaskan waters (Zheng and Kruse, 2006). Therefore, increased groundfish biomass may also be inhibiting Pribilof Island blue king crab recovery. Potential

groundfish predators in Pribilof waters are numerous and include Pacific halibut (*Hippoglossus stenolepis* Schmidt 1904), Pacific cod (*Gadus macrocephalus*, Tilesius 1810), walleye pollock (*Theragra chalcogramma*, Pallas 1814), and yellowfin sole (*Limanda aspera,* Pallas 1814). Together these predators exert substantial predation pressure on the Pribilof Island marine ecosystem.

Despite the large biomass of fish in this region, however, fish predation on blue king crab has rarely been documented. In diet analyses of groundfish across the Bering Sea, only three species, Pacific cod, walleye pollock, and yellowfin sole, were documented as blue king crab predators (Chilton et al., 2010; Livingston et al., 1993; Livingston and deReynier, 1996). These are three of the most abundant fish species in the region (Aydin et al., 2014) and even with low rates of predation could exert control over the blue king crab population. Furthermore, blue king crab are likely underrepresented in Bering Sea fish diet analyses due in part to the timing of groundfish samples not overlapping well with either peak abundance of juvenile king crab or their preferred, shallow water habitats.

Thus, to better understand how the aforementioned factors might affect Pribilof Island blue king crab recovery, we conducted a suite of laboratory experiments to assess the influence of temperature and the presence of a congener on habitat preference and fish predation survival of age-0 blue and red king crabs. Our habitat experiments compared blue and red king crab habitat preferences at two temperatures, representative of current and warming water conditions. To examine the influence of a congener on habitat preferences, we created mixed-species assemblages of blue and red king crab at two densities, low (five of each species) and high (10 of each species). Finally, we examined fish predation by presenting Pacific halibut predators with

three different assemblages of crab: blue king crab only, red king crab only, and an even mixture of blue and red king crab.

1.2 Materials and methods

1.2.1. Animals

Blue and red king crabs used in this study were reared at the Alutiiq Pride Shellfish Hatchery (hereafter "hatchery") in Seward, Alaska, following methods in Swingle et al. (2013), briefly described here. Wild ovigerous female blue and red king crabs were collected from near St. Matthew Island and near Juneau, Alaska (respectively) in fall 2010, shipped to the hatchery and maintained in 2000 L tanks with ambient, flow-through seawater until larvae hatched in spring 2011. Newly hatched larvae were placed in 1200 L cylindrical tanks and fed enriched *Artemia* nauplii daily (similar to procedures used in Hetrick et al., 2010). After metamorphosis to the juvenile stage, red king crabs were shipped to two different facilities due to logistical constraints: the University of Alaska Fairbanks Lena Point Facility in Juneau, Alaska, or to the NOAA Alaska Fisheries Science Center Laboratory in Kodiak, Alaska, in May 2011 and then reared (Daly and Swingle, 2013; Swingle et al., 2013) until November 2011 when they were shipped to the NOAA Alaska Fisheries Science Center's Behavioral Fisheries Ecology Laboratory in Newport, Oregon. Immediately prior to the experiments, age-0 crabs were placed in flow-through seawater at two different temperatures (mean ± SD = 2.8°C ± 0.5 and 7.8°C ± 0.0) with shredded polyvinyl chloride pipe or fish net added for structure and fed to satiation daily on a diet of Otohime™ pellets supplemented with gel food containing astaxanthin for red king crabs to ensure individuals maintained red coloration consistent with wild-caught crab (Daly et al., 2013). At the time of experiments crabs had experienced their second post-settlement molt (to

stage C3) and were 2-5 mm carapace length (CL). At this stage, the two species are morphologically distinct. While juvenile red king crabs have pronounced spines and bright red carapaces, similarly aged blue king crabs have fewer and smaller spines and a more drab, mottled coloration (Daly and Long, 2014b).

Pacific halibut (*Hippoglossus stenolepis* Schmidt 1904) used in predation trials were collected from Chiniak Bay, Alaska, with small trawl nets in the summer of 2011 and shipped and reared at the Alaska Fisheries Science Center's seawater laboratory in Newport, Oregon in ambient flow-through seawater (9ºC). Fish used in trials varied in length from 21.2 to 24.3 cm and were fed gel food comprised of herring and squid until several weeks prior to the start of predation trials, when their diet was switched to frozen krill to ensure familiarity with crustacean prey.

1.2.2 Habitat preferences for single-species assemblages of blue and red king crabs

To examine how habitat preferences of single-species assemblages of blue and red king crab are influenced by temperature, we provided age-0 crabs with four habitat treatment types: sand (0.35 mm quartz sand), oyster shell hash (<16 mm, Pacific Pearl brand), sand with algal mimic (multiple strands of green, chenille yarn 20 cm long), and shell hash with algal mimic (Fig. 2). The yarn for algal mimics was allowed to foul in flowing seawater for two weeks prior to the experiment, as previous research indicates that red king crab are attracted to fouled algal mimic for foraging opportunities (Pirtle and Stoner, 2010). These four habitat types were constructed to 1 cm depth in equally divided quadrants on the bottom of a 26.3 cm diameter bucket. Additionally, three pieces of algal mimic were folded in half and added to two of the quadrants. To test the effect of temperature on habitat preference, we chilled the seawater by placing six of

these buckets in a flowing seawater table held at approximately 2ºC (mean ± SD = 2.4°C ± 0.2) with water height in each bucket matching water height in the table. An additional six buckets were kept in an 8ºC (mean ± SD = 7.8°C ± 0.2) cold room. At the start of each trial, we individually released 10 C3 king crabs (blue or red, depending on the treatment) into the center where all four habitat types met, and then covered the bucket with a lid to reduce light. After 24 h, we removed the lid and recorded the quadrant location for each individual crab and whether or not it was on or under vertical structure. In total, we conducted 12 trials for each species (six at each water temperature). Crab habitat preferences were determined using Pearson's Chi-square tests in R (R Development Core Team, 2013) to compare observed crab distributions among the available habitat types to a uniform distribution. In addition, we used Fisher's exact tests in R to compare observed distribution of crabs on or under vertical structure with the introduction of a congener to a uniform distribution.

1.2.3 Habitat preferences for congener-present assemblages of blue and red king crabs

We then examined how blue and red king crab habitat preferences changed in the presence of a congener at high and low animal densities. These experiments used the same experimental set up described above. In these trials, however, we placed blue and red king crabs together in the buckets. Low-density congener-present trials consisted of a total of 10 age-0 king crabs (five blue and five red), while high-density congener-present trials consisted of a total of 20 age-0 king crabs (10 blue and 10 red). In total, we conducted 12 congener-present trials (six at each water temperature) for each density (low and high). Statistical analyses of these data were the same as used for single-species trials.

1.2.4 Fish predation

We based the design of our fish predation experiments on previous fish predation studies (Stoner, 2009). Thus, to better understand the influence of fish predation on blue and red king crab we conducted a separate suite of laboratory experiments using Pacific halibut as predators. These fish are not only abundant in the Pribilof Island region, but are effective and capable predators of juvenile red king crab in laboratory experiments (e.g., Pirtle et al., 2012) and were therefore chosen as predators for our blue king crab experiments. Fish predation experiments were carried out in four circular tanks (103 cm diameter) supplied with continuous flows (150 ml s^{-1}) of sand-filtered seawater held at 8° C (mean ± SD = 7.8°C ± 0.0). Based on crab habitat preferences observed in the aforementioned habitat experiments, a thin (~0.5 cm) layer of shell hash (pieces of 6-16 mm long oyster shell, Pacific Pearl brand) and 80 pieces of previously-fouled 20 cm long chenille yarn were added as substrate. Two Pacific halibut were placed in each tank several days prior to the start of the experiment, allowing them to acclimate to their new surroundings. During this acclimation period, fish pairs were fed frozen krill as an introduction to crustacean prey. If fish pairs did not feed on krill, non-feeding fish were substituted with a new fish pair. A total of four fish pairs were removed from consideration in this way.

We used fish pairs in this experiment because Pacific halibut are known to perform more consistently as predators with social facilitation (Stoner and Ottmar, 2004). Fish pairs were fed to satiation 48 h before trials and then not fed until the experiment to standardize hunger levels and to insure that fish were uniformly motivated to feed. On the morning (0900 h) of a predation trial, we slowly reduced lighting in the room to total darkness over a one-minute interval. Halibut

are visual predators (Ryer et al., 2008), so this prevented immediate predation as crabs were introduced and acclimated to the tank. We then randomly distributed 14 age-0 blue and or red king crabs (depending on treatment) over the middle of each tank. After a one-hour acclimation period for the crabs, we slowly returned the room lights to standard illumination and began video recording using cameras centered over each tank. Trials lasted 3 h and were recorded for the entirety. We terminated trials by trapping fish under an acrylic column (28 cm diameter). We then removed all substrates from the tank and counted remaining crabs.

Over the course of the experiment, six replicate fish pairs were presented with three treatments of age-0 king crab (~ 2-5 mm CL): 14 red king crab prey, 14 blue king crab prey, and a mixture of seven red and seven blue king crab prey to determine how crab survival for the two species varied in single and mixed-species assemblages. The order in which a fish pair received these treatments varied systematically (*i.e.*, of the six fish pairs, two received blue king crabs first, two received red king crabs first, and two received mixed red and blue king crabs first). This was done to minimize order effects, as this was the first time these halibut had encountered live crab prey and our limited number of available crabs precluded separate trials to acclimate halibut to live crab prey. Due to the low number of available blue king crabs, surviving crabs were reused in the last two (out of 18) predation trials, which were both congener present trials.

To assess differences in crab survivorship for fish predation trials, we performed a linear mixed effects analysis using *lme4* (Bates and Maechler, 2010) in R (R Development Core Team, 2013), with treatment (blue king crabs only, red king crabs only, and both species) and order as fixed effects and fish pairs as a random effect. Graphical analyses confirmed that normality and homoscedasticity assumptions were met. We obtained p-values through use of likelihood ratio tests, comparing the full model containing the effect in question (treatment) against a simplified

model in which that term was removed. Finally, post-hoc tests consisted of pairwise paired t-tests with Holm correction adjusted p-values. We also used a Pearson's Chi-square test in R (R Development Core Team, 2013) to assess differences between red and blue king crab survivorship in congener-present trials.

In addition to crab survival, we assessed fish predation efficacy using video recordings of the predation trials. These data allowed us to better explain any observed differences in crab survival, determining whether differences were related to the effort fish put into predation or the relative success of those efforts. In these recordings we tallied the number of strikes a fish made (distinctive forward lunges made in an attempt in capture prey) on a particular target (localized area in which the predator had identified a prey item and was attempting to capture it). As not all targets were successfully captured with the first strike, we therefore calculated metrics for the number of crabs consumed per strike and number of strikes made per target identified. Observations were made for all but one of the predation trials, as a flooding event clouded seawater in the last predation trial such that observations of fish movements were impossible. (By draining the tank we were able to determine crab survivorship; survivorship for this trial was 64% so visibility was considered sufficient for the halibut to successfully capture prey.) Thus, to assess differences in predation efficacy according to treatment type (blue king crabs only, red king crabs only, both species), we performed a linear mixed effects analysis using *lme4* (Bates and Maechler, 2010) in R (R Development Core Team, 2013). Each metric was assessed separately and considered the fixed effect for that model. For all models, fish pair was added as a random effect. Model assumptions were met, and significance and post-hoc tests were conducted as described above.

Finally, we compared fish activity levels among treatments to determine if differences in crab survival could be simply due to inactivity rather than differences in predation efficacy. Fish activity was calculated as the sum of the number of fish (0-2) active in a 15-minute block of time (n=12) divided by the total possible number of fish active over the entire trial (2*12=24). As graphical examinations showed these data were highly non-normal, comparisons of fish activity were made by transforming the data to a binomial distribution (any trial with fish activity less than 1 was assigned a 0 value) and analyzed as a general linear model with mixed effects (R Development Core Team, 2013), using the *glmer* function in *lme4* package. P-values were calculated with the same method as described for the other metrics of fish predation efficacy. We found that measures of fish activity did not vary among treatments (χ^2=2.5, p=0.29; blue king crabs: 50 +/- 22, both species: 83 +/-17, red king crabs: 20 +/- 20; mean activity score +/- SE).

1.3 Results

1.3.1 Habitat preferences

In single species trials, blue king crab habitat preferences varied by water temperature. In cold water (2°C), blue king crabs were not uniformly distributed (χ^2=34.0, p<0.001), preferring habitats with shell substrate while avoiding those with sand (Fig. 3A). At higher water temperatures (8°C) blue king crab were still most commonly found in habitats with shell substrate (Fig. 3A), but not significantly more so than in other habitat types (χ^2=7.1, p=0.07). In contrast, red king crab distribution among habitat types differed significantly from uniform at both water temperatures (8°C: χ^2=30.7, p<0.001; 2°C: χ^2=18.4, p<0.001). Individuals avoided habitats without mimic present, preferring habitats with shell substrate and algal mimic the most (Fig. 3B).

Habitat preferences of each species changed when in the presence of their congener. In low-density congener trials, most crab distributions were uniform (8ºC red king crabs: χ^2=2.3, p=0.52; 2ºC red king crabs: χ^2=1.7, p=0.63; 8ºC blue king crabs χ^2=6.5, p=0.09), indicating no habitat preference (Fig. 3C and 3D). Blue king crabs in cold water were the only group to exhibit a preference (χ^2=8.0, p=0.05), preferring habitat with shell substrate (Fig. 3C). In contrast, crab distributions in high-density congener trials were all significantly different from uniform. Regardless of temperature, blue king crabs sought out habitat with shell substrate and algal mimic (8ºC blue king crabs: χ^2=19.7, p<0.001; 2ºC blue king crabs: χ^2=20.1, p<0.001; Fig. 3E). Red king crabs preferred habitats with algal mimic present in warmer water temperatures (χ^2=8.4, p=0.04; Fig. 3F), as well as in colder water temperatures (χ^2=13.3, p=0.01; Fig. 3F), though the only habitat they appeared to avoid at either water temperature was that of bare sand (Fig. 3F). Furthermore, the distribution of crabs on versus under vertical structure did not differ from uniform, regardless of temperature or with the presence of congeners at either high or low densities. The results of Fisher's Exact test on single-species trials were as follows: p=0.48 (blue king crabs 2°C), p=0.40 (blue king crabs 8°C), p=0.06 (red king crabs 2°C), p=0.34 (red king crabs 8°C); low-density congener present trials, p=0.39 (blue king crabs 2°C), p=0.63 (blue king crabs 8°C), p=0.73 (red king crabs 2°C), p=0.92 (red king crabs 8°C); high-density congener present trials, p=0.09 (blue king crabs 2°C), p=0.79 (blue king crabs 8°C), p=0.41 (red king crabs 2°C), p=0.14 (red king crabs 8°C).

1.3.2 Fish predation trials

In fish predation trials, crab survival varied among treatment groups (blue king crabs only, red king crabs only, and both species) as evidenced by a significant improvement in the

model's ability to predict crab survival with the inclusion of the "treatment" term (χ^2=15.3, p<0.01; Fig. 4). Post-hoc tests indicated that survival was significantly higher in blue king crab only treatments than in red king crab only treatments (t=0.03; Fig. 4A). Furthermore, blue king crab survival was significantly higher when both species were presented together to fish predators (χ^2=16.0, p<0.01; Fig. 4B).

Measures of predation efficacy further indicate that red king crabs are easier prey for Pacific halibut than blue king crabs. Fish predators were significantly more efficient at preying on red king crab, with a higher ratio of crabs consumed per strike (χ^2=11.9, p=0.00; Fig. 5) and fewer strikes made per target (χ^2=6.9, p=0.03; Fig. 5) in trials with only red king crab present. In general, the two species of crab exhibited different behaviors in the presence of predators, with blue king crabs more likely to shelter under shell hash and red king crabs more likely to climb within the habitat.

1.4. Discussion

This study demonstrated that blue king crab exhibit plasticity in habitat preference. This is an unexpected result, as previous research has shown that blue king crab are morphologically adapted for shell hash habitat (Daly and Long, 2014b). As a result, any movement out of these specific habitat types might have consequences for survival. Despite this, when red king crab congeners were introduced in cold water trials, blue king crab habitat preferences did change. At both low and high densities, the presence of congeners led to a decrease in blue king crab use of shell hash habitat and an increase in use of habitat with vertical structure, specifically an increase in use of sand with algal mimic in low-density trials and of both sand with algal mimic and shell with algal mimic in high-density trials. Red king crab preferred these habitat types in single-

species trials. Thus, in cold waters, crowding appears to drive blue king crabs into areas preferred by red king crabs. This trend is counter-intuitive in light of recent research indicating that shell hash habitat may confer blue king crab a competitive advantage over similarly aged red king crab, as older red king crab predators preferentially prey upon red king crabs in shell hash habitat (Daly and Long, 2014). In addition, this behavior places the slower-growing blue king crabs in direct contact with red king crabs, which become potential predators as they grow. The reason for this move may, therefore, be related to the predation efficacy of red king crabs.

Laboratory studies have shown that vertical structure decreases the efficacy of both crab (Long and Whitefleet-Smith, 2013) and fish predators (Pirtle et al., 2012; Stoner, 2009) on juvenile king crab. Studies have also shown similar shifts in blue king crab habitat preference toward complex habitat when in the presence of age-1 red king crab predators, as well as successful predation of age-0 blue king crabs by age-0 red king crab (Long et al., 2015). Thus, the observed shift in blue king crab habitat preference indicates that age-0 red king crab, which tend to be larger and more aggressive than similarly aged blue king crab, may also be seen as a threat to the smaller blue king crabs. Phenotypically, blue king crabs lack spines or other predator deterrents, supporting the hypothesis that crypsis is a preferred survival strategy (Daly and Long, 2014b). However, in regions of high-crab density, encounter rates increase and crypsis may become a less effective strategy. In these cases, when the likelihood of encountering a predator is high, survival strategies may shift from those based on avoiding predation, to those based on deterring predation. Structure can deter predation by interfering with predators' movements (Bartholomew et al., 2000) and increasing the amount of area to be searched before finding prey (Long et al., 2012), while additionally providing a physical barrier sheltering prey from sight (Long and Whitefleet-Smith, 2013). The reduction of predation pressure provided by

complex habitat has been demonstrated in numerous aquatic systems (Everett and Ruiz, 1993; Gotceitas and Colgan, 1989; Ochwada et al., 2009).

Blue king crabs in warm water trials were less likely to use shell hash habitat, and more likely to use sand with algal mimic habitat than in cold water trials. Use of sand with algal mimic habitat increased when red king crab congeners were present, and was greatest in the high-density congener present trials. Increased use of habitat with structure in the presence of congeners parallels the shift observed in cold water trials and could provide increased protection from predators. Predation deterrence did not, however, explain the increased interest in sand with algal mimic habitat in single-species trials.

These results demonstrate that blue king crabs can be behaviorally plastic, switching from predator avoidance when predator encounter rates are likely low to predator deterrence when encounter rates are higher. Though blue king crabs are often described as a cold-water adapted species, they can tolerate a wide range of temperatures, suffering no physiological harm until around 21°C (Stoner et al., 2013). Temperature shifts could, however, cause behavioral changes in blue king crab populations. Conspecific cannibalism rates do not appear to increase among juvenile blue king crabs in reared in warmer waters (Stoner et al., 2013); however, fish and intra-guild predation rates on juvenile blue king crab have not been compared across temperatures and may increase. If these types of predation increase, cold water habitat could provide a refuge from predation. Fish predators are less active (e.g., Beamish, 1978; He, 2003; Stoner and Sturm, 2004) and metabolic rates drop (e.g., Andgilletta et al., 2002; Brett, 1971; He and Wurtsbaugh, 1993) in colder waters. Thus, predation rates in these regions are likely lower than in warmer waters. In warm waters the observed shift of blue king crabs into areas with

vertical structure warm water single-species trials could, therefore, represent another switch from predation avoidance to predation deterrence strategies.

Although red and blue king crabs are closely related, their habitat preferences showed marked differences. Red king crab preferred habitat with structure in single-species trials (shell with algal mimic), a result observed in previous research (Hetrick et al. 2010, Pirtle and Stoner 2010). In the presence of congeners, at both low and high densities, though crabs leave this preferred habitat type and move into shell hash habitat, an area that is relatively lightly used in single-species red king crab trials. Shell hash is well used by blue king crabs and perhaps red king crabs are attracted to blue king crabs, seeing them as a potential source of prey. Red king crabs are more aggressive and exhibit more intra-cohort cannibalism than blue king crabs (Stoner et al., 2013). An influx of red king crab could represent an increased predation threat to blue king crabs. This supports our interpretation that blue king crab habitat use patterns in the congener present trials represented a switch from predator avoidance to predator deterrence strategies.

Increased groundfish predation has long been suggested as a factor contributing to the Pribilof Island blue king crab recovery failure (Zheng and Kruse, 2006), but our results indicate that Pacific halibut, at least, are not likely to be restricting Pribilof Island blue king crab recovery. We found age-0 blue king crabs to be much more successful at avoiding fish predation than age-0 red king crabs, both in single-species (60 to 33%, respectively) and in congener-present (71 to 12%, respectively) predation trials. In contrast to our hypothesis that red king crab might have a negative impact on the ability of blue king crab to avoid predation, average blue king crab survival increased in the presence of red king crab congeners. Measures of fish predation efficacy (crabs eaten per strike and target, number of strikes per target) indicate that halibut, which are visual predators, had difficulty detecting blue king crabs due to their high

degree of crypsis. It is important to note that hatchery-reared red king crab juveniles are behaviorally plastic, becoming better at predator avoidance with increased exposure to fish predators (Daly et al., 2012). While we used naïve crab prey, our results are not likely an artifact of this as both species were unfamiliar with fish predators and thus both likely to improve predator avoidance skills with increased exposure to fish predators.

If the results of our fish predation study hold true in the wild, age-0 blue king crabs are likely less vulnerable to fish predation than wild age-0 red king crabs. Our research supports previous studies in suggesting that the recovery failure of the Pribilof Island stock may instead be tied to increases in intra-guild predation within and among cohorts (Long et al., 2015). Future research should examine predation rates with other fish predators in order to fully refute the role of fish predation in limiting Pribilof Island blue king crab recovery. Increases in crab density and crowding may affect fish predation efficacy with population-level effects. While we were not able to observe individual crab behavior in our fish predation experiments, our habitat experiments showed shifts in habitat use as a response to higher crab densities. Such shifts could affect the ability of blue king crabs to avoid fish predation, contributing to population bottlenecks.

More broadly, our research indicates that temperature could also mediate indirect interactions between congeners and their predators through shifts in habitat use. While the role of temperature in structuring marine ecosystems has been well documented, much of this research centers on the physiological tolerances of individual species and, more broadly, on overall changes in productivity associated with bottom-up controls (e.g., Fields et al., 1993; Lubchenco et al., 1993). Ecological studies have, in addition, assessed changes in predation risk (Elliott and Leggett, 1996), prey availability (Heath, 2005), foraging rate (van Dijk et al., 2002), and

competition (Persson, 1986) in a variety of fish species (for an excellent review see Graham and Harrod, 2009). In contrast, relatively little research has assessed the relationship between temperature changes and small-scale, shifts in behavior and habitat preference. Researchers are beginning to address the more subtle ways in which temperature influences behavior, from noting changes in sea turtle nesting habitats (Refsnider and Janzen, 2012), to detecting increased behavioral variability in hermit crabs (Briffa et al., 2013). These findings, as well as the shift in habitat preference observed in this study, indicate that temperature changes could affect ecological relationships in subtle and unexpected ways, presenting a new area of inquiry.

1.5 Acknowledgements

Thanks are due to Michelle Ottmar, Scott Haines, and Courtney Danly for help conducting experiments and maintaining the animals. In addition, we thank Ben Daly for experimental advice and Franz Mueter for advice on analysis. Funding was provided by the following organizations: National Sea Grant Aquaculture, National Science Foundation Marine Ecosystem Sustainability in the Arctic and Subarctic (MESAS) IGERT program (#DGE-0801720), and the Rasmuson Fisheries Research Center. Research was conducted under the UAF IACUC permit: 280889. Coauthors contributed advice on experimental design and analysis.

1.6 Figures

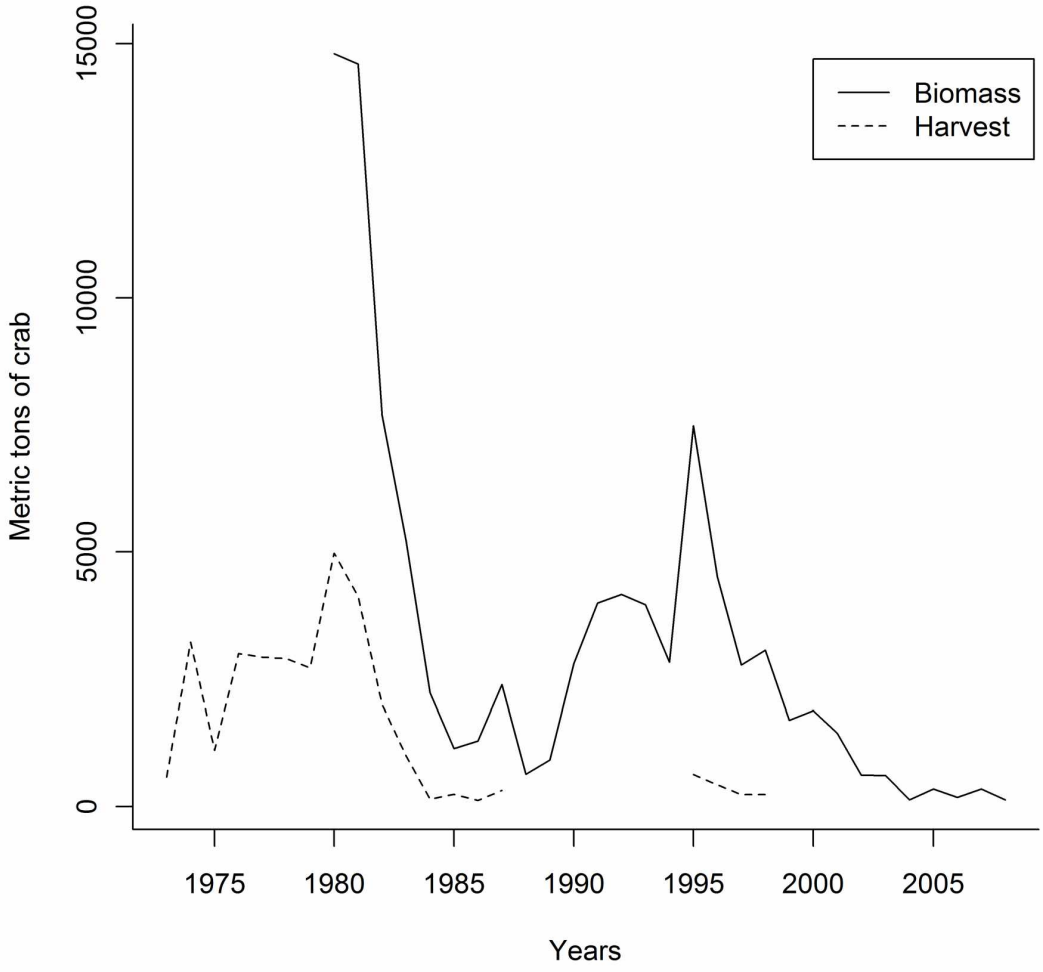

Figure 1.1 Changes in Pribilof Island blue king crab harvest, biomass over time (metric tons; dotted line) and mature male biomass (metric tons; solid line; from Foy, 2010).

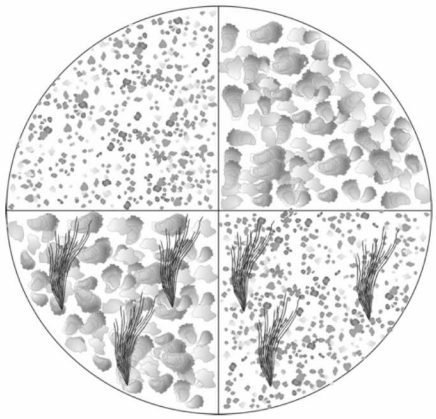

Figure 1.2 Crab habitat arrangement used in habitat preference trials: sand (upper left), shell (upper right), sand with algal mimic (lower right), shell with algal mimic (lower left).

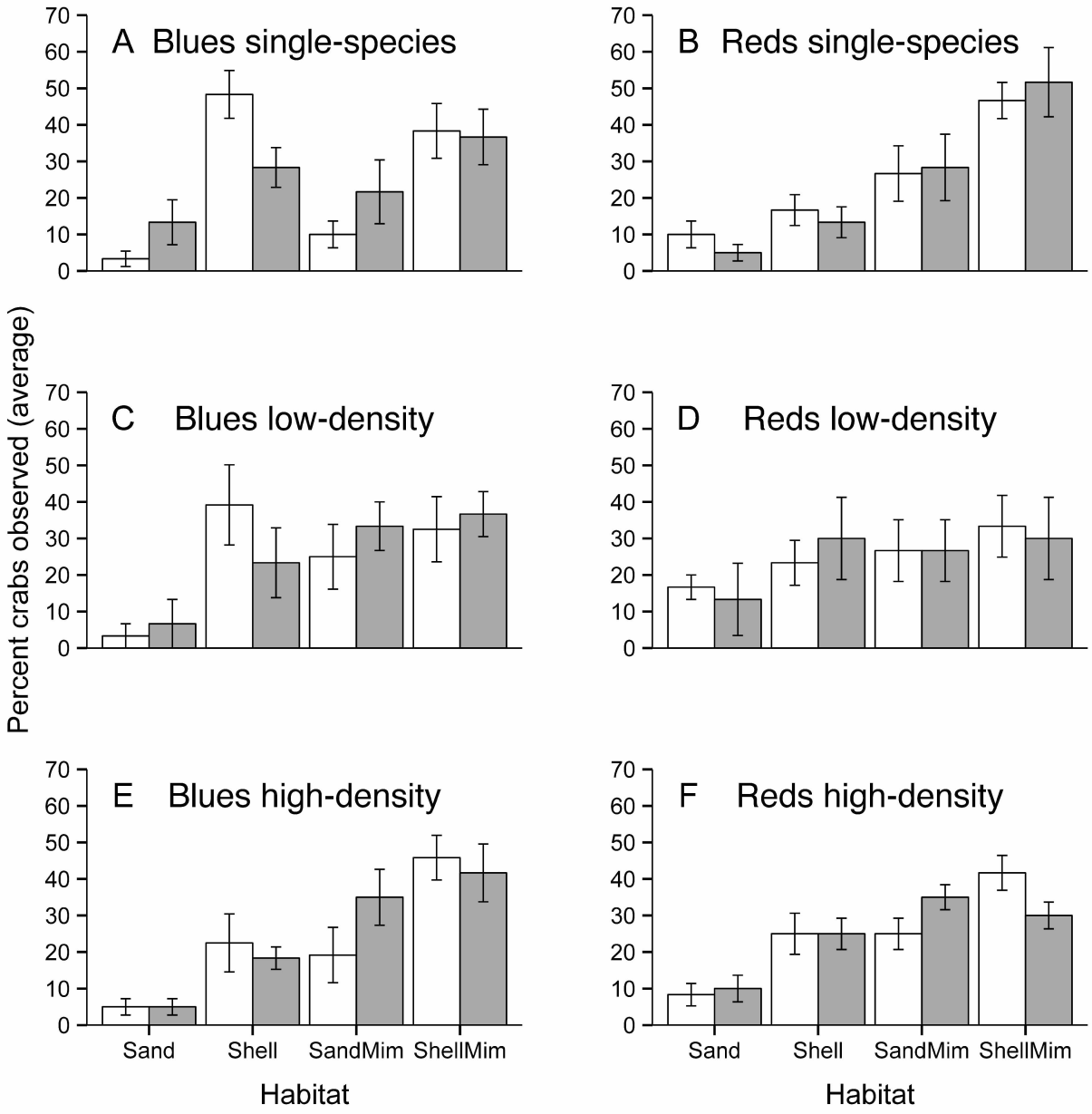

Figure 1.3 Blue and red king crab habitat preferences: Percentage (+/- SE) of crabs observed by habitat type at 2ºC (white bars) and 8ºC (gray bars) for single species trials: (A) blue king crabs, (B) red king crabs; low-density congener trials: (C) blue king crabs, (D) red king crabs; and high-density congener trials: (E) blue king crabs, (F) red king crabs. Habitat types include sand, shell, sand with algal mimic (SandMim) and shell with algal mimic (ShellMim).

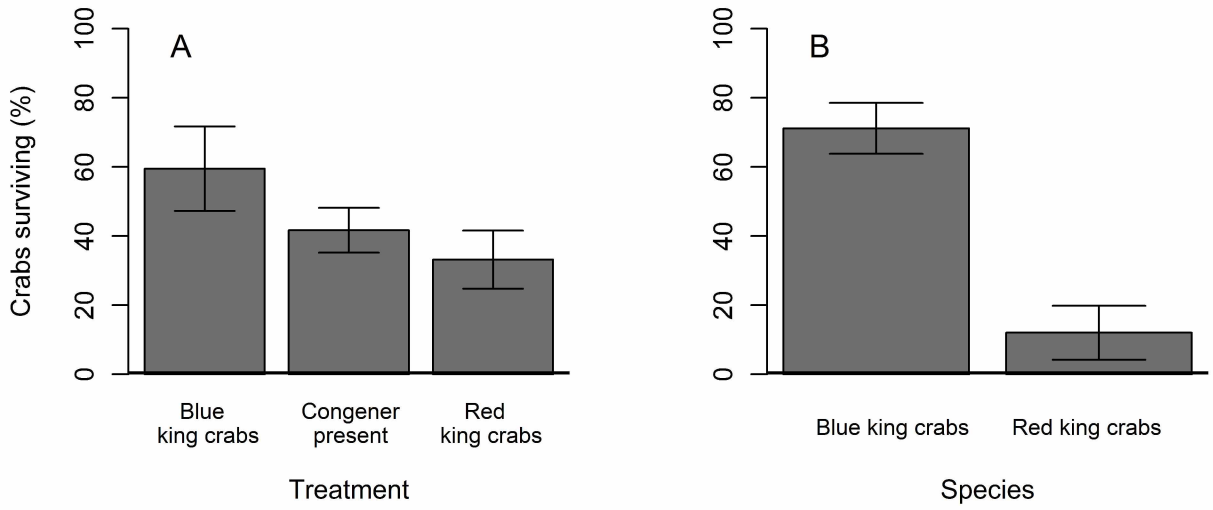

Figure 1.4 Blue and red king crab survival in fish predation trials (A) Total crab survival (% +/- SE) by treatment. Blue king crab had significantly higher survival than red king crab, while the result with a congener present was intermediate. (B) Crab survival (% +/- SE) by species in congener present trials. Blue king crabs had higher survival than red king crabs.

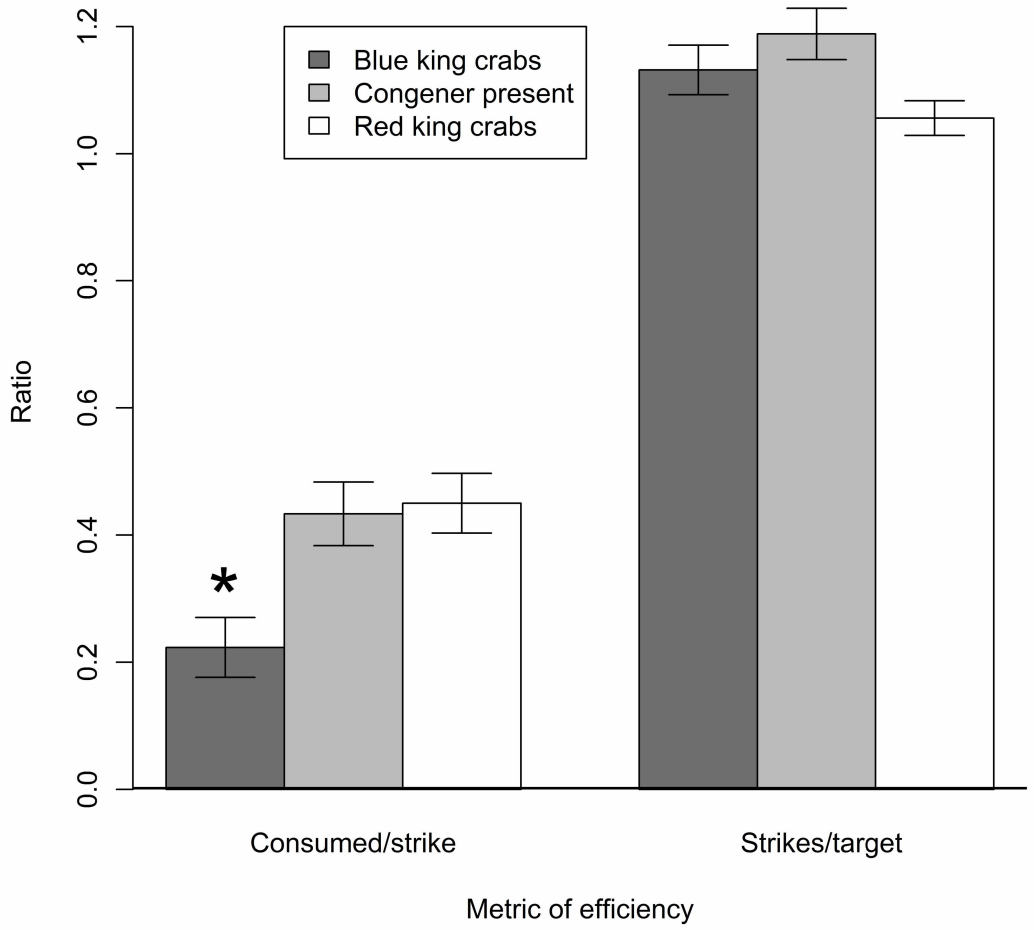

Figure 1.5 Fish predation efficacy by treatment: blue king crab trials (dark gray bars), congener present trials (light gray bars), and red king crab trials (white bars). The number of crabs consumed per strike varied by treatment, with successful consumption of crabs per strike lowest in blue king crab trials and highest in red king crab trials. In contrast, the number of strikes per target was similar among all three treatments. Error bars represent standard error. Star represents significant difference.

1.7 References

Andgilletta, M., Jr., P. Niewiarowski, C. Navas. 2002. The evolution of thermal physiology in ectotherms. Journal of Thermal Biology 27: 249-268.

Aydin, K., S. Barbeaux, D. Barnard, L. Chilton, B. Clark, M. Conners, C. Conrath, M. Dalton, K. Echave, L. Fritz, M. Furuness, D. Hanselman, A. Haynie, J. Hoff, T. Honkalehto, P. Hulson, J. Ianelli, S. Kotwicki, R. Lauth, S. Lowe, C. Lunsford, C. McGilliard, D. McKelvey, D. Nichol, B. Norcross, O. Ormseth, W. Palsson, C. Rodgveller, C. Rooper, M. Sigler, P. Spencer, I. Spies, W. Stockhausen, D. Stram, T. TenBrink, G. Thompson, C. Tribuzio, T. Wilderbuer, N. Williamson. 2014. Stock assessment and fishery evaluation report for the groundfish resources of the Bering Sea/Aleutian Islands regions. North Pacific Fishery Management Council, Anchorage, AK, 54 pp.

Bartholomew, A., R. Diaz, G. Cicchetti. 2000. New dimensionless indices of structural habitat complexity: Predicted and actual effects on a predator's foraging success. Marine Ecology Progress Series 206: 45-58.

Bates, D., M. Maechler, 2010. lme4: Linear mixed-effects models using S4 classes.

Beamish, F.W.H. 1978. Swimming capacity Fish Physiology 7: 101-187.

Bowers, F.R., M. Schwenzfeier, K. Herring, M. Salmon, K. Milani, J. Shaishnikoff, H. Barnhart, J. Alas, R. Burt, B. Baechler, A. Buettner, 2010. Annual management report for the commercial and subsistence shellfish fisheries of the Aleutian Islands, Bering Sea and the Westward Region's shellfish observer program, 2008/09, fishery management report no. 10-24. Alaska Department of Fish and Game Division of Sport Fish and Commercial Fisheries, Dutch Harbor, Alaska, 265 pp.

Brett, J.R. 1971. Energetic responses of salmon to temperature. A study of some thermal relations in the physiology and freshwater ecology of sockeye salmon (*Oncorhynchus nerka*). American Zoologist 11: 99-113.

Briffa, M., D. Bridger, P. Biro. 2013. How does temperature affect behaviour? Multilevel analysis of plasticity, personality and predictability in hermit crabs. Animal Behaviour 86: 47-54.

Chilton, E.A., K.M. Swiney, J.D. Urban, J.E. Munk, R.J. Foy. 2010. Ecosystem consideration indicators for Bering Sea and Aleutian Islands king and tanner crab species. In, Plan team for the king and tanner crab fisheries of the Bering Sea and Aleutian Islands (eds.) Stock assessment and fishery evaluation report for the king and tanner crab fisheries of the Bering Sea and Aleutian Islands regions, 2010 final crab SAFE. Alaska Department of Fish and Game Division of Sport and Commercial Fisheries, Anchorage, AK, 149 pp.

Daly, B., A.W. Stoner, G. Eckert. 2012. Predator-induced behavioral plasticity of juvenile red king crabs (*Paralithodes camtschaticus*). Journal of Experimental Marine Biology and Ecology 429: 47-54.

---, J. Swingle. 2013. High-density nursery culture of recently-settled blue king crabs (*Paralithodes platypus*): Comparisons to red king crabs (*Paralithodes camtschaticus*). Aquaculture 416-417: 196-200.

---, W.C. Long. 2014. Inter-cohort cannibalism of early benthic phase blue king crabs (Paralthodes platypus): Alternate foraging strategies in different habitats lead to different functional responses. PLOS One 9(2): 1-7.

---., W.C. Long. 2014b. Intra-guild predation among early benthic phase red and blue king crabs: Evidence for a habitat-mediated competitive advantage. Journal of Experimental Marine Biology and Ecology 451: 98-104.

---, Swingle, J.S. and Eckert, G.L. 2013. Dietary astaxanthin supplementation for hatchery-cultured red king crab, Paralithodes camtschaticus, juveniles. Aquaculture Nutrition 19: 312-320.

Elliott, J., W. Leggett. 1996. The effect of temperature on predation rates of a fish (*Gasterosteus aculeatus*) and a jellyfish (*Aurelia aurita*) on larval capelin (*Mallotus villosus*). Canadian Journal of Fisheries and Aquatic Sciences 53: 1391-1402.

Everett, R., G. Ruiz. 1993. Coarse woody debris as a refuge from predation in aquatic communities. Oecologia 93: 475-486.

Fields, P., J. Graham, R. Rosenblatt, G. Somero. 1993. Effects of expected global climate change on marine faunas. Trends in Ecology & Evolution 8: 361-367.

Francis, R.C., S.R. Hare, A.B. Hollowed, W.S. Wooster. 1998. Effects of interdecadal climate variability on the oceanic ecosystems of the NE Pacific. Fisheries Oceanography 7: 1-21.

Gotceitas, V., P. Colgan. 1989. Predator foraging success and habitat complexity: Quantitative test of the threshold hypothesis. Oecologia 80: 158-166.

Graham, C., C. Harrod. 2009. Implications of climate change for the fishes of the British Isles. Journal of Fish Biology 74: 1143-1205.

He, E., W. Wurtsbaugh. 1993. An empirical model of gastric evacuation rates for fish and a analysis of digestion in piscivorous brown trout. Transactions of the American Fisheries Society 122: 717-730.

---. 2003. Swimming behavior of winter flounder (*Pleuronectes americanus*) on natural fishing grounds as observed by an underwater video camera. Fisheries Research 60: 507-514.

Heath, M.R. 2005. Changes in the structure and function of the North Sea fish foodwebs, 1973-2000. ICES Journal of Marine Science 62: 847-868.

Hetrick, W.M., L.J. Cox, S.K. Atkinson, S.R. Malecha. 2010. Survival of red king crab (*Paralithodese camtschaticus*) juveniles on natural and artificial substrates. Journal of Life Sciences 4: 1-8.

Kruse, G.H., Y. Ishida, C.I. Zhang. 2009. Preface: Rebuilding of depleted fish stocks through and ecosystem approach to fisheries. Fisheries Research 100: 1-5.

Lambert, Y. 2011. Environmental and fishing limitations to the rebuilding of the northern Gulf of St. Lawrence cod stock (Gadus morhua). Canadian Journal of Fisheries and Aquatic Sciences 68: 618-631.

Livingston, P.A., A. Ward, G.M. Lang, M. Yang, 1993. Groundfish food habitats and predation on commercially important prey species in the Eastern Bering Sea from 1987 to 1989, NOAA Technical Memorandum, Alaska Fisheries Science Center, Seattle, WA, 202 pp.

---, Y. deReynier, 1996. Groundfish food habits and predation on commercially important prey species in the Eastern Bering Sea from 1990 to 1992. Alaska Fisheries Science Center, Seattle, WA, 223 pp.

Long, W.C., J. Popp, K.M. Swiney, S.B. Van Sant. 2012. Cannibalism in red king crab, *Paralithodes camtschaticus* (Tilesius, 1815): Effects of habitat type and predator density on predator functional response. Journal of Experimental Marine Biology and Ecology 422: 101-106.

---, L. Whitefleet-Smith. 2013. Cannibalism in red king crab: Habitat, ontogeny, and the predator functional response. Journal of Experimental Marine Biology and Ecology 449: 142-148.

---, S.B. Van Sant, J.A. Haaga. 2015. Habitat, predation, growth, and coexistence: Could interactions between juvenile red and blue king crabs limit blue king crab productivity? Journal of Experimental Marine Biology and Ecology 464: 58-67.

Lubchenco, J., S. Navarrete, B. Tissot, J. Castilla, 1993. Possible ecological responses to global climate change: Nearshore benthic biota of Northeastern Pacific coastal ecosystems. In: Mooney, H., E. Fuentes, B. Kronberg (eds.), Earth system responses to global climate change: Contrasts between North and South America. Academic Press, San Diego, CA, pp. 147-166.

Mueter, F.J., M.A. Litzow. 2008. Sea ice retreat alters the biogeography of the Bering Sea continental shelf. Ecological Applications 18: 309-320.

Murawski, S.A. 2010. Keynote: Rebuilding depleted fish stocks: The good, the bad, and, mostly, the ugly. ICES Journal of Marine Science 67: 1830-1840.

NMFS. 2013. Status of Stocks, 2012. Annual Report to Congress on the Status of U.S. Fisheries. US Department of Commerce, Washington DC, 8 pp.

NOAA. 2005. Current state of the Bering Sea. http://www.beringclimate.noaa.gov/bering_status_overview.html: Accessed 5 Nov 2014.

NPFMC. 2010. Initial review draft, environmental assessment for the proposed amendment to the fishery management plan for the Bering Sea and Aleutian Islands king and tanner crabs and the fishery management plan for the groundfish of the Bering Sea and Aleutian Islands to revise the rebuilding plan for Pribilof Islands blue king crab. North Pacific Fishery Management Council, Anchorage, Alaska, 202 pp.

Ochwada, F., N. Loneragan, C. Gray, L. Suthers, M. Taylor. 2009. Complexity affects habitat preference and predation mortality in postlarval *Penaeus plebejus*: Implications for stock enhancement. Marine Ecology Progress Series 380: 161-171.

Persson, L. 1986. Temperature-induced shift in foraging ability in two fish species, roach (*Rutilus rutilus*) and perch (*Perca fluviatilis*): implications for coexistence between poikilotherms. Journal of Animal Ecology 55: 829-839.

Pirtle, J.L., A.W. Stoner. 2010. Red king crab (Paralithodes camtschaticus) early post-settlement habitat choice: Structure, food, and ontogeny. Journal of Experimental Marine Biology and Ecology 393: 130-137.

---, G.L. Eckert, A.W. Stoner. 2012. Habitat structure influences the survival and predator-prey interactions of early juvenile red king crab Paralithodes camtschaticus. Marine Ecology Progress Series 465: 169-184.

Punt, A.E. 2011. The impact of climate change on the performance of rebuilding strategies for overfished groundfish species of the U.S. west coast. Fisheries Research 109: 320-329.

R Development Core Team, 2013. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.

Refsnider, J., F. Janzen. 2012. Behavioural plasticity may compensate for climate change in a long-lived reptile with temperature-dependent sex determination. Biological Conservation 152: 90-95.

Ryer, C.H., J.L. Lemke, K. Boersma, S. Levas. 2008. Adaptive coloration, behavior and predation vulnerability in three juvenile north Pacific flatfishes. Journal of Experimental Marine Biology and Ecology 359: 62-66.

Stoner, A.W., M.L. Ottmar. 2004. Fish density and size alter Pacific halibut feeding: implications for stock assessment. Journal of Fisheries Biology 64: 1712-1724.

---., E. Sturm. 2004. Temperature and hunger mediate sablefish (*Anoplopoma fimbria*) feeding motivation: Implications for stock assessment. Canadian Journal of Fisheries and Aquatic Sciences 61: 238-246.

---. 2009. Habitat-mediated survival of newly settled red king crab in the presence of a predatory fish: Role of habitat complexity and heterogeneity. Journal of Experimental Marine Biology and Ecology 382: 54-60.

---, M.L. Ottmar, S.A. Haines. 2010. Temperature and habitat complexity mediate cannibalism in red king crab: Observations on activity, feeding, and prey defense mechanisms. Journal of Shellfish Research 29: 1005-1012.

---, L.A. Copeman, M.L. Ottmar. 2013. Molting, growth, and energetics of newly-settled blue king crab: Effects of temperature and comparisons. Journal of Experimental Marine Biology and Ecology 442: 10-21.

Swingle, J., B. Daly, J. Hetrick. 2013. Temperature effects on larval survival, larval period, and health of hatchery-reared king crab, Paralithodes camtschaticus. Aquaculture 384-387: 13-18.

Tapella, F., M.C. Romero, B.G. Stevens, C.L. Buck. 2009. Substrate preferences and redistribution of blue king crab Paralithodes platypus glaucaothoe and first crab on natural substrates in the laboratory. Journal of Experimental Marine Biology and Ecology 372: 31-35.

van Dijk, P., G. Staaks, I. Hardewig. 2002. The effect of fasting and refeeding on temperature preference, activity and growth of roach, *Rutilus rutilus*. Oecologia 130: 496-504.

Zheng, J., D. Pengilly, 2003. Evaluation of alternative rebuilding strategies for Pribilof Islands blue king crabs, Regional information report No. 5J03-10. Alaska Department of Fish and Game Division of Commercial Fisheries, Juneau, Alaska, 26 pp.

---, G. Kruse. 2006. Recruitment variation of eastern Bering Sea crabs: Climate forcing or top-down effects. Progress in Oceanography 68: 184-204.

Chapter 2: Community development versus economic development: Place-making as a framework for understanding development in fishing communities[1]

Abstract

This paper describes how place-making theory, with its focus on power dynamics, local goals, and non-market, locally-valued, place-specific characteristics, can provide a useful framework for managers to better design fishing community policies. Social data in fisheries management, while becoming more common in fisheries management analyses, are typically restricted to quantitative measures. These data are limited, however, and often cannot adequately summarize the dynamics within fishing communities. In contrast, detailed ethnographic research and the theoretical framework of place-making can provide a useful methodology through which to gather social data to understand resource-dependent communities and the effects of fisheries management policies in these places. Place-making describes the process through which physical spaces are transformed into socially constructed places, invested with social and cultural meaning. Place-making ideas and practices can therefore interact with economic development efforts to help create (or fail to create) sustainable communities. To examine how place-making and development efforts articulate in the Pribilof Islands, we conducted six months of ethnographic research in the rural, Native communities of St. George and St. Paul, Alaska. We found that residents in both communities strategically reject development initiatives that might undermine local autonomy and rather pursue development that creates and furthers a place-

[1]Lyons, C, CL Carothers, and K Reedy. Community development versus economic development: Place-making as a framework for understanding development in fishing communities. Prepared for submission to *Maritime Studies*.

based, local economy. Furthermore, residents in St. Paul harnessed local development efforts that aligned well with their understandings of, and desires for, their community, successfully establishing a local halibut day-fishery, which, along with a local processing plant, support the community economically. In contrast, residents of St. George developed narratives of resistance to help gain control over local resources currently controlled by an external corporation tasked with representing the village. This study supports previous research indicating that policies and development projects that increase local power and self-determination are the most successful in furthering community sustainability and well-being.

2.1 Introduction

In this paper, we describe how detailed ethnographic research and the theoretical framework of place-making can provide a useful methodology through which to gather social data for informing fisheries management processes. A place-making framework considers the ways in which individuals and groups actively create and shape the places they live into communities, how "structures of feeling that bind space, time, and memory in the production of location" are formed (Gupta 1992). In short, it focuses on the cultural creation and understanding of local environments and therefore encapsulates important indicators of well-being such as fate control, cultural integrity and contact with nature (AHDR 2004).

These types of data are conspicuously absent from most management discussions, despite the legal requirement that managers examine potential effects of policies on fishing communities (Magnuson-Stevens Fishery Conservation and Management Act of 2006). While some social scientists in fisheries management acknowledge and lament these shortcomings (e.g., Sepez et al. 2006), little headway has been made toward including detailed, site-specific, socio-cultural data

on fishing communities in the decision-making process. On the rare occasions when managers do include non-economic social data in assessments, these data come from broad, large-scale datasets (e.g., US Census), garnered from available online sources, or based on surveys or interviews administered during brief visits to fishing communities. The data collected are often limited and typically focus directly on involvement in fisheries (Himes-Cornell et al. 2013). The complex relationships between fishing peoples and their resource bases, however, are difficult to capture in such broad scale data or numerical summaries (Sepez et al. 2006).

When managers exclude socio-cultural data the ramifications can be serious. Exclusion of these data can paint simplified pictures of a community, with unintended consequences, such as perpetuating inequality, reducing resilience, and disturbing networks of informal social controls over resources (Poe et al. 2014). This is especially true for indigenous communities, for whom historical conditions are necessary to understand or meaningfully assess contemporary conditions. Thus, we posit that examining intersections between place-making and development can provide a useful lens through which to understand the important social and cultural dimensions of fisheries dependent communities for inclusion in management decision-making. Such a framework allows for integration and comparison of socio-cultural values with the economic indicators and programs currently used in management, providing a useful point of entry into management discussions. Below, we provide an example of the framework's utility, using the Pribilof Island communities of St. George and St. Paul, Alaska as a case study.

2.2 Place-making

An understanding of place is essential to understanding place-making. Place, though often considered a constant backdrop on which to study social changes, is more than a static,

unchanging natural characteristic. Rather, place is a constantly changing social construct, one that is embodied in a concrete and particular location (Thornton 2008). Though bounded, place does not refer to an isolated area, separate from larger global communities and networks. As Harner (2001) explains, "place is the interaction between extralocal (global) forces, local histories, cultural constructs, and individual human agency". Furthermore, understandings of place can be predicated on two aspects of a landscape: "the physical support it provides (*means*) and the intangible rewards it offers (*meanings*)" (Marsh 1987). This distinction stresses the role of social, in addition to physical contributions in the formation of place. Succinctly put, place is the "milieu in which humans transform the earth into the home of human kind" (Sack 1999). It is also, however, the ways in which place shapes human communities and cultures. In many indigenous cultures, place names are embodied with moral stories and histories (Basso 1996; Thornton 2008). Walking the land or even thinking about these places, can therefore ground individuals in their cultural heritage.

Thus "place-making" can be seen as the process through which places are socially constructed and invested with social and cultural meaning and, in turn shape human communities. By answering everyday questions such as, "What happened here? Who was involved? What was it like? Why should it matter?" (Basso 1996), a set of shared symbolic and narrative elements become fused into a cohesive sense of place. The process is integrative and often contested, requiring a continual melding of geography, autobiography, and metaphor (Burton-Christie 2009), based on individual sensations and experiences (Tuan 1977). This melding is represented and reified through everyday life and things like performances, artwork, and even advertising efforts (Brannstrom and Neuman 2009). Building on Marsh's (1987) work, Harner (2001) argues that means and meanings continually interact as "changing power relations

(access to the means of existence) privilege one discourse, and the meanings in the landscape, over another". Development initiatives, which are often initiated by distant, powerful government centers, therefore can destabilize local power dynamics and alter local place-making efforts. In such cases, place-making can be used as a tool for local resistance (Gupta and Ferguson 1997; Scott 2008) and for imagining and defining alternative economies (Ingold 2011).

2.3 Pribilof Island history

Place-making is an active, continuous process; as such, it can be best understood through an historical perspective. St. Paul and St. George are small, mainly Aleut (Unangan)[A] villages, with an unusual history. The islands are roughly 40 miles apart and located in the Bering Sea, more than 200 miles from the western coast of Alaska. While known to the Aleut people, the islands were not home to permanent settlements at the time of Russian contact in the 18th century (Black 2004; Torrey 1978). Instead, Russian fur seal traders, upon discovering that the islands hosted fur seal breeding grounds, began to seasonally relocate Aleut hunters from their villages in the Aleutian Islands, bringing them to the Pribilof Islands and forcing them to harvest fur seals (Torrey 1978). Year-round settlements in the islands eventually developed in the early 1800s (Corbett and Swibold 2000).

In 1867, Alaska was sold to the United States, and Pribilof residents became wards of the federal government (Jones 1980). During this period, conditions in the Pribilof Islands steadily worsened, as first private corporations and then federal agents attempted to maximize seal harvest profits. Government agents implemented strict policies including: obligatory labor, federal control over local politics, a ban on sugar (which was frequently used to make alcohol), condoning of exile as a punishment, and, finally, a policy of isolation and secrecy designed to

prevent outsiders from discovering the cruel conditions shaping local life (Jones 1980). These policies, as well as the issuing of supplies rather than wages, gave government agents a great deal of control over local people.

World War II changed the relationship between Pribilof residents and the United States government. Fearing Japanese attack on the islands, government officials evacuated residents to an abandoned cannery in Funter Bay, near Juneau, Alaska (Torrey 1978). Residents from several other Aleut villages were also evacuated to camps in southeast Alaska. Conditions in the camps were dismal and an estimated one in 10 internees died due to disease and starvation (Sepez et al. 2007). Eventually, a few Pribilof Islanders were allowed to move from this camp to Juneau, to address a labor shortage in the city (Torrey 1978). Exposure to life in a modern community fueled a desire to fight for political rights and economic sufficiency.

After the war, residents were returned to the Pribilof Islands and initiated a series of campaigns to fight for their rights. These campaigns led to improved working conditions and increased local control (Torrey 1978), and the right to self-governance through the establishment of tribal governments (Jones 1980). Though the establishment of tribal governments brought the right to sue, apply for grants, and act in government-to-government consultation, the federal government retained substantial power in both communities (Jones 1980). However, the political environment changed significantly in the late 1960s, with Alaska gaining statehood. Statehood granted Alaska the right to 70% of the earnings from Pribilof Island sealing operations, making oversight of the islands financially draining to the federal government (Jones 1980). In response, the federal government attempted to consolidate the two Pribilof Island communities, by moving residents from St. George to St. Paul (Torrey 1978). This proved to be wildly unpopular with local residents, and although several families (approximately 60 people, at least a quarter of the

population) did move to St. Paul, the majority of St. George residents refused to move (EDAW 2008; Torrey 1978).

Soon after, the federal government announced its intention to withdraw from the islands (Torrey 1978). Declines in fur seal abundance, combined with the increased costs of paying residents living wages, made fur sealing a less profitable endeavor (Jones 1980). In 1973, the federal government closed down sealing operations on St. George and for the next 10 years, St. George was used as a base for researchers studying the decline of the local fur seal population (Jones 1980). During this period, the federal government continued to support the community, while seal harvesting continued in St. Paul.

To prepare for the government's withdrawal, residents worked to take control over their local economies. These economies were bolstered by funds earned through litigation (State of Alaska 2011). In protest of their treatment during World War II, the communities, along with several other Aleutian Island villages, sued the federal government and won approximately $8.5 million in settlement money that was shared among the communities (State of Alaska 2011). Their burgeoning self-reliance was dealt a strong blow in 1985, however, when declines in fur seal populations, combined with the anti-sealing agenda of environmental organizations like Greenpeace, created enough political will to close the fur seal fishery and abruptly withdraw from both communities. Pribilof Island residents responded by demanding government support to transition their local economy from a sealing base to a fisheries base. The outcome of the political struggle was two-fold: the federal government promised to provide $20 million dollars to fund the development of fisheries-related infrastructure on both islands and in 1992 also allocated fishing quota to St. Paul and St. George through the Community Development Quota (CDQ) program (Ginter 1995; State of Alaska 2011).

As a result of these actions, both communities were able to work toward establishing fisheries-based economies. Harbors were built on both islands and residents began participating in a local halibut fishery. In addition, the islands became service hubs for vessels participating in the Bering Sea crab fisheries. Floating and land-based processors brought landing tax revenue to the communities, supplemented by the sale of food, supplies and pot storage space to crab fishermen. Resource volatility and changes in resource management, however, have greatly affected the stability of both communities.

Community stability has also been affected by interactions among a suite of local and regional political entities that structure these communities today. Important political entities in the Pribilof Islands include the tribal governments, city governments, the regional ANCSA (Alaska Native Claims Settlement Act) corporation (Aleut Corporation), village ANCSA corporations (Tanaq in St. George and TDX in St. Paul), and CDQ corporations (APICDA in St. George and CBSFA in St. Paul). ANCSA and CDQ corporations own local resource rights, with surface resources allocated to the village corporations, subsurface resource rights to the regional corporation, and certain fish resource rights to the CDQ corporations (Case and Voluck 2002). The city government is responsible for maintaining infrastructure and amenities such as roads, electricity, and garbage management. The tribal government receives grant money to conduct social welfare programs or small-scale development projects, and has the right to enter into government-to-government consultations on policy and development initiatives. The competing needs of these organizations can, therefore, make day-to-day management of village life difficult.

Despite these difficulties, St. Paul is a bustling fishing community, with a fleet of around 20 local boats participating in a day fishery for halibut from June-October. Taxes collected from

a year round processing plant support the city government, providing funds for building and maintaining infrastructure and median household income is $38,750 (State of Alaska 2014). In contrast, St. George struggles. With no processing plant to provide tax money, the city government depends upon state and federal aid to maintain infrastructure. A handful of boats participate in the local halibut fishery and they depend upon a tender boat to ferry catch over to St. Paul. Bad weather and mechanical problems can prevent the tender from leaving harbor, occasionally causing the catch to spoil before it can be processed for commercial sale. Though median household income is higher than in St. Paul ($44,792; State of Alaska 2014), costs are also much higher in St. George. Heating fuel alone is 1.5 times higher than in St. Paul ($7.74/gallon compared to $5.20/gallon; State of Alaska 2014). Groceries, electricity, and gasoline are also more expensive in St. George and, as a result, 14.5% of the population lives below the poverty line, as compared to only 11.5% in St. Paul (State of Alaska 2014).

2.4 Alaskan development programs relevant to the Pribilof Islands

Today, life in the Pribilof Islands is profoundly affected by two development programs: ANCSA and CDQ programs. To understand how these programs work, however, it is necessary to first to understand the concept of development. "Development" was a response to the end of the colonial era in the aftermath of World War II. First at the Bretton Woods Conference (US Department of State 1944) and then again in Truman's inauguration speech (Truman [1949] 1964), wealthy, western nations began to realize that turmoil and poverty in the global South threatened the stability of a successful global economy. In response, they advanced the concept of "development" (Escobar 1997). At its core, development was about helping the poor and unfortunate, but it was an idea flawed by problematic assumptions about who the poor were, why

they were poor, and what could best be done to alleviate this poverty (Berger 1985). In the development paradigm, the "poor" are defined as those lacking sufficient monetary income and this lack is considered the root of all social ills (Escobar 1991). The cause of poverty is considered the result of a lack of "progress", which is defined as a process of linear and inevitable social and technological improvement, achieved through industrialization (Hearth 2009). Under this worldview, fostering economic growth through participation in the global market becomes the best way to reduce poverty. Thus, development programs fought to eradicate poverty through integration into the global market, using western, primarily urban-produced, technology and knowledge (Autumn 1996).

ANCSA led to the designation of land rights for Alaska Native groups, while the CDQ program provided fishing rights to local communities. Specifically, ANCSA outlined which lands remained in Native hands, and which became the property of the state and federal government (Mitchell 2001). Tribal governments, however, did not receive control over Native lands, rather ANCSA stipulated the formation of Native corporations (Berger 1985; Mitchell 2001). These corporations received title to Native lands and could manage or develop them for the benefit of shareholders. This structure was clearly part of a development and assimilation paradigm, with the corporations, theoretically, providing economic opportunity through increased development and industrialization opportunities in rural Alaska.

The development paradigm fostered by ANCSA had several flaws. In 1985, Berger conducted an intensive study of village life post-ANCSA; the people he spoke with valued access to their subsistence resources over opportunities to industrialize and felt that control over local harvest efforts had eroded (Anders and Langdon 1989; Conn and Langdon 1988; Langdon 1986). They feared, furthermore, that they might lose their lands over time (Berger 1985). The

new corporate structure legitimately jeopardized their land ownership, as a poorly run corporation might lose land to creditors or have shares purchased by outsiders. Finally, ANCSA undermined tribal sovereignty, as it removed land ownership rights from tribal control, as was the case with Native lands in other parts of the country, and bequeathed these rights to corporate entities with no connection to the tribal government (Case and Voluck 2002).

CDQ is a similarly structured development program, creating and distributing resource rights among corporate entities specifically created to represent Native interests (NRC 1999). Established in 1992, the CDQ program allocated rights to corporate entities for a percentage of the annual pollock harvest (Ginter 1995; NRC 1999). As, initially, none of these communities had the resources in place to fish these quota, the CDQ groups rented their quota to private corporations and invested the profits back into fisheries development projects (NRC 1999). Over time, the program changed. Allocations were made for additional fisheries, and the CDQ proportion of the total allowable catch increased to 10% (MSFCA 2006).

While initially planning to form a single CDQ group, the Pribilof Island communities of St. Paul and St. George eventually formed different CDQ groups. Discussions around the formation of a single CDQ group tapped into animosity between the communities, and residents could not come to an agreeable distribution of quota or of seats on the board between islands. People in St. Paul advocated that these be based on population, while St. George residents preferred an even split. Unable to fashion a satisfactory compromise, St. George split off from St. Paul and instead joined with communities in the Aleutian chain. Today, St. Paul is the sole member of Central Bering Sea Fishermen's Association (CBSFA), while St. George is one of six communities in Aleutian Pribilof Island Community Development Association (APICDA).

CBSFA is unique among the CDQ groups being the only CDQ corporation to serve just one village and headquartered in a constituent village (CBSFA 2013).

Therefore, to better understand how place-making and development efforts articulate in the Pribilof Islands, a member of our research team (C. Lyons) spent six months in the communities of St. George (June-September 2012) and St. Paul (September-December 2012), engaging in participant observation and conducting semi-structured interviews (26 in St. George and 24 in St. Paul). We selected participants via snowball sampling (Bernard 2006), focusing on long-term residents who had a vested interest in the community and encompassing a diversity of perspectives: men, women, elders, youths, fishermen, government officials, and people not directly involved in fisheries or fishery support services. Interviews were audio recorded and lasted anywhere from 30 min to 2 hours. For analysis, interviews were verbatim transcribed and inductively coded in Atlas.ti using a grounded theory approach (Strauss and Corbin 1997). This approach involves a researcher sorting codes together into themes, which serve as the foundation for the development of theory (Strauss and Corbin 1997). Research results were then presented to the communities for feedback to ensure that the findings aligned with the understandings of community members.

2.5 Vignette: Struggle in St. George

Far enough east from the bulk of Alaska to warrant being in a different time zone, the sun sets late in St. George. Walking down the street during one of their late summer sunsets you might think that the entire island has been abandoned to the birds and foxes. Flocks of least auklets (or *chuuchii* in Unangan) swirl across the sky on the way back to their hillside nests and houses are still dark. In a few minutes lights will blink on in every third or fourth house,

indicators that some people, at least, are still living here. But, as the numerous empty, abandoned houses reflect, life here isn't easy, hasn't ever been easy. The empty homes serve as reminders of a series of hardships: an attempt by the federal government to shut down the community and move residents to St. Paul in the 1960s, the ten-year period of economic stagnation that resulted when some residents refused to move off island and the government shut down fur sealing operations to save money, and the failed promise of a fisheries-based economy to replace fur sealing as an economic base.

Away from the village, on the far side of the island, the harbor stands nearly empty. One floating dock houses fewer than 10 fishing boats, all but one under 30 ft. Most of these boats are locally owned, but the largest, a 36 ft tender boat, is owned by the CDQ corporation. Filled with ice, the tender waits to shuttle fish to the processing plant 40 miles away in St. Paul. In a few weeks these boats will be hauled out and the harbor will be quiet again, save for the fall fuel barge, until next summer.

In the early 1990s, though, things were different. The lucrative Bering Sea crab fisheries were a derby-style fisheries and participants raced to haul up as many crab as possible before the season was shut down, often in a matter of days. The St. George harbor, narrow, shallow, rocky, and windswept, offered a place for crab processors to set up shop. Crabbers crowded into the dangerous port, happy to shave hours off the transit time required to transport crab to the processors in Dutch Harbor. Then came the crab crash of 2000. In part to help rebuild the drastically reduced crab stocks (particularly Bering Sea snow crab), managers "rationalized," or privatized access rights to the all Bering Sea crab fisheries in 2006. Guaranteed a set percentage of the allowed catch in each season, crabbers were no longer in such a terrible rush to drop off their harvest, preferring instead to take their catch to the safer harbors afforded by St. Paul or

Dutch Harbor[B], as a result the community lost considerable income from landing taxes[C]. A St. George fisherman explained the effects of crab rationalization on his community, saying, "When we had the crab processors up here I know that brought a lot of money, that brought business up here... but ever since crab rationalization it was like everything was just taken away from us. That was a big part of the city's income … [the economy] was just mainly crab."

Years later, locals still feel the loss of that income, legacy of the ill-designed harbor created as the community shifted from sealing to fishing. "Crabbing has a lot to do with the problems out here. Without the crabbing- when it stopped, it stopped everything here, because no monies anymore," an older gentleman lamented. A new harbor would mean the possibility of a service economy- selling fuel and food to fishermen. It would mean the possibility of tax income from crab processors, and the arrival of more barges, bringing a wider variety of goods and lowering prices. Improvements to the harbor are therefore a priority for locals. As one elder put it, "Unless we can reconfigure that harbor to encourage larger boats to come in… I think the clock is ticking here. I'm somewhat pessimistic about the future, to be honest." These sentiments are widely shared and, as a result, efforts to improve the harbor are universally supported in the village. Physical infrastructure improvements like these may represent the difference between a stable future and eventual abandonment of the community.

2.5.1 The harbor in St. George: An example of development conflicting with place-making

Unlike in St. Paul, no natural embayments existed on St. George that could be developed into a harbor. Instead engineers blasted rock and installed a large breakwater, to create a harbor. The project was more expensive than anticipated, however, and the resulting harbor was smaller, shallower, and more dangerous than originally designed. Thus, to help achieve the goal of

creating a more functional harbor in St. George, the state legislature recently allocated $2.5 million towards the redesign of the St. George harbor.

As part of the redesign project, engineers with the Alaska Department of Transportation visited St. George to talk with fishermen about the harbor. The engineers then returned to the island several months later to present the results of their efforts to the community in a public meeting. In the meeting residents questioned the utility of the proposed harbor designs, noting that the proposed changes would do nothing to help accommodate barges and other large vessels. The lead engineer dismissed their concerns, explaining, "The barge comes, what, four times a year? The design vessel [a hypothetical average vessel used to inform designs] comes four times a day. There are design tradeoffs. A big entrance for a barge allows lots of waves to enter the harbor." This sparked a host of angry comments, making the engineers testy and defensive and further angering locals who felt their concerns were being dismissed. Residents agreed the majority of vessels using the harbor would, in fact, be around seven local fishing boats less than 30 ft long, plus the tender boat (36 ft) working in the summer months. However, while barges (>100 ft) come rarely to the island, they are extremely important.

In a discussion later, an elder explained his concerns from that meeting.

> If the harbor is going to function as a fishing harbor, it's got to be able to accommodate barges. Not only for fuel, but for construction machinery, equipment, and materials. It's got to do that. It can't just be a harbor for 140 ft vessels. What [the engineer] said was that, he asked how many times a year do you get barges in here- four times a year. If the harbor is designed properly so that we could get barge services, we're going to get barges in and out of there more often. And I think he failed to see that… he was stuck on his

design and was going to push it through and that's no good. I mean, why bother to come out here and talk to us if you're not going to listen to our ideas too? They just wanted to ram it down our throats and be done with it.

This interaction encapsulates the struggle around development in St. George. Developers often feel residents are ungrateful for the money and effort being put into the community, while locals feel frustrated that developers don't take local ideas seriously and fail to meaningfully consult residents. These feelings are not limited to the harbor development project, but are pervasive. In a discussion about the local CDQ group, one St. George politician summarized the suite of local concerns eloquently:

> We've had our own thoughts and ideas with regard to development in St. George. And the people here have not seen any results for all the years trying to make positive things occur in St. George. This is a place that has a lot of needs. This is a place that's got a lot of social needs. This is a place that is facing a shutdown of its school. This is a place that has an unemployment rate, for the most part, nearing 80%. And when you've got problems like that and you're faced with those issues daily it's tough not to get frustrated or, at the very least, it's tough not to become angry. And people have every right to become angry. There are funds being spent in different areas that are not, in our opinion, totally appropriate to the mission of the CDQ program. All of us have our opinions I suppose, with regard to what we think the program was created for, what the mission of that program was. Now has it accomplished all of those? Not all of them, but some of them, they have, and you can't say that APICDA has not been a good partner to work

with, but it's sometimes been a very *difficult* partner to work with... we're being promised that there are going to be some things that are occurring at St. George once the harbor is complete. But, you know, we've seen it happen before. It's fits and starts…I mean, these are things that are promised, but we've dealt with a lot of those for many years here at St. George and none of those promises have ever been fulfilled to us. So it's difficult to sit and try to be cheerful or try to be optimistic that these things will occur.

This quote captures a variety of local concerns: an urgent desire for significant development in the community, frustration when agencies fail to deliver promised projects, and anger that local input and comments are largely ignored. Underlying all these concerns is the desire for autonomy- the ability to realize the changes they wish to see in their communities, on their own timeline and on their own terms.

2.5.2 *"The reincarnation of government control"*

When people in St. George talk about "the government" they are usually referring to the federal government and the connotations aren't positive; the phrase that closest captures local meaning is that of "slave masters". Elders remember being evacuated by the federal government and held in camps during World War II. They remember how the government agents tried to close the community in the 1960s and the numerous other ways in which residents were treated like second-class citizens. Children and grandchildren have been brought up on these stories of shame and anger and an awareness of this history permeates the community.

Thus, when discussions about development in St. George include comparisons to the government, it speaks to strong feelings of powerlessness and frustration. As an example, when

asked his opinion on APICDA's role in the community, an elder described his concerns: "You gotta have some local control. I don't like the idea of them dictating everything… creating CDQ was like the reincarnation of government control. And I think we need more local control in the community." Self-determination is a core dimension of human development and well-being in indigenous and rural fishing communities (AHDR 2004; Coulthard et al. 2011). And, on an individual level, a lack of fate control can lead to anger, violence, and disengagement, while those who feel they have control over their destiny are more likely to be engaged and active in community life (AHDR 2004).

While fate-control affects the well-being of communities, the struggle for control over the shape of development in St. George is about more than psychological benefits; it reflects distinct ideological differences between community members and development efforts from APICDA. As one elder puts it, "In some ways I don't think it's community development, it's whatever APICDA decides they want to do." This quote clearly reflects the ideological difference: the development APICDA does is *not* community development. Community development is something different. So what, exactly, is community development to St. George residents?

The question is difficult to answer, and was most commonly discussed in terms of what fishing *didn't* mean to residents. Specifically, residents expressed two primary concerns regarding APIDCA's vision of community development that do not mesh with local ideas about community development: (A) while APICDA does provide some opportunities to fish, these opportunities don't allow locals to fish in the manner they would like to fish and (B) APICDA would rather lease out local quota than help residents catch it. The following quotes illuminate these concerns by exploring local observations and critiques of APICDA's efforts to develop local fisheries.

2.5.2.1 Concern A: Fishing opportunities don't allow locals to fish in the way they desire to fish

> [We are] trying to get APICDA to get us the bigger boats we want, things that we want to make us more comfortable fishing on our boats… but they want us to fish the way they want to fish. So they're trying to control us. We don't want that. We're not the…we don't have the government anymore. They're trying to act like the government.

> The board members from APICDA, they told us that they wanted us to get more boats that are slow. No more than like 8-10 knots. They say fuel [efficiency is the reason why]… [But we] found boats that we wanted and they're not high speed, they can cruise up to 22-23 knots. Which is good because if we fish farther, between 10-70 or 100 miles [offshore], we have got to have the power and the speed to come back… If they gave us what we wanted, it's no hassle to them because they'll get their money back and we'll be able to catch the quota and we'd probably ask for more quota.

2.5.2.2 Concern B: APICDA would rather lease out quota than help locals catch it

> They gave up this year. 50-60,000 lbs [of our quota], they gave it away. They've been working with that partner boat for a while… they're more into getting the fishing off to someone else. The other thing is, when they do that they profit from it. And when they profit who really loses? We do.

Furthermore, the residents who consider themselves professional fishermen, who have traveled across the state, leaving home for months at a time in pursuit of fishing opportunities, agree that fishing in the local fishery is a different experience. As one APICDA employee explained, "A lot of these guys, they go out, come back in… and they go back out… they don't want to go to Atka [for instance]. Atka's way out there [in the Aleutian Chain] and it's pretty brutal out there… you gotta stay out there a couple days, you gotta live on the boat and a lot of guys don't want to make that jump." Another fisherman agreed, "I don't think anybody's willing to go out from here and fish halibut overnight and be on that water overnight… everybody here's pretty much fished those small boats in day fisheries. They just don't go out overnight or travel any great distance from here to fish."

Evident in these quotes is the local, small-scale nature of St. George community day fisheries. Residents value the ability to fish around their hometown, returning each night. However, fish density around the island is low, and the prime fishing areas are 70 or more miles offshore. In order to reach those waters and preserve the day-fishery nature of their fishery, residents want APICDA to help them acquire larger (30-40 ft), faster boats. In contrast, APICDA would prefer to loan out vessels they own (about 50 ft) that can make multi-day trips and travel to different areas, catching quota they own in areas across the Bering Sea. This represents one important source of the disagreement between community members and their CDQ group. While both groups desire local economic development, APICDA sees this development through the lens of business, tied to and dependent upon regional economic fisheries concerns. St. George Island residents, in contrast, see local economic development as predicated upon addressing local needs and concerns first and foremost, regardless of regional concerns. This disconnect continues

despite communication between residents and the corporation, not spitefully, but as a result of the complex fiduciary responsibilities the corporation holds for all six communities it represents.

2.6 Vignette: The contrast of St. Paul

In late September, halibut fishing is starting to wind down in St. Paul. The skies are gray more often than not and the wind is constant, blowing dust and grit around the streets and whipping the ocean up into frothy waves that are dangerous for small boats. The 30 ft aluminum skiffs preferred by local fishermen are tied up in the small boat harbor, though, waiting for a break in the weather. At home, eager fishermen are thawing bait and calling up middle schoolers to thread the bait over hundreds of hooks, ensuring everything is ready to go should the weather change. Across the harbor a 58 ft vessel, the *St. Peter*, sits in front of the processing plant, offloading halibut. Owned by the local CDQ group, CBSFA, the *St. Peter* has been fishing farther offshore, crewed by men who have already caught their allotted portion of the CDQ harvest and are now collecting their personal (individual fish quota; IFQ) harvest shares. The processing plant hums, as halibut are filleted, vacuum-packed, flash frozen, and placed in boxes marked with the CBSFA logo. In a few hours, trucks also bearing the CBSFA logo will load up stacks of these boxes for distribution to elders.

2.6.1 CDQ in St. Paul: An example of development supporting place-making efforts

This vignette captures just a few of the ways in which CBSFA has made an impact on the community of St. Paul. Residents are enthusiastic in their praise for the program and can list numerous ways in which the organization supports the community. The following quotes are representative of local sentiments toward CBSFA.

They're great. They rock. This is what I think of Central Bering Sea [CBSFA], they just rock. They help out this community so, so much. Very happy with them. I can't think of one person that could say one bad thing about Central Bering Sea. I can't see it… I work for the local tribe and we rock because we do so much for the community, right, but they surpass us. They're the only entity on the island that could surpass us, but give credit where credit is due. That's my opinion and I hope that every person you interview has that same opinion.

I like them, they help the school, they help the city, they help people. They help old folks, like me.

I think they're a good organization. They work good in the community. They do a lot of different things. Without their help we wouldn't have a fire station. Without their help the small boat harbor wouldn't be there. They help the elders with fuel and they also give out king crab, opilio crab, and halibut and a couple of salmons throughout the year [to the elders]. They're a good island entity and work well with all the other entities.

A CBSFA employee explains the organization's philosophy thusly:

> We help in many different areas, whether it's contributing to the elders or the school, the Montessori [program]… we do an elder's program for fuel and electricity. We try to contribute to them, but they can't actually go down to the dock and fish, so that was one way we could help them. We are trying to be joint partners with the tribe… we did a joint

> venture with the city on [a building] where we store our crane… the rescue boat you see down in the harbor, we helped with that. We actually completed the small boat harbor… the city needed a new fuel truck, we helped them get that… yeah, we try to see what new projects are out there that could help with the community, especially the fisheries area.

These quotes indicate that the development efforts of CBSFA align with local development goals of creating a local, fisheries-based economy. The program, however, did not work like this from initiation. Though based on a local fishermen's group, CBSFA like the other CDQ groups, was originally headquartered off-island in the business hub of Anchorage. Furthermore, it was staffed by outsiders, familiar with business, but unfamiliar with island needs and politics. Community members, therefore, had to fight to achieve local control. "In the early days, [we had] different management and they had their offices out in Anchorage and stuff. They didn't know what was going on and local people said, no that's not going to be happening. We're gonna bring the Anchorage office here," one elder explained.

The process of securing local control required a great deal of political will and organization, skills that residents had gained in the 1970-80s, when the government simultaneously relinquished control of the islands and shut down the local economic base, fur sealing. A city employee described the political battles locals initiated in the aftermath of fur sealing to develop an alternate, fisheries based economy: "In the mid to late '80s we were already working by ourselves to get [fisheries] allocations. By the time the CDQ program was devised we were already thinking on our own. We had our harbor under construction at the same time… after that the CDQ discussion started. People here will tell you that we started it [the movement to establish CDQ]… We originally asked for a 10% allocation of the groundfish quota

and right now that's around the total CDQ allocation. We started the harbor in the mid-80s. It was a three-phase process and in 27 years we finished the small boat harbor, the last phase. It complimented our goals of developing a new economy." Another factor that aided the establishment of local control was the fact that CBSFA was created to serve only one community (St. Paul), rather than multiple communities like the other CDQ groups (6-20 communities each; WACDA 2008).

Though CDQ has done much to develop a local economy in St. Paul, it is important to note that while the local halibut fishery provides money and employment opportunities for residents, it does not cover the cost of operating and maintaining city infrastructure. Rather, the community development efforts of CBSFA are buttressed by taxes collected on crab processed at the local plant (currently operated by Trident Seafoods). As one community member put it, "Basically, crab here is like the life blood of the economy. The city depends on the crab tax and all that." In this light, CDQ has not saved the community from collapse, rather it has contributed to local well-being by allowing development efforts to support local place-making efforts.

2.7 Local and extra-local politics

While aligning development projects with place-making efforts increases community stability, it is important to note that the structure of development programs can obstruct the ability of locals to establish such an alignment by complicating local politics and creating extra-local political conflicts with outside groups. These difficulties range from explicit restrictions on how funds can be spent to more subtle consequences associated with the corporatization of indigenous rights (e.g., Dombrowski 2001; Keys 1997). While these changes are complex and nuanced, these programs fundamentally change traditional relationships with resources from

subsistence (typified by place-based, long-term reciprocal relationships between people and the natural world; Moore and Russell 2009) to capitalist (utility-based, individualistic, short-term relationships with the environment as a commodity; Moore and Russell 2009) forms, putting stress on Native cultures and ways of life (Vaccaro et al. 2009). Such programs also make it possible for indigenous peoples to become alienated from their rights and resources; if a corporation fails to make a profit, the resource rights may be sold or environmentally destructive projects engaged in to pay off debts (Dombrowski 2001). Finally, shareholder bases can become divorced from communities, such that corporate goals no longer align with community goals. As corporations have fiduciary responsibility to benefit all shareholders equally, this can be a very problematic situation for these corporations. Below, we present examples of these kinds of struggles observed in each community.

2.7.1 St. George: "Who do you represent… the communities or the large fishing fleet?"

Residents of St. George agree that fishing isn't as good as it used to be. Fish are harder to catch, further offshore, and smaller than in the past. One fisherman describes the changes he's witnessed: "It's gotten way worse over the years, a lot, lot, lot worse. As a kid, we'd go out and fill the boat up in the harbor in a half hour with a hand line, just right out here, right in front of town, toward east side of the village. We never even needed to come out here. This harbor wasn't here. We didn't really need to come around this side. We just launched in front of town there, catch all our fish, and going to that end of the island or this end of the island was like a big thing. It was a long trip, it was far away." A younger community member agrees. "When we were growing up and [we were] having 15+ boats and not 15+ people fishing, my dad would be

like, 'I got 100 fish today' instead of, 'I got two because we had to throw one back, it was too small'."

Local halibut fishing pressure consists of a handful of fishermen using 20-30 ft skiffs and residents rarely catch the quota of halibut allotted to their community in any given year; as such, they believe local declines are not caused by the local fleet, but rather are a result of intensive trawling in the area. Residents agree that several miles due east of St. George is an area that fishermen in the trawl fleet consider a "sweet spot". Trawl vessels fish intensively in that area; halibut are a prohibited species for trawl vessels, so any incidental catch, or "bycatch," of halibut must be discarded at sea, often killing the halibut locals depend on. "I think there's trawlers operating too close to St. George. They come within three miles of that side of the island. They say they're a clean fishery. They're clean because they wipe out everything so they don't have to save anything. I mean, they don't have to mess with fish that they can't keep because they've wiped them out," one fisherman explained.

To a community with no other economic resources, the protection of halibut is a serious concern. Residents state that both the city and tribal governments have tried to establish buffers to protect these waters, working with the North Pacific Fishery Management Council, the state and federal governments, with no success to report at the time of this writing. APICDA has the political clout to participate in the management process and can speak on behalf of residents. However, much of APICDA's income comes from trawl fisheries throughout the Bering Sea. As a result, APICDA's role in fisheries management is much different from that of St. George community representatives. The former seeks to negotiate a balance among different user groups from which it benefits and to whom it is beholden. Island residents, in contrast, have little concern for the well-being of APICDA's business partners, focused as they are on the immediate

survival of their community. Thus the corporate structure of the CDQ program contributes to local strife, the dual goals of economic profit and community welfare at odds with local goals of conservation and community well-being. One St. George resident shared a story that well summarized local understandings of APICDA's interactions with trawlers, "[An APICDA employee] was on a committee, the sea lion committee for the North Pacific Fishery Management Council and he was, he pushed for allowing the trawlers to come within three miles of St. George. I asked him a question one time, 'Who do you represent? Do you represent the communities or the large fishing fleet?' He said he represented the large fishing fleet." Whether or not this story is true, it is a common local perception of APICDA's relationship with managers and trawlers and, furthermore, it underlines the confusion caused by the CDQ program's dual nature of profit maximization and charity.

While these frustrations extend beyond APICDA, the interactions with APICDA are especially problematic, as evidenced by the power APICDA wields in management circles. Recent legislation has mandated government consultation with ANCSA corporations, a move which could be extended to CDQ groups and might diminish the power of tribal governments to negotiate on their own behalf (Granitz 2012). If this becomes the norm, local efforts for change will become much more difficult. In response to these fears locals are partnering with large nonprofits and agencies like Greenpeace, who have enough political clout to advance local conservation messages to both regional managers and conservationists across the nation.

2.7.2 St. Paul: "They're not seeing how much struggling the shareholders do here"

The success of place-making efforts in St. Paul has not been without difficulty; local political battles divide the community and are exacerbated by the outside shareholder base to

which the local ANCSA corporation is beholden. Important local political entities include: the city government, the tribal government, the ANCSA Native corporation (TDX), and the local CDQ corporation, CBSFA. While board membership of these different entities often overlap, each organization has its own distinct agenda, often leading to conflict. Furthermore, these conflicts often spill over into the social realm, as family loyalty is split among the different entities. Most notable of these conflicts is a lawsuit recently settled between the city and TDX. As one resident described the suit:

> The city of St. Paul and TDX, the local corporation, have been in lawsuits for the last 15 years. And I think that plays a major role in how it may or may not have divided the community. And that's what I don't like, is how we're not as close-knit a community as we should be, as we used to be. When the government ran the community everybody was on the same page. Nobody really liked the way the government was controlling things, so everybody was working together to find a way to break free from that. And now that we have our own entities and our own organizations, I think personalities clashing may be dividing the community.

While some of the political battles fought on the island in the past 30 years can likely be laid at the feet of personalities, family politics, and the general bickering present in all small towns, much of it results from the corporate structure of ANCSA and local government restructuring by the Indian Reorganization Act. As described previously, ANCSA was a piece of legislation that devolved indigenous land rights into for-profit corporations. Village residents at the time were then issued shares in their respective corporation (Case and Voluck 2002). Over

time, however, many shareholders moved from their villages to cities like Seattle, Anchorage and Fairbanks. Thus, the current shareholder bases of the many ANCSA corporations- and the boards that represent them- are largely urban and divorced from the villages these corporations were originally created to represent. TDX, the ANCSA corporation for St. Paul, is no different. As a local politician explained, "The [ANCSA] corporation's a profit-making corporation and they have to answer to the shareholders, so if it looks like it's going to make money then they'll do it… I've had it said to me, hey I don't only have to answer to you guys, I have other shareholders that may not live here that we've got to answer to, too. And they're all about making money for the shareholders." This focus on profit-making and increasing shareholder dividends has slowed projects vital to community well-being, like the small boat harbor project.

ANCSA, therefore, provides an example of how development projects can hinder place-making efforts of even well-organized and politically motivated communities. The program's corporate structure effectively divorced land rights from the community. Therefore, community members interested in developing local land must gain the approval of urban shareholders who know little about local needs and desires. In addition, the mandate, and in fact legal responsibility, of any corporation is to maximize profit for shareholders. Local projects are often smaller scale with longer return on investment periods, making them less attractive to boards intent on maximizing shareholder dividends. This creates conflict and hinders development.

One woman summarized these interactions eloquently, "There's this division line between people that are from here, but don't live here any more and people that live here… that's been a stickler in this political spear-throwing where some people say, why are they telling us what to do, they don't live here! Well they still feel like they can because they're from here and that's what the land corporations have sort of done without realizing it, that's happened. So I

tell my sons, well don't try to be involved in managing or saying what should happen here if you're not going to live here."

2.8 Lessons for fisheries: Articulation of place-making and development

The relationships between place-making and development in the Pribilof Islands are multifaceted and complex; furthermore, fisheries and land policies have structured these relationships in numerous ways, both directly and indirectly. In general, due to their relative success in transitioning to a fisheries-based economy, residents in St. Paul expressed attitudes of political empowerment and autonomy and were pleased with local development efforts. In contrast, residents in St. George articulated their feelings of disenfranchisement and ambivalence toward development projects. While strongly desiring more local infrastructure and local fisheries opportunities in their community, residents of St. George felt that outsiders design these projects poorly, often ignoring or misconstruing local input. These community case studies suggest that residents of St. Paul and St. George strategically embrace development, rejecting development initiatives or discourses that might undermine local autonomy, in pursuit of creating and furthering place-based, local economies that are consistent with local values and connections to place.

Strategies for aligning place-making and development efforts in the Pribilof Islands share similarities with efforts documented in other communities. The literature describes several ways in which place-making efforts may interact with development initiatives, including: obtaining hegemonic equilibrium (Harner 2001), developing resistance narratives (Larsen 2004), engaging in translocality (McKay and Brady 2005), and embracing marginality (Heald 2008). In the first of these, the process of creating a sense of place is considered tied to conflicts between opposing

groups: capital and labor (Harner 2001). These groups contest for control of local means of production and a solid sense of place is only achieved when "shared beliefs about place meaning for the majority match the ideological beliefs of those in power" (Harner 2001). Larsen (2004) builds on this work, arguing that a sense of place is developed not only in struggles between labor and capital, but also between insiders and outsiders. He postulates that outsiders become important in the construction of a local sense of place when they are able to alienate residents from "the material appropriation of the environs" (Larsen 2004). The resultant powerlessness catalyzes local feeling, creating a narrative of resistance in which residents are framed as separate from and in opposition to outside groups and projects. In contrast, McKay and Brady (2005) discuss the place-making efforts surrounding translocal communities and resulting from migration and globalization. In this framework, translocal communities, places structured by a mix of local and circulating populations (Appadurai 1995), are structured by the network of absent residents. These residents, traveling to different urban or even international hubs, maintain connections with the community, enmeshing the local place in global flows of information and cash (McKay and Brady 2005), which structures local means and meanings. Finally, Heald (2008) describes how community residents draw upon their agency to actively choose to pursue place-making efforts as an alternative to development. In this case a community may choose to "embrace marginality" or work to create and maintain mixed economy lifestyles (Heald 2008).

Aspects of all four strategies, hegemonic equilibrium, resistance narratives, translocality and marginality, are present in the Pribilof Islands, to differing degrees. Both communities show evidence of translocality as they have experienced a great deal of outmigration in the past decades. As a result, connections with the mainland, maintained by family members living in

places like Anchorage and visiting the islands seasonally, have strengthened. The major ways in which place-making and development articulate in the Pribilof Islands, however, are more aptly described in terms of the relationships between labor, capital, and outside forces attempting to control local means of production.

In St. Paul, residents have largely won the battle for control of local resources, establishing hegemonic equilibrium, such that means (a fisheries-based economy) align with local meanings (being a fishing community able to participate in local day fisheries and deliver fish to a local processing plant). This equilibrium was achieved, in large part, through the capture of capital and the strengthening of local autonomy. A lack of power and capital reflects the state of many rural communities and reinforces postcolonial relationships with government centers in a core-periphery dynamic similar to that in much of the global South (Wallerstein 2004). In St. Paul, development projects such as CDQ, however, allowed the community to manage their own resources to obtain capital. As the only community in their CDQ corporation, they had much more control over the development of fisheries resources than other communities, like St. George. Also, significant is that the St. Paul CDQ corporation is headquartered in the community and run by residents. This has allowed residents a degree of local control unmatched in other Alaskan development program. With this autonomy, residents were then able to use these resources to gain capital with which to achieve local goals. This process has not been without struggle, some of which resulted from the structure of the development programs leading to fractioning of the community. It has, however, largely been successful.

In contrast, control over local means is still hotly contested in St. George. Local strategies for gaining control draw upon both the resistance narratives described by Larsen (2004) and the desire to embrace marginality documented by Heald (2008). The rural British Columbian

logging communities described in Larsen (2004) are similar in many ways to St. George. In both areas, residents view themselves as wielding little power and as being placed in opposition against outside forces controlling local resources. Furthermore, residents in both areas partnered with nonprofit organizations like Greenpeace to fight unwanted development projects, while establishing grassroots campaigns to develop local economies. A significant difference between the two areas, however, is that in St. George local rights to land and resources have been devolved to third-party corporate control, frustrating residents' efforts at developing a local economy. While residents have a voice on the board of the local village and CDQ corporations, the organizations remain insider-outsiders, at best. As such, their goals often do not align with local goals and thus reify the local resistance narrative.

While local goals do not necessarily align with those of development agencies, St. George residents do strongly desire more development in their community. As such, their resistance is limited in scope. Rather than eschewing development altogether, as residents did in Heald's (2008) study, residents of St. George support a number of proposed projects, including: a hunting lodge, a fish processing plant, ecotourism, and the harbor redesign. Local resistance centers, therefore, on place-making efforts and specifically the desire to see the development of a local fisheries-based economy in the community. Furthermore, residents desire this fishery to be structured in a particular way, as a day-fishery.

While the desire for a fisheries-based economy is central to place-making efforts in both Pribilof Island communities, it is not true of all Aleut communities. Through extensive ethnographic research in King Cove, Alaska and several other Aleutian chain communities, Reedy-Maschner (2010) has demonstrated that residents of these communities have a much more flexible understanding of place, drawing upon centuries of tradition, moving to follow resources

throughout the region. As a result, residents today identify as commercial fishermen above all else and willingly travel to follow the fish for weeks or months at a time when possible (Reedy-Maschner 2010). In contrast, Pribilof Island residents have a cultural history of being fur seal harvesters in a cash economy. For over 200 years they inhabited their islands, harvesting fur seals in the summers. Each morning, men would head down to the rookeries and return home in the evening, while women cared for children. This is the rhythm of life important to Pribilof Island residents and it is one they feel that fishing should be able to provide for them. Indeed, fishing does provide this daily rhythm for St. Paul residents. Thus, building on Heald (2008), our study indicates that a community can choose to prioritize place-making, without rejecting development entirely. Such communities strategically embrace development, choosing to maintain some of their "marginalized" qualities in favor of persevering peace, quiet, and tranquility and togetherness, over the most economically efficient projects.

Place-making, as a framework for understanding fishing communities, highlights these choices and tradeoffs, which are often obscured in the frameworks typically used to describe communities in fisheries management. According to "typical" frameworks, communities are either at the whim of their environments, limited by local geology and climate (e.g., Diamond 2005), or constrained by the ability of stakeholders to cooperate and organize (e.g., Ostrom 1990). Accordingly, the drastic difference between Pribilof Island communities is dismissible as a result of St. George's inferior harbor and the unwillingness of its residents to cooperate with St. Paul in the formation of a joint CDQ group. From this perspective, the decline of St. George is an unfortunate and unavoidable result.

In contrast, place-making shows the ways in which residents struggled with the legacy of colonialism to protect a cherished way of life. Far from being an apolitical inevitability, the

poverty of St. George is a common plight shared by numerous indigenous communities struggling to achieve stability in a post-colonial era. Like many indigenous communities in the U.S., St. George remains economically dependent on federal aid, mainly in the form of grants to the tribal government. Economic dependency is an expected result in these cases, as local land and resource rights are too limited to support residents (Bee and Gingerich 1977). Instead, the federal government sustains these regions with a "policy of appeasement", providing enough money to ameliorate, but not solve issues of local poverty (Bee and Gingerich 1977). Such a culture of dependency becomes entrenched, as attempts to increase local autonomy are rarely successful, representing major shifts in political power. Furthermore, in an era of reduced government spending, the resulting political backlash of failed initiatives might jeopardize the continuance of federal funding that communities have come to rely upon. Even when such initiatives are successful, without access to capital, tribal governments are able to do little more than "rubber-stamp" currently established, often exploitative, development projects (Bee and Gingerich 1977). Such cash-strapped organizations are unable to fund long-term developments that would benefit residents, concerned instead with simply making payroll. Finally, a large government bureaucracy has evolved to oversee the transfer of money to Native reservations and villages, and this infrastructure is self-sustaining, furthering a "reciprocal dependence" between communities and agencies (Bee and Gingerich 1977). In this context, the achievements of St. Paul community members are impressive. Local control of the CDQ resource has provided them with the necessary autonomy and capital required to implement long-term development projects designed to benefit their community.

The findings of this study therefore align with those of Bebbington (2000), who found that contrary to common poststructural critiques (e.g., Escobar 1997), government intervention in

the form of development projects can improve quality of life in rural communities. While the history of development is one of colonial control, subaltern status, and local resistance (Escobar 1997), the future of development need not be limited in such ways. Projects that increase local control over political and economic institutions can improve local quality of life (Bebbington 2000; this study). The communities of St. Paul and St. George elegantly illuminate the importance of this distinction. Management plans seeking to foster sustainable fishing communities would, therefore, greatly benefit from including such insight as can be provided by place-making.

Such a task sounds daunting in the face of a management structure traditionally consisting of top-down, centrally controlled regulations. These types of programs were born out of a desire to command and control resources, increasing legibility of users for taxation purposes (Scott 1998). The idea of devolving control to communities and stakeholders is, therefore, highly destabilizing. While the destabilizing nature of devolving control to local stakeholders has hindered the development of co-management regimes, they are currently gaining momentum in fisheries management (Armitage et al. 2007). This shift therefore provides evidence that, as Scott (1998) put it, "the state may in some instances be the defender of local difference and variety" in the face of globalization and neoliberalism. The process is slow, requiring a re-centering of power, based on the creation of relationships and trust with residents and stakeholders, as well as a respect of local ideas (Campbell and Hunt 2012). Such a re-centering furthermore requires focusing on local "place-based models of nature, culture, and politics" (Escobar 2001). In summary, place – its politics and character, its means and meanings – is important in designing both development initiatives and fisheries policies that support the well-being and sustainability of fishing communities.

2.9 Conclusion: The importance of place

Many fishing communities are struggling today. Through policies of privatization and declines in resources, residents are losing access to their resource bases. Despite this, and in the face of economic collapse, people are choosing to stay in these communities. These socially created places are therefore important. They represent shared history, a sense of community and family, as well as a way-of-life quite different than those found in urban spaces. In indigenous communities, place furthermore represents a connection to sovereignty, cultural heritage and sense of stewardship toward land and resources. Only by understanding all these factors, and the importance with which residents view them, can policy-makers understand community sustainability.

Fishery policies for indigenous and rural fishing communities cannot, therefore, be successful if the authors of these plans do not understand local goals and needs. While gaining this understanding is a difficult task, it is a worthwhile one. As Campbell and Hunt (2012) explain, the conflict between indigenous and government goals does not reflect different priorities – both groups desire to see increased income and opportunities for struggling communities; rather the disagreement centers around whose terms the development will come and how success is defined. Thus policy makers should be clear in stating goals and how these goals articulate with local understandings and desires.

As a tool to aid in this endeavor, we propose the use of place-making as frame work to structure discussions around community-based fisheries policy. While economic markers are commonly used as indicators for measuring the success of policies, and development programs in particular, they have many limitations. Economic markers cannot predict, describe, or explain conflicts between insider and outsider ideas about development and goals for the future. They

cannot adequately demonstrate whether local well-being has actually increased or decreased as the result of an intervention. And, finally, they cannot capture the loss of non-market, locally valued, place characteristics. Place-making, in contrast, can do all of these things.

2.10 Acknowledgements

The authors would like to thank the residents of St. George and St. Paul Island for their hospitality and willingness to share stories and experiences, as well as the tribal councils of both communities for endorsing and giving permission for the project. The authors further thank the CDQ employees who shared their understandings and experiences working with the Pribilof Island communities. In addition, they are grateful to Anna Kerttula for acting as a reviewer and advocate during the proposal process, and Rhys Smoker for assistance with fieldwork and moral support. Funding was provided by the Rasmuson Foundation and two National Science Foundation programs: IGERT Marine Sustainability in the Arctic and Subarctic Grant No. 0801720 and Arctic Social Sciences, Dissertation Improvement Grant No. 16385. Coauthors contributed advice on methodology and analysis.

2.11 End Notes

A. Aleut is currently the most common ethnonym of the Pribilof Island residents, but it is a term whose popularity and widespread results from European use of the term during the 18th century. Unangan is an older term that is becoming more popular, particularly among community groups work to revitalize connections with their cultural heritage (Black 1998).

B. The crab rationalization program created two processing districts (Northern and Southern) and crabbers were required to process a percentage of their crab quota in each district based on their historical landings. The Northern district consists of two harbors: St. Paul and St. George. St. George never had a land-based processing plant, only floating processors that would set up either in the harbor or in nearby waters. After rationalization one of the St. George processors went bankrupt and the other discontinued operations in the area after a storm further damaged the St. George harbor.

C. Landing taxes received by St. George were collected from floating processors operating either in the harbor or in waters just offshore of the island. These taxes are based on the unprocessed value of the resource, calculated as weight multiplied by a statewide average price set by the Alaska Department of Fish and Game (Landing tax 2007).

2.12 References

AHDR. 2004. Chapter 13: A human development agenda for the Arctic: Major findings and emerging issues. In Arctic Human Development Report. Akureyri, Iceland.

Anders, GC, and SJ Langdon. 1989. Alaska Native regional strategies. Human Organization 48: 162-172.

Appadurai, A. 1995. The production of locality. In Counterworks: Managing the diversity of knowledge, ed. R Fardon. New York, 204-225. New York: Routledge.

Armitage, D, F Berkes, and N Doubleday. 2007. Adaptive co-management: collaboration, learning and multi-level governance. Vancouver, British Columbia: University of British Columbia Press.

Autumn, S. 1996. Anthropologists, development, and situated truth. Human Organization 55: 480-484.

Basso, KH. 1996. Wisdom sits in places: Landscape and language among the western Apache. Albuquerque, New Mexico: University of New Mexico Press.

Bebbington, A. 2000. Re-encountering development: Livelihood transitions and place transformations in the Andes. Annals of the Association of American Geographers 90: 495-520.

Bee, R, and R Gingerich. 1977. Colonialism, classes, and ethnic identity: Native Americans and the political economy. Studies in Comparative International Development 12: 70-93.

Berger, TR. 1985. Village journey: The report of the Alaska Native review commission. New York, New York: Hill and Wang.

Bernard, HR. 2006. Research methods in anthropology: Qualitative and quantitative approaches. Lanham, MD: AltaMira Press.

Black, LT. 1998. Animal world of the Aleuts. Arctic Anthropology 35: 126-135.

Black, LT. 2004. Russians in Alaska: 1732-1867. Fairbanks, Alaska: University of Alaska Press.

Brannstrom, C, and M Neuman. 2009. Inventing the "Magic Valley" of south Texas, 1905-1941. Geographical Review 99: 123-145.

Burton-Christie, D. 2009. Place-making as conteplative practice. Anglican Theological Review 91: 347-371.

Campbell, D, and JE Hunt. 2012. Achieving broader benefits from indigenous land use agreements: community development in central Australia. Community Development Journal 84: 197-214.

Case, D, and DA Voluck. 2002. Alaska Natives and American laws: Second edition. Fairbanks, Alaska: University of Alaska Press.

CBSFA 2013. Central Bering Sea Fishermen's Association. http://www.cbsfa.com/index1.html. Accessed 23 July 2013.

Conn, S, and SJ Langdon. 1988. Retribalization as a strategy for achievement of group and individual social security in Alaska native villages- with a special focus on subsistence. In Between kinship and the state: Social security and law in developing countries, eds. F von Benda-Beckmann, K. von Benda-Beckmann, E. Casino, F. Hirtz, G.R. Woodman, and H.F. Zacher. Hawthorne, NY: Foris Publications.

Corbett, HD, and SM Swibold. 2000. The Aleuts of the Pribilof Islands, Alaska. In Endangered people of the Arctic: Struggle to survive, ed. MMR Freeman. Westport, Connecticut: The Greenwood Press.

Coulthard, S, D Johnson, and JA McGregor. 2011. Poverty, sustainability and human well-being: A social well-being approach to the global fisheries crisis. Global Environmental Change 21: 453-463.

Diamond, J. 2005. Collapse: How societies choose to fail or succeed. New York, NY: Penguin Books.

Dombrowski, K. 2001. Against culture: Development, politics, and religion in Indian Alaska. Lincoln, Nebraska: University of Nebraska Press.

EDAW 2008. Comprehensive baseline commercial fishing community profiles: Sand Point, Adak, St. Paul, and St. George, Alaska, Final Report. Anchorage, AK: North Pacific Research Board and North Pacific Fishery Management Council.

Escobar, A. 1997. Anthropology and development. International Social Science Journal 49: 497-515.

Escobar, A. 2001. Culture sits in places: reflections on globalism and subaltern strategies of localization. Political Geography 20: 139-174.

Escobar, A. 1991. Anthropology and the development encounter: The making and marketing of development anthropology. American Ethnologist 18: 658-682.

Ginter, JJC. 1995. The Alaska community development quota fisheries management program. Ocean and Coastal Management 28: 147-163.

Granitz, P. 2012. Native communities worry about new consultation policy for Native corporations. Alaska Public Media. http://www.alaskapublic.org/2012/08/24/native-communities-worry-about-new-consultation-policy-for-native-corporations/. Accessed 30 July 2014.

Gupta, A. 1992. The song of the non-aligned world: Transnational identities and the reinscription of space in late capitalism. Cultural Anthropology 7: 63-79.

Gupta, A, and J Ferguson. 1997. Beyond "culture": Space, identity, and the politics of difference. In Culture, power, place: Explorations in critical anthropology, eds. A Gupta, and J Ferguson. Durham, North Carolina: Duke University Press.

Harner, J. 2001. Place identity and copper mining in Sonora, Mexico. Annals of the Association of American Geographers 91: 660-680.

Heald, S. 2008. Embracing marginality: Place-making vs development in Gardenton, Manitoba. Development in Practice 18: 17-29.

Hearth, D. 2009. The discourse of development: Has it reached maturity? Third World Quarterly 30: 1449-1464.

Himes-Cornell, AH, K Hoelting, C Maguire, L Munger-Little, J Lee, J Fisk, R Felthoven, C Geller, and P Little. 2013. Community profiles for North Pacific fisheries- Alaska. In NOAA Technical Memorandum. Seattle, WA: National Marine Fisheries Service.

Ingold, T. 2011. The perception of the environment: Essays on livelihood, dwelling and skill. London: Routledge.

Jones, DK. 1980. A century of servitude: Pribilof Aleuts under US rule. Lanham, Maryland: University Press of America.

Keys, K. 1997. The community development quota program: Inequity and failure in privatization policy. American Indian Culture and Research Journal 21: 31-71.

Langdon, SJ. 1986. Contemporary Alaskan Native economies. Lanham, Maryland: University Press of America.

Landing tax. 2007. Fishery Resource Landing tax. Alaska State Statute AS 43.77.

Larsen, SC. 2004. Place identity in a resource-dependent area of northern British Columbia. Annals of the Association of American Geographers 94: 944-960.

Magnuson-Stevens Fishery Conservation and Management Act of 2006. 16 U.S.C §§ 1801-1891(d).

Marsh, B. 1987. Continuity and decline in the anthracite towns of Pennsylvania. Annals of the Association of American Geographers 77: 337-352.

McKay, D, and C Brady. 2005. Practices of place-making: Globalisation and locality in the Philippines. Asia Pacific Viewpoint 46: 89-103.

Mitchell, D. 2001. Take my land, take my life: The story of Congress's historic settlement of Alaska Native land claims 1960-1971. Fairbanks, AK: University of Alaska Press.

Moore, KD, and R Russell. 2009. Toward a new ethic for the oceans. In Ecosystem-based Management for the Oceans, eds. K McLeod, and H Leslie. Washington DC: Island Press.

NRC. 1999. The community development quota program in Alaska. Washington DC: National Academy Press.

Ostrom, E. 1990. Governing the commons: The evolution of institutions for collective action. Cambridge, UK: Cambridge University Press.

Poe, MR, KC Norman, and PS Levin. 2014. Cultural dimensions of socioecological systems: Key connections and guiding principles for conservation in coastal environments. Conservation Letters 7: 166-175.

Reedy-Maschner, KL. 2010. Aleut Identities: Tradition and modernity in an indigenous fishery. Montreal: McGill-Queen's University Press.

Sack, RD. 1999. A sketch of a geographic theory of morality. Annals of the Association of American Geographers 89:26-44.

Scott, JC. 1998. Seeing like a state: How certain schemes to improve the human condition have failed. New Haven, Connecticut: Yale University Press.

Scott, JC. 2008. Weapons of the weak: Everday forms of peasant resistance. New Haven, CT: Yale University Press.

Sepez, JA, K Norman, A Poole, and B Tilt. 2006. Fish scales: Scale and method in social science research for the North Pacific and West Coast fishing communities. Human Organization 65: 280-294.

Sepez, JA, CL Package, PE Malcom, and A Poole. 2007. Unalaska, Alaska: Memory and denial in the globalization of the Aleutian landscape. Polar Geography 30: 193-209.

State of Alaska. 2011. Alaska community database community information summaries. http://commerce.state.ak.us/dnn/dcra/home.aspx. Accessed 10 November 2011.

State of Alaska. 2014. Community and regional affairs database. http://commerce.state.ak.us/dnn/dcra/home.aspx. Accessed 24 February 2015.

Strauss, A., and J Corbin. 1997. Grounded theory in practice. London, UK: SAGE Publications.

Thornton, TF. 2008. Being and place among the Tlingit. Seattle, WA: University of Washington Press.

Torrey, BB. 1978. Slaves of the harvest: The story of the Pribilof Aleuts. St. Paul, Alaska: Tanadgusix Corporation.

Truman, HS. [1949] 1964. Public papers of the Presidents of the United States: Harry S. Truman. Washington DC: US Government Printing Office.

Tuan, Y. 1977. Space and place. Minneapolis, MN: University of Minnesota Press.

US Department of State. 1944. Proceedings and documents of the United Nations Monetary and Financial Conference, Bretton Woods, New Hampshire, July 1-22.

Vaccaro, I, LC Zanotti, and JA Sepez. 2009. Commons and markets: Opportunities for development of local sustainability. Environmental Politics 18: 522-538.

WACDA. 2008. Western Alaska Community Development Program: Supporting the advancement of Bering Sea communities. Anchorage, Alaska: WACDA.

Wallerstein, I. 2004. World-systems analysis. Durham, North Carolina: Duke University Press.

Chapter 3: Means, Meanings, and Contexts: A framework for integrating detailed ethnographic data into assessments of fishing community vulnerability[1]

Abstract

Current efforts at assessing the vulnerability of fishing communities center around the creation of quantitative indices. The quantification of social data, however, has several drawbacks. These include the loss of detail, removal of historical context, and obscuring of power dynamics. The Means, Meanings, and Contexts (MMC) Framework is presented as an alternative methodology, one that allows for the integration of qualitative social science into the understanding of community vulnerability, drawing upon ethnographic research techniques and theories of place-making. Place-making refers to the changing relationships between the physical support offered by a landscape (means), and the relationships among place, people, and lifestyle in a community (meanings). To adequately assess community vulnerability, researchers can collect data on both means and meanings within a community. Using these data, community vulnerability is assessed by responding to a series of 12 broad prompts. Responses to these prompts are summarized at three levels of detail: detailed textual description, tabular summary, and graphical summary. Using the Pribilof Island communities of St. George and St. Paul, Alaska as examples, this framework indicates that St. George is a highly vulnerable community, while St. Paul is moderately vulnerable. These results are in stark contrast with quantitative assessments of community vulnerability, which indicate that St. George is a low to moderately vulnerable community, while St. Paul is a highly vulnerable community. Tools like the MMC Framework,

[1]Lyons, C, Carothers, CL, and K Reedy. Means, meanings, and contexts: A framework for integrating detailed ethnographic data into assessments of fishing community vulnerability. Prepared for submission to Marine Policy.

therefore, help make a place for important, but complex, qualitative social data, in fisheries management.

3.1 Introduction

Though fisheries management issues touch on numerous social concerns, including access to resources, economic benefits, safety, and equity, US management organizations have only recently begun to collect data on these topics and still struggle with how to best integrate them into the decision-making process. The passing of the Sustainable Fisheries Act (SFA) in 1996 [1] served as an important impetus in the collection of sociocultural data in fisheries management, mandating the inclusion of geographic, in addition to user-group, communities in management analysis. It also created National Standard 8, a rule meant to provide for the sustained participation of communities engaged in or dependent upon fisheries by calling for managers to minimize economic impacts of management decisions on fishing communities according to the best available science and the extent practicable [2]. Despite the current interest in and support for inclusion of social data in fisheries management generated by this legislation, integration of these data into management plans remains problematic. Budget constraints limit the amount of in-depth ethnographic fieldwork social researchers can perform [3]. Thus, the majority of data included in social analysis are garnered from secondary data sources, supplemented with fieldwork when budgets permit. To further complicate matters, even when solid social data are available, they often are summarized in formats (*e.g.*, monographs) that are difficult for managers to access and integrate into management frameworks.

To address some of the difficulties associated with collecting and integrating sociocultural data, many have suggested a move toward quantifying social variables for use in

management processes. Quantification of social data is seen as having several advantages. These advantages include: data availability and comparability across a broad range of communities, familiarity to researchers used to working with quantitative fisheries and ecosystem data, as well as, suitability for predictive and widely generalizable modeling exercises. Examples include the development of quantitative social indicators, [e.g., 4, 5, 6], which can then be used to model concepts like model community well-being [e.g., 7] and generate rankings of communities [8].

Delineating clear categories of relevant social variables and creating conceptual models are useful for summarizing and communicating social data; however, there are tradeoffs associated with using solely quantitative data to represent the complex social dynamics of fishing communities. Quantitative data are often static and tend to prioritize economic measures, which, especially for indigenous communities, may not reflect local goals and priorities (*e.g.*, a measure like income, or total of cash resources coming into a household in a certain year, may not be appropriate for representing wealth in a community based largely on subsistence resource harvesting and sharing). Quantitative measures are limited in their ability to measure and represent important social dimensions like power dynamics and global-to-local connections. Common practices with quantifiable variables, such as aggregating and taking averages, can downplay differences, especially within marginalized groups. And, furthermore, the process of distilling complicated social data into easily summarized and manipulated numeric indicators often results in understandings of culture that are not grounded in understandings of the physical space needed to perform cultural practices [9]. Instead, these kinds of data are often best understood through inductive, ethnographic research approaches [10].

While the importance of ethnographic research has been acknowledged and furthered by anthropologists working in management settings [e.g., 10, 11-14], in institutions with limited

research budgets these data are rarely collected. This is due to a perceived impracticality of qualitative data: it is time-consuming to collect and difficult to summarize in ways that are meaningful to managers. The fact that ethnographic data require a substantial time investment to collect is incontrovertible. Their reputation as difficult to summarize, however, is contestable. Satterfield et al. [9], for example, suggest that this difficulty can be overcome through the development of simple summary indices. Building upon this suggestion, we present the MMC Framework below as a methodology for incorporating qualitative social science into decision-making efforts, drawing upon ethnographic research techniques, the theories of place-making and social vulnerability, and using two Alaska fishing villages as examples. We then compare these assessments with quantitative analyses to show the ways in which qualitative data can fundamentally change understandings of fishing communities.

The MMC Framework draws on Marsh's definition of place-making efforts as being comprised of the relationships between means and meanings over time [15]. In this context, *means* describe the biophysical features a landscape provides, while *meanings* describe the intangible rewards a landscape offers [15]. The Anthracite towns in Marsh's research were initially rich in means (coal resources), though lacking in meaning (residents were immigrants drawn by the lure of prosperity), but over the years evolved into communities scarce in means, but full of meaning to residents [15]. As a result of this increase in meanings, residents were loath to leave these towns, despite the poverty they experienced and the lack of future prospects. The contrast of means and meanings in their historical context, therefore, elegantly captures the complexities of local relationships with resources in many vulnerable fishing communities. Furthermore, while simplified, the dichotomy of means and meanings helps to describe the

interplay and interconnection of material (means) and symbolic (meanings) aspects of vulnerability.

3.2 Methods and theory

3.2.1 Community vulnerability

The growing field of vulnerability studies, a component of sustainability and resilience research often associated with global climate change concerns, addresses the impact of stresses or events on social and social-ecological systems [16]. Defined in numerous ways, for this analysis vulnerability can be considered "inherent characteristics of the system that create the potential for harm" [17]. This definition stresses the fact that vulnerabilities do not harm communities per se, but rather create the potential for harm in the face of new or continued stresses. Further, it highlights marginality and powerlessness of social groups [17].

Vulnerability is typically described in terms of exposure, sensitivity, and adaptive capacity [16, 18]. Exposure refers to the strength of stressors, sensitivity describes the degree to which a community is expected to respond to particular stressors, and, finally, adaptive capacity refers to a community's ability to respond and even exploit opportunities created in the wake of stresses [18, 19]. However, these concepts make less sense in the context of qualitative data. Rather than estimating specific exposures and system sensitivities, the framework presented below will discuss, qualitatively, how changes in stressors have caused specific reactions in communities over time. Similarly, adaptive capacity will be discussed in terms of observed responses to and strategies for overcoming vulnerabilities.

3.2.2 Place-making theory

To discuss place-making, one must first define what constitutes a place. While *space* is vast, general, and encompassing [20], *place* is local and specific, connoting a constantly changing meaning to residents [21]. Thus, place is a social construct and place-making the method in which place is constructed out of space. These meanings are mediated by: local history and landscape [15], the physical senses [20], ties to regional and global politics [22], and economic utility [23]. Thus, place-making is a concept that provides a framework for communicating the social and cultural values and relationships associated with a specific place.

An active, constantly evolving process, place-making is frequently negotiated between residents and outsiders. In some cases, local place-making efforts gain the upper hand, creating communities that do not conform to outsider ideals [24]. In other instances, however, the place-making efforts of outsiders successfully reshape local senses of place to serve outside interests [25]. When outsiders control or prohibit uses of local resources, it can destabilize the relationships between local means and meanings. The fight to align means and meanings into what Harner calls a hegemonic equilibrium [26], can thus shape a community and indicate that place-making can be an act of political resistance.

In addition to people shaping a place, place-making encompasses the ways in which places can help shape people. These processes are often evident in indigenous communities. In Apache culture, for example, place-names encapsulate several kinds of information: a description of the place (allowing comparisons of environmental change over time), a moral story, and a tool for teaching local cultural values [27]. Thus, by walking the land or even mentally picturing places, Apaches are able to connect with their homeland and culture [27]. The Tlingit, while living in dissimilar places to the Apache, have similarly deep connections to their

ancestral lands. In Tlingit culture, places have stories and crests or designs associated with them that also serve as mnemonics for passing on cultural lessons [21]. With its focus on the continually changing and contested nature of community, and its emphasis of both material (means) and symbolic (meanings) factors, place-making is therefore an ideal frame through which to better understand community dynamics and processes, such as vulnerability.

3.2.3 Data sources

The data used in this paper were collected from two sources: ethnographic fieldwork and published documents. Ethnographic fieldwork was conducted over the span of six months (the lead author spent three months each in the communities of St. Paul and St. George, Alaska). The goal of this fieldwork was to assess local understandings of place and learn about the effects fisheries management policies have had on life in the Pribilof communities of St. Paul and St. George, Alaska [28]. The ethnographic research utilized two methods: participant observation and semi-structured interviews. Participant observation is the signature method of cultural anthropology that involves researchers immersing themselves in communities to gain deeper understandings of local meanings and everyday life, while simultaneously maintaining intellectual distance to reflect upon cultural experiences [29]. In this research project, participant observation efforts took the form of living in the two communities in the Pribilof Islands, making acquaintances, attending local festivities and community meetings, and spending time at social centers. These efforts were supplemented by volunteer work on a variety of community service projects, including assisting with the local science camp and tutoring at local schools. The process of participant observation allows researchers to gain a deeper understanding of local culture, concerns, and needs and can help in the identification of key informants. Key informants

are individuals with a deep knowledge of the community, who act as cultural guides. In this research, key informants suggested interview topics, helped refine interview questions, and aided in identifying initial interview participants.

With the help of key informants, semi-structured interviews (26 in St. George and 24 in St. Paul) were conducted with a cross-section of long-term community residents. Semi-structured interviews follow a general script, with a list of topics or prompts, but allow room for respondents to direct the order and duration of interview topics [29]. Participants were selected for these interviews via snowball sampling, in which appropriate respondents are found based on suggestions provided by prior respondents [29]. This sampling technique allowed the field researcher to focus efforts on long-term residents who are invested in the community and was preferred to a random sample that would have included individuals present briefly in the community for work opportunities. Additionally, out of this pool of long-term residents a diversity of perspectives were gathered including: men, women, elders, youths, fishermen, government officials, and people not directly involved in fisheries or fishery support services. Interviews varied in length from approximately 30 minutes to 2 hours and followed a similar script, which included questions on individuals' connections to the community, as well as the importance and history of fisheries in their community. Participants received a small gratuity ($50 for elders and $20 for all others) as appreciation for their time. The interviews were recorded with a digital voice recorder, when permitted by respondents. Audio files were transcribed. Transcripts and field notes were analyzed and coded with the *Atlas.ti* software package, using a grounded theory approach [30]. This approach relies upon iterative coding until saturation; these codes are then grouped into distinct themes used as the basis of developing social theory [30]. The data obtained from this research project were then supplemented with

published data on the Pribilof Islands, gathered from a variety of sources. These include community profiles [31] and current quantitative vulnerability assessments of Alaskan communities [8]. Final results were then presented to community members to ensure they aligned with local understandings of vulnerability.

3.2.4 Framework

Drawing on the concepts of "means", "meanings", and "contexts", the MMC Framework is divided into corresponding categories (Table 1). As previously described, the category of "means" refers to the physical support offered by a landscape. Data in this category are often measured quantitatively and align with data typically included in current assessments of community vulnerability, including topics like: local economic base and employment opportunities, community demographics and population, as well as fishing infrastructure and fleet details (Table 1). The category of "meanings", in contrast, encapsulates the intangible benefits a landscape provides, often measured in qualitative ways as assessed through ethnographic research. This category includes topics such as social cohesiveness, sense of place, way-of-life, and identity (Table 1). Finally, the third category, "contexts", reiterates the role of history in understanding how community means and meanings articulate. Relationships between means and meanings are fluid, changing over time. Relative changes in these relationships can therefore structure residents' understanding of the present and are thus important in understanding community vulnerability. This category therefore includes changes in local fisheries participation over time, and how regulations, competitions with other fisheries or user-groups, and environmental conditions have affected rates of participation (Table 1).

Each of these three categories is then subdivided into a series of prompts a researcher can assess for a particular community. The prompts are purposefully broad to maximize the framework's utility, allowing it to be used with a myriad of communities experiencing a suite of differing stressors. In general, the prompts reflect key areas of concern for community well-being and sustainability established in the social science literature, topics such as: community history (particularly if there is a history of oppression) [32], autonomy or self-determination [33], access to resources [34], competition for resources [35], health of resources [36], history and trajectory of local fisheries participation [37], community conflict [38, 39], way-of-life [32], sense of place and identity [24, 40, 41], and hope for the future [42]. The prompts also include a few points the authors have identified as important in their own research, including the importance of quality infrastructure, hardship and quality of life, and successful adaptations [28].

3.2.5 Data summary

Responses to the 12 prompts are then summarized in three ways: a detailed textual description, a summary table, and graphical display. The detailed text consists of 1-2 paragraphs describing the researcher's subjective assessment of the degree of vulnerability a particular prompt represents to a specific community. This text also includes quotes from interviews and draws on analysis conducted with interview data to increase rigor and transparency of subjective classifications. For the second level of summary detail, these textual responses are distilled into a one-sentence description and collected into a table. The final level of summary detail consists of a graphical display, which acts as a visual summary and the end product of the vulnerability analysis. It is supported with the greater detail provided in text and tables.

The summary graphic therefore takes the place of a numeric metric or index and was inspired by a summary graphic developed by Berns and Conway [43] (Fig. 1). In both their analysis and the one presented here, the graphic is divided into three segments representing areas of high, moderate, and low vulnerability. Overall estimates of community vulnerability are assessed visually. In communities with high overall vulnerability, the graphic will be top-heavy, with the majority of responses categorized in the top box. The resulting pattern will, thus, be reminiscent of a downward pointing triangle (Fig. 1A). In contrast, communities with low overall vulnerability will have the majority of responses listed in the bottom box and will display an upward pointing triangle (Fig. 1B). Those with moderate vulnerability can be represented in two ways- either as an hourglass, with an even split between top and bottom boxes, or a diamond, with the majority of responses in the middle box (Fig. 1C-1D). To demonstrate the use of this framework an example is provided below, using ethnographic data collected on the Pribilof Island communities of St. Paul and St. George, Alaska. Results from this framework are then compared with findings from previously published quantitative vulnerability assessments.

3.3 Community vulnerability in the Pribilof Islands

The MMC Framework seeks to provide a thorough qualitative description of fishing communities. As such, the end product should focus on one community at a time and respond to each prompt in detail. For the sake of this manuscript, however, we present an abbreviated summary of prompt responses. Below we assess responses to prompts for both communities simultaneously, allowing us to highlight differences between the two. In addition, we focus our discussion on topics not typically included in management assessments (*i.e.*, the categories of

meanings and contexts). Detailed information on these communities is available in Chapter 2 [28].

3.3.1 Community profiles

St. George is a community of around 100 people located on the southernmost island of the Pribilof Island group. Political entities include the city government, the Traditional Council (tribal government), the Alaska Native Claims Settlement Act (ANCSA) village (Tanaq) and regional (Aleut Corporation) corporations, as well as the local community development quota (CDQ) group, the Aleutian Pribilof Island Community Development Association (APICDA). The city and tribe are the largest employers. The community has a state-funded school, though the future of this school is uncertain; a minimum of 10 children is needed to maintain state funding and the island is currently home to only 8-10 school-aged children (the number varies as children are often moved on and off the island to live with different relatives). The community has one small store and hotel and the economy is based on government grants to the Traditional Council. The fishing fleet consists of around five boats.

In contrast, St. Paul is a community of approximately 480 residents on the northernmost island in the Pribilof Island group. Political entities include the tribal government, the city government, the local community development quota group (Central Bering Sea Fishermen's Association; CBSFA), and the village corporation, Tanadgusix (TDX). The community has a state-funded school (K-12), a radio station, and a grocery store. The economy is fisheries-based; locals participate in a small-boat halibut fishery, and the city's operating budget is funded via taxes from resources (of which crab is the most lucrative) processed at the local plant. The local fishing fleet consists of around 20 boats, providing seasonal employment to a large portion of the

town. Members of the city and tribal governments, as well as the CDQ group, are actively involved in developing local fisheries and participating in fisheries management by attending meetings and speaking with politicians.

3.3.2 Means

3.3.2.1 Access to resources

The communities of St. George and St. Paul have access to fish resources (specifically Pacific halibut, *Hippoglossus stenolepis*) through the CDQ program. The two communities, however, are part of different CDQ corporations and these corporations act very differently within the communities. In St. George, most residents feel that anyone who wants to fish can participate in the local, near shore halibut fishery; however, nearshore waters are no longer productive fishing grounds. More productive waters are over 10 miles away from the island and their CDQ group, APICDA, has proven reticent to fund bigger, faster boats for local fishermen. Instead, APICDA hires out a larger non-local boat to help fish the local quota. The result is that locals feel they are being cut off from their own resources. In contrast, St. Paul residents have successfully gained both access to and control of their fishing rights through CBSFA. This has allowed them to develop infrastructure and buy boats that allow locals to successfully participate in a halibut day-fishery that provides locals with income and employment.

3.3.2.2 Conflict, competition, and state of resources

Residents on both islands have noticed declines in size and abundance of halibut in nearshore waters. They have different ideas, however, as to what is causing this decline. In St. George residents believe intensive trawling in nearby waters incidentally catches and kills a

substantial amount of local halibut as bycatch. One fisherman describes it thusly, *"You look at the trawl fisheries, sometimes they put out charts where they do a lot of the fishing and it's right here, right south of St. George, it's this big red spot. It's monitored that they fish, they drag a lot right off south of here... on the [shelf] edge and up north... the fishing's really good up there where the trawlers aren't a lot."* Unlike in St. George, many St. Paul residents state that declines in halibut are related to changing climate conditions or a natural cycle of fish abundance that peaks approximately every seven years. Notably, residents from both communities have brought their concerns before managers on numerous occasions, asking for restrictions on trawling in this area, but to little effect. The trawl industry is lucrative and wields substantial political clout. Further complicating matters both CDQ corporations generate a great deal of money from trawling efforts across the Bering Sea, so are not powerful advocates against this industry.

3.3.2.3 Infrastructure

Quality of infrastructure varies greatly between the two communities. St. George lacks important infrastructure crucial for supporting a fisheries economy and, more broadly, a sustainable community. This includes reliable transport on and off the island for people and supplies, a safe harbor large enough for supply barges, and an operational fish processing plant. In contrast, St. Paul has a substantial fishing infrastructure including a small-boat harbor, an active processing plant, and a crane used to assist in launching vessels. Transportation to and from the community is also more reliable than in St. George. The harbor is wider and deeper and has a barge landing. In addition, the airport is equipped with a functioning instrument landing system, which allows flights to land much more regularly in the fog and wind prevalent around the islands.

3.3.2.4 Quality of life

Life is difficult in both St. George and St. Paul. Prices for fuel, food, and electricity are high. Jobs are scarce, seasonal, and often low paying. Recreation opportunities are also limited, particularly for youth. The uncertainty and hardship of living in the islands takes a mental toll on residents. Like many similar rural Alaskan communities, alcohol and depression are significant problems. Things are worse in St. George where fog and wind regularly prevent planes from landing. This interferes with the regular delivery of mail and foodstuffs and makes it difficult for travelers to reach the island. In addition, health care facilities on St. George are limited. The island has no regular dentist, and is served by a rotating staff of nurses and doctors. Due to the unreliability of air transportation, medevac flights can be delayed for hours or even days. As a result, elders are often forced to move off island to be closer to health care.

3.3.3 Meanings

3.3.3.1 Autonomy and empowerment

In St. George, residents have little direct control over their resources. Resource rights are owned by: the Tanaq Corporation (terrestrial resources), Aleut Corporation (subsurface mineral rights) [44], and the Aleutian Pribilof Island Community Development Association (APICDA; fishery resources) [45]. Few residents are members of the boards of these corporations and, as such, locals have little say in the development and use of local resources. While mineral and terrestrial resources on the island are of little economic worth, local fish resources are quite lucrative. Residents, therefore, continually struggle with APICDA over the development of local fisheries. These struggles cause significant frustration. As one resident put it, "*Creating the CDQ*

(Community Development Quota) was like the reincarnation of government control [a period of time in which local life was managed by a US Treasury agent] and I think we need more local control in the community."

Residents of St. Paul have much greater control over their resources. Residents were active in establishing the CDQ program and the regionalization aspect of the crab rationalization program. These programs did much to support the local economy, providing the community with fishing rights and ensuring that a steady stream of tax money comes to the community through crab landing taxes collected at the processing plant. Furthermore, CBSFA, the local CDQ group, serves only the community of St. Paul and is run on-island, staffed by locals. This gives them unprecedented control over their local resources.

3.3.3.2 Conflict within the community

Historically, the major political entities in St. George (Tanaq Corporation, city government, and the Traditional Council) have not worked well together and the others (Aleut Corporation and APICDA) have little presence on the island. As one elder described it, *"[The] leaderships here don't function together. They're just on their own... they don't share thoughts together... they don't work with each other, so that's the downfall of everything."* While the organizations have not been engaged in major political battles of will, they have traditionally done little to coordinate or support each other. Several residents, however, have mentioned that this is starting to change. As one woman said, *"I actually give praise to the entities that they have come a long way... over the last 2-3 years I've noticed more communication, more coming together."* If this trend continues and the community can present a united political front, it will represent a substantial decrease in vulnerability.

St. Paul is a politically divided community. Disagreements among the city government, the tribal government, and the village corporation can be heated and have interfered with a number of development projects. A decades-long lawsuit between the corporation and the city government that was only recently settled illustrates the level of political rancor in the community. This political infighting is particularly troublesome, as many projects cannot be accomplished without the cooperation of all parties. This situation is a result of legislation like ANCSA, which devolved land rights to the village corporation. Thus, any development on local land must be negotiated with the corporation. As a for-profit venture, the corporation is beholden to its shareholders and the majority of these shareholders reside outside of the community in Anchorage or other urban centers. Therefore, corporate interests of profit maximization do not necessarily align with local interests of supporting and developing the community. This represents an area of substantial vulnerability. As one young man explained, *"What [we] need is for the community leaders to recognize the turmoil that they've caused by all their litigation and all the things that they've been battling over, how it has divided our community. Once they recognize that, I think we can put it all behind us and move toward a brighter future and start working for the community, rather than for your own personal gain for each entity."*

It is important to note, however, that much of the political division witnessed in Alaska Native communities is a result of legislative acts that have divided rights and power up among different groups within communities. The Alaska Native Claims Settlement Act (ANCSA) is a prime example of this. The act delegated land and mineral rights to village and regional corporations, thus alienating traditional governing bodies, such as tribal governments (the Traditional Council in St. George) and setting the stage for infighting. One elder elegantly summarized the unexpected ways in which ANCSA created conflict, *"I expected the regional*

corporations to try to work with the village corporation. [Instead] we got sued by the Aleut regional corporation over sub-surface rights because they claimed that we took subsurface material that we were not supposed to." In this context, achieving a united political will in any Alaska Native community requires a great deal of effort and is a significant achievement [46].

3.3.3.3 Identity and sense of place

Identity and sense of place share many similarities between the two Pribilof Island communities and center around relationships with fisheries. In St. George, locals recognize that their economy is currently based on transfer payments and grants obtained by the traditional council and not fisheries. Despite this, fishing is a large part of local identity. This is because many residents see fisheries development as the only possible future for their community. As one politician put it, "*[Are fisheries important?] Absolutely. There's no other way for St. George to develop an economic base to sustain itself... people aren't going to build TVs here."* Maintaining residence in St. George is a crucial concern for locals. For many of them, residency on the island is a key component of identity. As one woman put it, "*Our Aleut culture, that's unique. You can't find it anywhere else, well, in the Aleutian chain, but I think our [St. George] culture is unique."* Thus, identities are based in ties to the island- and ties to the island are based on fisheries. The discrepancy between the actual economic contributions of fishing and emotional meaning imbued to fishing represents a significant area of vulnerability for the community of St. George. For St. Paul residents continued residency is also a component of local identity. However, in their community a successful fishery aligns economic means with social meanings to support each other.

3.3.3.4 Way-of-life

The communities of St. George and St. Paul afford their residents a similar way-of-life. Residents enjoy a slower pace of life, peace and quiet, and the sense of safety that comes from living in a close-knit community. They also value the beauty of their natural environment and the ability to lead a subsistence lifestyle, harvesting seals, sea lions, birds, berries, fish, and reindeer. This subsistence way-of-life reaffirms locals' cultural heritage and connections. As one woman put it, "*We're a Native people, we're a tribe... our ancestors have been here thousands and thousands of years. We live here because our culture and our tradition is important to us, our island is beloved... this is our home.*"

Many people echoed the sentiment of home and belonging that living in these communities provided. Home, to them, was not just a place to live, but a community of friends and family. Not everyone gets along, but as one elder put it, "*When something goes wrong in the community, the whole community gets together and helps each other out.*" A resident in St. Paul echoed this sentiment, *"It's all about the people and the closeness, the love. You'll never have to worry about going hungry or having a roof over your head because we take care of our own. And that's what our parents instill in us and that's what we instill in our children and we'll keep that going for generation after generation."* The way-of-life that residents experience in St. George and St. Paul is cherished and, thus, acts as a powerful stabilizing force in the face of hardships and other stressors.

3.3.3.5 Leadership and successful adaptations

As part of their struggle for autonomy, politicians from St. George advocate for the community in a variety of political arenas. They travel to Juneau and Washington DC to attend

legislative meetings and provide comment. They also attend fisheries management meetings like the North Pacific Fishery Management Council. These efforts have varying degrees of success. Legislators often offer sympathy and promise support, but the community needs millions of dollars of infrastructure in order to build a fishing economy, and has yet to secure the bulk of these funds. Furthermore, residents find participation in fisheries management meetings particularly frustrating. One resident explains, *"I've been... to the North Pacific [Fishery Management Council] and I can tell you right now it does no good. They don't care... you're taking a small, 200-300,000 pound fishery and arguing with a billion dollar industry."* In response to these frustrations, and in the hope of increasing their political clout at these management meetings, the city government of St. George has partnered with Greenpeace to promote their vision of marine reserves around their island. As one island leader stated, *"If we can make those things happen, working with Greenpeace... we will do that... all we need to do is align ourselves with them."*

In contrast, the story of St. Paul is one of remarkable adaptation success. In the wake of the closure of fur sealing, residents successfully built infrastructure and transitioned the community to a fisheries-based economy. They continue to engage in political advocacy and local development projects in an effort to keep their community economically stable. The creation and establishment of CBSFA has proven a huge support in this process. Local leaders in the organization contribute to the community in a number of ways- providing food for elders, donations for the school, building fisheries infrastructure, and developing local seafood brands to increase the value of their fish harvest. One politician described the entity's work in the community, *"I think they're a good organization. They work good in the community, they do a lot of different things. Without their help we wouldn't have a fire station. Without their help the*

small boat harbor wouldn't be there. They do help the elders with fuel and they also give out [seafood]. They're a good island entity and work well with all the other entities." The adaptive capacity of St. Paul, therefore represents a significant stabilizing force for the community.

3.3.4 Contexts

3.3.4.1 History of oppression

The modern day villages of both St. Paul and St. George have a unique colonial history. For nearly a century, representatives of the US Treasury Department managed the villages, overseeing not only the fur seal harvest, but the lives of the residents involved in this harvest. Under Treasury Department control, locals were not allowed to drink alcohol and could not leave the island or marry without permission [47]. It wasn't until the latter half of the 20th century that residents gained citizenship and the right to form city and tribal governments [47]. However, despite all these achievements, the communities faced economic extinction in the mid-1980s when the government closed commercial fur seal harvest due to population declines and pressure from environmental groups [47, 48]. Over the next 30 years, residents fought for fishing rights and for help developing a fisheries-related infrastructure with mixed degrees of success.

Residents of both communities still remember the era of government control, either from living through it or being told stories by parents and grandparents. As one St. Paul politician explained, *"There were a lot of injustices done to the community… [they] managed the island through leases to companies to come in here and [harvest fur seals]. It paid for Alaska probably 15-20 times over and they didn't really take care of anybody out here. And here comes 1983 and, hey, guess what, we're pulling out of here, we'll build you a harbor, good luck, god bless, and see ya! They never took care of us, gave us our own allocation of fish or anything to make us a*

stable economy." An awareness of this history, therefore, permeates every interaction with government or outside development organizations.

3.3.4.2 History of local fishing

When the federal government ended fur sealing in the Pribilof Islands, residents of both communities realized that their only option was to develop the infrastructure necessary to become a fishing community. Through political advocacy both communities obtained funds to build harbors and other infrastructure. St. George Island, however, lacked a natural embayment suitable for building a harbor. As a result, their harbor had to be blasted out of rock and encircled with rock breakwaters. The resulting harbor was narrow, shallow, and difficult to navigate.

In the first few years after the St. George harbor's construction, several residents purchased boats, using loans from Tanaq, the village corporation. Over time, though, many of these men abandoned fishing. Low prices, difficult weather, and unreliable processing and shipping infrastructure made paying off boat loans difficult. While halibut fishing proved a difficult way to make a living, throughout the 1990s Bering Sea crab fisheries (particularly snow crab) were becoming increasingly lucrative and the community was able to develop an economy based on crab processing and outfitting crabbing vessels. Many residents remember this period as a peak in local wealth and well-being. With the snow crab crash and subsequent rationalization of all Bering Sea crab fisheries, the community lost its economic base. While they were allocated processing rights associated with two floating processors, one was owned by a company that went bankrupt and the other was unable to dock after a particularly bad storm damaged the harbor. When the harbor remained unrepaired after five years, the processor was released from its obligations to St. George. This was a substantial economic blow to the

community. As one woman explained, *"We need funding to fix that harbor so we can get our fishery back. How are we going to diversify our economy if we don't have a good harbor? You can't fish if boats can't come in here!"* Another resident added, *"[The economy] used to be fishing, but now it's bad... it's getting really hard."*

In contrast, St. Paul has steadily built up a fishing economy since the closure of fur sealing in 1983. During this period they established a functioning harbor, brought in processors, and successfully advocated for local fishing and processing rights through CDQ and crab rationalization programs. While their success in transitioning to a fisheries-based economy over the past several decades acts as a stabilizing force for the community, the resources they depend upon remain volatile. Recent cuts to crab and halibut quota represent serious threats to the community's sustainability. As one politician put it, "*Everything balances on fisheries management decisions, like the rationalization of crab. Thank god for regionalization or, oh my god, we'd be totally screwed."* Another resident agrees that their success is tenuous, *"I think fisheries is important right now economically, but commercial fur sealing was too and we still switched from one mono-economy to another mono-economy, so that's a little bit scary."*

3.3.4.3 Hope for the future

Residents have mixed feelings about the future of St. George. As one woman put it, "*There're days where I lose hope, but then there are days when I say, no this is my home and I'm still here, I still want to be here. I have to help.*" Residents recognize that the community needs substantial infrastructure developments in the next few years to remain viable, and that these developments will take the coordination of politicians and development agencies like APICDA. Pragmatists worry that these developments will not come. Many residents, however, remain optimistic.

Regardless of obstacles and personal opinions about the future, community members are committed to fighting for their home and have no plans to leave. As one elder put it, *"Everybody asks us, you gonna move? I tell them, my next move is to the cemetery."*

While residents of St. Paul hope that the future will bring better things for their community, they worry about the future. The volatility of crab and halibut resources and the potential for fisheries management decisions to impede local access to fish or reduce deliveries of crab to the processing plant represent very serious threats to the community's sustainability. Residents recognize that the success of their community hinges on these decisions and that the ability of locals to affect these decisions is uncertain. Put in terms of vulnerability theory, the community is highly sensitive to changes in fishing policy, resources, and the market. As one elder explained, *"I'm hoping that [the city] would continue to try to look for other sources of revenue than crab, [we're a] one species town... it's hard to predict. I just wish them well, that they will hopefully survive. They've got a big job keeping this community running... providing power, water, and all the essentials of life here."* In addition to these concerns, social problems like the graying workforce and the disaffection of younger generations represent an additional area of worry to residents. The future is therefore very uncertain and this uncertainty signifies an area of serious vulnerability for the community.

3.3.5 Qualitative community vulnerability

Overall vulnerability in St. George is high (Fig. 3A; Table 2A). The community has a history of oppression and colonial control and community members are still struggling to achieve local autonomy over their resources and way-of-life. While they have access to fish resources, these resources are controlled by an off-island corporation, which locals report does not share

their vision of fisheries development. Furthermore, the halibut resources on which they depend are now further from the island and more difficult to catch, possibly due to bycatch in trawl fisheries.

In addition to these difficulties, the community lacks adequate infrastructure to support a fisheries-based economy; the harbor is unsafe and the processing plant has never been used. It has been over 15 years since crabbers last regularly came to the community, supporting a local service economy. While local political entities are working to improve conditions, their efforts are uncoordinated and do not support each other. In spite of all these difficulties, locals value their community and the way-of-life it affords them- a slower pace of life, less crime, a sense of community, natural beauty, and the ability to lead a subsistence lifestyle. Locals create a sense of place and identity based on their status as residents and small-boat fishermen on St. George Island. As hardships increase, however, their ability to sustain these identities and senses of place declines. Nevertheless, residents continue to fight for their community, advocating politically and partnering with non-profit organizations. Though these strategies have proven only marginally successful, residents still hold out hope that things will change for the better.

In contrast, St. Paul is a moderately vulnerable community (Fig. 3B; Table 2B). Despite dependence on contested fish and volatile crab resources, the community has a great deal of social capital, autonomy, and a cohesive sense of place. Social capital helps residents cope with daily hardships, and make investing time and energy into community worthwhile for many residents. Furthermore, through CDQ the community has the autonomy to achieve local goals, building and cementing a community based on local place-making efforts. Obstacles such as a history of oppression, declines in resources, and local political conflict, however, give many residents worries about the future.

3.3.6 Vulnerability in St. George and St. Paul as understood by quantitative measures

In contrast to the framework presented here, current quantitative efforts to understand vulnerability in Alaskan communities are based on published data from the US census, Alaska Department of Fish and Game, and Army Corps of Engineers. These indices sought to describe vulnerability in response to climate change and so split vulnerability into three categories: exposure (data included erosion, permafrost, and sea ice coverage), resource dependence (based on observed community involvement in commercial, recreational, and subsistence fisheries, as well as marine mammal hunts), and adaptive capacity (which included demographics, economic opportunities, education, race, migration and transience, and poverty) [8]. Data used in these indices are based on government reports, census data, management records and other published sources [8]. To determine vulnerability, researchers used a principal components analysis and regression to calculate component scores and z-scores, which were used to assign ranks to individual communities [8]. The most vulnerable community received a rank of 1; the least vulnerable community received a score of 315. Relative vulnerability among communities was assessed by grouping the communities with the lowest ranks (20%) into the category "least vulnerable", and highest index values (20%) into the category "most vulnerable". The remaining communities were considered moderately vulnerable.

According to this framework, St. Paul is consistently assessed as more vulnerable than St. George (Table 3). Out of the 315 communities assessed, St. Paul ranked the 4th most vulnerable according to the adaptive capacity index, while St. George was only ranked 253rd. In addition, the three largest cities in Alaska (Anchorage, Fairbanks, and Juneau) were listed as more vulnerable, according to this index, than St. George [8]. This is an interesting conclusion, as St. George residents often speculate that their community will not exist in 10 years- concerns that

residents of major cities like Anchorage certainly do not share. While part of this discrepancy is due to their metric's focus on climate change vulnerability— the effect of increases in sea level and changes in sea ice cover are likely to be high in a low-elevation island community like St. Paul, thus raising its vulnerability score— a larger portion is due to St. George's relative invisibility in government databases.

For further comparison, another study, though not specifically addressing vulnerability, sought to detail connections between social and ecological systems in the Pribilof Islands [49]. These researchers supplemented published data sources with short surveys administered in person to residents [49]. The researchers then sought to correlate trends in community population over time with ecological and economic shifts in fisheries. After conducting their analysis, the researchers concluded that population in the islands was not affected by changes in fisheries and that, therefore, that the local economy was not closely linked to the environment [49]. This was an unexpected finding and the authors speculate about the importance of remittance payments and the high tolerance of individuals for dealing with uncertainty [49].

Qualitative research, however, can explain these demographic trends differently. Pribilof Island residents are greatly dependent upon marine resources both as a source of economic means and social meanings. Declines in means (*i.e.*, fish abundance), however, do not lead to concomitant declines in social meanings. Thus residents chose to remain in their communities, even in times of great scarcity, to preserve social meanings associated with identity and sense of place. Though the social-ecological system researchers spent time on island, speaking with residents, their examination was quantitative and based on their preconceived notions as to what data were important enough to connect. Their analysis provides another clear example of how qualitative data can provide important insights into fishing communities.

The striking difference in results between the framework presented here and quantitative approaches highlights the importance of detailed ethnographic data. Published data on rural Alaskan communities are limited and can paint an erroneous picture of local life. Furthermore, for many of these communities, major areas of vulnerability are legacies of decisions made decades earlier. Few of the data sources available for quantitative indices extend far enough back to account for these drivers of change. In the case of St. George, published data indicate that fisheries were never a major source of income for the community. The message this sends to managers is, therefore, that the community is not dependent upon fisheries and hence will not likely be affected by decreases in access or abundance of fish resources. Thus, these records obscure the very real battle that residents have fought to establish fishing in their community and their understanding that fisheries represent their only hope for the future.

3.4 Conclusions

Including social data in the fisheries management decision-making process is an essential step on the path toward achieving community sustainability. Tools like the framework presented above can help managers increase community sustainability by identifying areas needing aid, as well as, areas potentially sensitive to changes in management policies. Policies not grounded in detailed understandings of communities can lead to unintended negative consequences, such as: consolidating fishing rights into the hands of the wealthy [50], undermining indigenous peoples' fishing culture, practice, and economy [37, 51], and even increasing fishing pressure [52]. While an increased understanding of sociocultural dynamics is not a panacea, such an understanding will help managers craft policies that are specifically designed to enable fisheries to support local

ways of life. Policies structured in this manner are much less likely to create unforeseen negative impacts on fishermen and fishing communities.

While there is widespread agreement that integrating social data into management decision-making is a critical task, there remains debate over how to best integrate these data. In navigating this discussion, it is important to remember that social and socio-cultural data are complex and that reducing their complexity for the ease of integration into standard analytic approaches greatly reduces their usefulness. As Poe et al. [10] note, managers must "make a place for invisible and hard-to-measure concerns in decision-making, even if they don't fit in the status quo metrics". The MMC Framework presented above attempts to do just that. By including a flexible series of prompts that can be customized to reflect a wide variety of community concerns, and three levels of data summary (detailed textual, tabular, and graphical summaries), the MMC Framework provides a concrete set of tools for managers to integrate qualitative social data into policy-making discussions. Tools like this framework, therefore, help make a place for important, but complex, qualitative social data, in fisheries management.

3.5 Acknowledgements

Thanks to the residents of St. Paul and St. George for their hospitality, insight, and willingness to discuss life in their communities. Thanks also to Amber Himes-Cornell for offering insight and suggestions surrounding community vulnerability. Funding was provided by the Rasmuson Foundation and two National Science Foundation programs: the Arctic Social Sciences Dissertation Improvement Grant No. 16385 and the Marine Sustainability in the Arctic Subarctic IGERT (Grant No. 0801720). Coauthors contributed advice on methodology and analysis.

3.6 Figures

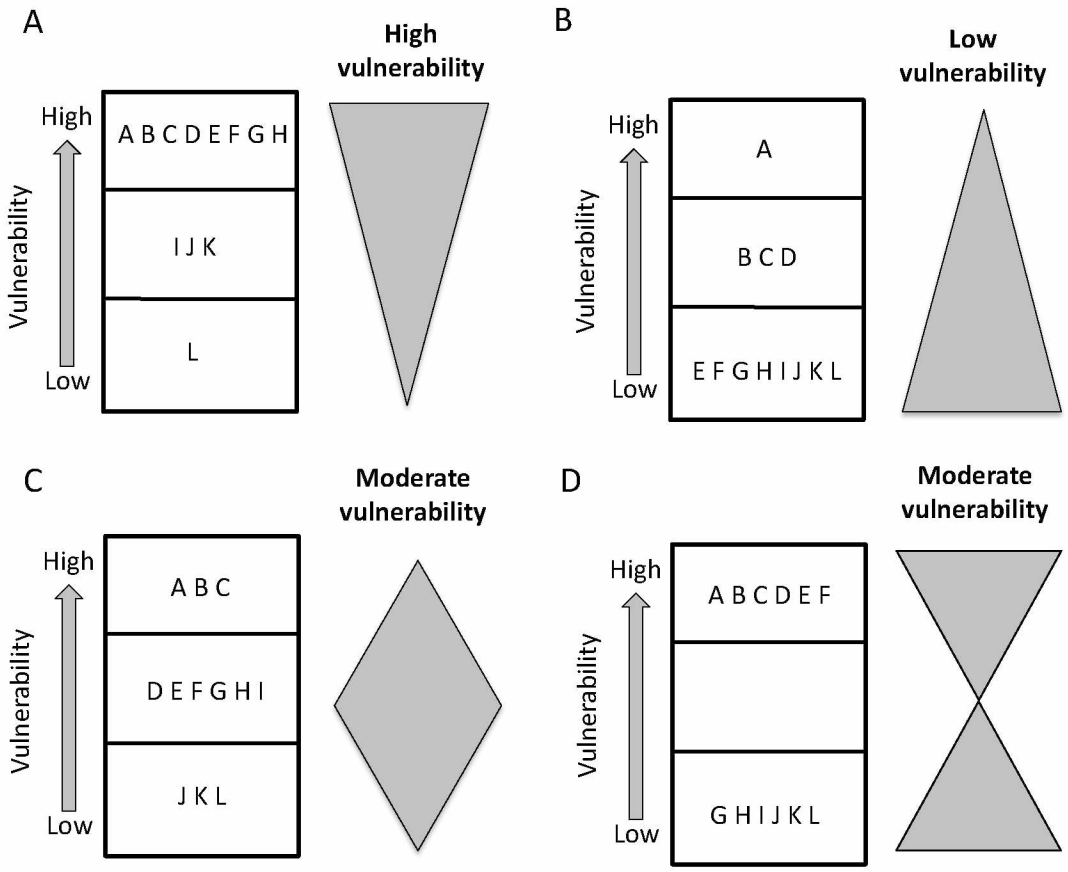

Figure 3.1 Community vulnerability summary graphic examples (A) pattern of responses for a community with high vulnerability, (B) pattern of responses for a community with low vulnerability, (C and D) patterns of responses for a community with moderate vulnerability.

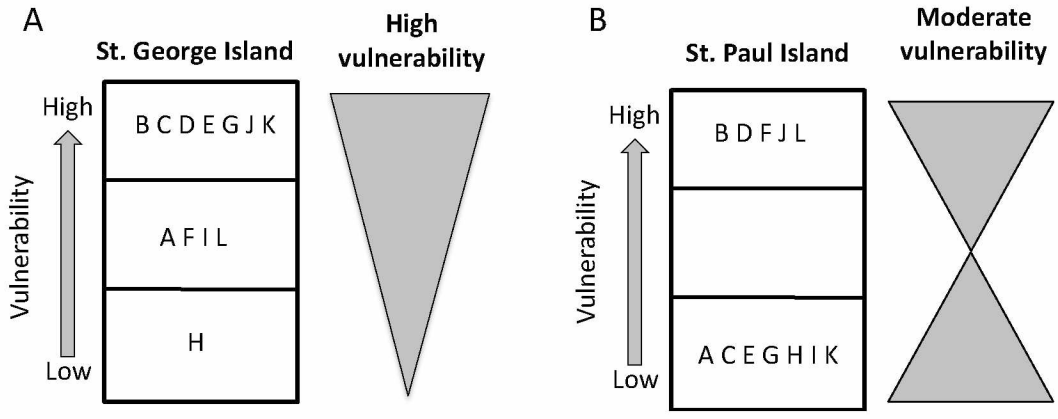

Figure 3.2 Community vulnerability summary graphics for communities (A) St. George, Alaska, (B) St. Paul, Alaska.

3.7 Tables

Table 3.1 Prompts for assessing community vulnerability

Assessing community vulnerability from an ethnographic perspective
MEANS
A. Access to resources
Has local access to resources increased or decreased over time? If access has decreased, when did residents have greatest access and how much time has passed since then?
B. Conflict, competition, and state of resources
Are other, potentially more powerful, user groups dependent upon or indirectly affecting local resources (e.g., interactions between commercial and sport fishing sectors, or bycatch in trawl fishery vs. directed fishery for these species)?
What are local perceptions of the resource? Are fish easier or harder to catch now than previously? Are fish smaller or larger than they used to be?
C. Infrastructure
Does the community have adequate fishing related infrastructure? Has local infrastructure declined or increased over time? When was local infrastructure at its peak and how long ago was that?
D Quality of life
Is life in the community difficult, can people make ends meet? Are there employment opportunities? Is every day life filled with hardship?
MEANINGS
E. Autonomy and empowerment
Do residents have power over local resources?
If not, are local thoughts and ideas included and respected by those in control of local resources? Is there a forum in which residents can participate? Or are local concerns ignored?
If disempowered, are locals engaging in successful forms of resistance?
F. Conflict within the community
Does the community have a united political will or is it fractionated among different competing political interests?
G. Identity/sense of place
Do residents have a coherent local identity (*e.g.*, a resident of this place, a commercial fisherman) that aligns with options available in reality (*e.g.*, can someone who wants to be a fisherman fish; can someone who wants to be a community member afford to stay in the community)?
Does this hold true for the community as a whole? That is, is there a community sense of place that matches reality (*e.g.*, if residents see their community as a fishing town, does fishing actually support the local economy)?
H. Way-of-life
Does living in the community provide a way-of-life appreciated by residents (*e.g.*, peace and quiet, slower pace, safety from crime, connection with nature)? Is this way-of-life being threatened, either by proposed development efforts or declining fisheries?
I. Leadership and successful adaptations
Are locals exhibiting adaptive capacity (*e.g.*, engaging in political activism at state and federal governments, organizing local efforts into co-ops, experimenting with local branding or value-added products, forming alliances with non-profit groups)? Are these efforts succeeding in or failing to meet local goals?
CONTEXTS
J. History of oppression
Does the community have a large indigenous or other minority group population(s) that have been historically oppressed under government policies?
K. History of local fishing
When did commercial fisheries develop in this community? What were initial fishing efforts like and how does that compare with efforts today? In general, have conditions improved or worsened over time?
L. Hope for future
Are people hopeful? Do they feel that working to change things will affect change?
Do they feel that working to change things will affect change?
Are youth being encouraged to leave the community or being discouraged from getting involved in fishing?

Table 3.2 Summary tables describing community vulnerability in communities (A) St. George and (B) St. Paul.

A

ST. GEORGE
MEANS
A. Access to resources
Somewhat; locals have direct access to local resources via APICDA, but they do not control these rights directly. While residents have a seat on the board of APICDA they have been unable to develop local fisheries as they desire.
B Conflict, competition, and state of resources
Conflict exists; Halibut around St. George are declining in number and size and residents feel this is due to bycatch from nearby trawlers. They are frustrated that local attempts to prohibit nearby trawling have failed. In addition, St. Paul fishermen sometimes fish in St. George waters, creating increased competition for scarce resources.
C. Infrastructure
No; St. George lacks the infrastructure necessary for establishing a fisheries-based economy. Transport (both air and sea) to and from the island is unreliable, the harbor is small and unsafe, and the fish processing plant remains closed.
D. Quality of life
Low; Daily life is difficult in St. George. High prices, few jobs, and unreliable transport create high levels of uncertainty and stress.
MEANINGS
E. Autonomy and empowerment
No; locals do not have autonomy. Furthermore, they are marginalized in management settings. Local resistance efforts have been met with had varying degrees of success, but have failed to shift power to community members. This lack of local power increases community vulnerability.
F. Conflict within the community
Yes; Political entities in the community have not always worked well together. Residents are hopeful that this is changing, but the lack of cohesive planning among the entities has traditionally been a source of weakness in the community.
G. Identity/sense of place
Lacking support; Local identities and senses of place revolve around fishing and residency in the community. Over time both of these pursuits are becoming more difficult.
H. Way-of-life
Cherished; Residents value the slow pace of life on island, the natural beauty, low crime rate, and ability to participate in subsistence harvests in St. George. They also value the ties to cultural heritage and a strong sense of community living on the island provides. Way-of-life therefore represents one of the community's greatest strengths.
I. Leadership and successful adaptations
Moderate; Residents of St. George have chosen to focus their energy on resistance rather than adaptation. Their resistance efforts include political advocacy, commenting at management meetings, and forming partnerships with organizations like Greenpeace. These efforts have not substantially changed local circumstances.
CONTEXTS
J. History of oppression
Yes; St. George is a community with a history of colonial control by the federal government. This historical legacy increases community vulnerability.
K. History of local fishing
Declining; Fish abundance, local infrastructure, and fish processing in the community have all declined from peaks in the 1980s and 1990s.
L. Hope for future
Moderate; Residents remain optimistic, but grow less so each year. They recognize that their community is in a precarious position.

Table 3.2 continued…

B

ST. PAUL
MEANS
A. Access to resources
Yes; the local CDQ group, CBSFA, controls access to St. Paul's fish resources. St. Paul is the only community served by CBSFA and so residents are ensured access to these resources.
B Conflict, competition, and state of resources
Conflict exists; Residents have noticed that halibut are smaller than they used to be and harder to catch. While residents have a variety of theories as to why this is, they do see trawlers as a threat to their local resources.
C. Infrastructure
Yes; St. Paul has adequate infrastructure for pursuing local fisheries. Furthermore, community members are working to develop more infrastructure.
D. Quality of life
Low; Daily life is difficult in St. Paul. High prices and few year round sources of employment create high levels of uncertainty and stress.
MEANINGS
E. Autonomy and empowerment
Yes; through local advocacy and the CDQ program locals have gained a great deal of control over both local resources and capital for investing in local projects.
F. Conflict within the community
Yes; Political entities in the community often fight over local resources and development projects. These conflicts represent a major area of vulnerability for the community.
G. Identity/sense of place
Supported; Local identities and senses of place revolve around fishing and residency in the community. Fisheries support both individual families and the community as a whole, thus supporting local identities and senses of place.
H. Way-of-life
Cherished; Residents value the slow pace of life on island, the natural beauty, low crime rate, and ability to participate in subsistence harvests in St. Paul. They also value the ties to cultural heritage and a strong sense of community living on the island provides. Way-of-life therefore represents one of the community's greatest strengths.
I. Leadership and successful adaptations
Yes; Residents in St. Paul have become deft at politically advocating for their community and have successfully used the CDQ program to achieve local goals.
CONTEXTS
J. History of oppression
Yes; St. Paul is a community with a history of colonial control by the federal government. This historical legacy increases community vulnerability.
K. History of local fishing
Increasing; Since the closure of fur seal harvesting, the community of St. Paul has steadily built up local fisheries, infrastructure, and participation.
L. Hope for future
Low; Residents worry about their future. They recognize that their success is tenuous.

Table 3.3 Quantitative vulnerability estimates from previous research [8]. Relative ranks (with 1 being most vulnerable) are in parentheses.

Vulnerability type	St. George	St. Paul
Exposure	Low (302)	Moderate (235)
Resource dependence	Moderate (104)	Moderate (87)
Adaptive capacity	Moderate (253)	High (4)

3.8 References

[1] Sustainable Fisheries Act of 1996. Pub. Law No. 104-297, 110 Stat. 3559.

[2] Gehan SM, Hallowell MG. Battle to determine the meaning of the Magnuson-Stevens Fisheries Conservation and Management Reauthorization Act of 2006: A survey of recent judicial decisions. Ocean and Coastal Law Journal 2012; 18: 1-34.

[3] Sepez J, Norman K, Poole A, Tilt B. Fish scales: Scale and method in social science research for the North Pacific and West Coast fishing communities. Human Organization. 2006; 65: 280-94.

[4] Bonzon A. Development of economic and social indicators for the management of Mediterranean fisheries. Marine and Freshwater Research. 2000; 51: 493-500.

[5] Jacob S, Weeks P, Blount B, Jepson M. Development and evaluation of social indicators of vulnerability and resiliency for fishing communities in the Gulf of Mexico. Marine Policy. 2012; 37: 86-95.

[6] Morzaria-Luna HN, Turk-Boyer P, Moreno-Baez M. Social indicators of vulnerability for fishing communities in the northern Gulf of California, Mexico: Implications for climate change. Marine Policy. 2013; 45: 182-93.

[7] Pollnac R, Abbott-Jamieson S, Smith C, Miller M, Clay P, Oles B. Toward a model for fisheries social impact assessment. Marine Fisheries Review. 2006; 68: 1-18.

[8] Himes-Cornell AH, Kasperski S. Assessing climate change vulnerability in Alaska's fishing communities Fisheries Research. 2015; 162: 1-11.

[9] Satterfield T, Gregory R, Klain S, Roberts M, Chan KM. Culture, intangibles, and metrics in environmental management. Journal of Environmental Management 2013; 117: 103-14.

[10] Poe MR, Norman KC, Levin PS. Cultural dimensions of socioecological systems: Key connections and guiding principles for conservation in coastal environments. Conservation Letters 2014; 7: 166-75.

[11] Jacob S, Jepson M. Creating a community context for the fishery stock sustainability index. Fisheries 2009; 34: 228-31.

[12] Sepez J, Tilt B, Package C, Lazarus H, Vaccaro I. Community profiles for North Pacific fisheries- Alaska. NOAA Technical Memorandum. Seattle, WA: National Marine Fisheries Service; 2005.

[13] Pinto da Silva P, Hall-Arber M. Special section on vulnerability and resilience in fisheries. Human Ecology Review. 2008; 15: 141-226.

[14] Colburn L, Clay P. The role of oral histories in the conduct of fisheries social impact assessments in Northeast US. Journal of Ecological Anthropology. 2012; 15: 2011-2.

[15] Marsh B. Continuity and decline in the anthracite towns of Pennsylvania. Annals of the Association of American Geographers. 1987; 77: 337-52.

[16] Turner BL, Kasperson RE, Matson PA, McCarthy JJ, Corell RW, Christensen L. A framework for vulnerability analysis in sustainability science. PNAS, Proceedings of the National Acadamey of Science 2003; 100: 8074-9.

[17] Cutter S, Barnes L, Berry M, Burton C, Evans E, Tate E. A place-based model for understandings community resilience to natural disasters. Global Environmental Chnage. 2008; 18: 598-606.

[18] Kofinas GP, Chapin FS. Sustaining livelihoods and human well-being during social-ecological change. In: Principles of Ecosystem Stewardship. Chapin FS, Kofinas GP, Folke C, (eds.). New York: Springer Science+Business Media; 2009.

[19] Gallopin GC. Linkages between vulnerability, resilience, and adaptive capacity. Global Environmental Chnage. 2006; 16: 293-303.

[20] Tuan Y. Space and place: The perspective of experience. Minneapolis, Minnesota: University of Minnesota Press; 1977.

[21] Thornton TF. Being and place among the Tlingit. Seattle, Washington: University of Washington Press; 2008.

[22] Escobar A. Culture sits in places: reflections on globalism and subaltern strategies of localization. Political Geography. 2001; 20: 139-74.

[23] Dirlik A. Place-based imagination: Globalism and the politics of place. Review (Fernand Braudel Center). 1999; 22: 151-87.

[24] Heald S. Embracing marginality: Place-making vs development in Gardenton, Manitoba. Development in Practice. 2008; 18: 17-29.

[25] Brannstrom C, Neuman M. Inventing the "Magic Valley" of south Texas, 1905-1941. Geographical Review. 2009; 99: 123-45.

[26] Harner J. Place identity and copper mining in Sonora, Mexico. Annals of the Association of American Geographers. 2001; 91: 660-80.

[27] Basso KH. Wisdom sits in places: Landscape and language among the western Apache. Albuquerque, New Mexico: University of New Mexico Press; 1996.

[28] Lyons C, Carothers C. Reedy K. Chapter 2: Community development versus economic development: Place-making as a framework for understanding development in fishing communities. In: Understanding place in fisheries management: An examination of ecological and social communiites in the Pribilof Islands, Alaska. Lyons, C., Eckert, G., Carothers, C., and C. Siddon (eds.). Fairbanks: University of Alaska Fairbanks; 2015.

[29] Bernard H. Research methods in anthropology: Qualitative and quantitative approaches, fourth edition. New York: AltaMira Press; 2006.

[30] Strauss A, Corbin J. Grounded theory in practice. London, UK: SAGE Publications; 1997.

[31] Himes-Cornell AH, Hoelting K, Maguire C, Munger-Little L, Lee J, Fisk J. Community profiles for North Pacific fisheries- Alaska. NOAA Technical Memorandum; Seattle: National Marine Fisheries Service; 2013.

[32] Cameron ES. Securing indigenous politics: A critique of the vulnerability and adaptation approach to the human dimensions of climate change in the Canadian Arctic. Global Environmental Chnage. 2012; 22: 103-14.

[33] AHDR. A human development agenda for the Arctic: Major findings and emerging issues. Akureyri, Iceland: Arctic Human Development Report; 2004.

[34] Mekbeb ET, Lilieholm RJ, Blahna DJ, Kruger LE. Resource use, dependence and vulnerability: Community-resource linkages on Alaska's Tongass National Forest. In: Brebbia CA, Tiezzi E (eds.). Ecosystems and Sustainable Development VII. Southampton, United Kingdom: WIT Press; 2009.

[35] Ford JD, Goldhar C. Climate change vulnerability and adaptation in resource dependent communities: A case study from West Greenland. Climate Research. 2012; 54: 181-96.

[36] Healey MC. Resilient salmon, resilient fisheries for British Columbia, Canada. Ecology and Society. 2009; 14: 2.

[37] Carothers C. Tragedy of commodification: Transitions in Alutiiq fishing communities in the Gulf of Alaska. MAST. 2010; 90: 91-115.

[38] Berger T. Village journey: The report of the Alaska Native review commission. New York: Hill and Wang; 1985.

[39] Dombrowski K. Against culture: Development, politics, and religion in Indian Alaska (Fourth world rising). Lincoln: University of Nebraska Press; 2001.

[40] Berkes F, Ross H. Community resilience: toward an integrated approach. Society and Natural Resources. 2013; 26: 5-20.

[41] Reedy-Maschner K. Aleut Identities: Tradition and modernity in an indigenous fishery. Montreal: McGill-Queen's University Press; 2010.

[42] BRIRC. Building Resilience in Rural Communities. Brisbane, Australia: University of Queensland and University of Southern Queensland; 2008.

[43] Berns R, Conway F. A framework for the preliminary assessment of vulnerability of fishing-dependent communities to climate change and variability. In: Carothers C, Criddle K, Chambers C, Cullenerg P, Fall J, Himes-Cornell A (eds.). Fishing People of the North: Cultures, Economies, and Management Responding to Change. Fairbanks: Alaska Sea Grant, University of Alaska Fairbanks; 2012.

[44] Alaska Native Claims Settlement Act of 1971. Pub.L. 92-203, 85 Stat. 688.

[45] NRC. The community development quota program in Alaska. Washington DC: National Academy Press; 1999.

[46] Anders G, Langdon S. Alaska Native regional strategies. Human Organization. 1989; 48: 162-72.

[47] Jones D. A century of servitude: Pribilof Aleuts under US rule. Lanham: University Press of America; 1980.

[48] Corbett H, Swibold S. Aleuts of the Pribilof Islands, Alaska. In: Freeman M (ed.). Endangered Peoples of the Arctic: Struggles to Survive and Thrive. Westport: Greenwod Publishing Group; 2000.

[49] Huntington HP, Kruse SA, Scholz AJ. Demographic and environmental conditions are uncoupled in the social-ecological system of the Pribilof Islands. Polar Research. 2009; 28: 119-28.

[50] Palsson G, Helgason A. Figuring fish and measuring men: The individual transferable quota system in the Icelandic cod fishery. Ocean and Coastal Management. 1995; 28: 117-46.

[51] Carothers C, Chambers C. Fisheries privatization and the remaking of fishery systems. Environment and Society: Advances in Research. 2012; 3: 39-59.

[52] Acheson JM. Confounding the goals of Management: Response of the Maine lobster industry to a trap limit. North American Journal of Fisheries Management. 2001; 21: 404-16.

General Conclusions

In this dissertation I sought to achieve two goals: to gain a more holistic understanding of the Pribilof Island social and ecological communities, and to gain proficiency conducting and communicating interdisciplinary research. As my educational background lay in marine ecology, this process began with an examination of Pribilof Island blue and red king crab ecology. Once this work was completed, I had planned to segue into interdisciplinary research, examining social connections to the Pribilof Island marine ecosystem and crab stocks in particular. In reality, however, I found that the relationships between social and ecological systems are not always easy to delineate, describe, or predict. Furthermore, I discovered that this conundrum was well illustrated in the relationship between Pribilof Island crab stocks and the Pribilof Island communities of St. Paul and St. George.

By the time I first visited the Pribilof Islands, my crab research had already been designed, funded, and scheduled; I was committed to this line of inquiry. In my conversations with Pribilof Island residents during this initial pilot study, however, I learned that while crab processing is the economic engine that supports the Pribilof Island economies, local residents are almost entirely disconnected from this process. Most residents recognize the importance of crab, but know little about either the crab fisheries or local crab species in general. The Bering Sea crab fisheries developed during a period of time in which most Pribilof Island residents were employees of the federal government, involved in the fur seal harvest. As such, they did not have the time or capital to invest in crab harvesting efforts that took place in the waters surrounding their home. Only when declines in fur seal abundance led to a closure of the fur seal harvest, did residents seek to diversify into other fishery opportunities. With limited infrastructure or capital available to residents, participation in the Bering Sea crab fisheries was not a viable option. As

such, my plan to examine connections between the Pribilof Island social system and local crab ecology required revising.

I, therefore, chose to shift my focus to a more general examination of the Pribilof Island social system as a whole. Freed from a direct focus on crabs, I was able to assess the myriad different relationships people had with fish resources and policies through the lens of place-making. This style of broad, holistic examination is more in the spirit of critical social science and allows a researcher more flexibility in responding to the self-identified areas of interest to research participants. My choice to embrace this open-ended style of research, furthermore, reflected an important step in the interdisciplinary research process: an epistemological shift.

Representing a change as significant as a regime shift in ecology, an epistemological shift requires a fundamental reordering of a researcher's understandings surrounding the nature of truth and the validity of positivism (Moon and Blackman 2014). Such a shift requires a researcher to recognize that critical social science is not simply the application of natural science frameworks and methodologies to human subjects. Critical social science disciplines, rather, see the world not as an objective reality, but as a social construct mediated by the actions of different groups of people (Eigenbrode et al. 2007). Only when a researcher fully understands and appreciates these differences can she effectively integrate ideas across disciplinary boundaries. The research described in Chapter 2 reflects just such an awareness.

While Chapter 2 represents my epistemological shift in understandings of social-ecological systems, Chapter 3 represents my attempt to summarize these understandings across disciplines. Faced with the difficulty of communicating across disciplines, many interdisciplinary researchers attempting to integrate the destabilizing insights of critical social science into fields traditionally dominated by natural scientists find it necessary to couch these insights in

terminology and frameworks familiar to natural science. Indeed, such an approach can often be seen by social scientists working to integrate anthropology and sociology into fisheries management (e.g., Jepson and Colburn 2013; Pollnac et al. 2006). While this process helps to aid in comprehension, such an approach risks perpetuating the idea of social science as "less than" natural science, a tool useful only in supplementing the more important work of natural science. Refusing to frame critical social science research in natural science frameworks, however, risks perpetuating the idea of these disciplines as irrelevant or useless to the more practical matters of resource management. Grappling with these problems was, therefore, a central concern of Chapter 3.

Revisiting the two overarching goals of this dissertation, I find that this work has addressed both goals, though not in the manner originally envisioned. Both Chapters 1 and 2 make disciplinary contributions, broadening understandings of ecological and social dynamics in the Pribilof Islands. While these investigations did not connect as explicitly as originally envisioned, knowledge from both provided me with the in-depth, interdisciplinary skills required to speak across disciplinary boundaries in Chapter 3. It is my hope that this work contributes to ongoing efforts to broaden the dialogue surrounding the sustainability of fishing communities and resources by providing practitioners of disparate disciplines new language and frameworks to assist in productive dialogues.

General References

Breslow, S.J. 2015. Accounting for neoliberalism: "Social drivers" in environmental management. Marine Policy. doi:10.1016/j.marpol.2014.11.018.

Dirlik, A. 1999. Place-based imagination: Globalism and the politics of place. Review (Fernand Braudel Center) 22: 151-187.

EDAW. 2008. Comprehensive baseline commercial fishing community profiles: Sand Point, Adak, St. Paul, and St. George, Alaska, Final Report. North Pacific Research Board and North Pacific Fishery Management Council. Anchorage, AK.

Eigenbrode, S.D., M. O'Rourke, J.D. Wulfhorst, D.M. Althoff, C.S. Goldberg, K. Merrill, W. Morse et al. 2007. Employing philosophical dialogue in collaborative science. BioScience 57: 55-64.

Escobar, A. 1995. Encountering development: The making and unmaking of the third world. New Jersey: Princeton University Press.

Escobar, A. 2001. Culture sits in places: reflections on globalism and subaltern strategies of localization. Political Geography 20: 139-174.

Foy, R.J. 2010. 2010 Stock assessment and fishery evaluation report for the Pribilof Islands blue king crab fisheries of the Bering Sea and Aleutian Islands regions. In Stock assessment and fishery evaluation report for the king and tanner crab fisheries of the Bering Sea and Aleutian Islands regions, ed. the Plan Team for the King and Tanner Crab Fisheries of the Bering Sea and Aleutian Islands. Alaska Department of Fish and Game. Anchorage, Alaska.

Jepson, M., and L.L. Colburn. 2013. Development of social indicators of fishing community vulnerability and resilience in the US southeast and northeast regions. In NOAA Technical Memorandum: National Marine Fisheries Service. St. Petersburg, FL.

Link, J. 2010. Ecosystem-based fisheries management: Confronting tradeoffs. Cambridge, UK: Cambridge University Press.

Marsh, B. 1987. Continuity and decline in the anthracite towns of Pennsylvania. Annals of the Association of American Geographers 77: 337-352.

McLeod, K., and H. Leslie. 2009. Ecosystem-based management for the oceans. Washington DC: Island Press.

Moon, K., and D. Blackman. 2014. A guide to understanding social science research for natural scientists. Conservation Biology 28: 1167-1177.

Pollnac, R.B., S. Abbott-Jamieson, C. Smith, M.L. Miller, P.M. Clay, and B. Oles. 2006. Toward a model for fisheries social impact assessment. Marine Fisheries Review 68: 1-18.

Springer, A.M., C.P. McRoy, and M.V. Flint. 1996. The Bering Sea green belt: Shelf-edge processes and ecosystem production. Fisheries Oceanography 5: 205-223.

Thornton, TF. 2008. Being and place among the Tlingit. Seattle, Washington: University of Washington Press.

Torrey, BB. 1978. Slaves of the harvest: The story of the Pribilof Aleuts. St. Paul, Alaska: Tanadgusix Corporation. Anchorage, AK.

Tuan, Y. 1977. Space and place. Minneapolis, Minnesota: University of Minnesota Press.

Appendix 1: IACUC approval form and permit information

(907) 474-7800
(907) 474-5638 fax
fyiacuc@uaf.edu
www.uaf.edu/iacuc

Institutional Animal Care and Use Committee
909 N Koyukuk Dr. Suite 212, P.O. Box 757270, Fairbanks, Alaska 99775-7270

November 7, 2011

To: Ginny Eckert, PhD
Principal Investigator

From: University of Alaska Fairbanks IACUC

Re: [280889-3] Pacific halibut SOP (Alaska Fisheries Science Center Newport, Oregon)

The IACUC reviewed and approved the SOP referenced below by Designated and Administrative Review.

Received:	November 2, 2011
Approval Date:	November 7, 2011
Initial Approval Date:	November 7, 2011
Expiration Date:	November 7, 2012

This action is included on the November 15, 2011 IACUC Agenda.

The PI is responsible for acquiring and maintaining all necessary permits and permissions prior to beginning work on this protocol. Failure to obtain or maintain valid permits is considered a violation of an IACUC protocol, and could result in revocation of IACUC approval.

(907) 474-7800
(907) 474-5638 fax
fyiacuc@uaf.edu
www.uaf.edu/iacuc

Institutional Animal Care and Use Committee

909 N Koyukuk Dr. Suite 212, P.O. Box 757270, Fairbanks, Alaska 99775-7270

November 2, 2011

To: Ginny Eckert, PhD
Principal Investigator

From: University of Alaska Fairbanks IACUC

Re: [278926-3] Groundfish predation, temperature changes, and competitors: Examining the interactions among potential drivers of Pribilof Island blue king crab recovery failure

The IACUC reviewed and approved the Amendment/Modification referenced below by Administrative Review.

Received:	November 2, 2011
Approval Date:	November 2, 2011
Initial Approval Date:	November 2, 2011
Expiration Date:	November 2, 2012

This action is included on the November 15, 2011 IACUC Agenda.

The PI is responsible for acquiring and maintaining all necessary permits and permissions prior to beginning work on this protocol. Failure to obtain or maintain valid permits is considered a violation of an IACUC protocol, and could result in revocation of IACUC approval.

(907) 474-7800
(907) 474-5638 fax
fyiacuc@uaf.edu
www.uaf.edu/iacuc

Institutional Animal Care and Use Committee

909 N Koyukuk Dr. Suite 212, P.O. Box 757270, Fairbanks, Alaska 99775-7270

October 26, 2011

To: Ginny Eckert
Principal Investigator

From: University of Alaska Fairbanks IACUC

Re: [281109-1] Personnel Information Form - Lyons

The IACUC reviewed and approved the Other referenced below by Administrative Review.

Received:	October 21, 2011
Approval Date:	October 26, 2011
Initial Approval Date:	October 26, 2011
Expiration Date:	October 26, 2012

This action is included on the September 9, 1999 IACUC Agenda.

Courtney Lyons does not need to complete an "Animal Care Worker" medical questionnaire form. She already has the required training necessary to do her research work (no "Lab Safety" online training needed since she is not working with chemicals).

The PI is responsible for acquiring and maintaining all necessary permits and permissions prior to beginning work on this protocol. Failure to obtain or maintain valid permits is considered a violation of an IACUC protocol, and could result in revocation of IACUC approval.

Appendix 2: IRB approval form

UNIVERSITY OF ALASKA FAIRBANKS

(907) 474-7800
(907) 474-5444 fax
fyirb@uaf.edu
www.uaf.edu/irb

Institutional Review Board
909 N Koyukuk Dr. Suite 212, P.O. Box 757270, Fairbanks, Alaska 99775-7270

May 17, 2012

To: Courtney Carothers
Principal Investigator

From: University of Alaska Fairbanks IRB

Re: [316803-2] Examining the intersections of place-making and development in the Pribilof Islands, Alaska

Thank you for submitting the Amendment/Modification referenced below. The submission was handled by Expedited Review under the requirements of 45 CFR 46.110, which identifies the categories of research eligible for expedited review.

Title:	Examining the intersections of place-making and development in the Pribilof Islands, Alaska
Received:	May 11, 2012
Expedited Category:	7
Action:	APPROVED
Effective Date:	May 17, 2012
Expiration Date:	April 18, 2013

This action is included on the June 14, 2012 IRB Agenda.

No changes may be made to this project without the prior review and approval of the IRB. This includes, but is not limited to, changes in research scope, research tools, consent documents, personnel, or record storage location.

Appendix 3: Written consent form

Informed Consent Form: Place-making in the Pribilof Islands

IRB: # 316803-1
Date Approved: April 18, 2012

Description of the Study:
You are being asked to take part in a research study about place-making efforts in the Pribilof Islands. Place-making is how people make meaning out of a physical place, like a town or an island. What makes a place "home" rather than just somewhere you live? Those actions, relationships, and feelings are place-making efforts. These efforts are important in creating healthy communities. The goal of this study is to learn what place-making efforts are important in Pribilof Island communities. This information will be shared with fisheries managers to help them sustain healthy fishing communities. You are being asked to take part in this study because of your long-time residence in the Pribilof Islands. Please read this form and ask any questions you may have before you agree to be in the study.

If you decide to participate, I will ask about your life in the Pribilof Islands. What makes this place different from other places you could be living? Why do you choose to live here? What would you change and what do you hope never changes?

Risks and Benefits of Being in the Study:
- You risk becoming upset as you talk about changes in your community over time.
- However, you benefit by getting a chance to list your concerns and see them shared with managers and scientists.

Confidentiality:
- We will keep all information about you, including answers to interview questions and recordings, private.
- We will not share any information that includes your name with anyone outside this project.
- We will protect your privacy in several ways. We will remove your name from documents and use a number code instead. We will shred trash before throwing it away. We will store research records in locked cabinets.
- We will use information from this study in reports and presentations, but we will never share your identity.

Voluntary Nature of the Study:
Taking part in this study is your choice. You can stop at any time or change your mind later and ask to be removed from the study. No matter what you decide, now or later, nothing will happen to you as a result.

Contacts and Questions:
If you have questions now, feel free to ask me now. If you have questions later, you may contact me via email (cdlyons@gmail.com) or by phone (360 333 4855).

If you have questions about your rights as a study participant, contact the UAF Office of Research Integrity at 474-7800 (Fairbanks area) or 1-866-876-7800 (toll-free outside the Fairbanks area) or fyirb@uaf.edu. They will answer any questions.

Statement of Consent:
I understand the procedures described above. My questions have been answered to my satisfaction, and I agree to participate in this study. I have been provided a copy of this form.

_____
Signature of Participant & Date

_____
Signature of Person Obtaining Consent & Date

Appendix 4: Written consent of Allan Stoner to include manuscript in dissertation

UNIVERSITY of ALASKA

Courtney Lyons <cdlyons@alaska.edu>

consent for dissertation chapter

1 message

allan stoner <allan.stoner@gmail.com> Mon, Apr 13, 2015 at 11:00 AM
To: Courtney Lyons <cdlyons@alaska.edu>

Hello Courtney,

I am pleased that the study we co-authored will be one of your dissertation chapters.

With this email I provide my consent to include the following chapter in your Ph.D. dissertation:
"Influence of temperature and congenere presence on blue (Paralithodes platypus) and red (Paralithodes camtschaticus) king crab habitat preference and fish predation".

Best wishes for your defense in May.

Allan Stoner