Spring 2015

Understanding Vulnerability in Alaska Fishing Communities: A Validation Methodology for Rapid Assessment of Well-Being Indices

Conor M. Maguire
Central Washington University, conormag60@gmail.com

UNDERSTANDING VULNERABILITY IN ALASKA FISHING COMMUNITIES: A VALIDATION METHODOLOGY FOR RAPID ASSESSMENT OF WELL-BEING INDICES

A Thesis

Presented to

The Graduate Faculty

Central Washington University

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

Resource Management

---

by

Conor Martin Maguire

May 2015

CENTRAL WASHINGTON UNIVERSITY

Graduate Studies

We hereby approve this thesis of

Conor Martin Maguire

Candidate for the degree of Master of Science

APPROVED FOR THE GRADUATE FACULTY

______________ ______________________________
Dr. Steven Hackenberger, Committee Chair

______________ ______________________________
Dr. James Huckabay

______________ ______________________________
Dr. Amber Himes-Cornell

______________ ______________________________
Dean of Graduate Studies

ABSTRACT

UNDERSTANDING VULNERABILITY IN ALASKA FISHING COMMUNITIES: A VALIDATION METHODOLOGY FOR RAPID ASSESSMENT OF WELL-BEING INDICES

by

Conor Martin Maguire

May 2015

Social well-being indices measure how fishing communities are likely to be affected by social-ecological perturbations, and are a significant tool to identify the primary issues influencing communities' sustained participation in fishing activities. In an attempt to further our understanding of how communities are affected by such perturbations, we have developed a rapid assessment methodology to test the external validity of a set of well-being indices that measure community vulnerability. This methodology informs how well such indices reflect the communities they represent by measuring elements of well-being through field observations, and comparing them to corresponding index components created from secondary data sources. This process helps us understand how well predetermined components of the well-being indices represent real-world conditions observed by researchers.

ACKNOWLEDGEMENTS

I would like to thank everyone whose dedication, encouragement, and assistance guided me through this process. Without all of you, this would never have been possible. I would like to first thank my esteemed chair and committee for sticking with me through the years. Drs. Steve Hackenberger and James Huckabay for your continued encouragement and helping me to keep my sense of humor; Dr. Amber Himes, for allowing me to contribute towards such a fascinating project, as well as assisting me all along the way; Kristin Hoelting and Dr. Richard Pollnac for all of your work during the creation and groundtruthing of the indices; and Dr. Stephen Kasperski for familiarizing me with the statistics. I also want to thank my friends and family, who have always been there to both keep me grounded and lift me up when needed; especially my parents Diahn and Terry and my wonderful wife, Christa. Thank you all!

Dedicated to my Grandfather, Martin Matthew Schmidt

1927-2011

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

INTRODUCTION

When the Magnuson-Stevens Fishery Conservation and Management Act (MSA) was enacted in 1976, its purpose was to promote optimum exploitation of federally managed waters by establishing a set of national standards for achieving "optimum yield." National Standard 8, under the MSA's 2006 reauthorization, instructs managers to, "Take into account the importance of fishery resources to fishing communities by utilizing economic and social data" (MSFCMA, 2007).

Over the past several years, there has been a mounting effort by regional fisheries science centers to assess socioeconomic vulnerability in fishing-dependent communities throughout the United States (Colburn & Jepson, 2012; Jepson, 2007; Jepson & Colburn, 2013). As part of this effort, the Alaska Fishery Science Center (AFSC) has developed a set of indicators measuring social vulnerability.

National standard 8 set the precedence for social science research within the broader context of fishery management. It recognizes that understanding social-ecological systems is imperative for effective management. According to the MSA, "fishing" communities are defined as depending significantly on fish harvesting or processing to meet social and economic needs (MSFCMA, 2007).

This definition of fishing communities as significantly dependent on fishery resources is important in determining a place-based unit of study. Fishing communities are a main area of interest for social scientists, as they are a physical embodiment of social-ecological systems. Communities of place are the zone of interaction between resource users and the environment.

Federal fishery managers were interested in the social well-being of fishing communities long before the initial passage of the MSA in 1976. During the 1940s and 1950s, advances in gear, vessel, and refrigeration technologies resulted in a boom of offshore groundfish fisheries. As demand increased for groundfish, the fishery became more industrialized; contributing to a rapid increase of factory longliners, gillnetters, and trawlers in the Gulf of Alaska (GOA) and Bering Sea. This period marked an increase in competition by foreign fleets, with much of the biomass being prosecuted by Russian and Japanese vessels. Pressures on offshore fisheries and competition with foreign entities lead to international debates over coastal sovereignty, which laid the groundwork for the MSA. The MSA established eight regional management councils, charged with formulating federal fishery policy. A 200-mile Exclusive Economic Zone was established to restrict foreign fishing effort, and the newly formed North Pacific Fishery Management Council (NPFMC) was instructed to develop management solutions to address the poor state of Alaska groundfish fisheries. Fishery Management Plans (FMPs) limited harvests, established gear restrictions, and reined in foreign fleets. Over the years following, the groundfish fishery became increasingly “Americanized,” and by 1991, it was fully domestic. It was this domestication and extension of exclusivity rights that preempted the slow transition from open-access, to market-based management of groundfish fisheries in Alaska.

Market-based governance of fisheries seen today has its roots in neoliberalization of common-pool resource management beginning in the 1950s (Mansfield, 2004a). Gordon (1954) first described the notion of how common-pool resources such as fisheries can fall victim to over-exploitation and economic inefficiencies. What he described was the inevitable "race to fish" that would ensue when self-maximizing harvesters compete for a resource where the stock value is essentially zero. In other words, there is a disincentive to leave fish in the water since there is no guarantee that somebody else will not capitalize on that opportunity to fish. Total effort expended will always approach the point where benefits are dissipated and over-exploitation of the resource occurs as new entrants arrive (Gordon, 1954; Mansfield, 2004a). Garrett Hardin's well-known 1968 paper echoed this concern, describing the dilemma of self-maximizing individuals operating within an open-access resource regime and the market failure and environmental degradation that inevitably ensue (Hardin, 1968).

Harvest caps were first adopted by the MSA to combat declining stocks and economic inefficiencies. These caps inevitably created an environment where individual fishermen competed with each other in a "derby-style" race to fish. While fishermen competed for harvest of the newly domesticated groundfish resource, a de facto quota share system was being developed to institute gear, vessel size, and target species restrictions (Holland & Ginter, 2001). As new entrants increased and rents dissipated, industry became increasingly frustrated with the apparent lack of action taken by the NPFMC to address open-access problems. By the late 1980s, domestic groundfish fisheries were saturated, and the NPFMC was forced to take action by declaring a moratorium on additional vessels in the GOA and Bering Sea regions in 1992. At this time, managers were looking for market-based solutions to the commons problem being experienced in Alaska, and many looked to catch share programs already in place in countries like New Zealand and Iceland (McCay, 2004).

Harvest caps proved to be untenable for many groundfish fisheries including crab and pollock; two of the North Pacific's most lucrative fisheries. While caps made sense in terms of managing fishery stocks, it led to both market inefficiencies and overfishing. One of the side effects of domesticating the offshore groundfish fishery is that it required large amounts of foreign and outside investment, since only inshore fisheries with ties to fishing communities had been developed to date. This left a rift between traditionally small, community-based inshore fisheries, and largely corporate offshore fisheries. Corporate vessels based in ports outside Alaska had the benefit of investor backing, which allowed them a competitive advantage when compared to smaller-scale family-owned operations (Mansfield, 2004b). However, these smaller operations were able to carve out a niche during open-access fisheries, by virtue that cost of entry was lower and many had been fishing for generations and had already accumulated the capital needed for participation. This changed when the NPFMC began adopting catch share programs, with the goal of "rationalizing" fisheries. The goal of such programs was to prevent inefficiencies, improve product quality, and improve overall safety. Catch share systems semi-privatize fisheries by allocating a right to fish based on catch history. These fishing rights are then commoditized by making them both durable and transferable. Catch shares were first introduced in Alaska in 1992 with the halibut and sablefish Individual

Fishing Quota (IFQ) programs. IFQs in Alaska were modeled after similar programs in the northeastern United States and Canada. In 1999, the American Fisheries Act allowed for the restructuring of the pollock fishery, which effectively led to its privatization in the Bering Sea, leaving the Gulf of Alaska the only remaining open-access pollock fishery. Finally, in 2005 the crab fishery was converted to a catch share program, ending a decades-long derby-style fishery (Mansfield, 2004b).

Catch share programs were immensely successful in meeting the goals they were set out for. Price of raw product increased, fishing became safer, product quality increased, marginal costs decreased, and salaries for crew and skippers became more predictable as vessels were guaranteed and apportionment of the total allowable catch. However, there were unintended consequences that affected fishing dependent communities, specifically. These included an increased cost of entry into the fishery, lower proportional and overall crew compensation, and the consolidation of catch shares (Olson, 2011). In addition, much of the initially allocated catch share was being bought and consolidated by entities outside of the communities which are dependent on them. As it became harder for communities to participate in fisheries, the NPFMC became more interested in measuring social impacts of management. This required a deeper understanding of the broader socio-political institutions that exist within communities (Jentoft, 2006). Social science focuses on fisheries as complex systems which interact with multiple processes and actors within social ecological systems. It is interested in the social, economic, and biological impacts of regulations, with the purpose of supporting management solutions that are equitable and sustainable (Clay & McGoodwin, 1995; Urquhart, Acott, Reed, & Courtney, 2011).

Indicators of social well-being have existed since the 1970s, although they have only recently become of interest to fishery managers since the adoption of National Standard 8 in the MSA. Initial adoption of social indicators in the Mid-Atlantic and Northeast regions of the United State was driven by concerns over gentrification and a loss of fisheries-related infrastructure in communities historically dependent on fisheries. These concerns gave rise to research in community vulnerability; however, place-based data collection was a difficult undertaking within the short timeframes assigned to developing FMPs. Rapidly assessable indicators of social vulnerability were created to address time and resource constraints inherent in the FMP process (Jepson and Jacob, 2007). Social indicators of gentrification pressure were developed by Colburn and Jepson (2012) for fishing communities in the Northeast and Southeast regions of the U.S., while Himes-Cornell and Kasperski (2015) developed similar measures of social vulnerability for the Alaska region. In addition to work developing indicators of social well-being, efforts have been made to devise methods of confirming their validity on a place level (Biedenweg et al., 2014; Colburn & Jepson, 2012; Jacob, Weeks, Blount, & Jepson, 2013; Marshall & Marshall, 2007; Morzaria-Luna, Turk-Boyer, & Moreno-Baez, 2013). The following article presents a methodology of validating and contextualizing a set of social well-being indices developed specifically for Alaska fishing communities. The purpose of this validation methodology is to assess how well well-being indices developed by the AFSC represent the communities they measure, as well as explore concepts of well-being from the perspective of those residing in them.

CHAPTER II

JOURNAL ARTICLE

Understanding vulnerability in Alaska fishing communities: A validation methodology for rapid assessment of well-being indices

Conor M. Maguire
National Marine Fisheries Service
7600 Sand Point Way NE
Seattle, Washington 98115, United States

Social well-being indices measure how fishing communities are likely to be affected by social-ecological perturbations, and are a significant tool to identify the primary issues influencing communities' sustained participation in fishing activities. In an attempt to further our understanding of how communities are affected by such perturbations, we have developed a rapid assessment methodology to test the external validity of a set of well-being indices that measure community vulnerability. This methodology informs how well such indices reflect the communities they represent by measuring elements of well-being through field observations, and comparing them to corresponding index components created from secondary data sources. This process helps us understand how well predetermined components of the well-being indices represent real-world conditions observed by researchers.

Keywords: Mixed-methods, Groundtruthing, Vulnerability, Well-being, Alaska fishing communites

1. Introduction

Fisheries are encompassed by institutional systems that embody a relationship between resource and appropriator. They are governed by various formal and informal rules and institutions, which are dictated by complex social-ecological processes. These rules are adaptive, and often reactive, due to uncertainty inherent in stock abundance, environmental conditions, political climate, and global economies. Depending on their level of reliance on fisheries, certain communities may be more susceptible to the resulting impacts from such disruptions. Entrenched political, market-based, and community-based institutional arrangements, which act as buffers to potential disruptions, are being perturbed by factors such as climate change and economic and social instability (Imperial and Yandle, 2005). Given such challenges, it is necessary for both communities and the institutions they rely on to be adaptive if they hope to sustain historical patterns of fisheries participation (Allison and Ellis, 2001; Berkes and Jolly, 2001). Determining vulnerability to economic, social, and environmental instability accomplishes an important step in assessing how communities may respond to disturbances, and may lead to better tools for making institutions more adaptive and robust.

The Magnuson-Stevens Fishery Conservation and Management Act (MSA) identifies "fishing communities" as a status of communities which depend significantly on fish harvesting or processing to meet social and economic needs (MSA, 2007). The concept of fishing dependence is different from fisheries engagement, which reflects the extent to which a community comprises aggregate fishing activity across the fishery as a whole. Fishing dependence is a more local concept, reflecting per capita involvement of local residents in fishing activities, and is a measure of how important fishing is to the health of the local economy (Himes-Cornell et al., 2013). While this definition serves a purpose in terms of creating an operational definition of "fishery dependence," it does not address the cultural and social values inherent in that term (Brookfield et al., 2005). To those living in a community, a sense of place may be experienced beyond the confines of political boundaries, and fishery dependence may not be limited to reported landings and other associated fishing activity (e.g., vessels owned or fishing permits held by local residents). It is important to explore these concepts if managers are to better understand the structure and needs of fishery-dependent communities, as well as how they react to changes in their social-ecological environment.

Historically, fishery managers placed little emphasis on studying social phenomena, opting for greater focus on biophysical and ecological disciplines. This has changed as the role of humans acting within fisheries has become better understood and the concept of fisheries social-ecological systems has developed (Ban et al., Clay and McGoodwin, 1995; Colburn et al., 2006; Himes-Cornell and Hoelting, 2015; Jentoft, 2006). This recognition of fisheries as complex social-ecological systems has led to efforts to understand social vulnerability of place-based fishing communities. By better understanding conditions contributing to vulnerability, managers can better project how communities may react to perturbations resulting from policy decisions. However, studying and reporting on fishing community vulnerability has proven somewhat challenging for social scientists working within federal resource management agencies. Fully understanding processes affecting community resilience traditionally requires ethnographic methods that produce qualitative findings that are often not well-suited to integration with standard quantitative metrics utilized by fishery managers (Sepez et al., 2006).

Many researchers can attest to the difficulty of quantifying vulnerability (Reed et al., 2006; Allison et al., 2009; Boyd and Charles, 2006). In addition to issues of data interpretability, there are issues of scale and feasibility related to mandates directed under the MSA, Executive Order 12898 (environmental justice), and the National Environmental Protection Act. In following these mandates, conducting lengthy and rigorous ethnographic fieldwork becomes increasingly resource intensive and is often precluded by demand for expedience (Sepez et al., 2006; Jacob et al., 2010). Expanding on traditional ethnographic studies, there has been a recent effort to develop quantitative indices derived from secondary data that aim to measure community vulnerability as a way of satisfying management directives outlined under the MSA while also addressing the issue of data standards and timeliness. The primary goal of these efforts is to create a reliable and consistent method of quantifying vulnerability that remains grounded and relevant at a community level (Himes-Cornell and Kasperski, 2015; Jacob et al., 2010; Jepson and Colburn, 2013). To this end, components of community "well-being" were constructed for the purpose of estimating how vulnerable communities are to perturbations as well as gauging how their imbedded institutions might react. These indices are only as good as the data used to create them, and ethnographic data are still needed to assess the reliability of secondary data included in them (Jepson and Jacob, 2007). To increase confidence in such indices and interest in ultimately adopting them in social impact assessments, we propose the use of ethnographic techniques to assess their validity, which we refer to as "groundtruthing."

This paper presents a methodology for a rapid qualitative assessment measuring external validity of community well-being indices (Himes-Cornell and Kasperski, 2015) and is inspired by similar work carried out in fishing communities in the Gulf of California (Morzaria-Luna et al., 2013), Gulf of Mexico (Jacob et al., 2013), New England (Colburn and Jepson, 2012), northern Australia (Marshall and Marshall, 2007), and Puget Sound (Biedenweg et al., 2014). This methodology applies a qualitative ranking system similar to that developed by Jacob et al. (2010; 2013) to measure how representative the quantitative indices are on a community level. This type of validation confirms that the quantitative indices, and the secondary data they rely on, reflect the conditions actually found in communities. If both quantitative and qualitative techniques generate similar findings, it presents evidence of the findings being oriented in reality, rather than being a product of the methodology itself (Johnson et al., 2007). The results of our study suggest that numerous obstacles exist to its effective implementation, arising from field logistics as well as data quality issues. However, we believe it is a promising and useful method that can be used to fulfill an important management need.

1.1. What are we trying to measure? An overview of resilience, vulnerability and well-being

The health of fishing dependent communities depends heavily on conditions that facilitate institutions which maintain well-being and promote resilient social-ecological systems (Criddle, 2012). Social-ecological systems (SES) embody patterns of interaction between social and natural systems, specifically those which enable a social system to maintain a desired state (Berkes and Folke, 1998; Folke et al., 2005). These interactions are often heavily influenced by institutions that govern conditions that influence the overall structure, function, or identity of the social components of that system (Folke et al., 2004; Adger, 2000). Ultimately, human communities represent just one component of complex SESs nested within larger social-ecological landscapes. Using an SES conceptual framework for thinking about community vulnerability and resilience is useful because it recognizes communities as dynamic systems existing within nested states of equilibrium, or a state of panarchy (Gunderson and Holling, 2002; Holling, 1973).

Panarchy refers to adaptive cycles that, when broken down into their constituent feedback systems, dictate interactions between multi-scalar stable states that ultimately affect an SES's overall resilience over time (Walker et al., 2004). Resilience can be broken down into three components: persistability, adaptability and transformability (Himes-Cornell and Hoelting, 2015). Persistability refers to the likelihood that a SES can persist in its current state (Holling and Gunderson, 2002). Adaptability refers to adaptive capacity, or the ability of actors within an SES to influence resilience, and is often seen as influenced by the availability of community capital, most notably social and human capital, but can also include political, financial, information, infrastructure, and institutional forms of capital (Allison et al., 2009; Smit and Wandel, 2006). Transformability refers to the capacity to either transition between systems, or create a whole new one when an existing system becomes undesirable or unsustainable. Within a SES, this means the ability to create a fundamentally new system as opposed to the ability to maintain an existing state, as influenced by adaptive capacity (Folke, 2006).

Two distinct but related concepts are often used to explore issues of adaptive capacity: resilience and vulnerability; terms that are typically defined according to the contexts in which they originated (Norris et al. 2008). Although they are at times used interchangeably (Adger, 2000), they are borne of different epistemologies (Miller et al. 2010). The concept of resilience can be traced back to engineering and ecological traditions, which focus on the response of material to external forces and measures of environmental stress and regime shift, respectively (Adger, 2000; Holling, 1973; Martin-Breen and Anderies 2011:43). On the other hand, concepts of vulnerability are based on the more constructivist disciplines of human and political ecology. This concept tends to focus on measuring exposure to disruptive influences (Turner et al., 2003). Related to both the concepts of resilience and vulnerability are institutions which reinforce norms and rules that connect social and ecological systems (Adger, 2000). As mentioned previously, adaptive capacity relates to the conditions present in a community that contribute to the ability of institutions to function (Ainuddin and Routray, 2012; Smit and Wandel, 2006). These are important factors to consider when designing indices that measure social vulnerability of communities, as they constitute a measure of adaptive capacity in addition to measuring how effective institutions are at mitigating and absorbing disruptions.

Fully embodying the components of panarchy, SESs emerge as dynamic systems existing somewhere between a state of equilibrium and a chaotic periphery. What happens at the periphery determines whether an SES will remain tenable (persist), can be modified into a parallel state (adapt), or collapse and transform (Holling, 1973). Tied to that periphery is the level of well-being experienced by human communities which exist within a given SES. Well-being is described in three dimensions: objective, subjective, and relational (Armitage et al., 2012). These dimensions of well-being can provide insight into a community's ability to preserve a desired state, or transition from an undesirable one.

Social well-being places its origins in social psychology, and is generally defined as an evaluation of personal satisfaction and positive affect at the individual level (Keyes, 1998). Originally, subjective well-being formed from an interest among psychologists and sociologists to examine an individual's "cognitive and affective" evaluation of their quality of life (Diener et al., 1999). Britton and Coulthard (2013) expanded the concept beyond subjective well-being, describing both material and relational dimensions. Material well-being embodies observable products of well-being that contribute toward resilience (e.g., resources, services, and other physical assets). Relational well-being refers to institutions, rules, norms, and interactions which promote social benefits (e.g., social capital, laws, and shared value systems). Similar to social well-being as defined above, community well-being describes a community's ability to function within a SES (Adger, 1999, 2000, 2003). The overall goal of the well-being indices being validated here is to measure community-level attributes that may be contributing to a specific outcome so that researchers and fisheries managers may better understand both exposure to potential perturbations (proximity to the chaotic periphery) as well as predict how communities may adapt to or resist them.

2. Material and methods

We used a mixed-methods (Creswell, 2003; Creswell et al., 2011) approach applying both grounded theory and quantitative methods. First developed in the late 1960s, grounded theory presents a method for working with qualitative data that views the researcher as part of the research, rather than an unattached observer (Glaser and Strauss, 2009). In contrast to a traditional approach of exploring data within the parameters of an existing theory or hypothesis, grounded theory assumes that value can be found in the creation of theory from data using iterative and inductive processes (Heath and Cowley, 2004). We used a method adopted by Corbin and Strauss (1990), which contrasts from Glaser and Strauss' original theory both ontologically and methodologically. While Glaser emphasized theoretical coding (for theory building), Corbin and Strauss emphasized structural coding, which is conducive to the development and integration of categories. This approach lends itself to a mixed-methods research design in that qualitative data can be coded and categorized in ways that are better comparable with quantitative data.

Grounded theory relies on interpretations of reality based on participant experience with their environment, which for our research involved the experiences of fishing community residents (Glaser, 2002). These interpretations can be coded into constructs, which can then be compared against each other, or in this case with components of well-being. Initial constructs were created from an assessment of available literature, and continued to emerge through a process of constant comparison of participant experiences. Constructs help describe real world properties that cannot be directly observed (Luna-Reyes and Andersen, 2003). These difficult-to-observe properties are of interest when determining validity of well-being indices as they can include relational and subjective dimensions of well-being, which are often difficult to quantify. These constructs were then adapted to match components of well-being through a process of interpretation of both respondent and researcher experiences. This allowed us to link both constructs and components in a way that allowed for deeper exploration into how grounded well-being indices were in reality.

Through this process we created a nuanced and flexible methodology. Our approach involved five steps, including development of constructs of reality, as well as a series of methods used to determine the validity of the resulting constructs. In chronological order, the steps included 1) constructing indices of well-being using Principle Component Factor Analysis (PCFA), 2) clustering communities based on the well-being indices, 3) groundtruthing fieldwork in communities representative of community clusters, 4) assigning qualitative ranks to each community based on that fieldwork, and 5) a statistical assessment of agreement between qualitative rankings and quantitative indices. In combination, these steps allowed us to examine both the external validity of the well-being indices and the reliability of researcher observations in the field. The details of each step are discussed below.

2.1. Step 1: Quantitative indicator development

The first step in our methodology involved creating well-being indices that classify community vulnerability. These indices provide a quantified representation of conditions affecting well-being on a community level, as well as index components that describe latent qualities of group variables relating to well-being.

Secondary data sources were used to create the indices and seHimeslected variables were based on research by Jepson and Colburn (2013) and Colburn and Jepson (2012), and were specifically chosen to capture unique characteristics of Alaskan communities. The full data set includes 78 social and 73 fisheries variables collected for 346 Alaska communities (determined as Census Designated Places) using a variety of state and federal sources and represented average values over the period of 2005-2009. Social and economic data were compiled from sources including U.S. Census Bureau 2005-2009 5-year estimates (U.S. Census Bureau, n.d.), the Alaska Local and Regional Information Network (Alaska Department of Labor and Workforce Development, n.d.), education statistics and reports, (Alaska Department of Education and Early Development, n.d.), Community Database Online (Alaska Department of Commerce, Community, and Economic Development, n.d.), and various local community comprehensive plans. Fishery data were compiled by the Alaska Fisheries Information Network (AKFIN, n.d.) drawing from sources including the National Marine Fisheries Service (2011a, 2011b), Alaska Department of Fish and Game (2011a, 2011b), and Alaska Commercial Fisheries Entry Commission (2015).

With such a large number of variables used in determining well-being, a data reduction technique was needed to reduce them to a manageable level. Principal components factor analysis (PCFA) was employed to reduce variables through the development latent components that influence community well-being. We conducted separate PCFAs first using social data (e.g., poverty, employment), and then fishery data (e.g., landings, permits). For both analyses, we eliminated variables that were redundant or had too many missing values. We used a scree test to determine the number of components that could be considered in the PCFA, where the number of components appropriate to consider corresponded to the inflection point of the scree plot. During this step, we used a varimax rotation of the factor loadings with Kaiser normalization in order to isolate variables that have the highest factor loading for each component. This was meant to ease interpretation of factor loadings by altering them so that they were more discretely attributed to each factor. We used the Kaiser criterion to keep only components with eigenvalues greater than 1 in the final analysis. An Armor's theta reliability test was used in order to test the internal consistency of the variables in each component, where a value of theta greater than 0.5 is considered acceptable (Jepson and Colburn, 2013; Himes-Cornell and Kasperski, 2015a, 2015b; Smith et al., 2011). Ultimately, the final analysis was able to maintain theta reliability scores above 0.8; confirming the reliability of the PCFA instrument.

Due to insufficient availability of some data, we reduced the number of communities included in the analyses to 284 to account for missing values or other instances where an individual community designation did not seem appropriate (e.g., Auke Bay was combined with Juneau). In many cases data were highly skewed, in which case we employed a log10 transformation to make patterns more apparent. Selected variables were put into a correlation matrix to determine additional redundancy, and highly correlated variable groupings were collapsed. Additional processing was required on a per-variable basis until both PCFAs produced satisfactory components. The result of this effort was a total of seven components of social vulnerability explaining 62% of variance; and eight components of fishery dependence explaining 72% of variance (Tables 1 and 2). The social components were labeled as the following: community size, infrastructure, rural/village character, poverty, transient population, foreign-born Asian population, and retirees/low female labor force participation. Fishery involvement components were then labeled as the following: fishery participation, fishery participation per capita, crab/ American Fisheries Act (AFA)/Federal Processing Permits (FPP), sportfishing participation, FPP per capita/sea otter subsistence, local landings/vessels/processors, marine mammal and salmon subsistence, and federal crab permits/beluga harvests. The social components were intended to capture a snapshot each community's overall (material) social well-being, while fishery involvement variables were intended to measure dependence on, and engagement in, commercial, recreation, and subsistence fishing activities.

Table 1.
Social Vulnerability Principal Components Factor Analysis (Armor's Theta = 0.959).

Component Constructs	Five Highest Loading Variables	Eigenvalue	% variation explained	Cum. % variation explained
Community Size	Total employment Peak quarterly # of workers Population Total households # of workers employed in all four quarters	15.88	0.20	0.20
Infrastructure	Clinic present Water services Sewer services Post office present Piped water utilities	8.87	0.11	0.32
Rural/Village Character	Avg. household size (2005-2009 ACS) Avg. household size (2000 Census) % population under 18 Alcohol control laws % speaking primary language other than English	7.56	0.09	0.41
Poverty	% Living below poverty line (per capita) % families living below poverty line % households earning under $10k % unemployed % occupied households lacking plumbing	7.17	0.09	0.50
Transient Population	% Living in another country one-year prior % living in another state one-year prior % population black or African American % of households renting % living in same house one-year prior	3.30	0.04	0.54
Foreign Born Asian Population	% Foreign born population % population Asian	3.24	0.04	0.59
Retirees/Low Female Workforce	% Households with 65 or older resident % receiving social security % 25 and older with less than 9th grade education % retired % employed females 16 and over	3.04	0.04	0.62

Table 2.
Fishery involvement principal components factor analysis (Armor's Theta = 0.975).

Component Constructs	Five Highest Loading Variables	Eigenvalue	% variation explained	Cum. % variation explained
Fishery Participation (total)	Vessels homeported Vessels owned by residents Crew licenses Total CFEC permits fished Total CFEC permit holders	15.91	0.22	0.22
Fishery Participation (per capita)	FFP permit holders Sablefish IFQ account holders Vessels owned by residents Vessels homeported Halibut IFQ account holders	11.27	0.15	0.37
Crab, AFA, and FPP	Crab permits fished Crab permits held by residents Crab IPQ account holders AFA permit holders (per capita) AFA permits fished (per capita)	8.38	0.11	0.49
Sportfishing (per capita)	Sport fish licenses sold Sport fish licenses held	3.80	0.05	0.54
FPP (per capita) and Seat Otter Subsistence (per capita)	FPP permits used FPP permit holders # of sea otters harvested	3.73	0.05	0.59
Landings (per capita), Vessels (per capita), and Processors (per capita)	Vessels making landings # of shoreside processors receiving landings Total net pounds landed Total ex-vessel value of landings	3.43	0.05	0.64
Marine Mammal (per capita) and Salmon Subsistence (per capita)	Marine mammals harvested Subsistence salmon permits returned Marine mammal pounds harvested # of subsistence salmon harvested	3.34	0.05	0.68
Federal Crab Permits (per capita) and Beluga Subsistence (per capita)	Crab permits fished Crab permit holders Subsistence beluga harvested	2.85	0.04	0.72

Note: If "per capita" is listed next to a construct in column 1, assume all variables related to that construct are measured as such; otherwise, individual per capita variables will be listed as such in column 2.

2.1.1. Assessing external validity of the indicators

Well-being indices such as those reviewed here are only useful as long as they exhibit an acceptable amount external validity, meaning how well the indices represent the communities they measure (Jacob et al., 2013). While individual variables affecting vulnerability and well-being can often be quantified, producing a reliable composite index presents more of a challenge. Interaction between variables and how they collectively contribute to overall well-being is poorly understood, making it difficult to understand their influence on overall community well-being and vulnerability (Kelly and Adger, 2000). Moreover, it is difficult to determine what type of generalizations can be made from context-driven variables or how the insights gained can help explain how perturbations affect individual communities (Boyd and Charles, 2006). Because of this, groundtruthing is important to validate the representativeness of indices as well as formulate a context in which to apply them.

2.2. Step 2: Cluster Analysis

To begin the groundtruthing process, we developed a method to group communities based on the results of the two PCFAs conducted in Step 1. This aided in selecting a manageable sample of total communities for qualitative data collection. Moreover, we wanted a quantifiable way of assessing how characteristically distinct communities were from each other so that we did not spend limited resources visiting communities that were categorically similar. To do this, we used a non-hierarchical K-means cluster analysis technique previously tested and validated by Smith et al. (2010).

K-means cluster analysis is a popular method of grouping multivariate data through a process of maximizing between-group variability, while minimizing within-group variability. The clustering process itself used component scores derived from the transformed variables used in both the fishery and social PCFAs. Normalized component scores accounted for skew and prevented inaccurate clustering. Communities were then grouped into a fixed number of predetermined clusters. This was accomplished by analyzing overall Euclidian distance from an empirical mean of all cases (communities) and creating "seeds" based on the number of clusters desired. Communities were then assigned to their nearest seed, minimizing within-group variability (Jain, 2010; Smith et al., 2010).

Several exploratory cluster analyses were conducted using 7, 15, 20, 25, 30, and 35 clusters. The goal was to determine an appropriate number of clusters that accurately grouped communities based on our existing knowledge. While a compact and isolated cluster may make superficial sense, further investigation was required to confirm whether groups were truly clustered appropriately. To do this, we examined the PCFAs component scores in conjunction with the cluster analyses to gather a better picture of what characterized each cluster. In this case a higher score equated to a higher influence of a particular component, and vice versa. Finding a balanced number of clusters proved challenging, as a smaller number of larger clusters risked grouping communities that should not be together, while a large number of smaller clusters could overly disseminate communities, impacting their usefulness. The decision of the number of clusters to create in the analysis was reached by comparing each iteration of the cluster analysis (i.e., 7, 15, 20, 25, 30 and 35 clusters), and determining whether communities fit in their respective clusters based on a review of available literature on community characteristics, community profiles (Himes-Cornell et al., 2013), and original (untransformed) social and fishery variables (e.g., large multi-species commercial fishing communities grouped together). A degree of researcher interpretation was necessary to determine if there were any glaring errors in delineations, which might reveal data errors. Ultimately, an we decided that an analysis based on the creation of 25 clusters was most appropriate. The cluster analysis results are displayed in the Appendix A.

Using the cluster analysis results, we selected representative sample communities in which to undertake qualitative fieldwork. Sample site selection was determined according to cluster representation, as well as time and budget constraints. An attempt was made to conduct fieldwork in as many communities as possible by focusing on communities that spanned clusters but were located within a feasible geographic range. We also elected to undertake fieldwork only in clusters that were primarily influenced by some type of fishing activity (subsistence, commercial, or recreational). Each of the candidate clusters was analyzed to determine which communities were both geographically close and the most central in the cluster (as determined by Euclidean distance from its center). Ultimately, we selected a total of 13 communities for the fieldwork component, representing 11 of the 25 clusters.

2.3. Step 3: Field-based groundtruthing

We developed a fieldwork protocol using a multifaceted grounded theory approach. First, a stakeholder analysis was required to identify key informant categories to initially target (Prell et al., 2009; Reed et al., 2006). For each community selected for fieldwork, we gathered historic and contextual information as a starting point. This information was independent from the secondary data used in the creation of the quantitative well-being indices, and was based on a comprehensive search of available literature. Through this we identified expected informant types for each community, including community leaders; commercial, recreational, and subsistence fishermen; fishery support businesses; and other local businesses and services. We then compared these informant types with relevant aspects presented in the component scores of the PCFAs.

Once informant types were identified, interview topics were chosen so that we could undertake fieldwork while possessing an understanding of salient themes with which to best engage respondents. Available literature was referenced with the PCFA components to identify themes that could be used as interview prompts. Recognizing the potential for bias in the initial selection of interview topics, we included an iterative, soft systems approach to identifying additional topics while in the field (Reed et al., 2006; Mingers, 1980). Allowing informant-identified topics to emerge during the interview process and using them to further inform the interview process going forward helped correct misinterpretations made during the interview design phase.

The initial interview topics were adapted into a field protocol that guided open-ended interviews. Topics were categorized into specific key-informant protocols based on unique characteristics of groupings of informants, including commercial fishermen, recreational fishermen, subsistence fishermen, local business owners, and community leaders. In addition, we developed a general protocol that included topics to discuss in all interviews. Topics by protocol are summarized in Table 3. Interviewers were allowed a large degree of latitude when determining the flow and content of the interview. In many cases, informants were allowed to determine the direction of the interview while the interviewer posed topics ensuring that discussions addressed themes pertaining to targeted constructs and the informant's relationship with them. As the fieldwork team became more familiar with locally salient themes, questions became more adept at gathering thematically targeted perspectives while continuing to build on them. This allowed interviewers to target core themes, while continuing to use broad themes so that each informant had an opportunity to identify new ones.

Table 3.
Topics Included for Each Interview Protocol Type.

Protocol	**Interview topics**
General (short form)	• Characterizing the community • Important issues facing the community • How community has changed over the past 5-10 years • How residents get along and deal with disagreements • Strengths and weaknesses of community • Future of the community
Commercial fishing	• How and where fish are off-loaded • Fishing supplies bought in and outside community • Relationship between fishermen in community • Changes seen in fishing historically vs. today • Places or occasions where commercial fishermen and/or their families gather • Location of local commercial fishermen's official residence
Recreational fishing (charters and private anglers)	• Description of charter fishing clientele, crewmembers • Relationship between fishermen in community • How catch is used and who it is shared with • Fishing supplies bought in and outside community • Travel needed to purchase supplies • Changes seen in recreational fishing historically vs. today • Importance of recreational fishing to culture of community
Subsistence fishing	• Species caught for subsistence locally • Informant role/experience in subsistence fishing • How catch is used and who it is shared with • Distance to fishing grounds • Reason for undertaking subsistence fishing • Places or occasions where subsistence fishermen and/or their families gather • Changes seen in recreational fishing historically vs. today
Local business	• Goods and services provided or get from local fishermen • How climate change has impacted their business
City leadership	• Important sources of jobs and income in community • Importance of fishing for the economy and culture of community • Major community fishing-related events • Comparison of current fishing industry compared to historical fishing • Policies in place (at any level of government) to encourage or restrain the fishing industry • Role of climate change and fishing in the community's comprehensive plan • Expected effects of climate change on community

2.3.1. Conducting ethnographic fieldwork

Fieldwork was divided into three segments that took place between May and September 2013, with each trip lasting between 10 and 16 days. Time spent in each community was determined according to population, with larger communities receiving longer visits. Effort was made to contact key informants prior to arrival so that we would be able to become quickly oriented with fieldwork sites upon arrival. We used random sampling, purposive quota sampling and snowball sampling methods to ensure a broad spectrum of informant types were interviewed. We asked each informant interviewed through the random and purposive quota sampling techniques to recommend additional community members who would be able to provide a useful perspective.

A total of 286 (n = 286) informants were interviewed; a summary of interviews can be found in Table 5. Several protocols were administered in situations where a single informant satisfied multiple roles, resulting in an interview protocol tally exceeding the total number of informants (Table 4). Determining adequate sample size was dependent on the community being studied. For larger communities (N > 200), we attempted to interview 20-30 informants, while 10-20 interviews were attempted in communities with populations less than 200 (N < 200). These targets were reached after determining the number of respondents needed to reach content saturation, or when additional data collection failed to yield further insight, as well as taking a pragmatic view of what could be accomplished under time and resource constraints. In a review of available literature, Mason (2010) highlights the diverse opinions regarding adequate sample size, ranging from a minimum of 15 respondents, to a maximum of 30-50 for grounded theory applications. However, a range of influences affected how many interviews were attained in addition to population size. These included the availability of venues, weather, timing, community layout, and the willingness of residents to participate. Thus, in the tradition of mixed-methods pragmatism, a flexible sampling method was adopted that responded to conditions present in sample sites (Giddings and Grant, 2007).

During fieldwork, an effort was also made to assess physical assets and characteristics of a community. This included an inventory of available services and infrastructure as well as a photo survey. Some elements of community infrastructure were included in the original dataset; however, the ground assessment aided in validating data and improving quality. Photo surveys targeted elements of the community that we thought to be unique or important to its character. These included culturally defining elements (e.g. locally produced artwork, landmarks), community style or aesthetics (e.g. community centers, unique or defining architecture), fisheries-related infrastructure (e.g. harbors, docks, seafood processors), physical landscape (e.g. natural spaces, topography), and other elements that helped characterize the community (e.g. community message boards). In addition to informing and supplementing data, photo accounts aided us in assessing the overall physical condition of the community. Finally, workshops were held in communities where interest was expressed. In addition to familiarizing community members with the research, these workshops provided an opportunity to collectively discuss and refine the interview topics.

Table 4.
Total Number of Interviews Conducted across Interview Protocols and Communities.

Protocol / Community	General (short form)	Commercial fishing	Recreational fishing	Subsistence fishing	Business operation	Community leader	Total interviewed
Aleknagik	11	5	3	6	0	3	13
Dillingham	35	12	4	13	9	8	40
Kenai	13	3	0	1	6	2	15
King Salmon	14	3	8	3	4	3	14
Kodiak	44	14	2	2	9	5	49
Naknek	23	10	2	8	4	5	24
Ouzinkie	15	6	1	6	0	2	18
Port Graham	5	1	2	4	1	2	10
Port Lions	15	6	6	4	0	2	19
Sand Point	23	15	1	7	4	5	27
Seldovia	22	6	5	2	1	2	26
Soldotna	15	2	6	0	5	1	16
South Naknek	12	8	1	6	1	4	15
Total protocols administered	**247**	**91**	**41**	**62**	**44**	**44**	**286 indiv.** / **529 protocols**

Table 5.
Kappa Interpretation Scale (Landis and Koch 1977).

Kappa	Agreement
< 0	Less than chance agreement
0.01 - 0.20	Slight agreement
0.21 - 0.40	Fair agreement
0.41 - 0.60	Moderate agreement
0.61 - 0.80	Substantial agreement
0.81 - 0.99	Almost perfect agreement

2.4. Step 4: Developing comparative qualitative and quantitative rankings

2.4.1. Qualitative rankings

We ranked each of the 13 communities based on the research team's qualitative observations during fieldwork. Qualitative ranks were created based on the constructs defining each of the components in the two PCFAs (see the first column of Tables 1 and 2 for these constructs). Based on their experience conducting fieldwork, each team member independently ranked each construct using the combined interview and observational data from each community they visited. The magnitude of these ranks was categorized and coded numerically as follows: “high”=3, “medium”=2 and “low”=1. For example, if a team member perceived that a community had high levels of poverty (e.g., high unemployment, poor living conditions), than he or she would assign a rank of 3 to the corresponding “poverty” construct, and so on.

Depending on how many research team members visited each community, this method allowed for two or three independent ranks per construct per community, allowing us to compare individual observations. We analyzed these ranks using an inter-rater agreement test to understand how consistently the team members ranked the constructs. Inter-rater agreement is commonly assessed using one of the following statistical tests; percentage agreement, correlation statistics (e.g., Pearson’s *r*, Spearman’s rho), or Cohen’s kappa. Following Jacob et al. (2010, 2013), we selected a weighted Cohen’s kappa statistic $(\hat{\kappa})$ to measure the degree of consistency between the qualitative ranks of multiple team members (Cohen, 1960, 1968). This was chosen over a simple percent agreement because it produces a more conservative measurement by adjusting for agreement due to random chance. Weights were assigned depending on how far apart team members’ ranks were, with less weight given to pairings that were farther apart. Rather than simply testing for perfect agreement, this allowed us to incorporate a degree of agreement which is useful when considering the subjective nature of qualitative ranking (Viera and Garret, 2005).

The weighted Cohen's kappa comparing two individual raters (referred to above as team members) is calculated by taking percentage of observed agreement (P_a) and subtracting expected random chance agreement (P_e), divided by 1 minus expected random chance agreement, such that:

$$\hat{\kappa} = \frac{P_a - P_e}{1 - P_e}. \tag{1}$$

As there are three categories (k=3) that a rater can choose (high, medium, low), agreement is weighted among raters based on their strength of agreement using:

$$\omega_{ij} = 1 - \left(\frac{|i - j|}{k - 1} \right) \tag{2}$$

where i and j index the scores (high=3, medium=2, low=1) for raters 1 and 2 respectively. Perfect agreement (e.g. high/high) was assigned a weight of 1, partial agreement (e.g. high/medium) was assigned a weight of .50, and poor agreement (low/high) was assigned a weight of 0. This allowed for the inclusion of partial agreements when they otherwise would have been excluded. The percentage of observed agreement is:

$$P_a = \sum_{i=1}^{k} \sum_{j=1}^{k} \omega_{ij} p_{ij}, \tag{3}$$

where p_{ij} is the percentage of ratings i by rater 1 and j by rater 2 (Fleiss, Levin, and Paik 2003). The expected random change agreement is:

$$P_e = \sum_{i=1}^{k} \sum_{j=1}^{k} \omega_{ij} p_{i.} p_{.j}, \tag{4}$$

where $p_{i.} = \sum_j p_{ij}$ and $p_{.j} = \sum_i p_{ij}$.

For each community, each team member's qualitative ranks were compared against each other using this weighted kappa to produce a measure referred to as "inter-observer reliability." Since Cohen's kappa is a two-rater test, it was performed two to three times for each community depending on how many team members were at a given site. If observers were not in adequate agreement, then results from the following external validity test for that community were determined as inconclusive due to poor reliability of qualitative observations. To be considered adequate, an average kappa of at least .20 was required across pairs of observers. Landis and Koch (1977) provide a useful scale for kappa interpretation in which a kappa of .20 or greater signifies an acceptable amount of agreement (Table 5). In addition, results from at least one test required a probability score under .05 to reject the null hypothesis, which was that observed agreement was likely due to random chance alone. With relatively few sets of observations to compare, at least one test of team member agreement had to produce significant results for an average kappa to be accepted and used in Step 5. Justification for this is based on the fact that with fewer observations, each observer carries more weight. For example, in cases where there were three sets of observations, one significant result accounted for 66% of observations (or 2 out of 3 observers). Finally, we tested how consistently the team members were cognitively framing each of the individual constructs across communities. We conducted a construct reliability test for each individual construct, as opposed to each sample community (as described above). Again, we calculated a weighted Cohen's kappa based on paired ranks provided by each researcher. In this analysis, constructs were the unit of analysis instead of communities, and the same acceptance parameters were used for the kappa as for the previous tests. This test allowed us to determine whether it was appropriate to perform the external validity test in Step 5 (below). If team members were conceptualizing constructs (e.g., poverty) in ways that were incommensurable, then it may not be appropriate to use these qualitative rankings in the analysis.

2.4.2. Quantitative rankings

Quantitative components had to also be ranked so that they could be compared against qualitative constructs. However, the ranking processes differed in that it was not based on interview data and team member experience. Instead, it based on component scores derived from the PCFA. As previously mentioned, each component score represents a relative magnitude of influence a component has within a community. A simple max-min is determined to provide a range of scores from which to assign ranks. Following the magnitude scale used for the qualitative constructs, the well-being index component scores for each community were again ranked “high”=3, “medium”=2, or “low”=1. Many component scores were skewed towards -1; therefore, we used a Jenks natural breaks classification method to prevent a misleading number of communities assigned with “low” ranks across components (ESRI, 2011). This method is similar to a single dimension K-means cluster analysis, assigning component scores to the three possible ranking groups based both on their magnitude and their relationship to each other.

2.5. Step 5: Statistical assessment of external validity

Using Stata statistical software (StataCorp, 2011), multiple two-rater weighted kappa tests were performed on all 13 sample communities. To examine the external validity of the well-being indices, we examined agreement between quantitative and qualitative ranks by measuring inter-rater agreement with a weighted Cohen's kappa test (Jacob et al., 2010; Jacob et al., 2013). Like inter-observer agreement, this measured the degree to which two observations converged on a single conclusion (McHugh, 2012). However, instead of measuring agreement between team member's rankings, we used this test to compare each team member's qualitative ranks with the communities' corresponding quantitative ranks in order to measure how well they reflect reality. Again, acceptable inter-observer agreement had to have been reached in order for this test to proceed. As with the previous test, if at least one test result was significant then the kappas from each test for that community were averaged to create a single composite kappa (Conger, 1980). This averaged kappa was then compared against the Landis and Koch scale (Table 5) in order to determine the validity of the well-being index associated with it. This scale allowed us to determine the degree of representativeness a particular index possessed, and communities with an average kappa score below .20, or tests resulting in P-scores at or above .05, were determined as having indices with poor or questionable external validity. This method adopts a slightly different approach than the inter-observer reliability test in that insignificant results do not automatically discount the external validity test for that community (Table 6). This is due to the assertion that if team members were in acceptable agreement, than their observations of reality are accurate thus negating the difference between poor agreement and agreement due to random chance.

Table 6.
Results of Inter-Observer Reliability and External Validity Tests.

Inter-observer reliability test			***External validity test***		
Community	**Average Kappa**	**P < .05***	**Average Kappa**	**P < .05***	**Result**
South Naknek	0.5959	Yes	0.11	Yes	Poor External Validity
Soldotna	0.5056	Yes	0.44	Yes	Moderate External Validity
Seldovia	0.2083	No	-0.20	Yes	Inconclusive
Sand Point	0.3638	Yes	0.41	Yes	Moderate External Validity
Port Lions	0.3982	Yes	0.11	No	Poor External Validity
Port Graham	0.7121	Yes	0.34	Yes	Fair External Validity
Ouzinkie	0.5552	Yes	0.21	No	Poor External Validity
Naknek	0.2294	Yes	0.15	No	Poor External Validity
Kodiak	0.6154	Yes	0.06	No	Poor External Validity
King Salmon	0.4526	Yes	0.37	Yes	Fair External Validity
Kenai	0.2091	Yes	0.32	Yes	Fair External Validity
Dillingham	0.0796	Yes	0.06	No	Inconclusive
Aleknagik	0.5291	Yes	0.36	Yes	Fair External Validity

* *P-values were not averaged. If at least one test produced a significant result of P < .05, then the corresponding kappa was accepted.*

3. Results

Confidence in the results of the external validity tests relies on two assumptions: 1) the ontological assumption that there is a measurable objective reality that is dictated by interactions of actors within their SES (Charmaz, 2008); and 2) that our observations of that reality are more accurate than index conclusions. While quantitative data is objective in that is has been standardized and strictly defined, our observations, and those of interviewees, are grounded in subjective experience (Mills et al., 2006). While this can lead to struggles when reconciling qualitative and quantitative data, verification of observations via inter-rater agreement tests, such as the one used here, can help increase confidence that those observations are grounded in reality as long as we accept that multiple descriptions of phenomena can exist without being in contradiction (Heath and Cowley, 2004).

The results of the inter-observer reliability and final external validity tests are found in Table 6. Two communities, Seldovia and Dillingham, failed to produce significant results in either or both of the inter-observer reliability and external validity tests, and were given inconclusive designations. Five communities, Kodiak, Naknek, Ouzinkie, Port Lions, and South Naknek, exhibited poor external validity either due to low average kappa or high probability of agreement being attributed to random chance. Six communities, Aleknagik, Kenai, King Salmon, Port Graham, Sand Point, and Soldotna, exhibited fair or higher external validity, resulting from a significant kappa of .20 or greater.

While inter-observer reliability was tested for, there was still the possibility that individual team members were conceptualizing constructs inconsistently, meaning that they may not have been cognitively framing constructs in ways that were compatible with each other or in relation to the well-being indices, resulting in incommensurable ranks. Each team member was tested for reliability of their conceptualization of each construct across each sample community (Table 7). In theory, if team members were conceptualizing constructs in ways consistent with each other, then very little variation would be seen when comparing team member agreement on that construct across each community. For example, if team members A and B both agreed that poverty was low in community X, then they should be able to apply that same assessment criteria when observing conditions of poverty in community Y. However, if while in community Y, team member A assigns a rank of low, while team member B assigns a rank of high, then there is a breakdown of conceptual consistency and we must re-examine how we are framing poverty. Overall, construct framing was fairly consistent (Table 7). Of the 19 constructs, only two were considered inconclusive ($p < 0.05$); low female workforce and salmon subsistence. Of the average kappa values that produced significant results, only beluga harvesting had a kappa that fell below 0.20 and was determined to have slight agreement. By assessing these results, we can determine constructs that may warrant further investigation in terms of how we are defining them. Ultimately, constructs with slight or inconclusive agreement may impact results of the inter-observer reliability tests by confusing real world conditions with team members' personal interpretation of those conditions (Table 6). Therefore, this test can act as an initial diagnostic of the overall method by highlighting differences in the cognitive processes that provide the foundation for qualitative ranking.

Table 7.
Results of the Construct Reliability Test.

	P < .05*	**Average kappa**	**Rank**
Social construct			
Community Size	Yes	0.42	Moderate Agreement
Infrastructure	Yes	0.52	Moderate Agreement
Rural/Village Character	Yes	0.74	Substantial Agreement
Poverty	Yes	0.48	Moderate Agreement
Transient Population	Yes	0.31	Fair Agreement
Foreign Born Asian Population	Yes	0.55	Moderate Agreement
Retirees	Yes	0.22	Fair Agreement
Low Female Workforce	No	-0.04	Inconclusive
Fisheries involvement construct			
Fishery Participation	Yes	0.52	Moderate Agreement
Crab, AFA, and FPP	Yes	0.42	Moderate Agreement
Sportfishing	Yes	0.37	Fair Agreement
Processor Activity	Yes	0.62	Substantial Agreement
Sea Otter Harvesting	Yes	0.26	Fair Agreement
Perceived Amount of Landings	Yes	0.75	Substantial Agreement
Vessels Located in Community	Yes	0.51	Moderate Agreement
Marine Mammal Harvesting	Yes	0.24	Fair Agreement
Salmon Subsistence	No	-0.05	Inconclusive
Number of Crab Permits	Yes	0.36	Fair Agreement
Beluga Harvesting	Yes	0.19	Slight Agreement

* *P-values were not averaged. If at least one test produced a significant result of $P < .05$, then the corresponding kappa was accepted.*

4. Discussion

The methods described here aim to establish a rapid assessment methodology to compare qualitative constructs derived from groundtruthing fieldwork with quantitative well-being constructs derived from indices. Ultimately, the results gave a mixed impression of index validity as a measure of community vulnerability. We have found that vulnerability is very place-specific, despite our efforts to design a generalized measure of vulnerability. Vulnerability is nuanced and it appears that broadly applied metrics may not adequately describe conditions that are place-specific in scale. This does not necessarily negate the usefulness of these metrics, but helps us identify components that fall short when applied broadly, as well as those which do not. Moreover, this form of rapid assessment allows researchers to not only address concerns of external validity, but target areas where additional research effort is needed. This could include additional fieldwork in a community or representative cluster of communities, or modification of a particular construct so that it may better measure community vulnerability.

During the groundtruthing process, challenges and limitations emerged throughout each phase. These limitations and caveats must be addressed in order to better understand the methodology's strengths and weaknesses. Overall, time and resources available presented the largest challenge to conducting fieldwork in each location. Depending on respondents' willingness to participate, it was sometimes difficult to build rapport when time in a community was limited. Some respondents distrusted the team member's motivations or were hesitant or unwilling to converse with us regarding subjects that they found sensitive. Others would only allow us limited access to their perspectives, sometimes cutting interviews short. While these challenges were present in most communities, they were manageable and did not inhibit our ability to conduct research in any of the sample sites. However, inconclusive results in some communities may have been due to data limitations. Thus, if possible, it may be beneficial to focus future fieldwork on communities where data were absent or underrepresented. The complexity of the process was of concern as well, and it was often challenging for two to three researchers to conduct interviews using an iterative and adaptive process while maintaining consistent interview styles, especially given the semi-structured nature of the interviewing methodology. However, this is a trade-off we wanted to make in order to take advantage of interviewee experiences that were slightly tangential to our formal interview topics. While research conditions at times were less than ideal, pragmatism dictated that research should be adaptive and flexible, working with what is available to produce the best possible results (Giddings and Grant, 2007; Glaser, 1992; Heath and Cowley, 2004).

Interpreting results from the PCFAs also produced challenges for ranking qualitative constructs. In several instances latent components that emerged were influenced by redundant or seemingly unrelated variables. Because of this, some components either seemed duplicative (e.g., “crab, American Fisheries Act, and Federal Processing Permits” and “number of crab permits” constructs; refer to Table 2), or were difficult to separate from each other for the purpose of qualitative ranking or to observe during fieldwork (e.g., “retirees/low female workforce;” refer to Table 1). Interpreting factor loadings presented a unique challenge when seemingly disparate variables combined into the same component. In addition, it was difficult to categorize components into constructs in ways that would be easily discernible in the field. We dealt with these challenges by categorically separating such components into two constructs before ranking them as qualitative constructs (e.g., separating “retirees” from “low female workforce”). When the time came to compare qualitative and quantitative ranks from each individual researcher, the constructs were condensed back to their original components using a simple modal response method similar to that used by Jacob et al. (2013). This conservative approach allowed for identical ranks for each construct to be preserved, while those that differed regressed to a more neutral rank. For example, if a researcher gave a ranking of “high,” or “medium” to the “retirees” qualitative construct, and ranking of “low” for the “low female workforce” qualitative construct, then the condensed qualitative rank of “medium” would be used for comparison with the quantitative component.

In terms of the construct reliability test, results were encouraging considering that team members, in the interest of staying as independent as possible, purposefully held very little discussion regarding how to frame the constructs prior to ranking. Constructs that tested either as not reliable or inconclusive were also among those concepts that were the hardest to distinguish based on visual inspection of the community and/or may have only been recorded as a interview topic by a single interviewer (or none at all). Identifying potential weaknesses and strengths in qualitative observations allowed us to identify which constructs may need additional framing and refining, while also providing appropriate caveats to results. While identifying three inconsistently framed constructs helps us better calibrate our methods, the presence of inconsistent constructs does not discredit results of the other tests since the majority of constructs were found to be reliable. Moreover, identifying problematic constructs may provide important context when looking at external validity because it can challenge positivist assumptions pertaining to observations, at least in relation to those constructs. Conversely, inconsistencies may reflect insufficient qualitative data, which would support additional scrutiny when providing context to the indices, as well as warrant further study into those particular areas.

For example, team member A may have given a rank of 2 to beluga subsistence in Aleknagik based on interviews with residents who described belugas traveling up the Wood River, while team member B may not have interviewed anyone who described belugas as being an important subsistence resource, thus giving a rank of 1. This shows how agreement can hinge on the quality of interviews and emphasizes how important reaching a saturation point is for gathering reliable qualitative data. The point at which qualitative data has reached a point of saturation is often determined during the coding process (Guest et al., 2006), although it can also be assessed while in the field with a priori codes. In addition, within the context of construct ranking, it can be assumed that highly salient themes have a better chance of emerging during interviews; therefore frequency and detail of those themes can be used as a barometer for relative importance in the community. Returning to the beluga subsistence example, if beluga subsistence is truly important to Aleknagik as a whole, then the chance of beluga harvesting being mentioned during interviews is increased by virtue of it being a salient theme. As long as there is an adequate sample size, then it can be determined that relative importance is tied to how often the topic is introduced. Taking into account the inter-observer reliability test, this means that team member A's rank of 2 and team member B's rank of 1 are in fact both an accurate reflection of reality (again assuming that multiple descriptions of phenomena can exist without being in contradiction).

While this test offered reassurance that constructs were being framed in similar ways, it did not account for the larger issue of whether or not team members were framing constructs in ways compatible with the well-being indices overall. This issue arises from the fact that while component scores were ranked in relation to all 284 communities used in the PCFA (Methods Step 1), the reference scale available to team members was limited only to the communities they visited. Control for this is then dependent on how representative community clusters are (Methods Step 2), as well as the number of clusters visited during fieldwork (Methods Step 3). Since only 11 out of 25 clusters were visited, such potential impacts on testing external validity (Methods Steps 4 and 5) must be recognized.

5. Conclusions

Groundtruthing methods such as those used in this study are important in that they create meaning and context which can be applied to indices such as those developed for measuring community vulnerability. Our research has affirmed that it is not enough to simply create an index of well-being, since that index requires place-specific meaning if it is to be used in explaining real-world phenomena or projecting community-based responses to SES-directed perturbations. Moreover, a detailed exploration of how qualitative constructs link broadly derived indices with more nuanced characteristics found in individual communities can assist in determining the usefulness of such indices as a management tool.

A mixed methods data collection technique, coupled with the rapid qualitative ranking method presented here serves as an important first step in helping researchers gather a foundational understanding of the external validity of quantitative community well-being indices. To summarize the benefits, the method first reveals instances in which well-being indices may have been inadequate at describing local conditions related to vulnerability and resilience. Although results from seven of the thirteen communities exhibited poor or inconclusive external validity that does not necessarily provide conclusive evidence that the method used in building the indices are inherently flawed. Communities are diverse and making generalizations on a macro scale is difficult. A variable that may be acceptable in a well-being index for one community may not be acceptable for another. The rapid assessment methodology outlined in this paper allows researchers to identify strengths and weaknesses within the indices themselves, and thus direct efforts towards uncovering why an index worked for one community, but not another. Second, it sets the stage for further index confirmation through detailed content analysis of qualitative interview data collected during fieldwork. To provide better confirmation of external validity and context for interpretation of the well-being indices, future work should include an intensive content analysis of transcripts and field notes. A rapid assessment such as the one detailed here will support that process through identifying constructs that were both contentious among the research team members, and poorly understood in terms of their relationship to the indices. Overall, this rapid assessment allows researchers to critique how well-being indices reflect individual communities, and perhaps predict their validity within a larger cluster of related communities. It is a way of applying well-being indices to a place-based community, and sets the stage for further inquiry into how phenomena within a community relate to constructs embedded within the indices themselves. This method also stresses the importance of groundtruthing quantitative indices so they may be better calibrated to reflect the communities they seek to measure.

References

Adger, W. N. (1999). Social vulnerability to climate change and extremes in coastal Vietnam. *World Development, 27*(2), 249-269.

Adger, W. N. (2000). Social and ecological resilience: are they related? *Progress in Human Geography, 24*(3), 347-364.

Adger, W. N. (2003). Social capital, collective action, and adaptation to climate change. *Economic Geography, 79*(4), 387-404.

Ainuddin, S., & Routray, J. K. (2012). Community resilience framework for an earthquake prone area in Baluchistan. *International Journal of Disaster Risk Reduction.* (In Press). Retrieved from www.elsevier.com/locate/ijdrr.

Alaska Commercial Fisheries Entry Commission. (2011). Alaska commercial fishing permits, permit holders, and vessel licenses, 2000 – 2010. Data compiled by Alaska Fisheries Information Network for Alaska Fisheries Science Center, Seattle. [URL not publicly available as some information is confidential.]

Alaska Department of Communiy and Regional Affairs. (n.d.). *Community Database Online.* Retrieved from http://commerce.state.ak.us/cra/DCRAExternal.

Alaska Department of Fish and Game. (2011a). Alaska sport fish and crew license holders, 2000 – 2010. ADF&G Division of Administrative Services. Data compiled by Alaska Fisheries Information Network for Alaska Fisheries Science Center, Seattle. [URL not publicly available as some information is confidential.]

Alaska Department of Fish and Game. (2011b). Data on Alaska fish processors. ADF&G Division of Commercial Fisheries. Data compiled by Alaska Fisheries Information Network for Alaska Fisheries Science Center, Seattle. [URL not publicly available as some information is confidential.]

Alaska Commercial Fisheries Entry Commission. (2015). Alaska fish ticket data. Data compiled by Alaska Fisheries Information Network for Alaska Fisheries Science Center, Seattle. [URL not publicly available as some information is confidential.]

Alaska Department of Labor and Workforce Development. (n.d.). *Alaska Local and Regional Information Network.* Retrieved from http://live.laborstats.alaska.gov/alari/.

Alaska Department of Education and Early Development. (n.d.). *Statistics and Reports.* Retrieved from http://eed.alaska.gov/stats/.

Alaska Fisheries Information Network. (n.d.). *AKFIN Answers.* Retrieved from www.akfin.org.

Allison, E. H., & Ellis, F. (2001). The livelihoods approach and management of small-scale fisheries. *Marine Policy, 25,* 377-388.

Allison, E. H., Perry, A. L., Badjeck, M. C., Adger, W. N., Brown, K., Conway, D., . . . Dulvy, N. K. (2009). Vulnerability of national economies to the impacts of climate change on fisheries. *Fish and Fisheries, 10,* 173-196.

Armitage, D., Bene, C., Charles, A. T., Johnson, D., & Allison, E. H. (2012). The interplay of well-being and resilience in applying a social-ecological perspective. *Ecology and Society, 17*(4), 1-15. Retrieved from http://www.ecologyandsociety.org/vol17/iss4/art15/.

Ban, N. C., Mills, M., Tam, J., Hicks, C. C., Klain, S., Stoeckl, N., . . . Chan, K. M. A. (2013). A social-ecological approach to conservation planning: Embedding social considerations. *Frontiers in Ecology.* Retrieved from http://www.centerforoceansolutions.org/sites/default/files/publications/Ban%20et%20al%202013.pdf.

Berkes, F., & Jolly, D. (2001). Adapting to climate change: Social-ecological resilience in Canadian western arctic community. *Conservation Ecology, 5*(2), 18-32.

Berkes, F., & Folke, C. (1998). Linking social and ecological systems for resilience and sustainability. In F. Berkes & C. Folke (Eds.), *Linking Social and Ecological Systems* (1-25). Cambridge: Cambridge University Press.

Biedenweg, K., Hanein, A., Nelson, K., Stiles, K., Wellman, K., Horowitz, J., & Vynne, S. (2014). Developing human wellbeing indicators in the Puget Sound: Focusing on the watershed scale. *Coastal Management, 42*(4), 374-390.

Boyd, H., & Charles, A. (2006). Creating community-based indicators to monitor sustainability of local fisheries. *Ocean and Coastal Management, 49*, 237-258.

Britton, E., & Coulthard, S. (2013). Assessing the social wellbeing of Northern Ireland's fishing society using a three-dimensional approach. *Marine Policy, 37,* 28-36.

Brookfield, K., Gray, T., & Hatchard, J. (2005). The concept of fisheries-dependent communities. A comparative analysis of four UK case studies: Shetland, Peterhead, North Shields and Lowestoft. *Fisheries Research, 72,* 55-69.

Charmaz, K. (2008). Constructionism and the Grounded Theory. In J. A. Holstein and J. F. Gubrium (Eds.), *Handbook of Constuctionist Research* (397-412). New York: The Guilford Press.

Clay, P. M., & McGoodwin, J. R. (1995). Utilizing social sciences in fisheries management. *Aquatic Living Resources 8*(3), 203-207.

Cohen, J. (1960). A coefficient of agreement for nominal scales. *Educational and Psychological Measurement, 20,* 37–46.

Cohen, J. (1968). Weighted kappa: Nominal scale agreement with provision for scaled disagreement or partial credit. *Psychological Bulletin, 70,* 213–220.

Colburn, L. L., & Jepson, M. (2012). Social indicators of gentrification pressure in fishing communities: A context for social impact assessment. *Coastal Management, 40*(3), 289-300.

Colburn, L. L., Abbott-Jamieson, S., & Clay, P. M. (2006). Anthropological applications in the management of federally managed fisheries: Context, institutional history, and prospectus. *Human Organization, 65*(3), 231-239.

Conger, A. J. (1980). Integration and generalization of kappas for multiple raters. *Psychological Bulletin, 88,* 322-328.

Corbin, J. M., & Strauss, A. (1990). Grounded Theory research: Procedures, canons, and evaluative criteria. *Qualitative sociology, 13*(1), 3-21.

Creswell, J. W. (2003). *Research design: Qualitative, quantitative and mixed methods approaches* (2nd ed.). Thousand Oaks: Sage Publications.

Creswell, J. W., Klassen, A. C., Plano-Clark, V. L., and Smith, K. C. (2011). *Best practices for mixed methods research in the health sciences.* Bethesda: National Institutes of Health.

Criddle, K. R. (2012). Adaptation and maladaptation: Factors that influence the resilience of four Alaskan fisheries governed by durable entitlements. *Marine Science, 69*(7), 1168-1179.

Diener, E., Suh, E. M., Lucas, R. E., & Smith, H. L. (1999). Subjective well-being: Three decades of progress. *Psychological Bulletin, 125*(2), 276-302.

ESRI. (2011). ArcGIS Desktop: Release 10. Redlands, CA: Environmental Systems Research Institute.

Fleiss, J. L., Levin, B., & Paik. M. C. (2003). *Statistical methods for rates and proportions*. (3rd ed.). New York: Wiley.

Folke, C. (2006). Resilience: The Emergence of a perspective for social-ecological systems analysis. *Global Environmental Change, 16,* 253-267.

Folke, C., Carpenter, S., Walker, B., Scheffer, M., Elmqvist, T., Gunderson, L., & Holling, C. S. (2004). Regime shifts, resilience, and biodiversity in ecosystem management. *Annual Review of Ecology, Evolution, and Systematics*, 35, 557-581.

Folke, C., Hahn, T.; Olsson, P., & Norberg, J. (2005). Adaptive governance of social-ecological systems. *Annual Reviews Environmental Resources, 30,* 441-473.

Giddings, L. S., & Grant, B. M. (2007). A Trojan horse for positivism? A critique of mixed methods research. *Advances in Nursing Science, 30*(1), 52-60.

Glaser, B. (1992). *Basics of grounded theory analysis: Emergence vs. forcing*. Mill Valley, CA: Sociology Press.

Glaser, B. (2002). Constructivist Grounded Theory? *Forum: Qualitative Social Research, 3*(3), Art. 12, Retrieved from http://nbn-resolving.de/urn:nbn:de:0114-fqs0203125.

Guest, G., Bunce, A., & Johnson, L. (2006). How many interviews are enough? An experiment with data saturation and variability. *Field Methods, 18,* 59-82.

Gunderson, L.H., & Holling, C.S. (Eds.). (2002). *Panarchy: Understanding Transformations in Human and Natural Systems*. Washington, D.C.: Island Press.

Healey, M. C. (2009). Resilient salmon, resilient fisheries for British Columbia, Canada. *Ecology and Society, 14*(1), 2.

Heath, H., & Cowley, S. (2004). Developing a grounded theory approach: a comparison of Glaser and Strauss. *International Journal of Nursing Studies, 41*, 141-150.

Himes-Cornell, A. & Hoelting, K. (2015). Resilience strategies in the face of short and long-term change: Outmigration and fisheries regulation in Alaska fishing communities. *Ecology and Society, 20*(2), 9.

Himes-Cornell, A., Hoelting, K., Maguire, C., Munger-Little, L., Lee, J., Fisk, J., . . . Little, P. (2013). *Community profiles for North Pacific Fisheries – Alaska.* U.S. Department of Commerce, NOAA Tech. Memo. National Marine Fisheries Service-AFSC-259, Volumes 1-12.

Himes-Cornell, A., & Kasperski, S. (2015a). Assessing climate change vulnerability in Alaska's fishing communities. *Fisheries Research*, *162*, 1-11.

Himes-Cornell, A., & Kasperski, S. (2015b). *Using socio-economic and fisheries involvement indices to better understand Alaska fishing community well-being.* Manuscript submitted for publication.

Holling, C. S. (1973). Resilience and stability of ecological systems. *Annual Reviews of Ecological Systems, 4,* 1-23.

Holling, C.S., & Gunderson, L.H. (2002). Resilience and adaptive cycles. In L. H. Gunderson & C. S. Holling (Eds.), *Panarchy: Understanding transformations in human and natural systems* (25-62). Washington: Island Press.

Imperial, M. T., & Yandle, T. (2005). Taking institutions seriously: Using the IAD framework to analyze fisheries policy. *Society and Natural Resources, 18,* 493-509.

Jacob, S., Weeks, P., Blount, B. G., & Jepson, M. (2010). Exploring fishing dependence in Gulf Coast communities. *Marine Policy*, *34*(6), 1307-1314.

Jacob, S., Weeks, P., Blount, B. G., & Jepson, M. (2013). Development and evaluation of social indicators of vulnerability and resiliency for fishing communities in the Gulf of Mexico. *Marine Policy*, *37*, 86-95.

Jain, A. K. (2010). Data clustering: 50 years beyond k-means. *Pattern Recognition Letters*, *31*(8), 651-666.

Jentoft, S. (2006). Beyond fisheries management: The Phronetic dimension. *Marine Policy, 30,* 671-680.

Jepson, M., & Colburn, L. L. (2013). Development of social indicators of fishing community vulnerability and resilience in the US Southeast and Northeast regions. US Department of Commerce, NOAA Technical Memorandum NMFS-F/SPO-129, 64p.

Jepson, M. & S. Jacob. (2007). Social indicators and measurements of vulnerability for Gulf Coast fishing communities. *NAPA Bulletin*, *28*, 57-68.

Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed methods research: A research paradigm whose time has come. *Educational Researcher, 33*(7), 14-26.

Johnson, R. B., Onwuegbuzie, A. J., & Turner, L. A. (2007). Toward a definition of mixed methods research. *Journal of Mixed Methods Research, 1*(2), 112-133.

Kelly, P. M., & Adger, W. N. (2000). Theory and practice in assessing vulnerability to climate change and facilitating adaptation. *Climatic Change*, *47*(4), 325-352.

Keyes, C. L. M. (1998). Social well-being. *Social Psychology Quarterly, 61*(2), 121-140.

Landis, J. R., & Koch, G. G. (1977). The measurement of observer agreement for categorical data. *Biometrics*, 159-174.

Lowe, M. E. (2008). Crab rationalization and potential community impacts of vertical integration in Alaska's fisheries. In M. E. Lowe, & C. Carothers (Eds.), *Enclosing the fisheries: People, places, and power*. Symposium 68. Bethesda, MD: American Fisheries Society.

Luna-Reyes, L. F., & Andersen, D. L. (2003). Collecting and analyzing qualitative data for system dynamics: Methods and models. *System Dynamics Review, 19*(4), 271-296.

Magnuson-Stevens Fishery Conservation and Management Act of 2007. § 301, 16 U.S.C. § 1851 (2007).

Marshall, N. A., & Marshall, P. A. (2007). Conceptualization and operationalizing social resilience within commercial fisheries in northern Australia. *Ecology and Society, 12*(1), 1. Retrieved from: http://www.ecologyandsociety.org/vol12/iss1/art1/.

Martin, I. E. (2008). Resilience in Lower Columbia River Salmon Communities. *Ecology and Society*, *13*(2), 23.

Martin-Breen, P., & Anderies, J. M. (2011). *Resilience: A literature review*. The Rockefeller Foundation. Retrieved from http://www.rockefellerfoundation.org/blog/resilience-literature-review.

Mason, M. (2010). Sample size and saturation in PhD studies using qualitative interviews. *Forum: Qualitative Research, 11*(3). Retrieved from http://www.qualitative-research.net/index.php/fqs/article/view/1428/3027.

McGinn, T., Wyer, P. C., Newman, T. B., Keitz, S., & Leipzig, R. (2004). Tips for learners of evidence-based medicine: 3 Measures of observer variability (kappa statistic). *Canadian Medical Association Journal, 171*(11), 1369-1373.

McHugh, M. L. (2012). Interrater reliability: The kappa statistic. *Biochemia Medica*, *22*(3), 276-282.

Miller, F., Osbahr, H., Boyd, E., Thomalla, F., Bharwani, S., Ziervogel, G., . . . Nelson, D. (2010). Resilience and vulnerability: Complementary or conflicting concepts? *Ecology and Society*, *15*(3), 11. Retrieved from http://www.ecologyandsociety.org/vol15/iss3/art11/.

Mills, J., Bonner, A., & Francis, K. (2006). The Development of constructivist grounded theory. *International Journal of Qualitative Methods*, *5*(1), 25-35.

Mingers, J. (1980). Towards an appropriate social theory for applied systems thinking: critical theory and soft systems methodology. *Journal of Applied Systems Analysis*, *7*, 41-50.

Morzaria-Luna, H. N., Turk-Boyer, P., & Moreno-Baez, M. (2013). Social indicators of vulnerability for fishing communities in the northern Gulf of California, Mexico: Implications for climate change. *Marine Policy.* Retrieved from http://dx.doi.org/10.1016.2013.10.013.

National Marine Fisheries Service. (2011a). Alaska Individual Fishing Quota (IFQ) permit data. NMFS Alaska Regional Office. Data compiled by Alaska Fisheries Information Network for Alaska Fisheries Science Center, Seattle. [URL not publicly available as some information is confidential.]

National Marine Fisheries Service. (2011b). Data on Limited Liability Permits, Alaska Federal Processor Permits (FPP), Federal Fisheries Permits (FFP), and Permit holders. NMFS Alaska Regional Office. Data compiled by Alaska Fisheries Information Network for Alaska Fisheries Science Center, Seattle. [URL not publicly available as some information is confidential.]

Norris, F. H., Stevens, S. P., Pfefferbaum, B., Wyche, K. F., & Pfefferbaum, R. L. (2008). Community resilience as a metaphor, theory, set of capacities, and strategy for disaster readiness. *American Journal of Community Psychology*, *41*, 127-150.

Prell, C., Hubacek, K., & Reed, M. (2009). Stakeholder analysis and social network analysis in natural resource management. *Society and Natural Resources*, *22*(6), 501-518.

Reed, M. S., Fraser, E. D., & Dougill, A. J. (2006). An adaptive learning process for developing and applying sustainability indicators with local communities. *Ecological Economics*, *59*(4), 406-418.

Sepez, J., Norman, K., Poole, A., & Tilt, B. (2006). Fish scales: scale and method in social science research for North Pacific and west coast fishing communities. *Human Organization*, *65*(3), 280-293.

Smit, B. & Wandel, J. (2006). Adaptation, adaptive capacity, and vulnerability. *Global Environmental Change, 16,* 282-292.

Smith, S. L., Pollnac, R. B., Colburn, L. L., & Olson, J. (2011). Classification of coastal communities reporting commercial fish landings in the US Northeast region: Developing and testing a methodology. *Marine Fisheries Review*, *73*(2), 41-61.

StataCorp. 2011. *Stata Statistical Software: Release 12*. College Station, TX: StataCorp LP.

Turner, B. L., Kasperson, R. E., Matson, P. A., McCarthy, J. J., Corell, R. W., Christensen, L., . . . Schiller, A. (2003). A framework for vulnerability analysis in sustainability science. *Proceedings of the National Academy of Sciences*, *100*(14), 8074-8079.

U.S. Census Bureau. (n.d.). 2009 American Community Survey 5-Year Estimates, Tables DP02, DP03, DP04, and DP05. Generated using American FactFinder. Retrieved from http://factfinder2.census.gov.

Viera, A. J., & Garrett, J. M. (2005). Understanding interobserver agreement: The kappa statistic. *Family Medicine. 37*(5), 360-363.

Walker, B., Holling, C. S., Carpenter, S. R., & Kinzig, A. (2004). Resilience, adaptability and transformability in social-ecological systems. *Ecology and Society*, *9*(2), 5.

COMPREHENSIVE REFERENCES

Adger, W. N. (1999). Social vulnerability to climate change and extremes in coastal Vietnam. *World Development, 27*(2), 249-269.

Adger, W. N. (2000). Social and ecological resilience: are they related? *Progress in Human Geography, 24*(3), 347-364.

Adger, W. N. (2003). Social capital, collective action, and adaptation to climate change. *Economic Geography, 79*(4), 387-404.

Ainuddin, S., & Routray, J. K. (2012). Community resilience framework for an earthquake prone area in Baluchistan. *International Journal of Disaster Risk Reduction.* (In Press). Retrieved from www.elsevier.com/locate/ijdrr.

Alaska Commercial Fisheries Entry Commission. (2011). Alaska commercial fishing permits, permit holders, and vessel licenses, 2000 – 2010. Data compiled by Alaska Fisheries Information Network for Alaska Fisheries Science Center, Seattle. [URL not publicly available as some information is confidential.]

Alaska Department of Communiy and Regional Affairs. (n.d.). *Community Database Online.* Retrieved from http://commerce.state.ak.us/cra/DCRAExternal.

Alaska Department of Fish and Game. (2011a). Alaska sport fish and crew license holders, 2000 – 2010. ADF&G Division of Administrative Services. Data compiled by Alaska Fisheries Information Network for Alaska Fisheries Science Center, Seattle. [URL not publicly available as some information is confidential.]

Alaska Department of Fish and Game. (2011b). Data on Alaska fish processors. ADF&G Division of Commercial Fisheries. Data compiled by Alaska Fisheries Information Network for Alaska Fisheries Science Center, Seattle. [URL not publicly available as some information is confidential.]

Alaska Department of Fish and Game, and Alaska Commercial Fisheries Entry Commission. (2015). Alaska fish ticket data. Data compiled by Alaska Fisheries Information Network for Alaska Fisheries Science Center, Seattle. [URL not publicly available as some information is confidential.]

Alaska Department of Labor and Workforce Development. (n.d.). *Alaska Local and Regional Information Network.* Retrieved from http://live.laborstats.alaska.gov/alari/.

Alaska Department of Education and Early Development. (n.d.). *Statistics and Reports.* Retrieved from http://eed.alaska.gov/stats/.

Alaska Fisheries Information Network. (n.d.). *AKFIN Answers.* Retrieved from www.akfin.org.

Allison, E. H., & Ellis, F. (2001). The livelihoods approach and management of small-scale fisheries. *Marine Policy, 25,* 377-388.

Allison, E. H., Perry, A. L., Badjeck, M. C., Adger, W. N., Brown, K., Conway, D., . . . Dulvy, N. K. (2009). Vulnerability of national economies to the impacts of climate change on fisheries. *Fish and Fisheries, 10,* 173-196.

Armitage, D., Bene, C., Charles, A. T., Johnson, D., & Allison, E. H. (2012). The interplay of well-being and resilience in applying a social-ecological perspective. *Ecology and Society, 17*(4), 1-15. Retrieved from http://www.ecologyandsociety.org/vol17/iss4/art15/.

Ban, N. C., Mills, M., Tam, J., Hicks, C. C., Klain, S., Stoeckl, N., . . . Chan, K. M. A. (2013). A social-ecological approach to conservation planning: Embedding social considerations. *Frontiers in Ecology.* Retrieved from http://www.centerforoceansolutions.org/sites/default/files/publications/Ban%20et%20al%202013.pdf.

Berkes, F., & Jolly, D. (2001). Adapting to climate change: Social-ecological resilience in Canadian western arctic community. *Conservation Ecology, 5*(2), 18-32.

Berkes, F., & Folke, C. (1998). Linking social and ecological systems for resilience and sustainability. In F. Berkes & C. Folke (Eds.), *Linking Social and Ecological Systems* (1-25). Cambridge: Cambridge University Press.

Biedenweg, K., Hanein, A., Nelson, K., Stiles, K., Wellman, K., Horowitz, J., & Vynne, S. (2014). Developing human wellbeing indicators in the Puget Sound: Focusing on the watershed scale. *Coastal Management*, *42*(4), 374-390.

Boyd, H., & Charles, A. (2006). Creating community-based indicators to monitor sustainability of local fisheries. *Ocean and Coastal Management, 49*, 237-258.

Britton, E., & Coulthard, S. (2013). Assessing the social wellbeing of Northern Ireland's fishing society using a three-dimensional approach. *Marine Policy, 37,* 28-36.

Brookfield, K., Gray, T., & Hatchard, J. (2005). The concept of fisheries-dependent communities. A comparative analysis of four UK case studies: Shetland, Peterhead, North Shields and Lowestoft. *Fisheries Research, 72,* 55-69.

Charmaz, K. (2008). Constructionism and the Grounded Theory. In J. A. Holstein and J. F. Gubrium (Eds.), *Handbook of Constuctionist Research* (397-412). New York: The Guilford Press.

Clay, P. M., & McGoodwin, J. R. (1995). Utilizing social sciences in fisheries management. *Aquatic Living Resources 8*(3), 203-207.

Cohen, J. (1960). A coefficient of agreement for nominal scales. *Educational and Psychological Measurement, 20,* 37–46.

Cohen, J. (1968). Weighted kappa: Nominal scale agreement with provision for scaled disagreement or partial credit. *Psychological Bulletin*, 70, 213–220.

Colburn, L. L., & Jepson, M. (2012). Social indicators of gentrification pressure in fishing communities: A context for social impact assessment. *Coastal Management*, *40*(3), 289-300.

Colburn, L. L., Abbott-Jamieson, S., & Clay, P. M. (2006). Anthropological applications in the management of federally managed fisheries: Context, institutional history, and prospectus. *Human Organization, 65*(3), 231-239.

Conger, A. J. (1980). Integration and generalization of kappas for multiple raters. *Psychological Bulletin, 88,* 322-328.

Corbin, J. M., & Strauss, A. (1990). Grounded Theory research: Procedures, canons, and evaluative criteria. *Qualitative sociology*, *13*(1), 3-21.

Creswell, J. W. (2003). *Research design: Qualitative, quantitative and mixed methods approaches* (2nd ed.). Thousand Oaks: Sage Publications.

Creswell, J. W., Klassen, A. C., Plano-Clark, V. L., & Smith, K. C. (2011). *Best practices for mixed methods research in the health sciences.* Bethesda: National Institutes of Health.

Criddle, K. R. (2012). Adaptation and maladaptation: Factors that influence the resilience of four Alaskan fisheries governed by durable entitlements. *Marine Science, 69*(7), 1168-1179.

Diener, E., Suh, E. M., Lucas, R. E., & Smith, H. L. (1999). Subjective well-being: Three decades of progress. *Psychological Bulletin, 125*(2), 276-302.

ESRI. (2011). ArcGIS Desktop: Release 10. Redlands, CA: Environmental Systems Research Institute.

Fleiss, J. L., Levin, B., & Paik. M. C. (2003). *Statistical methods for rates and proportions*. (3rd ed.). New York: Wiley.

Folke, C. (2006). Resilience: The Emergence of a perspective for social-ecological systems analysis. *Global Environmental Change, 16,* 253-267.

Folke, C., Carpenter, S., Walker, B., Scheffer, M., Elmqvist, T., Gunderson, L., & Holling, C. S. (2004). Regime shifts, resilience, and biodiversity in ecosystem management. *Annual Review of Ecology, Evolution, and Systematics*, 35, 557-581.

Folke, C., Hahn, T., Olsson, P., & Norberg, J. (2005). Adaptive governance of social-ecological systems. *Annual Reviews Environmental Resources, 30,* 441-473.

Giddings, L. S., & Grant, B. M. (2007). A Trojan Horse for positivism? A critique of mixed methods research. *Advances in Nursing Science, 30*(1), 52-60.

Glaser, B. (1992). *Basics of grounded theory analysis: Emergence vs. forcing*. Mill Valley, CA: Sociology Press.

Glaser, B. (2002). Constructivist Grounded Theory? *Forum: Qualitative Social Research, 3*(3), Art. 12, Retrieved from http://nbn-resolving.de/urn:nbn:de:0114-fqs0203125.

Gordon, H. S. (1954). The economic theory of a common-property resource: the fishery. *The Journal of Political Economy,* 124-142.

Guest, G., Bunce, A., & Johnson, L. (2006). How many interviews are enough?: An experiment with data saturation and variability. *Field Methods, 18,* 59-82.

Gunderson, L.H., & Holling, C.S. (Eds.). (2002). *Panarchy: Understanding Transformations in Human and Natural Systems*. Washington: Island Press.

Hardin, G. (1968). The tragedy of the commons. *Science, 162*(3859), 1243-1248.

Healey, M. C. (2009). Resilient salmon, resilient fisheries for British Columbia, Canada. *Ecology and Society, 14*(1), 2.

Heath, H., & Cowley, S. (2004). Developing a grounded theory approach: a comparison of Glaser and Strauss. *International Journal of Nursing Studies, 41*, 141-150.

Himes-Cornell, A. & Hoelting, K. (2015). Resilience strategies in the face of short and long-term change: Outmigration and fisheries regulation in Alaska fishing communities. *Ecology and Society, 20*(2), 9.

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

Himes-Cornell, A., & Kasperski, S. (2015a). Assessing climate change vulnerability in Alaska's fishing communities. *Fisheries Research*, *162*, 1-11.

Himes-Cornell, A., & Kasperski, S. (2015b). *Using socio-economic and fisheries involvement indices to better understand Alaska fishing community well-being.* Manuscript submitted for publication.

Holland, D. S., & Ginter, J. J. (2001). Common property institutions in the Alaskan groundfish fisheries. *Marine Policy*, *25*(1), 33-42.

Holling, C. S. (1973). Resilience and stability of ecological systems. *Annual Reviews of Ecological Systems*, *4*, 1-23.

Holling, C.S., & Gunderson, L.H. (2002). Resilience and adaptive cycles. In L. H. Gunderson & C. S. Holling (Eds.), *Panarchy: Understanding transformations in human and natural systems* (25-62). Washington, D.C.: Island Press.

Imperial, M. T., & Yandle, T. (2005). Taking institutions seriously: Using the IAD framework to analyze fisheries policy. *Society and Natural Resources*, *18*, 493-509.

Jacob, S., Weeks, P., Blount, B. G., & Jepson, M. (2010). Exploring fishing dependence in gulf coast communities. *Marine Policy*, *34*(6), 1307-1314.

Jacob, S., Weeks, P., Blount, B. G., & Jepson, M. (2013). Development and evaluation of social indicators of vulnerability and resiliency for fishing communities in the Gulf of Mexico. *Marine Policy*, *37*, 86-95.

Jain, A. K. (2010). Data clustering: 50 years beyond k-means. *Pattern Recognition Letters*, *31*(8), 651-666.

Jentoft, S. (2006). Beyond fisheries management: The Phronetic dimension. *Marine Policy*, *30*, 671-680.

Jepson, M. (2007). Social indicators and measurements of vulnerability for Gulf Coast fishing communities. *NAPA Bulletin, 28*(1), 57-68.

Jepson, M., & Colburn, L. L. (2013). Development of social indicators of fishing community vulnerability and resilience in the US Southeast and Northeast regions. US Department of Commerce, NOAA Technical Memorandum NMFS-F/SPO-129, 64p.

Jepson, M. & S. Jacob. (2007). Social indicators and measurements of vulnerability for Gulf Coast fishing communities. *NAPA Bulletin*, *28*, 57-68.

Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed methods research: A research paradigm whose time has come. *Educational Researcher, 33*(7), 14-26.

Johnson, R. B., Onwuegbuzie, A. J., & Turner, L. A. (2007). Toward a definition of mixed methods research. *Journal of Mixed Methods Research, 1*(2), 112-133.

Kelly, P. M., & Adger, W. N. (2000). Theory and practice in assessing vulnerability to climate change and facilitating adaptation. *Climatic Change*, *47*(4), 325-352.

Keyes, C. L. M. (1998). Social well-being. *Social Psychology Quarterly, 61*(2), 121-140.

Landis, J. R., & Koch, G. G. (1977). The measurement of observer agreement for categorical data. *Biometrics*, 159-174.

Lowe, M. E. (2008). Crab rationalization and potential community impacts of vertical integration in Alaska's fisheries. In M. E. Lowe, & C. Carothers (Eds.), *Enclosing the fisheries: People, places, and power*. Symposium 68. Bethesda, MD: American Fisheries Society.

Luna-Reyes, L. F., & Andersen, D. L. (2003). Collecting and analyzing qualitative data for system dynamics: Methods and models. *System Dynamics Review, 19*(4), 271-296.

Magnuson-Stevens Fishery Conservation and Management Act of 2007. § 301, 16 U.S.C. § 1851 (2007).

Mansfield, B. (2004a). Neoliberalism in the oceans: "Rationalization," property rights, and the commons question. *Geoforum*, *25*, 313-326.

Mansfield, B. (2004b). Rules of privatization: Contradictions in neoliberal regulation of North Pacific fisheries. *Annals of the Association of American Geographers, 94*(3), 565-584.

Marshall, N. A., & Marshall, P. A. (2007). Conceptualization and operationalizing social resilience within commercial fisheries in northern Australia. *Ecology and Society, 12*(1), 1. Retrieved from: http://www.ecologyandsociety.org/vol12/iss1/art1/.

Martin, I. E. (2008). Resilience in lower Columbia River salmon communities. *Ecology and Society*, *13*(2), 23.

Martin-Breen, P., & Anderies, J. M. (2011). *Resilience: A literature review*. The Rockefeller Foundation. Retrieved from http://www.rockefellerfoundation.org/blog/resilience-literature-review.

Mason, M. (2010). Sample size and saturation in PhD studies using qualitative interviews. *Forum: Qualitative Research, 11*(3). Retrieved from http://www.qualitative-research.net/index.php/fqs/article/view/1428/3027

McCay, B. (2004). ITQs and community: An essay on environmental governance. *Agricultural and Resource Economics Review, 33*(2), 162-170.

McGinn, T., Wyer, P. C., Newman, T. B., Keitz, S., & Leipzig, R. (2004). Tips for learners of evidence-based medicine: 3 Measures of observer variability (kappa statistic). *Canadian Medical Association Journal*, *171*(11), 1369-1373.

McHugh, M. L. (2012). Interrater reliability: The kappa statistic. *Biochemia Medica*, *22*(3), 276-282.

Miller, F., Osbahr, H., Boyd, E., Thomalla, F., Bharwani, S., Ziervogel, G., . . . Nelson, D. (2010). Resilience and vulnerability: Complementary or conflicting concepts? *Ecology and Society*, *15*(3), 11. Retrieved from http:// www.ecologyandsociety.org/vol15/iss3/art11/.

Mills, J., Bonner, A., & Francis, K. (2006). The development of constructivist grounded theory. *International Journal of Qualitative Methods*, *5*(1), 25-35.

Mingers, J. (1980). Towards an appropriate social theory for applied systems thinking: critical theory and soft systems methodology. *Journal of Applied Systems Analysis*, *7*, 41-50.

Morzaria-Luna, H. N., Turk-Boyer, P., & Moreno-Baez, M. (2013). Social indicators of vulnerability for fishing communities in the northern Gulf of California, Mexico: Implications for climate change. *Marine Policy.* Retrieved from http://dx.doi.org/10.1016.2013.10.013.

National Marine Fisheries Service. (2011a). Alaska Individual Fishing Quota (IFQ) permit data. NMFS Alaska Regional Office. Data compiled by Alaska Fisheries Information Network for Alaska Fisheries Science Center, Seattle. [URL not publicly available as some information is confidential.]

National Marine Fisheries Service. (2011b). Data on Limited Liability Permits, Alaska Federal Processor Permits (FPP), Federal Fisheries Permits (FFP), and Permit holders. NMFS Alaska Regional Office. Data compiled by Alaska Fisheries Information Network for Alaska Fisheries Science Center, Seattle. [URL not publicly available as some information is confidential.]

Norris, F. H., Stevens, S. P., Pfefferbaum, B., Wyche, K. F., & Pfefferbaum, R. L. (2008). Community resilience as a metaphor, theory, set of capacities, and strategy for disaster readiness. *American Journal of Community Psychology, 41*, 127-150.

Olson, J. (2011). Understanding and contextualizing social impacts from the privatization of fisheries: An overview. *Ocean & Coastal Management, 54*, 353-363.

Prell, C., Hubacek, K., & Reed, M. (2009). Stakeholder analysis and social network analysis in natural resource management. *Society and Natural Resources*, *22*(6), 501-518.

Reed, M. S., Fraser, E. D., & Dougill, A. J. (2006). An adaptive learning process for developing and applying sustainability indicators with local communities. *Ecological Economics*, *59*(4), 406-418.

Sepez, J., Norman, K., Poole, A., & Tilt, B. (2006). Fish scales: Scale and method in social science research for North Pacific and west coast fishing communities. *Human Organization*, *65*(3), 280-293.

Smit, B. & Wandel, J. (2006). Adaptation, adaptive capacity, and vulnerability. *Global Environmental Change*, *16*, 282-292.

Smith, S. L., Pollnac, R. B., Colburn, L. L., & Olson, J. (2011). Classification of coastal communities reporting commercial fish landings in the US Northeast region: Developing and testing a methodology. *Marine Fisheries Review*, *73*(2), 41-61.

StataCorp. 2011. *Stata Statistical Software: Release 12*. College Station, TX: StataCorp LP.

Turner, B. L., Kasperson, R. E., Matson, P. A., McCarthy, J. J., Corell, R. W., Christensen, L., . . . Schiller, A. (2003). A framework for vulnerability analysis in sustainability science. *Proceedings of the National Academy of Sciences*, *100*(14), 8074-8079.

Urquhart, J., Acott, T., Reed, M., & Courtney, P. (2011). Setting an agenda for social science research in fisheries policy in northern Europe. *Fisheries Research, 108*, 240-247.

U.S. Census Bureau. (n.d.). 2009 American Community Survey 5-Year Estimates, Tables DP02, DP03, DP04, and DP05. Generated using American FactFinder. Retrieved from http://factfinder2.census.gov.

Viera, A. J., & Garrett, J. M. (2005). Understanding interobserver agreement: The kappa statistic. *Family Medicine. 37*(5), 360-363.

Walker, B., Holling, C. S., Carpenter, S. R., & Kinzig, A. (2004). Resilience, adaptability and transformability in social-ecological systems. *Ecology and Society*, *9*(2), 5.

APPENDIXES

Summary of K-means cluster analysis output (all 25 cases).

Component	Between SS	df	Within SS	df	F-ratio
Community Size	188.27	24	94.73	259	21.45
Infrastructure	189.65	24	93.35	259	21.92
Rural/Village Character	217.21	24	65.79	259	35.63
Poverty	200.31	24	82.69	259	26.14
Transient Population	123.24	24	159.76	259	8.33
Foreign Born Asian Population	162.18	24	120.82	259	14.49
Retirees/Low Female Workforce	219.95	24	63.06	259	37.64
Fishery Participation	228.20	24	60.91	259	40.43
Fishery Participation (per capita)	138.23	24	42.69	259	34.94
Crab, AFA, and FPP	269.33	24	64.21	259	45.27
Sportfishing (per capita)	299.87	24	38.54	259	83.97
FPP and Sea Otter Subsistence (per capita)	112.62	24	45.49	259	26.72
Landings, vessels, and Processors (per capita)	171.07	24	127.72	259	14.46
Marine Mammal and Salmon Subsistence (per capita)	89.16	24	76.26	259	12.62
Crab Permits and Beluga Subsistence (per capita)	259.92	24	63.89	259	43.90
Total	2,869.20	360	1,199.88	3,885	