

## **Perceived Adaptive Capacity and Natural Disasters: A Fisheries Case Study**

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## 1. Introduction

In preparing for and recovering from the aftermath of a disaster, measuring and understanding levels of adaptive capacity (ability to adapt to change) can help to target planning and recovery efforts. Adaptive capacity and related concepts of resilience and vulnerability have become an important area of study in general, and in fisheries specifically. Much debate exists in the literature concerning conceptual definitions of resilience, vulnerability, and adaptive capacity and how these concepts correlate with each other in the context of complex social-ecological systems (see Gallopín 2006; Cutter et al. 2008; Rajib et al. 2014). In this study, we adopt conceptual definitions from Jepson and Colburn (2013), where vulnerability is considered a pre-existing state that can show either high or low vulnerability to stressors and impacts, resilience is an assessment of long-term trends in relative vulnerability, and adaptive capacity is the ability of individuals or groups to respond to or bounce back from specific stressors and impacts. Based on these definitions, enhancing adaptive capacity through adequate planning efforts is a fundamental step in promoting resilience (re. Wagner et al. 2014). However, different individuals or groups have different characteristics of adaptive capacity, so it becomes important to understand what variables lead people to react in specific ways. Some of these variables are related to membership in specific groups (Cutter et al. 2003; Brooks et al. 2005). In this paper, the focus is on work-related groups (re. Smith and Clay 2010), specifically, commercial and for-hire fishermen.

Commercial fishing is characterized by the landing of fish and other seafood for sale to market. That is the commercial fisherman's business, though it is also often a way of life. For-hire fishing, on the other hand, is based on renting recreational fishing time on a vessel to a group (charter fishing) or a set of individuals (party boat fishing). Thus, the owner of a for-hire vessel earns a living by charging recreational fishermen to go out on his/her vessel. For-hire fishermen may or may not also consider fishing to be a way of life. Though both commercial and for-hire fishermen depend upon similar natural resources, we predict that differences inherent to these two sectors lead to different levels or types of adaptive capacity. While it is expected that commercial fishermen's perceptions are influenced by a strong attachment to the occupation of fishing as supported by a large body of literature (Apostle et al. 1985; Pollnac and Poggie 1988; Binkley 1995; Pollnac and Poggie 2006; Marshall et al. 2007; Glazier 2007; Pollnac et al. 2015), aspects affecting for-hire fishermen's views on their adaptive capacity are largely unknown. Understanding differences between commercial and for-hire fishermen in characteristics of adaptive capacity in general and to natural disasters is important for both fisheries policy and coastal community disaster planning. Here, we focus specifically on levels of *perceived* adaptive capacity, since, in the face of stressors, people often act upon their subjective perceptions rather than objective measures, as subjective perceptions and objective measures can be very different from each other (Grothmann and Patt 2005; Smith and Clay 2010).

The objective ability or capacity of human individuals or societies to adapt to change is linked to availability of resources (e.g., financial, institutional) and an individual's or group's *access* to those resources. Many of these can be measured via secondary data regularly collected by government agencies at multiple geographic scales and by specific industry sub-groups (e.g. the US Census). In contrast, subjective aspects of adaptation are associated with their *perception of the adequacy* of available resources (e.g., financial, social) in allowing and aiding them to cope and adapt, and the extent to which people feel they are prepared to endure such changes or impacts and undertake steps to cope with them.

Secondary data are often available only at the national level (e.g., World Values Survey 2014), and not necessarily tied to sub-groups such as fishermen. Thus, sub-group level analyses often require primary data collection.

In the context of fishing communities, understanding fishermen's perceived levels of adaptive capacity can help develop rules and regulations that promote resilience and maintain livelihoods while safeguarding the sustainability of resources. Implementing policies that take into account the resilience and adaptability of resource users is also believed to maximize compliance and, therefore, be more effective in meeting policy goals (Marshall and Marshall 2007; Kalikoski et al. 2010). In fact, certain approaches to natural resource management that are more participatory and flexible (e.g., adaptive management, co-management) are regarded as efficient methods for establishing and increasing adaptive capacity in social-ecological systems (Folke et al. 2002; McClenachan et al. 2015). Knowing the differences in adaptive capacity of fishing communities, as based on their relative dependence on commercial or for-hire fishing can help to further target these policies.

Many studies have been conducted to investigate socio-economic impacts of natural and man-made transformations on commercial fisheries, including aspects of adaptation to natural disasters (Acheson 1981; Clay 1996; Flint and Luloff 2005; Olson 2006; Pomeroy et al. 2006; Jepson and Jacob 2007; Pollnac et al. 2008; Ebbin 2009; Forster et al. 2014; Deason et al. 2014). Fewer efforts have focused on similar aspects in the recreational fishing industry, which includes the for-hire sector (Murray et al. 2010). For decades, commercial fisheries in the US have been the subject of frequent and sometimes substantial changes in policy, implemented to conserve fish stocks. More recently, a shift to stricter regulations on recreational fishing activities has been discussed in the literature in light of increased resource exploitation by this sector (Sutinen and Johnston 2003; Cooke and Cowx 2006; Abbott and Wilen 2009; Abbott et al. 2009; Murray et al. 2010; Ihde et al. 2011; MacKenzie and Cox 2013). Changes associated with the adoption of strict regulations to conserve declining fish stocks can have very significant consequences for commercial and for-hire fishermen alike, thus stressing the importance of understanding specific factors influencing fishermen's perceptions of their adaptive capacity and how they differ between sectors within the industry.

Multiple recent studies address the difficult state of affairs for many fishermen and fishing communities throughout the U.S. as a result of fish stock decline and strict regulations (Clay et al. 2014; Jacob et al. 2013; Olson 2011; Carothers et al. 2010; Allen and Gough 2006). Many of these issues are becoming increasingly critical under climate change and prospects of drastic environmental transformation, as well as more frequent and intense natural disasters (Howard et al. 2013). Coastal communities such as those involved in fishing are among the social-ecological systems most vulnerable to natural disasters (Mamauag et al. 2013; Becker et al. 2014). Extreme climate events such as floods, storms, and hurricanes can have important effects on fisheries production in marine systems (Brander 2007; Chang et al. 2013) that, coupled with other direct and indirect effects of natural disasters (e.g. destruction of homes and businesses, and impacts on tourism), can result in major socio-economic impacts to entire coastal communities. These extreme natural events compound the ongoing impacts of fishing and environmental changes (including climate change) on fish stocks, along with fisheries regulatory changes designed to maintain or rebuild those stocks to sustainable levels. These changes that significantly affect coastal environments have led to increased concern in recent decades with aspects of vulnerability and resilience in U.S. fishing communities (Jepson and Colburn 2013; Jacob et al. 2013; Forster et al. 2014; Wagner et al. 2014; Deason et al. 2014). However, studies have often focused on fishermen in general, or only on commercial fishermen, not making the comparison between fishery sectors conducted in the present

study. Since fishing communities differ in their relative dependence on commercial fishing, for-hire fishing, or a combination of both (Jepson and Colburn 2013), it is important to compare aspects of vulnerability and resilience of different sectors within the industry.

In the case of natural disasters, degrees of vulnerability are highly determined by factors such as geographic location and intensity of the disaster; a successful recovery from impact can depend heavily on a system's capacity for adaptation (Cutter et al. 2008). In the U.S., fishery law requires that fisheries regulations provide for the sustained participation of fishing communities and the minimization of adverse economic impacts (MSFCMA 2007). Thus, one geographic unit that should be assessed for resilience and vulnerability is the *community*. Fishery management practices that also promote adaptive capacity, and ultimately resilience, in fishing communities can help to increase the chance for those communities to successfully recover from a natural disaster. Fishermen's perceived adaptive capacity to impacts, which is the focus of this research, can be used as an indicator of overall adaptability and coping capacity of communities that are highly dependent on fishing resources. These aspects should be considered in conjunction with objective measures and other aspects of the larger community not examined in this study (e.g. perceptions of other community members). To the extent that large numbers of fishermen may have different types of adaptive capacity, successful recovery may vary in degree or character.

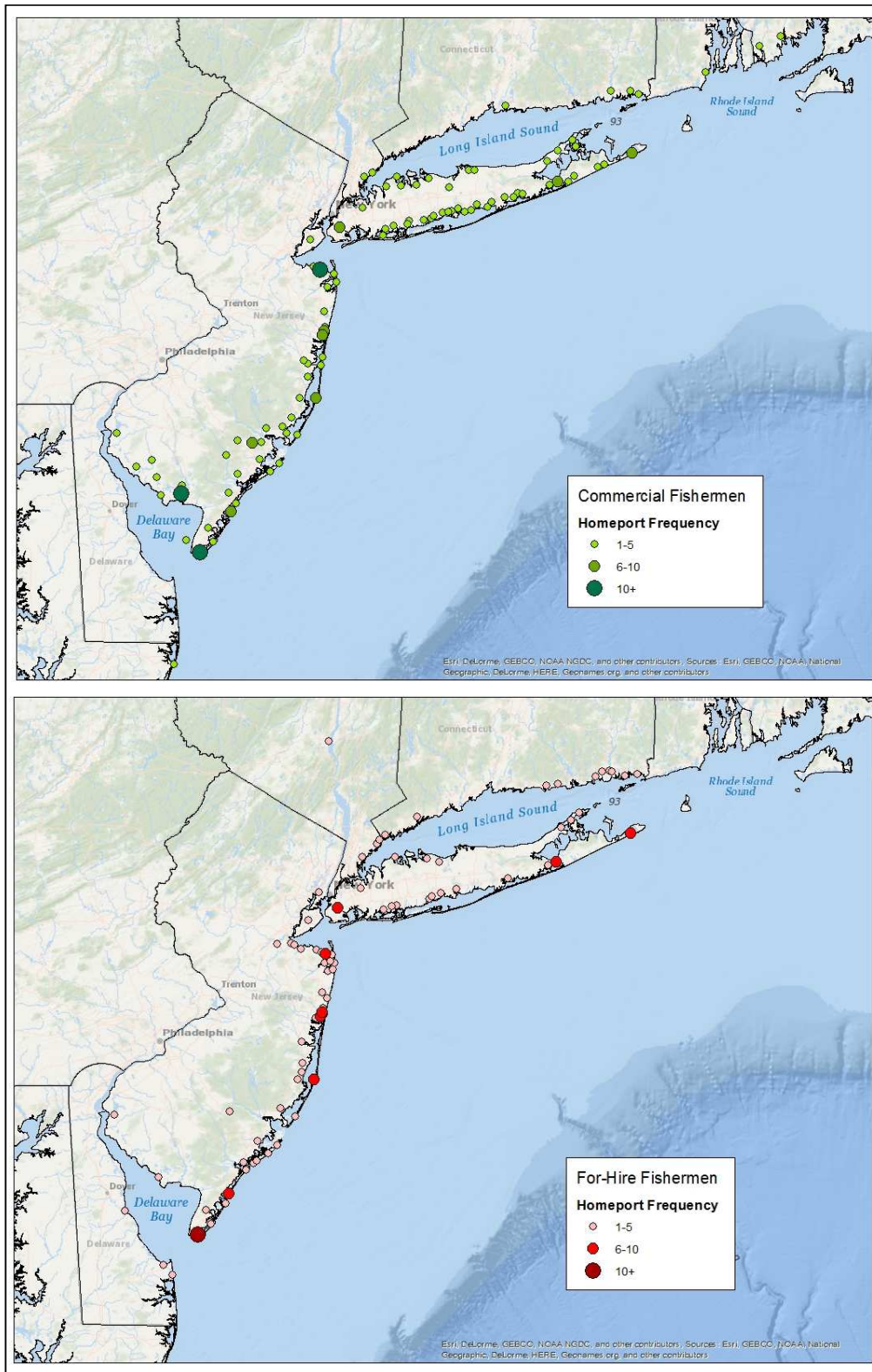
This study focuses on commercial and for-hire fishermen of New York and New Jersey one year after Hurricane Sandy and quantitatively analyzes their perceived adaptive capacity. Hurricane Sandy provided an ideal case study for the investigation of variables related to perceived adaptive capacity in fishing, both in general and in response to natural disasters. Sandy made landfall on October 29, 2012 at Brigantine, NJ and, though the impacts stretched along the U.S. east coast and even inland, New Jersey and New York were the hardest hit states in terms of both property damage and number of deaths (NWS 2013; CDC 2013). Marine fishing was highly disrupted for coastal fishing communities, resulting in the U.S. Secretary of Commerce issuing both a fishery resource disaster and a catastrophic regional fishery disaster for both New York and New Jersey on November 16, 2012 (NOAA 2012). Major impacts to fisheries businesses were related to physical damages to vessels, gear, marinas, and other indispensable infrastructure, revenue losses associated with those and with other direct and indirect impacts (e.g. lost time at sea, lack of buyers/clients), and consequential environmental changes affecting important fish stocks. In New York and New Jersey, the commercial and recreational fishing industries play important economic and social roles for many people and entire communities. For these reasons, this study provides an example of the importance for both fisheries policy and fishing community recovery planning of differentiating between these (and other) sub-groups. This effort will help researchers and policy makers better understand and address each fishing type's (and potentially entire communities') perceptions of their ability to recover from impacts of future natural and human driven stressors and changes.

## **2. Methods**

The data used in this study was collected as part of an effort by NOAA Fisheries in 2014 (see Colburn et al. 2015) to assess long-term socio-economic impacts of Hurricane Sandy on fishing communities per National Standard 8 requirements (MSFCMA 2007). The broader study also sampled fishing-related businesses (e.g. marinas and seafood dealers) and inquired about a broader range of topics than are discussed here. A multi-mode approach including mail, telephone, and in-person was used to maximize the number of completed surveys (Dillman et al. 2009). For the initial mail effort, a list of fishermen (commercial and for-hire) was compiled based on state and federal license holder registries. A target

sample of 599 was calculated based on a 5% confidence interval and a 95% confidence level ( $n = [0.5 \times (1-0.5)] / [(0.05/1.96)^2]$ ; true  $n = (n \times N) / (n + N - 1)$ ). The mail survey yielded a total of 216 completed surveys. In order to maximize the number of surveys, a follow-up telephone effort was conducted and all non-responding fishermen in the original list of potential respondents were called at least once. A total of 305 additional fishermen were interviewed by phone. Finally, one fisherman was interviewed in person during fieldwork that specifically targeted other populations in the broader study (see Colburn et al. 2015). Counting responses from all modes, 522 commercial and for-hire fishing vessel owners/permit or license holders with addresses in New York and New Jersey completed the survey, representing 87% of the target sample (522 out of 599).

Breaking down by sector and state, the respondents consisted of 292 commercial fishermen (135 from New York and 157 from New Jersey) and 230 for-hire fishermen (60 from New York and 170 from New Jersey). Percentage contributions of each fishery type by state to the total sample were representative of their contributions to the overall universe used in this study. Differences between contribution to universe and to sample by each fishery type ranged from 0.2% (NJ for-hire) to 1.7% (NY for-hire). The geographic distribution of fishermen surveyed at the homeport level showed good coverage across both states (Figure 1). In some cases, fishermen holding fishing licenses from New York or New Jersey, and thus included in the sample frame, had homeports in adjacent states.



**Figure 1. Geographic distribution at the homeport level of all commercial and for-hire fishermen surveyed.**

To measure perceived adaptive capacity among fishermen, statements based on a scale of subjective resilience developed by Marshall and Marshall (2007) were used. Originally, the scale was developed in the context of policy change, to measure fishermen's perception of their ability to adapt to changes in fishing regulations. Although most statements in the original scale allow for generalization and were considered pertinent in the context of the present research, modifications to content and language were made to conform to the background and objectives of this study. Only one original statement was excluded. The scale used in the present study can be seen in Table 1. The most important modifications to the original scale (see Marshall and Marshall 2007 for original scale) were to include statements directly involving the idea of adaptation to natural disasters (statements 9 and 10). Fishermen interviewed were asked to indicate their levels of agreement with the eleven statements and responses were coded on a five-point Likert scale (1 = strongly disagree; 2 = disagree, 3 = neutral; 4 = agree; and 5 = strongly agree). The scale was reversed for negatively worded statements, indicated with an asterisk in Table 1.

**Table 1. Questions used to assess perceived adaptive capacity among commercial and for-hire fishermen (Modified from Marshall and Marshall 2007).**

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1. I have other options available if I decide to no longer be a fisherman.
  2. I am confident that I could get work elsewhere if I needed to.
  3. I would be nervous trying something else outside the fishery.\*
  4. I have planned for my financial security.
  5. Every time there is a change I plan a way to make it work for myself.
  6. I am more likely to adapt to change compared to other fishermen.
  7. I do not think I am competitive enough to be a fisherman much longer.\*
  8. I am confident things will turn out well for me.
  9. If there are any more natural disasters in the scale of Hurricane Sandy I will not be able to continue to be a fisherman much longer.\*
  10. I can cope with impacts to the fishery due to natural disasters such as Hurricane Sandy.
  11. I am interested in learning new skills outside the fishery.
- 

\*Negatively worded statements were coded on a reversed scale

Though separate surveys were administered to commercial and for-hire fishermen, to allow for certain more targeted questions based on their different business practices, both surveys asked for the same demographic and fishery attribute (background) variables: age, years of experience in fishing, the length of their (only or primary) vessel, and whether or not fishing constituted their primary source of income. These variables are representative of important aspects potentially related to adaptive capacity such as resources invested in the fishing activity (material and non-material), size of the operation, and individual potential for adaptation through alternative sources of income.

The variable 'level of impact from Hurricane Sandy,' used as an objective measure of impact from the storm, was developed using fishermen's responses to three other questions in common across the two surveys. These concerned effects of the storm on their fishing business: 1) Did you have to stop fishing/operating because of Sandy?; 2) Did you experience physical damages to infrastructure

indispensable for your fishing business as a result of Sandy?; and 3) Did you experience revenue losses associated with Sandy? “Yes” and “No” answers were coded 1 and 0 respectively and a scale ranging from 0 to 3 was created by summing each respondent’s answers to the three questions.

In order to understand differences in major aspects characterizing perceived adaptive capacity for each fishery sector, Principal Component Analyses (PCA) were conducted separately for commercial and for-hire fishermen, using each group’s responses to the eleven adaptive capacity statements displayed in Table 1. Pearson’s Correlations between background variables, level of objective impact from Hurricane Sandy, and perceived adaptive capacity were also conducted for each fishery sector to understand both the characteristics affecting individuals’ perception of their ability to adapt to change and the potential differences between the two fishery sectors.

### 3. Results

Commercial and for-hire fishermen were analyzed and compared with regard to all background variables (Table 2). Commercial fishermen in the sample were, on average, more experienced and more likely to have fishing as a primary occupation than for-hire fishermen, as differences between the two groups were statistically significant for these two variables. No differences were found between the two groups with regard to average age, or length of primary vessel (all statistics can be seen in Table 2).

**Table 2. Descriptive statistics of background variables, and statistical analyses comparing those variables between commercial and for-hire fishermen ( $\bar{x}$  = mean value; s = standard deviation)**

VARIABLES	COMMERCIAL	FOR-HIRE	COM. vs F-H
Fishing is Primary Occupation (% yes)	77.1%	37.9%	$\chi^2 (1) = 80.7, p < 0.001$
Years of Fishing Experience	$\bar{x} = 34.1 (s = 14.5)$	$\bar{x} = 20.8 (s = 13.2)$	$t (515) = 10.734, p < 0.001$
Age	$\bar{x} = 54.7 (s = 12.5)$	$\bar{x} = 55.8 (s = 10.8)$	$t (513.01) = -1.02, p > 0.05$
Primary Vessel Length (Ft)	$\bar{x} = 36.6 (s = 20.9)$	$\bar{x} = 36.0 (s = 15.5)$	$t (509.59) = 0.37, p > 0.05$

Table 3 shows results for the three dichotomous variables used to create the objective measure of impact from Hurricane Sandy. Overall, the majority of fishermen in both sectors experienced direct impacts from Hurricane Sandy as evidenced by their responses to the three overarching questions used to create the scale. The only exception was for-hire fishermen’s responses with regard to physical damages (see Table 3). A t test was used to compare commercial and for-hire fishermen with regard to their score on the overall impact scale developed by summing the three variables described. Differences between the two sectors were not statistically significant.



**Table 3. Results of responses from commercial and for-hire fishermen with regard to the three dichotomous questions used to create the Hurricane Sandy Impact Scale ( $\bar{x}$  = mean value; s = standard deviation)**

VARIABLE	COMMERCIAL	FOR-HIRE
	Yes (%)	Yes (%)
Physical damages	57.2	44.3
Revenue loss	72.7	73.5
Interrupted operation	78.3	79.8
<i>Impact Scale (0-3):</i>	$\bar{x} = 2.1 (s = 1.0)$	$\bar{x} = 1.9 (s = 0.9)$
<i>Com. vs F-h:</i>	$t (512) = 1.181, p > 0.05$	

The PCA analysis using the eleven adaptive capacity statements resulted in three similar components for both commercial and for-hire fishermen. The scree test was used to determine the number of factors to retain. Components were named according to the characteristics of the items included in them: Ability to Persist in Fishing (1c and 2f), Alternative Income (2c and 1f), and Adaptation to Change (3c and 3f) (see Table 4). Groupings of items were similar between commercial and for-hire fishermen with only two statements presenting differences between the two: *I have planned for my financial security* and *I am confident things will turn out well for me*. For commercial fishermen, these two statements were grouped in the component named Ability to Persist in Fishing which was the component that explained the most variance for the group (29.7%). For for-hire fishermen, the two statements were grouped in the component named Alternative Income which, in turn, was the component that explained the most variance for this group (32.2%). Another important difference found between commercial and for-hire fishermen regarded the statement *I am interested in learning new skills outside the fishery*. While for both fishing types it had the highest correlation score in the component Adaptation to Change (3c and 3f), only among for-hire fishermen this correlation is negative (Table 4).

**Table 4. Results of a principal component analysis using commercial and for-hire fishermen's level of agreement with the perceived adaptive capacity statements. Shaded cells represent variables with highest factor loading for each component. (1c and 2 f = Ability to Persist in Fishing; 2c and 1f = Alternative Income; 3c and 3f = Adaptation to Change).**

PERCEIVED ADAPTIVE CAPACITY STATEMENTS	COMMERCIAL			FOR-HIRE		
	1c	2c	3c	1f	2f	3f
I have planned for my financial security	<b>.612</b>	.409	.044	<b>.585</b>	-.279	.338
I am confident things will turn out well for me	<b>.599</b>	.211	.301	<b>.506</b>	-.398	.403
I can cope with impacts to the fishery due to natural disasters such as Hurricane Sandy	<b>.583</b>	.200	.066	.273	<b>-.537</b>	.162
I do not think I am competitive enough to continue to be a fisherman much longer*	<b>.520</b>	-.258	.100	-.015	<b>.697</b>	.143
If there are any more natural disasters on the scale of Hurricane Sandy I will not be able to continue to be a fisherman much longer*	<b>.651</b>	.022	-.003	.004	<b>.827</b>	-.068
I have other options available if I decide to no longer be a fisherman	.019	<b>.810</b>	.277	<b>.851</b>	.125	.060
I am confident that I could get work elsewhere if I needed to	.251	<b>.748</b>	.335	<b>.853</b>	.024	.171
I would be nervous trying something else outside the fishery*	.063	<b>.647</b>	-.121	<b>.510</b>	.213	.069
I am more likely to adapt to change compare to other fishermen	.261	.007	<b>.749</b>	.242	-.041	<b>.804</b>
Every time there is a change I plan a way to make it work for myself	.470	.035	<b>.639</b>	.204	-.304	<b>.693</b>
I am interested in learning new skills outside the fishery	-.274	.270	<b>.637</b>	<b>.416</b>	-.153	<b>-.443</b>
<i>Percent Variance Explained</i>	<i>29.693</i>	<i>14.075</i>	<i>9.959</i>	<i>32.165</i>	<i>14.074</i>	<i>10.300</i>

\* Negatively worded statements were coded on a reversed scale

Pearson's Correlations were used to analyze relationships between factor scores for the three perceived adaptive capacity components (Ability to Persist in Fishing, Adaptation to Change, and Alternative Income) and the variables 'level of impact from Sandy', age, years of fishing experience, and vessel length. Correlations between variables for *commercial* fishermen can be seen in Table 5. Level of impact from Sandy was negatively correlated with two perceived adaptive components: Ability to Persist in Fishing and Alternative Income, meaning higher impact is associated with a perceived lower ability to persist and being less confident in obtaining an alternative (non-fishing) source of income if needed. Alternative Income was negatively correlated with vessel length, meaning fishermen with larger vessels were less confident in their ability to obtain alternative sources of income if needed. The component Adaptation to Change showed negative correlations with age and fishing experience, which were, in turn, positively correlated with each other, meaning older fishermen tend to have more years of fishing experience and be less adaptable to change.

**Table 5. Pearson's Correlations between background variables and perceived adaptive capacity components for commercial fishermen (statistically significant correlations are in bold)**

VARIABLES	1	2	3	4	5	6	7
1. Level of Impact	--						
2. Ability to Persist	<b>-.217**</b>	--					
3. Alternative Income	<b>-.201**</b>	.028	--				
4. Adaptation to Change	-.054	.005	.032	--			
5. Age	-.034	-.089	.023	<b>-.288**</b>	--		
6. Fishing Experience	.093	-.017	-.082	<b>-.226**</b>	<b>.679**</b>	--	
7. Vessel Length	.045	.076	<b>-.259**</b>	.047	-.068	-.070	--

\*\* $p < 0.01$

Table 6 shows correlations between variables for *for-hire* fishermen. Similar to the pattern observed for commercial fishermen, level of impact from Sandy was negatively, though more weakly, correlated with the components Ability to Persist in Fishing and Alternative Income. This means higher impact is associated with lower ability to persist and being less confident in obtaining an alternative (non-fishing) source of income if needed. Vessel length and fishing experience were positively correlated with each other (meaning more experienced fishermen tended to have larger vessels) and negatively with the component Alternative Income (meaning both more experienced fishermen and fishermen with larger vessels were less confident in their ability to obtain alternative sources of income if needed). Age and fishing experience were positively correlated with each other, as for commercial fishermen, with older fishermen tending to be more experienced. The component Adaptation to Change did not show any correlations with 'level of impact from Sandy' or any of the background variables for for-hire fishermen.

**Table 6. Pearson’s Correlations between background variables and perceived adaptive capacity components for for-hire fishermen (statistically significant correlations are highlighted in bold)**

VARIABLES	1	2	3	4	5	6	7
1. Level of Impact	--						
2. Ability to Persist	<b>-.170*</b>	--					
3. Alternative Income	<b>-.177*</b>	.010	--				
4. Adaptation to Change	.079	.064	-.013	--			
5. Age	0.17	.012	-.064	.124	--		
6. Fishing Experience	.061	0.72	<b>-.300**</b>	.000	<b>.334**</b>	--	
7. Vessel Length	.128	.068	<b>-.227**</b>	-.103	-.038	<b>.400**</b>	--

\* $p < 0.05$  / \*\* $p < 0.01$

#### 4. Discussion

With climate change, including sea-level rise and likely increased frequency and severity of storms, fishermen will need to be further prepared to endure and adapt to multiple impacts. Planning for fisherman and fishing community resiliency in the face of these impacts requires understanding the factors that influence fishermen’s capacity to adapt – in general and based on key sub-categories, including commercial versus for-hire. The increased attention recently to new types of regulations for recreational fisheries makes understanding the differences and similarities between commercial and for-hire sectors especially important. This study has concentrated on subjective assessments, or perceptions, of adaptive capacity. This area has been noted for its importance, given that people often act based on perceived capacity regardless of objective capacity, though few quantitatively assessed case studies have been undertaken for fisheries. Objective assessments are also needed, though that is beyond the scope of this paper.

Comparisons between commercial and for-hire fishermen with regard to background characteristics of the sample revealed important differences between the two groups. On average, for-hire fishermen had fewer years of fishing experience than commercial fishermen but virtually identical average ages, perhaps suggesting for-hire fishermen enter the profession later in life. Also, for the majority of fishermen in the for-hire sector, fishing was *not* a primary source of income, while for most commercial fishermen the opposite was true (see Table 2). These two results combined suggest for-hire fishing may be a post-retirement job for at least some for-hire fishermen. A great number of sociological and anthropological studies describe commercial fishing as a family enterprise and an ‘occupational culture,’ passed on through generations of fishermen (Norr and Norr 1974; Davis 1986; Pollnac 1988; Poggie et al. 1995; Reed et al. 2013). Consequently, many commercial fishermen begin taking trips on family-owned vessels at a very young age (Davis 2012) and have, in general, great personal attachment to the occupation of fishing. Characteristics and motivations of for-hire fishermen are not extensively described in the literature. One study of offshore charter and party boat fishermen in the Gulf of Mexico by Norris-Raynbird (2004) describes the existence of four different “types” of charter fishermen, largely distinguished by years of experience and attachment to fishing: weekend warrior, wave cowboy, investor, and traditional. The last type (traditional) shares important characteristics with depictions of commercial

fishermen in the literature. The *traditional* for-hire “type” comprises those with longer term involvement in fishing and whose livelihoods depend on the activity mostly or entirely. Other “types” of for-hire fishermen may be less experienced and less attached to the occupation (weekend warriors), see themselves as free and nonconformist “rebels” (wave cowboys), or have a relationship with fishing that is more “business-like” (investors). The existence of the “non-traditional types” of for-hire fishermen described by Norris-Raynbird (2004) could help explain the differences found between sectors in the sample, where a portion of those involved in for-hire fishing do not share the same general dependence and attachment typically found among commercial fishermen. This also points to the need for more studies of for-hire fishermen’s motivations to fish and, potentially a need for greater disaggregation in general within studies of for-hire fishermen.

Based on the results of this study, the differences between the for-hire and commercial sectors described above are believed to influence fishermen’s perceptions of their ability to adapt to changes, including impacts of natural disasters. The results from the PCA analysis using the perceived adaptive capacity items resulted in groupings (components) that were very similar between the commercial and for-hire sectors, emphasizing the robustness of the measurement. Component characteristics support some of the earlier findings of differences and similarities between commercial and for-hire fishermen. Among commercial fishermen the statements *I have planned for my financial security* and *I am confident things will turn out well for me* were associated with items related to their ability to persist within the occupation of fishing, whereas among for-hire fishermen these two statements were associated with items suggesting adaptive capacity through alternative occupation and availability of income outside of fishing. The two statements in question represent important indicators of fishermen’s general perception of their future financial and psychological well-being (good), and the results of the PCA analyses show that for commercial and for-hire fishermen these aspects are associated with different factors. Further, among for-hire fishermen, willingness to learn new skills outside the occupation of fishing was negatively correlated with other statements associated with adaptation to change, while among commercial fishermen this correlation was positive. Among commercial fishermen the idea of acquiring new non-fishing skills may be associated with potential future adaptation strategies, while for-hire fishermen seem to already have a broader scope of possibilities in place and, therefore, may not associate future adaptation with needing to *learn* new skills.

Correlations between the three perceived adaptive capacity components and background variables reveal more complex details of the relationships described above. Among for-hire fishermen, perceptions of their ability to obtain alternative income were correlated with fishing experience, with less experienced fishermen presenting more positive views on their ability to secure other sources of income. These results support previously mentioned dichotomies within the for-hire fishing culture described in the article by Norris-Raynbird (2004). Three of the four “types” of for-hire fishermen described in aforementioned study show lower levels of experience, and also less attachment to and less dependence on the occupation. This heterogeneous depiction of for-hire fishermen, stressing differences in occupational attachment and dependency, could also explain the correlation found between fishing experience and length of primary vessel among for-hire fishermen, where those who owned smaller vessels tended to be less experienced. Norris-Raynbird (2004) describes a positive relationship between number of years in for-hire fishing and well equipped, medium/large vessels. The “traditional” type, that is most similar to commercial fishermen, had in general more experience in the for-hire business and owned more equipped and larger vessels when compared to the other “types” (2004: 57).

Among commercial fishermen, negative correlations were found between both age and fishing experience and the perceived adaptive capacity component Adaptation to Change, suggesting that younger and less experienced fishermen are more confident in their ability to adapt to changes in general and more willing to learn skills outside of the occupation of fishing. The idea of younger commercial fishermen being more adaptable to changes in the occupation of fishing than their older counterparts has been previously discussed in the literature. Marshall and Marshall (2007), in the study that developed the subjective adaptive capacity scale modified and used in this paper, found that younger commercial fishermen in Northern Australia scored higher than older fishermen in the component that included two of the same statements as this paper's Adaptation to Change component: *I am more likely to adapt to change compared to other fishermen* and *Every time there is a change I plan a way to make it work for myself*. The authors explained that the older fishermen interviewed scored lower in that component possibly because of their great level of attachment to the occupation, because they did not think they had the necessary skills to adapt, or because they found the idea of reorganizing simply "exhausting" (2007: 6). Other studies (Bailey 1982, Almeida et al. 2003, Pita et al. 2010) have shown that younger commercial fishermen in various parts of the world are generally more comfortable than older fishermen with the idea of occupational mobility, i.e., the possibility of getting work outside of fishing. It is interesting, however, that age and fishing experience were not correlated with commercial fishermen's perceptions of their ability to obtain alternative sources of income. This suggests greater complexity of these relationships and possibly that younger fishermen's perception of their ability to adapt to change may not necessarily be related with obtaining work outside the fishery.

For both commercial and for-hire fishermen, statistically significant correlations were found between the components Ability to Persist in Fishing and Alternative Income and the variable 'level of impact from Sandy.' Although correlations among commercial fishermen were stronger, negative relationships indicate that both commercial and for-hire fishermen who endured more impacts from Hurricane Sandy presented lower levels of perceived adaptive capacity on these components, which are related to 1) their ability to cope with impacts to their fishing activity by a natural disaster and in general, and 2) their confidence in having alternative occupations and income sources in the hypothetical event they could no longer fish. These results suggest that fishermen's perceptions of their own ability to cope and adapt were influenced by their experience facing Hurricane Sandy.

The observed relationships support previous studies. According to Grothmann and Patt (2005), two important aspects rule people's perceptions of their adaptive capacity towards natural disasters: the first, referred to as risk perception, assesses the probability and severity of a hypothetical threat; the second, referred to as risk experience appraisal, assesses the severity of a risk experienced in the past. Risk experience appraisal is assumed to negatively influence perceptions of adaptability to natural disasters, thus resulting in higher risk perception (Grothmann and Patt 2005). In the present study, the intensity of impacts from Hurricane Sandy suffered by both commercial and for-hire fishermen (risk experience appraisal) had an influence on their subjective evaluation of their ability to cope in the future (risk perception).

Interestingly, in this study, the fishermen most impacted by Sandy presented lower levels of perceived adaptive capacity not only in the face of future natural disasters, but also regarding their ability to find work outside of the fishery in the face of other potential changes that could force them out of the industry. It is possible that those who experienced the most catastrophic impacts from Hurricane Sandy may have

seen themselves close to losing their ability to continue in the fishing business due to damage and lost revenue and were, therefore, forced to face – and not just hypothetically – the possibility of being unable to find a job elsewhere. Further research is needed to better understand fishermen’s risk experience appraisal in the context of natural disasters and its impacts on their perceptions of their ability to find occupations or income outside of the fishery.

## **5. Conclusions**

Findings of this study show important differences and similarities between commercial and for-hire fishermen regarding their perceived adaptive capacity to natural disasters and to change in general. While both groups show high levels of perceived adaptive capacity in general, for-hire fishermen presented more confidence in their ability to obtain work and income outside the fishery when compared to commercial fishermen. As predicted, commercial fishermen’s subjective adaptive capacity was associated with their ability to remain in the fishery, driven by their strong attachment to the occupation. Individual attributes (age and experience in the fishery) were also associated with levels of perceived adaptive capacity in ways that differed between for-hire and commercial fishermen, suggesting further complexity of this variable. These findings are important when considering impacts of management strategies aimed at reducing effort in the fishery. Further, those who suffered the most significant impacts from Hurricane Sandy presented lower levels of confidence in their ability to persist in the fishery and find alternative work when compared to those less impacted. This was true for both commercial and for-hire fishermen, although the relationship was weaker for the for-hire fishermen. This finding suggests important compounding vulnerabilities: the intensity of past threats (in this case Hurricane Sandy) affected levels of perceived adaptive capacity among fishermen. Overall, the results of this study point to the importance of further work on perceived adaptive capacity among different sub-groups of fishermen, including additional studies of for-hire and commercial fishermen in other geographic locations. Understanding how different groups of fishermen react to major impacts is critical for the development of fishery management plans and climate adaptation plans that foresee and effectively address potential negative social consequences of change for fishermen and fishing communities.

## References

- Abbott, J. K. and J. E. Wilen (2009). Rent dissipation and efficient rationalization in for-hire recreational fishing. *Journal of Environmental Economics Management* 58: 300-314.
- Abbott, J. K., V. Maharaj and J. E. Wilen (2009). Designing ITQ Programs for Commercial Recreational Fishing. *Marine Policy* 33: 766-774.
- Acheson, J. M. (1981). Anthropology of fishing. *Annual Review of Anthropology* 10: 275-316.
- Almeida, O. T., K. Lorenzen, and D. G. McGrath (2003). Commercial fishing in the Brazilian Amazon: regional differentiation in fleet characteristics and efficiency. *Fisheries Management and Ecology* 10: 109-115.
- Allen, S., and A. Gough (2006). Monitoring environmental justice impacts: Vietnamese-American longline fishermen adapt to the Hawaii swordfish fishery closure. *Human Organization* 65(3): 319-328.
- Apostle, R. L., L. Kasdan, and A. Hanson (1985). Work satisfaction and community attachment among fishermen in Southwest Nova Scotia. *Canadian Journal of Fish Aquatic Sciences* 42: 256-267.
- Bailey, C. (1982). "Small-scale fisheries of San Miguel Bay, Philippines: occupational and geographic mobility." ICLARM Technical Reports 10, 57p. Institute of Fisheries Development and Research, College of Fisheries, University of the Philippines in the Visayas, Quezon City, Philippines; International Center of Living Aquatic Resources Management, Manila, Philippines; and the United Nations University, Tokyo, Japan.
- Becker, A. H., P. Matson, M. Fischer, and M. D. Mastrandrea (2014). Towards seaport resilience for climate change adaptation: Stakeholder perceptions of hurricane impacts in Gulfport (MS) and Providence (RI). *Progress in Planning*. Available at: [doi:10.1016/j.progress.2013.11.002](https://doi.org/10.1016/j.progress.2013.11.002).
- Binkley, M. (1995). Risks, dangers, and rewards in the Nova Scotia offshore fishermen. Montreal: McGill-Queen's University Press.
- Brander, K. M. (2007). Global fish production and climate change. *Proceedings of the National Academy of Sciences of the United States of America* 104(50): 19709-19714.
- Brooks, N., W. N. Adger, and P. M. Kelly (2005). The determinants of vulnerability and adaptive capacity at the national level and the implications for adaptation. *Global Environmental Change* 15: 151-163.
- Carothers, C., D. K. Lew, and J. Sepez (2010). Fishing rights and small communities: Alaska halibut IFQ transfer patterns. *Ocean and Coastal Management* 53:518-523.
- CDC (US Centers for Disease Control and Prevention) (2013). "Deaths Associated with Hurricane Sandy – October – November 2012." *Morbidity and Mortality Weekly Report (MMWR)*. Online at: <http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6220a1.htm>
- Chang, Y., M. Lee, K. Lee, and K. Shao (2013). Adaptation of fisheries and mariculture management to extreme oceanic environmental changes and climate variability in Taiwan. *Marine Policy* 38: 476-482.



Clay, P. M. (1996). Management regions, statistical areas and fishing grounds: Criteria for dividing up the sea. *Journal of Northwest Atlantic Fishery Science* 19: 103–126.

Clay, P. M., A. Kitts, and P. Pinto da Silva (2014). Measuring the socio-economic performance of catch share programs: definition of metrics and application to the Northeast U.S. groundfish fishery. *Marine Policy* 44:27-36.

Colburn, L. L., P. M. Clay, T. Seara. C. Weng, and A. Silva (2015). “Social and economic impacts of Hurricane/Post Tropical Cyclone Sandy on the commercial and recreational fishing industries: New York and New Jersey one year later.” *NOAA Technical Memorandum, NMFS-F/SPO 157*. 79 p.

Cooke, S. J. and I. G. Cowx (2006). Contrasting recreational and commercial fishing: Searching for common issues to promote unified conservation of fisheries resources and aquatic environments. *Biological Conservation* 128: 93-108.

Cutter, S. L., B. J. Boruff, and W. L. Shirley (2003). Social vulnerability to environmental hazards. *Social Science Quarterly* 84 (2): 242-261.

Cutter, S. L., L. Barnes, M. Berry, C. Burton, E. Evans, E. Tate, and J. Webb (2008). A place-based model for understanding community resilience to natural disasters. *Global Environmental Change* 18(4): 598-606.

Davis, D. L. (1986). Occupational Community and Fishermen's Wives in a Newfoundland Fishing Village. *Anthropological Quarterly* 59(3): 129-142.

Davis, M. E. (2012). Perceptions of occupational risk by US commercial fishermen. *Marine Policy* 36: 28-33.

Deason, G., E. Seekamp, and C. Barbieri (2014). Perceived impacts of climate change, coastal development and policy on oyster harvesting in the Southeastern United States. *Marine Policy* 50: 142-150.

Dillman, D. A., J. D. Smyth, and L. M. Christian (2009). “Internet, Mail and Mixed-Mode Surveys: The Tailored Design Method.” John Wiley and Sons, Inc., New York.

Ebbin, S. A. (2009). Institutional and ethical dimensions of resilience in fishing systems: Perspectives from co-managed fisheries in the Pacific Northwest. *Marine Policy* 33: 264-270.

Flint, C. G. and A. E. Luloff (2005). Natural resource-based communities, risk, and disaster: An intersection of theories. *Society & Natural Resources* 18(5): 399-412.

Folke, C., S. Carpenter, T. Elmqvist, L. Gunderson, C. S. Holling, and B. Walker (2002). Resilience and sustainable development: Building adaptive capacity in a world of transformations. *Ambio* 31(5): 437-440.

Forster, J., I. R. Lake, A. R. Watkinson, and J. A. Gill (2014). Marine dependent livelihoods and resilience to environmental change: A case study of Anguilla. *Marine Policy* 45: 204-212.

- Gallopin, G. C. (2006). Linkages between vulnerability, resilience, and adaptive capacity. *Global Environmental Change* 16(3): 293-303.
- Glazier, E. W. (2007). Hawaiian fishermen. Belmont, CA: Thompson Wadsworth Co.
- Grothmann, T. and A. Patt (2005). Adaptive capacity and human cognition: The process of individual adaptation to climate change. *Global Environmental Change* 15: 199-213.
- Howard, J., E. Babij, R. Griffis, B. Helmuth, A. Himes-Cornell, P. Niemier, M. Orbach, L. Petes, S. Allen, G. Auad, R. Beard, M. Boatman, N. Bond, T. Boyer, D. Brown, P. M. Clay, K. Crane, S. Cross, M. Dalton, J. Diamond, R. Diaz, Q. Dortch, E. Duffy, D. Fauquier, W. Fisher, M. Graham, B. Halpern, L. Hansen, B. Hayum, S. Herrick, A. Hollowed, D. Hutchins, E. Jewett, D. Jin, N. Knowlton, D. Kotowicz, T. Kristiansen, P. Little, C. Lopez, P. Loring, R. Lumpkin, A. Mace, K. Megerink, J. R. Morrison, J. Murray, K. Norman, J. O'Donnell, J. Overland, R. Parsons, N. Pettigrew, L. Pfeiffer, E. Pidgeon, M. Plummer, J. Polovina, J. Quintrell, T. Rowles, J. Runge, M. Rust, E. Sanford, U. Send, M. Singer, C. Speir, D. Stanitski, C. Thornber, C. Wilson and Y. Xue (2013). Oceans and marine resources in a changing climate. In R. N. Hughes, D. J. Hughes, and I. P. Smith (Eds.), *Oceanography and Marine Biology: An Annual Review - Volume 51* (pp.71-192). Boca Raton, FL: CRC Press.
- Ihde, T. F., M. J. Wilberg, D. A. Loewensteiner, Da. H. Secor, and T. J. Miller (2011). The increasing importance of marine recreational fishing in the US: Challenges for management. *Fisheries Research* 108: 286-276.
- Jacob, S., J. Landau, B. Blount, H. McIlvaine-Newsad, and P. Weeks (2013). "Social Impacts of the Allocation/Reallocation of Marine Fisheries Resources on Communities in the Gulf of Mexico and South Atlantic: Development of an Empirical Predictive Model." Technical Report, 159p. Marine Fisheries Initiative Competitive Grant Program (MARFIN). NOAA NMFS 09MF034 (ESS). Online at: [http://www.gulfsouthfoundation.org/uploads/108\\_112\\_final\\_jan2013.pdf](http://www.gulfsouthfoundation.org/uploads/108_112_final_jan2013.pdf)
- Jepson, M., and S. Jacob (2007). Social indicators and measurements of vulnerability for Gulf coast fishing communities. *NAPA Bulletin* 28: 57-68.
- Jepson, M., and L. L. Colburn (2013). "Development of Social Indicators of Fishing Community Vulnerability and Resilience on the U.S. Southeast and Northeast Regions" NOAA Technical Memorandum, 64p. NMFS-F/SPO-129. Online at: [http://sero.nmfs.noaa.gov/sustainable\\_fisheries/social/documents/pdfs/communities/2013/vulnerability\\_resilience\\_social\\_indicators.pdf](http://sero.nmfs.noaa.gov/sustainable_fisheries/social/documents/pdfs/communities/2013/vulnerability_resilience_social_indicators.pdf)
- Kalikoski, D. C., P. Q. Neto, and T. Almudi (2010). Building adaptive capacity to climate variability: The case of artisanal fisheries in the estuary of the Patos Lagoon, Brazil. *Marine Policy* 34(4): 742-751.
- MacKenzie, C. J. A., and S. P. Cox (2013). Building legitimacy of the recreational fishing sector in mixed commercial-recreational fisheries. *Ocean & Coastal Management* 75: 11-19.
- Mamauag, S. S., P. M. Aliño, R. J. S. Martinez, R. N. Muallil, M. V. A. Doctor, E. C. Dizon, R. C. Geronimo, F. M. Panga, and R. B. Cabral (2013). A framework of vulnerability assessment of coastal

fisheries ecosystems to climate change – Tool for understanding resilience of fisheries (VA-TURF). *Fisheries Research* 147: 381-393.

Marshall, N. A., D. M. Fenton, P. A. Marshall, and S. G. Sutton (2007). How resource dependency can influence social resilience within a primary resource industry. *Rural Ecology* 72(3): 359-390.

Marshall, N. A. and P. A. Marshall (2007). Conceptualizing and operationalizing social resilience within commercial fisheries in Northern Australia. *Ecology and Society* 12(1): 1 [online] URL: <http://www.ecologyandsociety.org/vol12/iss1/art1/>

McClenachan, L., G. O'Connor, and T. Reynolds (2015). Adaptive capacity of co-management systems in the face of environmental change: The soft-shell clam fishery and invasive green crabs in Maine. *Marine Policy* 52: 26-32.

MSFCMA (Magnuson-Stevens Fishery Conservation and Management Act) Reauthorization of 2007, 16 U.S. Code § 1851 (a)(8). Online at: [http://www.nmfs.noaa.gov/sfa/magact/MSA\\_Amended\\_2007%20.pdf](http://www.nmfs.noaa.gov/sfa/magact/MSA_Amended_2007%20.pdf).

Murray, G., T. Johnson, B. J. McCay, M. Danko, K. St. Martin, S. Takahashi (2010). Creeping enclosure, cumulative effects and the marine commons of New Jersey. *International Journal of the Commons* 4(1): 367-389.

NOAA (National Oceanic and Atmospheric Administration) (2012). "Secretary of Commerce declares fisheries disaster for New York and New Jersey in the aftermath of Sandy." Press Release, November 16, 2012. Online at: [http://www.noaaneews.noaa.gov/stories2012/20121116\\_fisher\\_declaration.html](http://www.noaaneews.noaa.gov/stories2012/20121116_fisher_declaration.html)

Norr, K. L. and J. L. Norr (1974). Environmental and technical factors influencing power in work organizations: Ocean fishing in peasant societies. *Sociology of Work and Occupations* 1(2): 219-251.

Norris-Raynbird, C. (2004). 'For-hire' in the US Gulf of Mexico: A typology of offshore charter and party boat operations. *MAST (Maritime Studies)* 23(2): 37-73.

NWS (US National Weather Service) (2013). "Hurricane/Post Tropical Cyclone Sandy, October 22-29, 2012." Service Assessment Report, 65p. Online at: <http://www.nws.noaa.gov/os/assessments/pdfs/Sandy13.pdf>

Olson, J. (2006). Changing property, spatializing difference: The sea scallop fishery in New Bedford, Massachusetts. *Human Organization* 65(3): 307-318.

Olson, J. (2011). Understanding and contextualizing social impacts from the privatization of fisheries: an overview. *Ocean and Coastal Management* 54(5): 353-363.

Pita, C., H. Dickey, G. J. Pierce, E. Mente, and I. Theodossiou (2010). Willingness for mobility amongst European fishermen. *Journal of Rural Studies* 26: 308-319.

Poggie, J., R. Pollnac, and S. Jones (1995). Perceptions of vessel safety regulations: A southern New England Fishery. *Marine Policy* 19(5): 411-418.

- Pollnac, R. B. (1988). Social and cultural characteristics of fishing peoples. *Marine Behavior and Physiology* 14(1): 23-39.
- Pollnac, R. B. and J. J. Poggie (2006). Job Satisfaction in the Fishery in Two Southeast Alaskan Towns. *Human Organization* 65(3): 329-339.
- Pollnac, R. B., S. Abbott-Jamieson, C. Smith, M. Miller, P. Clay, and B. Oles (2008). Toward a model for fisheries social impact assessment. *Marine Fisheries Review* 68(1-4): 1-18.
- Pollnac, R. B. T. Seara, and L. L. Colburn (2015). Aspects of fishery management, job satisfaction, and well-being among commercial fishermen in the Northeast Region of the United States. *Society & Natural Resources* 28(1): 75-92.
- Pomeroy, R., B. Ratner, S. Hall, J. Pimoljinda, and V. Vivekanandan (2006). Coping with disaster: rehabilitating coastal livelihoods and communities. *Marine Policy* 30: 786-793.
- Rajib, S., J. Joerin and R. R. Krishnamurthy (2014). The Concept of Resilience to Disasters In *Building Resilient Urban Communities* (pp. 216). Bingley, UK: Emerald Group Publishing Limited.
- Reed, M., P. Courtney, J. Urquhart, and N. Ross (2013). Beyond fish as commodities: Understanding the socio-cultural role in inshore fisheries in England. *Marine Policy* 37: 62-68.
- Smith, C. and P. M. Clay (2010). Measuring Subjective and Objective Well-Being: Examples from Five Commercial Fisheries. *Human Organization* 69(2):158-168.
- Sutinen, J. G. and R. J. Johnston (2003). Angling Management Organizations: Integrating the Recreational Sector into Fishery Management. *Marine Policy* 27: 471-487.
- World Values Survey (2014). Findings. Collection of Graphs Representing WVS Data. Figure on Cross-National Differences in Satisfaction. Online at: <http://www.worldvaluessurvey.org/>
- Wagner, M., N. Chhetri, and M. Sturm (2014). Adaptive capacity in light of Hurricane Sandy: The need for policy engagement. *Applied Geography* 50: 15-23.