


FEATURE

Perceptions of Resilience in Fishery-Dependent Bahamian Communities Following a Category 4 Hurricane



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Fishery-dependent communities in coastal environments are often vulnerable to hurricanes, but diverse and accessible fisheries may buffer the effects of extreme storms and promote community resilience. We began evaluating this possibility with a qualitative study in the Lowe Sound and Red Bays communities in The Bahamas immediately after the impact of a category 4 hurricane. We interviewed 68 households, asking about the relationships between the storm's impacts and fisheries resources. Lowe Sound respondents described fisheries as natural insurance that provided food and income. Both communities indicated that retaining access to boats was critically important. Respondents most often blamed impacts on low-elevation geography, followed by religious interpretations. Fishers linked damages with climate change more often than other community members, suggesting that fishers have an experiential knowledge of climate change. We discuss the importance of fisheries as natural insurance, how recovery efforts can strengthen resilience, and potential outreach strategies that incorporate local knowledge.

INTRODUCTION

Global climate change presents significant risk to communities that are dependent on fisheries. Globally, fisheries support the livelihoods of over 500 million people (FAO 2010). Most fishery-dependent communities are situated in developing nations and face climatic shocks and stresses, such as hurricanes, floods, droughts, sea level rise, land erosion, and temperature and rainfall fluctuations (IPCC 2007). Extreme weather events, such as hurricanes and floods, may exacerbate the otherwise gradual impacts of climate change by rapidly disrupting fishing operations and destroying land-based infrastructure (Westlund et al. 2007).

Several factors may help to explain how extreme weather events impact the resilience of fishery-dependent communities. Low livelihood diversification among some fishery-dependent communities may increase their vulnerability to climate change, as fishing activities often have high exposure and sensitivity to extreme weather events (Islam et al. 2014). Further, more vulnerable households often lack the financial capital needed to accumulate and maintain fishing equipment or to diversify their livelihoods (Paavola 2008; Black et al. 2011; Deressa et al. 2011). Fishers lacking the resources necessary to repair or replace fishing-related assets, such as fishing boats and equipment that have been destroyed by a storm, are less likely to return to fishing as their main livelihood (Bates 2002). Conversely, dependence on fisheries can improve community resilience when fisheries are not impacted by a natural disaster. Previous research suggests that communities can rely on natural resources as an insurance policy against climate and market variation (Schwartzman 1989; Clement 1993; Chibnik 1994). Higher diversity in natural products (e.g., forest plants or different fish species) may render higher income stability after disasters (Pattanayak and Sills 2001). However, using fisheries as natural insurance may require switching to alternative fish species and changing fishing grounds, as in the case of Ugandan fishers responding to increased floods and droughts (Musinguzi et al. 2016).

In this study, we build on existing climate vulnerability and resilience research (Islam et al. 2014; Musinguzi et al. 2016) with a qualitative case study of respondents ($n = 68$) from Lowe Sound and Red Bays, two fishery-dependent communities on Andros Island (hereafter, Andros), The Bahamas. These communities provide an excellent case study because they are traditionally tied to fisheries and Hurricane Matthew directly hit both on October 6, 2016, at category 4 strength. Hurricane Matthew greatly impacted the northern Caribbean and southeastern USA, making landfall in the Dominican Republic, Haiti, Cuba, The Bahamas, and several southeastern U.S. states; the hurricane reached category 5 strength at the lowest latitude ever recorded in the Atlantic basin, and it directly caused nearly 600 deaths (Stewart 2017). Lowe Sound suffered extensive damage to all homes and a major loss of

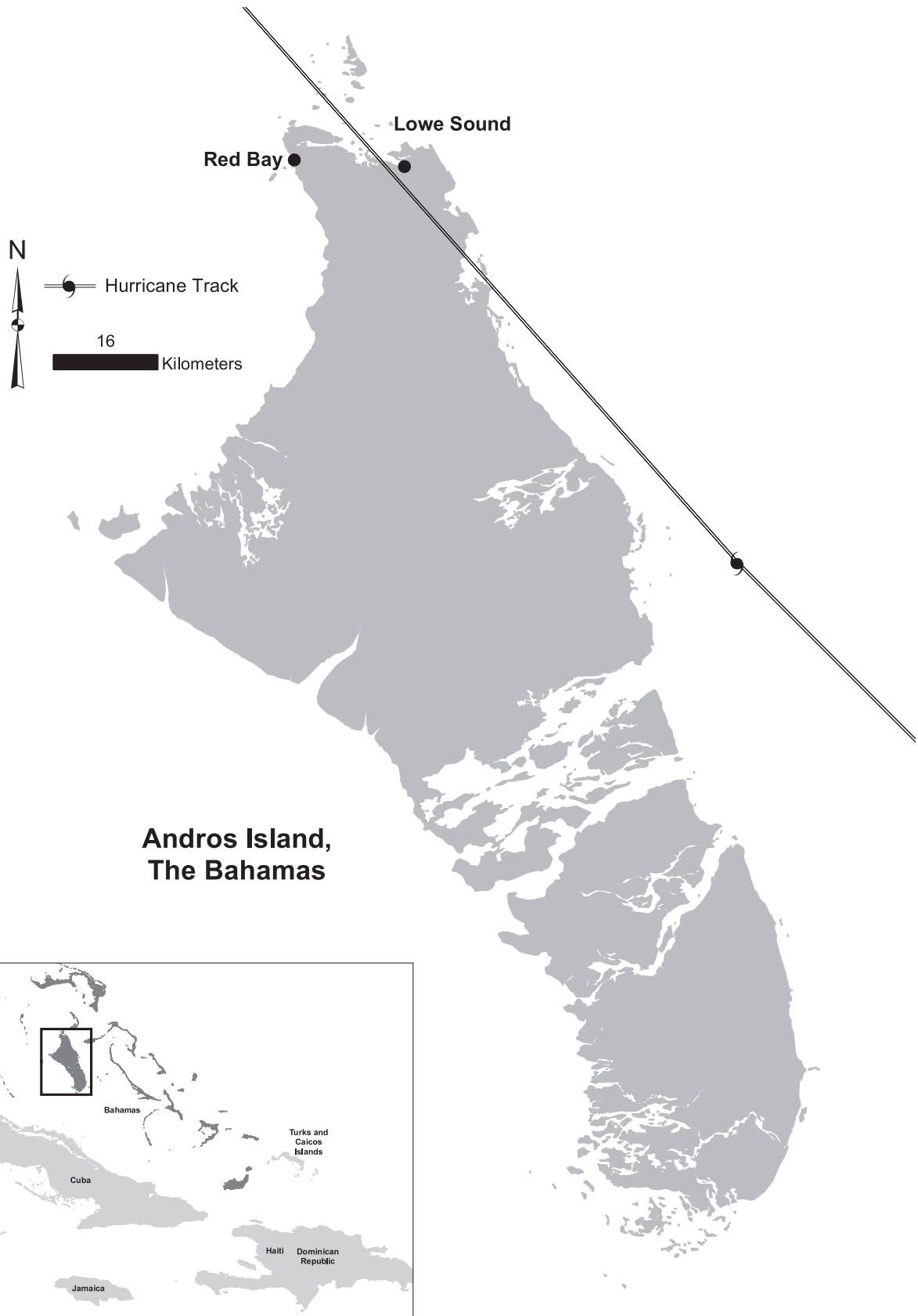
fishing boats, while Red Bays experienced substantial—but less severe and extensive—wind and flood damage (Turnquest 2016). To evaluate and compare vulnerability and resilience across these communities, we identified and focused on six key themes: local perceptions of the causes of destruction, fishing impact, community recovery, fisheries as natural insurance, sea level rise, and future evacuation plans. The present study builds on previous research by exploring how impact severity shapes community response to climatic shocks and the degree to which community members perceive fisheries as natural insurance. The Lowe Sound and Red Bays communities provide an informative case study due to their low elevation (0–4 m), immediate proximity to the coast, and fishery-dependent livelihoods (Silvy et al. 2018).

METHODS

Study Area

Lowe Sound and Red Bays are located on Andros, the largest island in the Bahama Archipelago. Lowe Sound had 712 inhabitants and Red Bays had 284 inhabitants in 2010 (Bahamas DOS 2010). Lowe Sound is on the northern coast of Andros, whereas Red Bays is on the northwestern coast; the communities are approximately 11 km apart (Figure 1). Red Bays was on the leeward side of Andros during Hurricane Matthew, whereas Lowe Sound was on the windward side. Red Bays has minimal mangrove protection and is in a shallower area, which has resulted in the re-settlement of the community after previous storms (Howard 2006). Marine activities have been central to the survival of Andros communities for centuries; fishing has been the leading industry throughout the island's recorded history (Silvy et al. 2018). Residents of Lowe Sound are economically dependent on fishing activities but were less isolated from other areas historically and have less reliance on fishing for sponges, locally known as “sponging” (Howard 2002). Red Bays has a subsistence economy; residents engage in fishing, lobstering (residents refer to Caribbean spiny lobster *Panulirus argus* as “crawfish”), and sponging activities to earn income (Howard 2002). Sponging was a major industry in Red Bays until an unidentified disease destroyed the most valuable sponge beds in 1938. Sponging has recovered but is no longer the dominant economic activity (Howard 2002; our field notes). The community of Red Bays was largely isolated from the remainder of the island until the road into the settlement was paved in the 1980s (Howard 2002).

In the days immediately before Hurricane Matthew made landfall, residents were advised to evacuate low-lying regions of The Bahamas (Brown 2016). The immediate coastal proximity and low elevation of both Lowe Sound and Red Bays led to storm damage. In Lowe Sound, storm surge reached 2.4 km inland and surged over 3 m above normal sea level (Hunt 2016; Scavella 2016). Water supply systems in both communities were temporarily disrupted, destruction of the



**Andros Island,
The Bahamas**

Figure 1. Storm track of Hurricane Matthew (2016) and the location of the study areas (Lowe Sound and Red Bays) in the northern section of Andros Island, The Bahamas.

telecommunications tower cut off all telephone communications, and electricity was lost for several weeks. After the storm, local officials requested food, water, and cleaning supplies from the National Emergency Management Agency (NEMA; Turnquest 2016). An estimated 304 people were displaced from their homes (Scavella 2016), and the most damage to infrastructure and homes occurred in Lowe Sound (*The Nassau Guardian* 2016; respondents in this study).

Approach

We utilized a naturalistic approach of qualitative research (Lincoln and Guba 1985) to explore local perceptions of resilience in the fishing communities of Lowe Sound and Red Bays. This approach reflected our purpose: to understand and explore the meanings and processes as informants lived them. The naturalistic approach aims not to generalize with numerical representations but to explore multiple realities arising from social circumstances (Lincoln and Guba 1985; Guba and Lincoln 2005). We used “snowball sampling” (Noy 2008) wherein known fishers in each community were asked to identify other households that were involved in fishing. We continued interviewing until no new themes emerged (Peterson et al. 2010); 46 households in Lowe Sound and 22 households in Red Bays were interviewed. We supplemented interview data with field notes, including informal conversations and interactions with locals.

We conducted interviews using nine prompts (Table 1), and transcribed the audio recordings immediately after interviews had concluded. Interviews were transcribed and coded using Weft QDA software (Fenton 2006). We coded by re-reading interview transcripts and selecting quotations or observations that provided indications of how people from both settlements were recovering from Hurricane Matthew as well as impacts of the hurricane on their livelihoods. We identified themes (Table 1) related to climate change resilience using a combination of recurring motifs in the interviews and field notes. To assess intercoder reliability, the established metric of

consistency in qualitative text analysis (Krippendorff 2004), two interviewers coded 20 randomly selected interviews (10 interview transcripts from Lowe Sound and 10 transcripts from Red Bays). We evaluated intercoder reliability by using Cohen’s kappa (Lombard et al. 2002), and values were above 0.82 for each theme, indicating high intercoder reliability. To categorize quotations, we denote the date and location of the interview with the first letter of the informant’s first and last pseudonym. For example, an interview with “John Smith” on May 15, 2017, in Lowe Sound is denoted as “J.S. 5/15/17 LS.” We reference quotations from field notes using the pseudonym of the source and field notes (i.e., “J.S., field notes” or simply “field notes”). We refer to all other observations as field notes. Pseudonyms are used to protect the confidentiality of respondents, in compliance with the North Carolina State University Institutional Review Board (IRB) requirements for researching human subjects (IRB Number 4000). We used chi-square (χ^2) tests to examine for differences in the frequency of themes between residents in the communities of Lowe Sound and Red Bays.

RESULTS

Respondents from both Red Bays and Lowe Sound viewed fisheries as a reliable source of economic security and social recovery after Hurricane Matthew. Our results indicate that fisheries were respondents’ main source of livelihood. All respondents fished or had a family member that fished. Among respondents, 60.3% were male ($n = 41$), and 43.3% participated directly in fishing, crabbing, or sponging for their livelihoods ($n = 29$). All respondents who indicated direct participation in these activities were male. We included responses from female respondents due to shared affiliations with fishing at the family level.

Responses regarding the extent of damage to the two communities mirrored published reports (*The Nassau Guardian* 2016); Lowe Sound suffered greater damage than Red Bays. According to Gavin, a Red Bays resident, “Lowe Sound was destroyed. Completely destroyed” (G. 5/29/17 RB). Oliver reported, “Lowe Sound wasn’t lucky because the storm surge was 15 feet [4.6 m] high and the water destroyed a lot of people’s houses, cars, boats; they couldn’t find a lot of boats, and bodies came up out of the graves” (O. 5/28/17 RB). News media similarly described displaced caskets and human remains from a seafront cemetery after Hurricane Matthew (Chance 2016). Conversely, Mark said that in Red Bays, “We ain’t have no water, just breeze” (M. 5/28/17 RB).

Community perceptions between Lowe Sound and Red Bays respondents were similar except for the perceptions of fish as natural insurance. Collectively, respondents in both communities offered similar explanations for the hurricane’s cause of destruction; 55.2% implicated geography of the settlements where the storm made landfall (e.g., situated near or along the coast) and the timing of the storm relative to tides, 26.8% believed God was punishing the residents of Lowe Sound for violating religious norms, and 10.4% cited climate change. These explanations are explored further in the next section (Cause of Destruction). The majority of respondents in both Lowe Sound and Red Bays believed that their communities would recover from the storm (62.2% and 63.6% respectively). More respondents from Lowe Sound reported negative fishing impacts (64.4%) compared to respondents from Red Bays (40.9%), although this difference was not statistically significant ($\chi^2 = 3.3340$, $P = 0.343$). Similar numbers

Table 1. Themes associated with responses to interview prompts for residents of Lowe Sound and Red Bays, The Bahamas. Prompts that are listed multiple times yielded multiple themes.

Prompt	Theme emerging from prompt
Will you describe your experience with Hurricane Matthew?	Cause of destruction
Why do you think the hurricane did so much damage in Lowe Sound?	Cause of destruction
Do you think sea level is rising here?	Sea level rise
What people were impacted most by the storm?	Community recovery
How has the storm impacted the ways your family makes a living?	Community recovery
Did you need to move because of the storm?	Community recovery
Did you have to change your job because of the storm?	Community recovery
What people were impacted most by the storm?	Fishing impact
How were fishermen impacted here?	Fishing impact
How were fishermen impacted here?	Fish as natural insurance
Will you evacuate if another storm comes?	Future evacuation

of respondents from Lowe Sound and Red Bays indicated that they would evacuate in the case of a future hurricane (53.3% and 45.5%, respectively; $\chi^2 = 0.3670$, $P = 0.947$). Respondents from Lowe Sound were more likely to perceive fish as natural insurance compared to Red Bays respondents (55.6% and 18.2%, respectively; $\chi^2 = 8.4074$, $P = 0.004$).

Cause of Destruction

Respondents attributed storm damages to multiple causes, and respondents from both communities typically discussed impacts to Lowe Sound when describing storm damage. Explanations for the causes of destruction (see above) did not differ between communities ($\chi^2 = 1.3269$, $P = 0.515$). Hugo, a woodcarver from Red Bays, said, “Lowe Sound is surrounded by water, in the front and the back and then the ocean. They had the ocean tide come in head on, and in the back, the creek flooded” (H.W. 5/29/17 RB). A Lowe Sound resident also described the water coming on both sides, “the way the storm was spinning, it might have come from the back, and it brought the sea and everything... The wind didn’t cause the damage, it was the sea” (N.B. 5/26/17 LS). Nancy, the daughter of a Lowe Sound store owner, explained that “We are right next to the water, and there was a surge and the houses were right there, so it was easy for the water to come in” (N. 5/28/17 LS). Derek said that Hurricane Matthew hit Lowe Sound as hard as it did because of “the position and the direction that the storm came from” and that the settlement is “close to the edge of the ocean” (D. 5/27/17 LS). A farmer in Red Bays explained that another reason the storm did so much damage in Lowe Sound was due to structurally weak buildings: “The majority of the structures were really old, and they never repaired them” (C.M. 5/29/17 RB). He also said that the sea wall in Lowe Sound was not very effective: “The sea wall they built for Lowe Sound, that wasn’t a wall... I don’t think the wall was even 3 feet [0.9 m] high” (C.M. 5/29/17 RB).

The second most common explanation for extensive damage in Lowe Sound was punishment from God for violating religious norms. Deron, a fisher from Lowe Sound, explained, “In this part of Andros and The Bahamas, we are very religious. For a lot of us, we believe that this was a warning. People live too wickedly... We need some waking up at times” (D. 5/27/17 LS). Pierce, a resident of Lowe Sound, compared the settlement to Las Vegas in the United States: “We call this place Sin City. Party all night. Gambling, women... the big man above. He trying to give us a warning. There are wicked people here” (P.M. 5/26/17 LS). Beatrice also spoke of Hurricane Matthew as a warning: “A lot of wrongdoings here, you know. I think the Lord is showing Andros, you know... A lot of wickedness go down, especially in Lowe Sound” (B.T. 5/26/17 LS). Another woman from Red Bays noted that residents were not changing their ways. She said, “Most people ain’t worshipping right. He did it to show that He could take your life just like that. ‘I can send disaster to wake y’all up’” (L. 5/29/17 RB).

Among the seven respondents that cited climate change as the cause for damages, five were fishers. When describing adaptive strategies to mitigate the effects of climate change, Oliver, a sponger from Red Bays, responded, “There’s nothing they can do about it. It’s just happening. If there’s another hurricane in the future that’s worse than Matthew because of global warming and the surge is 30 feet [9 m], not even 60 feet [18.3 m], no part of this land would be safe” (O. 5/28/17 RB).

Derek mentioned, “I think it’s climate change. You notice it’s getting hotter and hotter every year” (D. 5/28/17 LS). Scott, an angler in Red Bays, also anticipates more difficulty in facing future storms: “You can feel it. Eventually storm is going to get worse. Going to have a lot of climate change” (S. 5/28/17 RB).

Sea Level Rise

Although few respondents connected climate change to the severity of Hurricane Matthew, many reported noticeably rising sea levels. Fewer than half of the respondents in Lowe Sound (40.0%) and more than half of the respondents in Red Bays reported rising sea levels (55.6%; $\chi^2 = 1.0965$, $P = 0.295$). Adam described, “I watched the sea level come up more than it did years ago” (A.G.G. 5/28/17 LS). Oliver also reported a sea level rise: “The ocean level is rising... if Red Bays wasn’t high as it is, the entire settlement would be underwater” (O. 5/28/17 RB). Justin noted, “Sometimes the tide in the road, man. Near spring. I don’t know what to think about that” (J. N. 5/28/17 RB). Sabrina, a woman from Lowe Sound, also reported unusually high water levels for the region: “Did you see last night? The water was in the road!” (S.A. 5/28/17 LS). For both Lowe Sound and Red Bays, the proximity to the coast provided residents with high exposure to changes in sea level, though most residents did not connect the sea level rise to hurricane intensity or climate change.

Community Recovery

Most respondents from both Lowe Sound (60.0%) and Red Bays (68.2%) believed that their communities would eventually fully recover from the storm ($\chi^2 = 0.4229$, $P = 0.515$). Adam, a contractor in Lowe Sound, stated that the community would take “2, 3 years to get back together, as long as there’s no more hurricanes or major damages” (A.G.G. 5/28/17 LS). Roofers in Red Bays said, “Next 2, 3 years [Red Bays] should be organized, you know. But Lowe Sound going to be about 5 years” (C. 5/29/17 RB). Hector, a conch stand (restaurant) owner that rebuilt shortly after the storm, urged the younger generation in Lowe Sound to come together and work to rebuild their community (H. field notes). A Lowe Sound homeowner said, “Most of the people around here are saying ‘I’m waiting for the government to do this’ or ‘I’m waiting for the government to do that,’ but they don’t... we don’t wait for the government. We got and try, try on your own. You got to show that effort” (C.P. 5/26/17 LS). Some residents were confident in their ability to recover. A farmer in Red Bays stated, “We always pull through, somehow” (C.M. 5/29/17 RB). According to Sandy, “Lowe Sound is a resilient community. You can’t take a fisherman and put him on the farm, and Lowe Sound, the community and the people, are fisherman. They need to be back home with they people and they water” (S. 5/27/17 LS). Derek also spoke of the resilience of Lowe Sound, believing that most residents will move back once the settlement is rebuilt. He said, “People love they homes. Especially if you were born here, your mother and grammy was born here, and people just, you know, don’t want to move away from they homes. So, yeah, I think a lot of people will come back” (D. 5/27/17 LS). Although respondents acknowledged the difficulty of rebuilding, most predicted that their communities would recover.

Respondents were concerned about psychological recovery after the storm. Paul, a fisher from Lowe Sound, said that it would be impossible for Lowe Sound to recover from psychological trauma: “The mental part is not fixable. We had a lot of loss. Stress related as well as physically and

economically. I think that is the biggest killer right now in our settlement” (P.M. 5/27/17 LS). Hugo knew a friend that had to go to “Nassau because he was crazy, he had to go to a place to rehab” because the hurricane had such a detrimental impact on his mental health. He said, “A lot of people still haven’t caught themselves... They’re still in shock” (H.W. 5/29/17 RB). Deron also argued that the mental impacts were even worse than the physical damages: “It’s not the damages, it’s the mind state. You live in a home all your life, your kids grow up in it, and all of a sudden you wake up and it’s gone” (D. 5/27/17 LS). During an interview in Lowe Sound, lightning struck, followed by thunder, and all of the bar patrons jumped at the sound. A man walking in the street flinched and ran to take shelter in a bar; several people then made nervous jokes about another hurricane (field notes).

Fishing Impact

Red Bays was spared some of the boat damages and losses experienced by Lowe Sound residents. More respondents from Lowe Sound reported negative impacts on fishing livelihoods (64.4%) compared to respondents from Red Bays (40.9%), although this difference was not significant ($\chi^2 = 3.3340$, $P = 0.343$). The most common negative impact to fishing livelihoods described by respondents included destruction of boats and other fishing equipment, such as “crawfish condos” (artificial reefs used to attract lobsters). With lobster season being the most lucrative fishing season in North Andros, the crawfish condos were important for the livelihoods of Lowe Sound residents. Deron explained, “The traps to catch fish and crawfish, normally we crawfishing and scale fishing, conch, what that did was all the stuff we put down to catch fish was gone. The stuff we put down, what we call fish drops, everything was washed away. It was like someone just swept the bottom of the water, left it clean” (D. 5/27/17 LS). Adam also spoke about the destruction of traps: “It moved a lot of traps and stuff. Broke up traps, broke up boats” (A.G.G. 5/28/17 LS). Simon described how Hurricane Matthew “[changed] the whole fishing industry when it comes to crawfish” (S.O. 5/26/17 LS). He said, “the artificial reefs, so we put down for the crawfish, everything was displaced,” and he described how fishing spots that were marked on GPS devices no longer held crawfish. “You can go out there, where your GPS take you to where they are, and they wouldn’t be there” (S.O. 5/26/17 LS). Other respondents commented on the loss and destruction of fishing boats. Hunter said, “Everybody boat getting smashed” (H. 5/26/17 LS). Sabrina said that her family’s boat was destroyed and, therefore, fishing would never recover (S. 5/28/17 LS).

Conversely, Red Bays respondents reported disruptions to fishing, but none reported losing a boat. A store owner said, “We tied [boats] to the trees. No damage boats around here” (P.S. 5/28/17 RB). Justin, a Red Bays sponger, said, “The storm really destroy some of the areas for the sponge for me. Killed a lot... destroy a lot of the sponging ground” (J.N. 5/28/17 RB). Most Red Bays residents only noted that muddy waters and rough seas occurred after the storm. A fisher, Gavin, said, “It took months before the water get clear. We live on the west coast, and from the north, if you go this way it’s all mud banks. So once that stirs up, it takes a lot to settle” (G. 5/29/17 RB). Another angler said, “The fishing went bad for a while. October, November, December? We have a bad fishing time. The water muddied up for the longest. Especially Lowe

Sound, they have to go way out to the Berry Islands, Bimini to catch fish” (C. 5/29/17 RB).

Fish as Natural Insurance

Several respondents considered fisheries a readily available and largely indestructible resource to use in times of need. Although this sentiment occurred in both communities, respondents from Lowe Sound were more likely to believe that the fishery provided insurance against the negative impacts of storms (55.6%) than respondents from Red Bays (18.2%; $\chi^2 = 8.4074$, $P = 0.004$). Miles said, “Fishing ain’t never changed. That’s still the same” (M.C. 5/27/17 LS). Nate said, “Fishing still good, so that’s all you can ask for, you know. The conch industry, that’s never going to stop” (N. 5/27/17 LS). A bar patron also spoke on the resilience of the fishing industry and the community as a whole: “Ain’t nothing you could do with Lowe Sound. It’s here to stay. We got the sea. That’s all we need... The sea never go broke, always remember that. Crawfish, conch, and fish will always sell” (N.B. 5/26/17 LS). As Sarah noted, the fishing community got “right back. Every day people go in the boat to go get their conch. So they bring sometimes like four- or five-thousand conch per days” (S.R. 5/27/17 LS). A fisher in Lowe Sound exclaimed, “This is the Great Bahama Bank. There’s nothing they can do to us. This is the richest bank in The Bahamas. They cannot stop us... This is our livelihood” (G.B. 5/27/17 LS). When describing why fishing jobs are more resilient to hurricanes than other jobs, a Red Bays farmer said, “Because the Father [God]. It’s just the way it was designed. After the weather settled, everything came back to normal. As long as your boat wasn’t damaged or taken away, you didn’t have a problem and you could go right back to work” (C.M. 5/59/17 RB).

Some even described aspects of the community’s fishing production that had improved as a result of Hurricane Matthew. Paul said, “The good thing was the crawfish. It bring so much crawfish that it helped a lot in the aftermath. People could just walk out there and grab a crawfish; that’s how many there was” (P.M. 5/27/17 LS). Several other Lowe Sound fishers mentioned an increase in lobster after the storm. A bar patron said, “That’s the only thing good that Matthew did for us. It bring in more crawfish for us. That’s the only thing he did great” (N.B. 5/26/17 LS). Matt reported, “In fact, the storm may have increased the fishing in Lowe Sound. Because the waves that come in brought in a lot of crawfish. It cleaned the ocean floor, which make it more accessible for fish to feed. I think it done good” (M. 5/28/17 LS).

For many fishers in Lowe Sound, boat donations and government support were vital to restoring their fishing livelihoods. A woman in Lowe Sound said, “People had worldwide sponsors, you know. Worldwide sponsors and stuff, so they just bought them engines and bought them boats and all sorts of stuff” (B.S. 5/26/17 RB). Adam reported, “NEMA and the government gave us a voucher to Marlin Marina on Nassau to get an engine or materials to fix the boat” (A.G.G. 5/28/17 LS). Fishing was even able to support those who could not recover their boats after the storm. Nate, a fisher in Lowe Sound, did not receive a donation or voucher to repair one of his boats, but he was still able to support a fishing livelihood by fishing with other community members on their boats (field notes). Additionally, we saw several tarps (tarpaulins)—which were supplied by the U.S. Agency for International Development to temporarily aid leaking roofs—being used instead to cover conches on boats, even for some residents who still had leaky

roofing (field notes). This suggested that increasing the survival of conches during transportation was more valuable and important to some fishers in Lowe Sound than improving housing conditions.

Future Evacuation

Overall, half of the respondents planned on evacuating for the next hurricane (50.7%; $n = 34$). Specifically, 53.3% of respondents from Lowe Sound reported that they would evacuate, and 45.5% from Red Bays planned to evacuate ($\chi^2 = 0.3670$, $P = 0.947$). Sandy said, “If thunder roll, this family gone! Literally, trust me! As soon as school is closed, we are out of here” (S. 5/27/17 LS). When considering staying, Miles exclaimed, “Where? Here? Never! My granny says if they call for lightning storms, we ain’t staying here... Something you only see in the movies” (in reference to Hurricane Matthew; M.C. 5/27/17 LS). A Lowe Sound fisher said, “If we had a category 0 coming, we not staying here. I’m going, I’m not staying for nothing. I’m not staying, I’m going” (D. 5/28/17 LS). A roofer in Red Bays explained that evacuation would depend on the intensity of the storm. He said, “If it’s a cat 1 or 2, everyone can stay in their house. But a cat 5, 4? It depends on where it’s coming, but if it’s coming from the west? They better be sure to get out of here” (C. 5/29/17 RB). Several Lowe Sound residents mentioned the lesson they learned by staying through the storm. A Lowe Sound man said, “Trust me, they will run next time; 1, 2, 3, I don’t care what it is. I’m not staying here, not after that one. Everyone has learned their lesson” (N.B. 5/26/17 LS). Mabel alluded to the lesson learned: “A lot of people will evacuate. A lot of people didn’t leave because they didn’t expect it to be as bad” (M.P. 5/28/17 LS).

DISCUSSION

Fisheries can impart natural resilience to vulnerable communities by providing insurance against economic and environmental shocks. In our study, the perceptions of fisheries acting as a natural insurance may explain the observed resilience to Hurricane Matthew’s impacts among Lowe Sound residents. Despite high exposure to the powerful storm, fishers in Lowe Sound managed to sustain their livelihoods. This aligns with research suggesting that the most exposed communities are not always the most sensitive to climatic shocks (Gbetibouo et al. 2010; Islam et al. 2014). Interestingly, Lowe Sound residents were more likely than Red Bays residents to indicate that fisheries acted as a natural insurance, despite greater damages in Lowe Sound, including the loss of fishing equipment. There are a few potential explanations for this pattern. First, Lowe Sound residents were able to continue fishing after the storm despite the damage to boats and equipment, and the juxtaposition between devastated homes on land and the sustained availability of fisheries in the water may have highlighted the importance of fisheries as natural insurance for their community. Second, some hurricane survivors search for “silver linings” to cope in the aftermath of a storm (Stanko et al. 2015). For Lowe Sound residents, fisheries may have acted as a “silver lining” that drives community perceptions of fisheries as a natural insurance and provides them with confidence that their community will recover. The historical loss of the core fishery in Red Bays helps to explain why fewer residents there viewed fisheries as natural insurance after the storm. Sponging was the major industry for the community from 1830 until 1930, when a disease decimated the sponges, the industry, and the

community (Howard 2002). The sponging industry in Red Bays has never fully recovered, and residents still discuss the collapse (field notes). The historical impacts to the community, including the loss of the sponging industry, may have inoculated residents against perceptions that fisheries will always be available as insurance against disasters.

This study suggests that fishing livelihoods may promote awareness of climate change and that fishers may be local conduits for climate change outreach. The impacts of climate change are incremental and often go unseen, attributes that likely contribute to climate change denial (Whitmarsh 2011; Spence et al. 2012). However, when daily rituals associated with livelihoods expose people to evidence of climate change, they are more likely to acknowledge it (Wolf and Moser 2011). The daily activities of fishers involve intimate relationships with sea level and water temperature (Wolf and Moser 2011) and seem likely to fit the types of activities that promote awareness of climate change. Fishers made up a majority of the respondents that linked the hurricane impacts with climate change, and these individuals could serve as key spokespersons for outreach intended to promote adaptation to climate change because they are trusted as local experts on both climate and community wellbeing (Naess 2013). Our findings also align with previous research among Inuit hunters in Canada, who observe wind patterns to make hunting and migration decisions (Gearheard et al. 2010). They have also reported long-term changes in wind patterns, which suggests that careful, consistent observations of weather may serve as indicators for climate change.

This study adds to the emerging research highlighting the importance of integrating religion into climate change adaptation communication efforts. The interactions between religious beliefs and climate change perceptions are complex (Wardekker et al. 2009), and strong religious beliefs are often blamed for divisive climate change perceptions (Smith and Leiserowitz 2013). However, religious messaging can provide avenues for effective climate change communication, as evidenced by Kathryn Hayhoe’s interactions with evangelical Christians in the United States (Hayhoe and Farley 2009; Webb and Hayhoe 2017). Hayhoe, an evangelical Christian climate scientist, incorporates personal religious values and includes biblical text and spiritual commentary in her presentations (Webb and Hayhoe 2017). This builds trust with her evangelical Christian audiences, which helps to increase their acceptance of anthropogenic climate change and their awareness of potential climate change impacts (Webb and Hayhoe 2017). A similar approach may be effective on Andros. Christianity is the dominant religion in The Bahamas; over 90% of the population practices Christianity, and the Constitution of The Bahamas requires the government to guarantee respect for Christian values (U.S. Department of State 2008). Our respondents perceived hurricane impacts through a lens of Christianity. Strategies such as partnering with local religious leaders or training communicators that incorporate faith and climate change messaging may similarly help to align the beliefs of fishery-dependent communities with empirically grounded climate change science and predictions. For fishery-dependent communities, such as Lowe Sound and Red Bays, recognizing climate change and understanding the potential future impacts will become increasingly important for planning and implementing actions to mitigate damages from climatic shocks, which are predicted to increase in the future (Allison et al. 2009).

This study also highlights how restoring access to fishery livelihoods affected by climatic shocks can improve the resilience of fishery-dependent communities. Fishing boats are key productive assets of sustainable fishing livelihoods (Allison and Ellis 2001). Iwasaki et al. (2009) reported that fishery-dependent communities in India identified fishing gear as a priority for maintaining livelihoods and identified fishing boats as the resources that were most vulnerable to climate change shocks. Our results align with this research, as fishers in Red Bays stated that they continued fishing with undamaged boats, and many fishers in Lowe Sound credited donations for boat repairs from relief organizations and boat sharing with friends for restoring their livelihoods. Our observations of roofing tarps being preferentially used to protect catch rather than to repair leaking roofing highlight the importance of protecting livelihoods after climatic shocks. Post-storm recovery often focuses on restoring physical infrastructure, such as housing, hospitals, and churches (Aldrich 2012). This restoration is critically important, but our results indicate that residents in some communities may prioritize restoring access to their livelihoods. Future post-storm restoration efforts should continue to link fishery-dependent communities with productive assets (Putnam 2001; Marín et al. 2015). We also suggest building and developing physical infrastructure that improves boat security, such as marinas with floating docks and tall pilings (Adriance 2011). These structures have not been developed in either Lowe Sound or Red Bays.

CONCLUSIONS

One-third of all humans live within 100 km of the sea (IPCC 2014), and a dearth of relevant science creates a bottleneck for resilience planning in these areas (Clark et al. 2016; Arkema and Ruckelshaus 2017). Qualitative studies can support this need by focusing research on the resilience of fishery-dependent communities in natural (versus experimental) settings. More specifically, qualitative research can help to paint a picture of resilience from the perspective of local communities (Lincoln and Guba 1985), assist in developing theory about resilience rooted in local experience (Strauss and Corbin 1994), and empower local voices in future planning efforts. This case study of fishery-dependent communities in Lowe Sound and Red Bays provides valuable insights regarding both the importance of fishing livelihoods for maintaining community resilience in the aftermath of a climatic shock and ways to improve climate change outreach intended to promote future resilience. Understanding the complex social and ecological contexts that aid and hinder the resiliency of fishery-dependent communities is challenging. In North Andros, multiple social and ecological factors influenced community resilience. Fisheries were perceived as a natural insurance because multiple species were consistently available, and access via boats was either uninterrupted or rapidly restored. Accessing this insurance when needed, however, requires communities and relief agencies to develop and maintain the means to protect boats and gear or to store backup equipment in safe locations. Availability and access to fisheries may have also boosted the psychological resilience of fishery-dependent communities after Hurricane Matthew.

Communication efforts that include community members and incorporate local values can improve the resiliency of fishery-dependent communities in the future. Our results indicate that local fishers may be good spokespersons

for climate mitigation outreach efforts because they gain awareness of climate change through their livelihood activities and are respected within their communities. Outreach efforts to improve resilience can also be strengthened by incorporating local values, such as those linked to religion, or by partnering with religious organizations to develop trust with communities. Local experiences on Andros, however, may paint an artificially positive picture of how fisheries may operate as an insurance policy for coastal communities after major climatic disturbances. After all, our respondents knew that they were making withdrawals from what they referred to as the “richest bank” when they were catching fish on the Great Bahama Bank. Smaller, more degraded fisheries would offer less valuable insurance after major disturbances. These insights and guidelines for action are likely most relevant for fishery-dependent communities similar to Red Bays and Lowe Sound (Arkema and Ruckelshaus 2017), but the study design provides a template for gaining local insight about resiliency to climate-change-related disturbances in fishery-dependent communities globally.

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