Incorporating fishing community perceptions into fisheries management through semantic network analysis:
Case studies of the U.S. Virgin Islands and Fiji

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Abstract

Historical review illustrates that humans have had a profound impact on the coastal marine ecosystem, with overfishing eclipsing all other human disturbances. Recognition of this anthropogenic impact and attempts at managing fisheries over time highlight the need to manage the behaviors of people, not just fish, when managing fisheries.

This study explores the application of a software program to present qualitative data in a format more in line with a management system largely driven by quantitative analysis. Utilizing the case studies of reef fish spawning aggregation management in the U.S. Virgin Islands and Fiji, this research addresses the need to represent and incorporate fishing community perspectives into fisheries management. Through in-depth interviews and the application of semantic network analysis, qualitative open-ended responses to questions related to: 1) changes in marine resources, 2) reef fish spawning aggregations, and 3) local fisheries management are presented as semantic networks.

These networks provide snapshots identifying the collective knowledge, feelings, and perspectives of the fishing communities in these two locations with different community and fisheries management structures. The identification and representation of shared resource management themes can aide managers in identifying appropriate management strategies given the specific social context.
“...it’s salt water in my blood. I love the ocean and I love the fishing.” - USVI fisher 2010

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1.0 Introduction

1. Project description

Historical review illustrates that humans have had a profound impact on the marine environment, and that overfishing has “fundamentally altered coastal marine ecosystems” eclipsing all other human disturbances (Jackson et al., 2001). The reasons “involve both a scant understanding of extinction risk in the marine environment and misconceptions about the resilience of marine fish populations to heavy exploitation” (Sadovy, 2001). Recognition of this anthropogenic impact and attempts at managing fisheries over time illustrate the idea that fisheries management really involves managing people, not fish (Hall-Arber et al., 2009; Abbott-Jamieson and Clay, 2010).

Since 2001 the U.S. National Marine Fisheries Service (NMFS) has ramped up funding efforts to incorporate sociocultural data into the fisheries management process (Abbott-Jamieson and Clay, 2010). In light of that, this study explores the application of a software program to present qualitative data in a format more in line with a management system largely driven by quantitative analysis and the reliance of models to represent reality (Hall-Arber et al., 2009; Abbott-Jamieson and Clay, 2010). This research addresses the need to represent and incorporate fishing community perspectives into fisheries management, and does so using the case studies of reef fish spawning aggregation management in the U.S. Virgin Islands (USVI) and Fiji. This was achieved through in-depth interviews and the application of semantic network analysis of open-ended responses to questions related to: 1) changes in marine resources; 2) reef fish spawning aggregations; and 3) local fisheries management.

The semantic network results presented in this study are snapshots identifying the collective knowledge, feelings, and perspectives of the fishing communities in these two locations with different community and fisheries management structures. The identification and representation of shared resource management themes can aide managers in identifying management strategies and making decisions that are most appropriate for the specific setting. The social context framing management issues should be characterized so that it can be better understood. Demographic data alone is not sufficient.
2. What are FSAs and why are they an important management issue?

“Overfishing in many regions is increasing because of growing local and export demand for reef fishes and unsustainable fishing practices such as the overexploitation of spawning aggregations” (Kuridrani, 2008). Many larger species of commercially important coral reef fishes aggregate in large numbers at specific locations, seasons and moon phases to spawn (Johannes, 1978; Sadovy, 1996). These aggregations are believed to be the primary source of larvae that support local fisheries (Sadovy, 1996), and are also prime targets for fishers, who often take advantage of this unique opportunity for a relatively high catch volume per unit of time invested and potential for fast income (Beets and Friedlander, 1998; Rhodes, 1999). This practice that has occurred in both the USVI and Fiji can be particularly damaging to the local marine ecosystem and local community where FSAs serve as important sources of food and income.

In addition to the predictable nature of the timing and location of FSAs, species that aggregate to spawn share a combination of life history characteristics that make them particularly vulnerable to overexploitation (Sadovy, 2001; Luckhurst, 2002; Claydon, 2004). These life history traits include:

1. high fecundity,
2. a dispersive egg and larvae phase,
3. slow growth rate,
4. late sexual maturity,
5. small home ranges, and
6. protogynous hermaphroditism (Johannes, 1978; Sadovy and Eklund, 1999; Luckhurst, 2002; Nemeth et al, unpublished).

Nassau grouper, *Epinephelus striatus*, for example, gather to spawn at specific locations for only two weeks out of the entire year. For these, and many other aggregating species, this synchronized spawning event represents their only opportunity for reproduction (Sadovy and Eklund, 1999). This large fecund fish is easy to catch during these brief spawning aggregations and also as juveniles (Sadovy, 2001). The vulnerability of this species is illustrated by the commonly cited decline of the Nassau grouper and the disappearance of spawning aggregations
throughout its range documented by Sadovy in 1993, which resulted in the 1996 designation as endangered on the IUCN Red List and the US Endangered Species Act (Sadovy, 2001; Nemeth et al, 2006; Sadovy De Mitcheson et al, 2008). While this represents an extreme example of extirpation, it provides a good illustration of the complexities involved in FSA-forming species life history traits, monitoring population decline, and management measures.

Most reef fish species have complex life cycles that include the utilization of a variety of habitats. The larvae of reef species are typically pelagic, inhabiting the open ocean, with juvenile recruitment occurring in reef-adjacent habitats, such as mangroves, coral or rocky rubble, and seagrass beds. Adults are sedentary reef inhabitants, exhibiting site specificity and small predictable habitat ranges that can make these species easy targets for fishermen during this time as well (Sadovy and Eklund, 1999; Nemeth et al, unpublished). The need for multiple habitats during their life cycle defines the biophysical range of FSA management, and makes managing spawning aggregating species a complex endeavor requiring habitat connectivity and ecosystem based management (source).

Slow growth rates, delayed sexual maturity, and long lifespan (11 to 22 years) make the stocks of FSA-forming species less resilient to heavy exploitation from fishing (Sadovy et al, 1992; Nemeth, 2005). When protogynous hermaphroditism, demonstrated by species of most groupers and wrasses, is coupled with fishing targeting larger sizes, the reproductive output can be reduced and the sexual composition of the population altered (Claydon, 2004). This can greatly affect local populations, as seen with the red hind, E. guttatus, population in the U.S. Virgin Islands in the late 1980s (Olsen and LaPlace, 1978; Beets and Friedlander, 1998; Nemeth, 2005).

3. **Case studies: FSAs in the USVI and Fiji**

This study utilizes a case study approach. The units of analysis are individual participants who are then nested spatially and temporally within the larger case studies of the two geographical locations, the USVI and Fiji (Yin, 1194; Ayres et al, 2003; Gray and Campbell, 2007). While reef fish spawning aggregations have been documented all over the world (as of April 2012 the Society for the Conservation of Reef Fish Spawning Aggregations (SCRFA) database had a total
This research focuses on the fishing communities of St. Thomas, St. John, and St. Croix, USVI, and Kadavu and Ono, Fiji (www.scrfa.org). A fishing community is defined by the MSA as a placed-based entity that is substantially dependent and engaged in commercial, recreational, and/or subsistence fishing (Abbott-Jamieson and Clay, 2010; Stoffle et al., 2011).

3.1. Biophysical environments

Though Fiji is located in the South Pacific and the USVI in the Caribbean, they share similar biophysical environments, most notably coral reef ecosystems and the aggregating reef fish species Serranidae. Groupers in both locations migrate from their inshore home reefs to offshore spawning aggregation sites to reproduce. This migration poses management challenges, as previously discussed, in both locations.

The U.S. Virgin Islands

The USVI is comprised of three main islands, St. Thomas, St. John, and St. Croix, and about 50 cays (Kojis and Quinn, 2006) (Figure x). St. Thomas and St. John are located in the northern USVI and lie on the Puerto Rican Bank. The marine environment in the northern USVI contains extensive shallow water and deepwater coral reefs (Kojis, 2004). A deep trench separates St. Croix from St. Thomas and St. John. Two protected grouper spawning aggregations, Grammanik Bank and Hind Bank Marine Conservation District, are located in this trench (Figure x). St. Croix is the largest of the three main islands, and yet has an insular shelf that is both smaller and more shallow than those of the other islands. Located east of St. Croix’s insular shelf is another protected grouper spawning aggregation known as Lang Bank (Figure 3). Species utilizing these aggregation sites include red hind, Nassau, yellowfin (Mycteroperca venenosa), tiger (M. tigris), and yellowmouth (M. interstitialis) groupers (Nemeth, 2006).
Figure 1. Map of Caribbean and US Virgin Islands (Stoffle et al, 2011)

Figure 2. Map of St. Thomas and St. John, USVI showing closed FSA sites and managed areas. Map: K. Buja (Rothenberger et al, 2008)
Fiji consists of 844 islands and cays, most of which are uninhabited (The et al, 2009). The island of Kadavu and the nearby cay of Ono are southeast of the main island of Viti Levu (Figure 4). Kadavu and Ono are surrounded by the Great Astrolabe Reef. Naiqoro Passage is one of the main passages through the reef and is a known and researched grouper spawning aggregation site. Villages on northern Kadavu and Ono were selected for this study because of their proximity and customary rights to this resource (Figure 5).
Figure 4. Map of Fiji (www.destinationworld.com)

Figure 5. Northern Kadavu and southern Ono, Fiji- blue dots indicate village study sites
3.2. Social environment and context

The fisheries in both the USVI and Fiji are relatively small-scale artisanal tropical island fisheries that traditionally rely on the harvest of coral reef resources. While these two case study locations share similar physical environments, the social environment of these locations varies considerably and is the subject of this research. Historical information sheds light on the social environment that has evolved through the relationship between humans and the marine environment (Patton, 2002; Stoffle et al, 2011). The USVI and Fiji share a human history of colonial rule (the USVI was a Danish colony from 1672 to 1917 and Fiji was a British colony from 1874 to 1970), but beyond this similarity, their cultures are notably distinct (Hendricks, 2009; Srebrnik, 2002).

The U.S. Virgin Islands

During the 18th and early 19th centuries when the USVI was a Danish colony, enslaved West Africans were imported to support the sugar industry. The influx of West African tradition into Dutch, French, and Danish cultures created a unique cultural environment. After the abolition of slavery and transition to a US territory the islands slowly transformed from an agricultural dominated economy (which was no longer profitable without slavery) into a tourist destination (Hendricks, 2009). Tourism brought with it the opportunity to earn money, which drew people from neighboring islands, mainly of Hispanic and French descent, and Caucasians from the US mainland (Harrigan and Varlack, 1877).

The migration of Puerto Ricans and immigrants of French decent from St. Barths were influential to the fishing communities in St. Croix and St. Thomas respectively (Stoffle et al, 2011). Today, the culture of the USVI reflects the influence of these ethnicities with African Americans (West Indian) comprising the majority of the population. Despite the African American ethnic majority in the overall population on all three islands, a census of USVI commercial fishermen in 2006 found that USVI fishers identified themselves as black/West Indian (38.5%), Hispanic (33.1%), or French (16.7%) (Kojis, 2006).
“The US Virgin Islands and the Black Experience,” an article by Harrigan and Varlack, explores how the transition from colonial rule and slavery (forced labor) to independence (where there were few opportunities and idleness was possible) to a period of immigration and tourism, all play into the attitudes and culture of Virgin Islanders. When the US first purchased the islands, there was a period of naval rule before the USVI became a civil regime (Harrigan and Varlack, 1977). During this time, “the administration of the U.S. Navy[] stifled the political and civil rights of the subjugated islanders” (Hendricks, 2009). Parallels can be drawn between the attitudes experienced during that time of “let the navy do it,” with sentiments expressed today of “let the federal government do it.”

On the contrary, it has also been argued that Caribbean fishermen were “a privileged slave subgroup within the plantation system, and that their special socioeconomic role permitted a particularly smooth transformation to a life as free fishermen” (Price, 1966). Regardless of which theory is more accurate, the feeling of disempowerment discussed by Harrigan and Varlack should be considered in order to better understand a fisherman’s perspective of current management systems in the USVI, especially in terms of a lack of ownership and feeling responsible for natural resources. Starting in 1960, the population of white US mainlanders doubled from 3,900 to 6,500 within a five year period (Hendricks, 2009). During this time “many native-born Virgin Islanders felt displaced and marginalized” (Hendricks, 2009). Mario Moorehead, native Virgin Islander and “champion of black nationalism in the Virgin Islands during the period of 1968 to 1986,” describes such feelings (Hendricks, 2009):

“…[I]n general, the recent white arrival from the US mainland has not been a good neighbor. Lacking roots in this community, he finds little in common with native Virgin Islanders and makes no serious effort to bridge the cultural gap that separates us. He is one of many migrants from many places and has little sense of responsibility to this community…” (Harrigan and Varlack, 1977).

These defensive feelings still affect the attitudes of Virgin Islanders today, playing out as negative feelings, and in some cases hostility, towards federal management from the mainland. This attitude combined with the presence of different cultures has resulted in a fractioned island
community. More cohesive are the fishing communities of each Virgin Islands. Data collected by NMFS between 2004 and 2010 “support the notion that an island as a whole can be classified as a fishing community [ ] due to strong historic and contemporary socio-cultural [ ] ties to the fishery, its participants and the people impacted by its existence” (Stoffle et al, 2011).

Fiji

After gaining independence and experiencing years of government instability in the form of numerous political elections and subsequent coups, modern Fiji has emerged as a blend of indigenous Fijian, Indo-Fijian (ancestors of Indian or Asian decent many of whom came to Fiji during British rule as indentured laborers), Chinese, and European cultures (Srebrnik, 2002). Most of Fiji’s population is concentrated near the coast, where there has been a long tension between the two dominant cultural groups, indigenous Fijian (also referred to as Native Fijian) and Indo-Fijian, over access rights to marine resources (Teh et al, 2009). Indigenous Fijians have customary marine tenure rights, known as *i qoliqoli*, while Indo-Fijians have no indigenous rights to natural resources.

Traditional Fijian society has relied heavily on marine resources both for subsistence and livelihoods (Teh et al, 2009). This long reliance on the ocean has fostered a strong cultural connection to the coastal environment. Native Fijians live communally within a hierarchical village structure that has fostered small communities of shared social norms. The chief, or *Ratu*, presides over each village with the help of his/her village spokesperson, *Turana ni Koro*. The village structure is based on a culture of respect and cultural protocol, and great emphasis is placed on the importance of family. “The social structure and close-knit units in Fijian communities demand that people strictly follow tradition and respect each other” (Veitayaki, 2011).

The importance of fishing and strong connection to marine resources experienced within both of these cultures “spans both time and space, maintaining a strong presence in the past, present, and future” (Stoffle et al, 2011). These unique cultures have undoubtedly shaped local fisheries management, and will continue to play an influential role in future management strategies. This reiterates the importance of understanding the culture grounding the management strategies.
3.3. FSA management context

The U.S. Virgin Islands

In 1985, under the authority of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), the Caribbean Fisheries Management Council (CFMC) and the Department of Commerce through the National Marine Fisheries Service (NMFS) established the Fishery Management Plan (FMP) for the Shallow-water Reef fish Fishery of Puerto Rico and the USVI. The FMP established a management system for the reef fish resources within the EEZ and the waters under the authority of the Territory of the USVI (CFMC, 1985).

The CFMC, one of eight regional councils in charge of managing US fish stocks, is comprised of ten members, seven with voting power and three who can voice opinion, but cannot vote on Council decisions (www.caribbeanfmc.com). It is important to note that although the Council is under federal authority, of the ten voting CFMC members four are from the USVI and four from Puerto Rico. The Council’s headquarters are located in Puerto Rico and largely staffed by Puerto Ricans, which has created some animosity from Virgin Islanders who feel the Council does not adequately represent the interests of Virgin Islands.

Implementation and enforcement of the FMP and other fisheries regulations in the USVI requires the cooperation of numerous agencies and departments. The CFMC is responsible for plan development, NMFS implements approved plans, the Division of Fish and Wildlife (USF&W), Department of Planning and Natural Resources assists with environmental impact review and develops biological resource evaluations, and the Coast Guard, NMFS, the government of the Territory of the USVI (under agreements) enforce regulations implemented by the FMP (CFMC, 1998). The FMP for the USVI was designed to rebuild declining reef fish stocks and reduce conflicts among fishers (CFMC, 1996).

In 1990, through the recommendations of the CFMC Amendment 1 to the FMP was established. This amendment prohibited the harvest or possession of Nassau grouper and created a seasonal closure of the Red Hind Bank off of St. Thomas (CFMC, 1990). Three years later Amendment 2
to the FMP designated the seasonal closure of Lang Bank, off of St. Croix (CFMC, 1993).

After several years of seasonal protection from the Red Hind Bank, the red hind spawning population began to show signs of recovery (Beets and Friedlander, 1998; Nemeth, 2005). As a result, in 1999 the Red Hind Bank was established as the Red Hind Marine Conservation District becoming the first no-take fishery reserve in the USVI. The establishment of this permanent no-take reserve reflected a shift in management from a seasonal closure single-species approach to a more inclusive ecosystem-based management. Not only were red hind afforded protection, but the marine reserve also protected habitat critical to the species.

During this period the CFMC also officially recognized the importance of habitat in fisheries management with the 1998 Amendment to the FMP designating Essential Fish Habitat (EFH). The recognition of the value of the “waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity” illustrates a movement towards an ecosystem-level approach to fisheries management that includes habitats important to all life history stages of the fish (CFMC, 1998).

In 2005, the documented annual spawning aggregation of yellowfin grouper, *Mycteroperca venenosa*, at the Grammanik Bank, St. Thomas was closed to fishing during the spawning season, February 1 through April 30 (50 CFR Part 622). The establishment of this seasonal closure was based on public discussion forums with stakeholders such as the St. Thomas Fishermen’s Association, scientists from the University of the Virgin Islands (funded through NOAA and Puerto Rico Sea Grant), and management and enforcement agencies (USF&W, Coast Guard, USVI Division of Environmental Enforcement). David Olsen, staff scientist for the Planning and Natural Resources Department's Fish and Wildlife Division, commented that through this negotiation process "we were able to get rid of all of the big closures" (Dominique, 2005). The CFMC’s incorporation of other stakeholders resulted in a more inclusive management decision-making process.

“The spawning fish are future fish - all the fish are full of eggs. You're catching the babies with the parents," said Kenny Turbe, a local fisherman and conservationist who called the partial-year
closure of Grammanik Bank "a super decision” (Freehill, 2006). Despite the recognized attempt for more inclusive measures and support from some fishermen, others feel that "If they put the rest of this closure on us, you might as well put an end to fishing," St. Croix fisherman Jose Alberto Sanchez said at a recent meeting of fishermen who oppose the changes. (Joy 2004). Today the Grammanik Bank is a multi-species spawning aggregation site used by several commercially important species of groupers and snappers (Kadison, 2006).

In addition to the protection afforded to FSAs though CFMC closures, some areas utilized by aggregating species as habitat, nursery grounds, or migration corridors are protected through the National Park Service, the Department of the Interior and the USVI territorial government. Virgin Islands National Park federally prohibits commercial fishing in its waters within the 3-mile territorial sea. Fishing is also prohibited within the no-take national monuments of VI Coral Reef National Monument, St. John, (with the exception of bait fishing in Hurricane Hole and fishing for blue runner with special permits) and Buck Island Reef National Monument, St Croix (Figures 6 and 7).

Marine closed areas designated by the territorial government through USF&W prohibit fishing year-round. These include: St. James Reserve (exceptions for cast net fishing for baitfish and permitted hook and line fishing), Cas Cay/Mangrove Lagoon Reserve (exceptions for cast net fishing for baitfish in outer lagoon areas), and Compass Point Marine Reserve and Wildlife Sanctuary in waters off St. Thomas, Salt River Marine Reserve and Wildlife Sanctuary and St. Croix East End Marine Park, St. Croix, and The Small Pond at Frank Bay Wildlife and Marine Sanctuary, St. John.
Figure 6. Virgin Islands National Park and VI Coral Reef National Monument (USVI DPNR 2009)

Figure 7. Buck Island Reef National Monument, St. Croix, USVI (USVI DPNR 2009)

See Appendix A for a summary of USVI FSA closures.

Fiji
Traditionally in Fiji closely related social groups under the authority of the village chief have managed their own coastal resources. Through ownership of the customary fishing areas (*i qoliqoli*), local authority extends from shore to the outer reefslope (Veitayaki, 1998). Within this customary marine tenure system, the community has the right to organize fishing activities, declare temporary no take areas (known as *tabus*), and seasonal species bans (Minter, 2008, Teh et al, 2009). Villagers are expected to use their own *i qoliqoli*. People who wish to fish in another *i qoliqoli* must obtain permission from the village chief (Veitayaki, 1998; The et al, 2009). Compliance of this traditional management system was enforced through retribution within the village (Veitayaki, 1998; The et al, 2009).

Historically, this system has protected the food and income source of many local communities. “However, due to the increase in the demand and the force driven through the introduction of a cash based economy, this fragile system has started to show signs of dwindling stocks” (Fong et al, 2009). Fiji presently has 410 *i qoliqolis* (Figure 8) (Jupiter, 2011).

![Figure 8. Map of the extent of the *i qoliqoli* or traditional fishing areas in Fiji (FLMMA 2010)](image-url)
Currently, the marine resources of Fiji are governed through authorities of native local communities and the national government through the Fisheries Division and the Native Fisheries Commission. The National Constitution provides the framework for this formal relationship between customary law and national legislation, with the Fijian Fisheries Act (Laws of Fiji, Chapter 158, 1985) legally defining the relationship. The Fisheries Act recognizes customary fishing rights of native Fijians within the i qoliqoli, but provides no specific guidelines for resource management (Teh et al, 2009). The Fisheries Act established a resource access permit and license system (controlled by both the national government and the customary owner), stipulated regulations on fish size limits and species and methods of fishing, and created the ability to designate restricted areas if heavy overfishing occurs (Minter, 2008; Teh et al, 2009).

The Fisheries Act legally created the role of fish warden to patrol and enforce i qoliqoli and tabu areas. In addition to enforcing compliance through the retribution system, many villages now designate and employ fish wardens. The Fisheries act also defines punishable offenses, however penalties under the Fisheries Act are minimal. This is especially a challenge due to the fact that “customary law is not formally recognized within the national legal system [and therefore] customary rules can only be enforced to the extent that they do not contravene national law” (Minter, 2008). Community imposed sanctions seem to be “a major point of tension” between customary law and the national government (Minter, 2008).

Since the early 1990s the Fiji Locally Managed Marine Areas (FLMMA) network has played a key role in this relationship of dual governance. This community-based marine resource management effort is a partnership between 275 villages and 18 partners including national government departments, NGOs, and the University of the South Pacific (Teh et al, 2009). FLMMA’s objective is to sustain local fisheries for coastal communities while promoting collaboration and using “participatory techniques in the empowerment of people and communities” (FLMMA, 2010). Through FLMMA the use of traditional fisheries management measures within the i qoliqoli have grown. Most notably is the use of tabus, traditional no-fishing areas, as a method to strategically reduce fishing pressure in specific areas.
The villages of the Nakasaleka District, which includes 11 villages in the northern Kadavu sub-district of Nakasaleka and 12 villages on Ono, are the traditional customary owners of the Great Astrolabe Reef (George O’Connor, Kadavu Yaubula Management Support Team coordinator, per. com.) (Figure 5). Each of these villages has its own tabu area, typically located just offshore indicated by buoys or markers. The Naiqoro Passage spawning aggregation site (the main identified aggregation area for camouflage grouper, *Epinephelus polyphekadion*, brown-marbled grouper, *E. fuscoguttatus*, and black-saddled coral grouper, *Plectropomus laevis*) is located within this *iqoliqoli*, and is afforded protection as a tabu area by the villages in close proximity (with the village of Matasawalevu being the primary custodian) (Sadovy, 2009). Fisheries Department regulations prohibit fishing the Passage during the months of July, August, and September during the identified grouper spawning aggregation season. This regulation is supported by the villages of the Nakasaleka District.

Though Fiji and the USVI share similar biophysical environments and a human history that includes colonial rule and ethnic divides, the social and fisheries management context framing the resource management issue of spawning aggregations is distinctly different. Most notable are the distinctions between 1) the tight-knit social units fostered through the Fijian village structure and the loose association of the fishing communities (culturally, socially, and economically) experienced in the USVI, and 2) the community-based fisheries management scheme in Fiji and the top-down federal management process in the USVI. The extent to which these different community characteristics play into fishing community perspectives of the three research topics is addressed below.

2.0 Methods

1. Data collection of fishing community perceptions

In order to capture a snapshot of the USVI and Fijian fishing communities and their perspectives of if and how local marine resources have changed over time, reef fish spawning aggregations, and local fisheries management, 44 semi-structured interviews were conducted with fishers, their
families, and other relevant individuals on St. John, St. Thomas, and St. Croix, US Virgin Islands and Kadavu and Ono, Fiji.

Between August 2010 and April 2011, Lia Ortiz, University of the Virgin Islands (UVI) graduate student and Dr. Kostas Alexandridis Assistant Professor of Marine and Environmental Studies, UVI, conducted 19 interviews with individuals of the USVI fishing community. Interviews and data collection were part of Ortiz’s UVI thesis project entitled: *The cultural and social roles of the St. Thomas fishery in determining the identity of the local community*, funded through VI-EPSCoR. Fourteen interviews took place on St. Thomas, four on St. Croix, and one on St. John. The total number of participants was determined according to funding resources, time constraints, and the willingness of the participants. Interviews were conducted either at the Center for Marine and Environmental Sciences conference room at UVI or another location chosen by the informant. Most interviews took place in a location more comfortable for the informant (79% or 14 informants), i.e. home, Betsy’s Bar in Frenchtown, the fish markets, or their workplace (Ortiz, 2012). The range of interview times was 39-100 minutes, with the average interview being 65mins long (Ortiz, 2012). In some cases, other persons were present, i.e. a family member of the participant, a fishing community member, or the principal investigator of the main research project, Dr. Kostas Alexandridis, PhD.

Kristen Maize, Duke University graduate student, conducted 24 interviews in the villages of Lagalevu, Tiliva, Nakoronawa, Lomakoro, Lawaki, Salotavui, Kavala, Narikoso, and Vabea in the Nakasaleka district of Kadavu and Ono, Fiji over the course of two weeks in August 2011. Maize conducted these interviews as part of an independent master’s research project affiliated with Duke University and SCRFA. This research was designed to compliment the data collected in the USVI and present two case studies exploring the application of SNA to incorporate fishing community perspectives in fisheries management.

The Fiji interviews took place within the villages, typically either in the interviewee’s home or the community hall. Although interviews were conducted one-on-one, other people were often present (either waiting for their turn to be interviewed or part of the kava ceremony), and on occasion even chimed in with their opinion during the interview. When this occurred, the
interview became more of a focus group, than one-on-one interview. During two of the interviews more than one person was interviewed at once, but in both instances one individual dominated the discussion and thus was treated as a single respondent. The length of the interviews ranged from 10 to 50 minutes. Average interview time was 24 minutes. While many of the villagers speak English, a Fijian translator accompanied the interviewer. The translator was on hand to assist in the event that the interviewee preferred to speak in Fijian or did not fully understand a question. Waisea Naisilisili, Wildlife Conservation Society (WCS) Fiji, and Thomas Peckham, Kadavu Provincial Fisheries Department officer, Kavala Bay station, acted as translator during interviews.

Data on fishers’ perspectives were collected by engaging stakeholders through one-on-one interviews using the semi-structured open-ended interview technique. This technique allowed the interviewer to explore leads as they emerged from the conversation, while following a guide of clear instructions and general script (see Appendix B and C for attached question guide for USVI and Fiji) (Merriam, 2001). It also provided the flexibility necessary to conduct interviews around the participants’ busy schedules.

The snowball technique was utilized to identify potential interview candidates in both locations. Snowball sampling identifies potential participants by starting with a small set of key informants, who, after being interviewed, are asked to identify others who they believe will be an appropriate interview candidate (Atkinson and Flint, 2001). Participants for this study were determined by referrals on the basis of knowledge with regard to the fishery.

Informant consent was requested at the beginning of each interview. USVI interviews requested written participant consent. In Fiji, oral consent (following an oral consent script) was requested from participants. The USVI consent form and interview questions were approved by UVI’s Institutional Review Board (IRB), and the oral consent form and interview guide used for the research in Fiji was approved by Duke University’s IRB.

While the interview protocol between locations was consistent, the questionnaire guides varied. The USVI questionnaire was focused at understanding the socio-cultural and ecological
dynamics of the USVI fishery and its fishing community (Ortiz, 2012). Due to historic tensions within the USVI fishing community between local fishers and federal fisheries management agencies involving the closure of spawning sites, questions regarding FSAs were intentionally omitted (Alexandridis per. com.). The perceptions related to FSAs analyzed in this study were provided by the participants without prompting, typically in response to questions related to fisheries management.

The question guide used during interviews in Fiji was designed to correspond to the USVI questions relating to changing marine resources and fisheries management, in addition to basic demographic questions (see Appendix B). The Fiji questionnaire did not include questions on the topics of ciguatera, hurricanes, or cultural traditions tied to fishing, and instead asked questions focusing on fish spawning aggregations and attitudes towards fisheries management. Participants were asked whether there was a certain time of year when they caught only or mainly a particular species of fish, and if when they caught those fish they noticed if they had eggs in their bellies. These questions were used as a proxy to determine knowledge of FSAs (Sadovy, 2007). Use of the term FSAs was largely avoided with the exception of whether or not they were familiar with the term itself.

The Fiji interview guide was also designed to complement a previous FSA study conducted by Nanise Kuridrani on Kadavu in 2008. Participants were asked questions to create a fishery profile (i.e. fishing methods, fish species and catch trends over time), collect information on FSAs (do you catch a certain species more during one time of year, where?), and information on fisheries regulations and management (are you aware of regulations issued by the Fiji Fisheries Department?) (Appendix C).

All interviews were recorded using a Dictaphone device and later transcribed verbatim. The interviewer refrained from taking notes during the interview, but conducted post interview debriefs. Debriefs addressed the interviewer’s overall impressions, the non-verbal behavior and responses exhibited by the interviewee, and circumstances that may have affected the interviewees behavior or responses. Also noted, was how engaged the interviewee appeared and if the interviewer received the feedback they expected. Interviews were ranked by the
interviewer using an interview quality scale to reflect whether responses appeared to be honest, relevant, and unbiased (low quality, moderate quality and high quality).

In Fiji, high quality interviews comprised 50% of the 24 interviews conducted, 33% were deemed moderate quality interviews, and 17% were considered low quality interviews. Interviews were deemed high quality based on body language and the ease with which the participant discussed the topics. Low quality interviews were typically the result of the translator’s over interpretation of the participant’s responses or body language, and answers that suggested the participant was uninterested in the interview or was attempting to respond favorably (see discussion). In the USVI, 42% of the 19 interviews were categorized as high quality and 47% moderate quality. The other 11% were considered low quality, because (according to the principle investigator) their responses appeared to be either irrelevant or dishonest based on facial and body expressions or state of mind (i.e. intoxication).

2.2 Data analysis

Table 1. Definition of terms included in the description of the data analysis

<table>
<thead>
<tr>
<th>Term</th>
<th>Meaning as applies to this study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Textual data</td>
<td>participants' responses to interview questions</td>
</tr>
<tr>
<td>Attribute data</td>
<td>data associated with the responses and used to characterize participants</td>
</tr>
<tr>
<td>Semantic Network Analysis (SNA)</td>
<td>content analysis that measures the relationship of the meaning of words in terms of their proximity</td>
</tr>
<tr>
<td>Concept or semantic categories</td>
<td>the categories created by the SNA software that contain concepts and text from participant's responses</td>
</tr>
<tr>
<td>Semantic network</td>
<td>graphical representation of the SNA concept categories and their relationship to each other</td>
</tr>
</tbody>
</table>

Interview recordings were transcribed verbatim and organized using Excel. Informants’ responses to individual questions were kept intact, but organized according to the three research topics (changes to marine resources, fish spawning aggregations, and local fisheries management). These responses were assessed as *textual data* (also referred to as *related responses*) (Alexandridis, 2010). To better understand the relationships between the informants and their responses, *attribute data* (also referred to as *associated responses*—attribute data associated with the responses) was gleaned from the *textual data* (Alexandridis, 2010). In this study, attribute data is used to characterize the informants and provide context for the interviews.
Summary statistics of the attribute data were performed to characterize and compare the demographics between respondents from both locations.

SPSS Text Analytics for Surveys 4.0.1, a software program designed to combine qualitative and quantitative analysis, was used to perform Semantic Network Analysis (SNA) of the open-ended responses (textual data). SNA is a type of content analysis that measures the relationship of the meaning of words (semantics) in terms of their proximity to each other (Atteveldt, 2008). In this method, the process of communication is used not only to transmit information, but also to understand the social content of a message and “community-building shared experiences” (Atteveldt, 2008).

SNA “analyzes text as a set of phrases and sentences whose grammatical structure creates a context for the meaning of the response” (IBM, 2010). Based on algorithms designed to recognize semantic patterns (semantic network, co-occurrence, and concept inclusion were used for this study), linguistic associations and concept themes are discovered from the text (Figure 9). In other words, the algorithms take into account the syntax within a sentence or paragraph, and it is the syntax and text frequency that dictate how categories are created. Distinctions between positive and negative statements can also be made, such as the positive statement: “I like to fish because it makes me feel free” and the negative one: “the government makes fishing too hard.”

![Figure 9. Simplified SNA process performed by SPSS text analytics software](image-url)
Categories are defined by individual’s collective responses, focusing on the broader themes. Semantic networks illustrate knowledge representation in social collectives and measure association among concepts or groups of concepts extracted from the textual data (Alexandridis, 2010). The greater number of individuals who share (in their responses) the same semantic concept, the more representative that concept is of social knowledge or shared perspectives. These semantic associations or weights represent the strength of the relationships among concept categories. The frequency of a term, its relationship (hierarchically) to other terms, and the number of respondents who all reference the same term are assessed to determine a concept’s semantic relevance.

Multiple iterations of the data were run using the software, applying various combinations of parameters (libraries, algorithms, and category settings) (Figures 10 and 11). Extracted terms (terms considered semantically important for analysis) were automatically categorized, and then manually edited for the most accurate representation of the responses. This method of subtly manipulating the categories created through unsupervised classification is known as semi-structured classification (Alexandridis per. com.).

Figure 10. Final settings used to build concept categories using SPSS software. Note: for all analysis these settings were used except for questions related to Fiji FSAs where type instead of type pattern was used (see Discussion)
The extracted terms for all categories were carefully examined to validate the concept categories (Ayres et al, 2003). Manual concept category manipulation (supervised classification) was intentionally minimized for the final results. Numerous iterations were run, and then manipulated (in some instances drastically) to see how it affected the results. Categories that did not appropriately represent the data were deleted or the data within that category was moved to another more representative category (see Results). This was done in an attempt to calibrate the data to more accurately reflect the participants’ responses to the interview questions. The final results required minimal manipulation due to the fact that the most appropriate program settings were selected to represent the data.

The resulting semantic network graphs are the most appropriate representations of the data, based on participant observation and review of the participant responses. These networks were
analyzed using a Grounded Theory approach to tease out and interpret themes as they emerged from the text. Grounded Theory “is the generation of emergent conceptualizations into integrated patterns, which are denoted by categories and their properties” (Glaser, 2002). In applying Grounded Theory, it is the intent of this research to move beyond the descriptions of what the fishing communities in the USVI and Fiji say about FSAs, marine resources, and fisheries management to broader, more abstract concepts associated with this data. While two case studies, bounded in time and space, are used in this study, the objective of this research is that the derived concepts can be applied to fisheries management generally.

Included in this study are demographic and descriptive variables that characterize both of the fishing communities studied. Excerpts from the interview responses are also presented to illustrate the themes identified through the semantic networks and represent the voices of the study participants. The inclusion of this data is not in keeping with Grounded Theory, but is considered relevant for understanding the context from which these concepts have emerged (Glaser, 2002).

3.0 Results: Characterizing fishers’ perspectives

The attribute data presented below as “informant characterization” are only descriptive of the pool of respondents for each location, rather than describing differences among respondents.

1. USVI informant characterization

Of the 19 interview participants, 74% of the informants were male (15) and 26% female (4) (Figure 2). Average informant age was 59 years old. The average family size was 5 people, including spouse, children or anyone that was a dependent of the head of household. Education levels of the informants ranged from elementary completion up to a doctoral degree. On average, an informant has at least a high school education. Table 2 presents descriptive statistics for informant demographics: age, family size and education.
Figure 12. Average sex of USVI participants

Table 2. USVI participant demographic descriptive statistics

<table>
<thead>
<tr>
<th>Summary Statistics</th>
<th>Age</th>
<th>Family Size</th>
<th>Education</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>58.63</td>
<td>5.16</td>
<td>10.74</td>
</tr>
<tr>
<td>Standard Error</td>
<td>3.63</td>
<td>0.76</td>
<td>0.77</td>
</tr>
<tr>
<td>Median</td>
<td>55</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>15.82</td>
<td>3.32</td>
<td>3.35</td>
</tr>
<tr>
<td>Sample Variance</td>
<td>250.36</td>
<td>11.03</td>
<td>11.2</td>
</tr>
<tr>
<td>Range</td>
<td>54</td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td>Minimum</td>
<td>32</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Maximum</td>
<td>86</td>
<td>12</td>
<td>15</td>
</tr>
<tr>
<td>Confidence Level (95.0%)</td>
<td>7.63</td>
<td>1.6</td>
<td>1.61</td>
</tr>
</tbody>
</table>

The fishing status of each informant was determined by whether they were one of three categories: (1) full-time commercial fisher, (2) part-time commercial fisher or (3) agency/recreational fisher. 74% (14 informants) were full-time commercial fishers, 21% (4 informants) agency/recreational and 5% (1 informant) part-time fishers (Figure 13). 58% (11) of the informants claimed that either they or their family member that fished/is fishing is a licensed fisher. 84% (16 informants) of the informants claimed that they are fishers, either commercial or recreational and 16% (3 informants) were family of a fisher. The average duration of time spent as part of the fishing community was 45 years. 42% (8 informants) claimed that fishing continues to serve as a livelihood presently and 68% (13) of the informants stated that at least one of their family members still fish for a livelihood.
2. **Fiji data informant characterization**

Of the 24 participants in Fiji, 71% were male (17) and 29% were female (7) (Figure 14). The average age of participants was 55.5 years, and mean family size was six people. The average duration of years spent fishing was 41 years (Table 3).
Table 3. Fiji participants' demographic statistics

<table>
<thead>
<tr>
<th>Summary Statistics</th>
<th>Age</th>
<th>Family size</th>
<th>Years fishing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>55.5</td>
<td>5.74</td>
<td>41.22</td>
</tr>
<tr>
<td>Standard Error</td>
<td>2.93</td>
<td>0.53</td>
<td>2.96</td>
</tr>
<tr>
<td>Median</td>
<td>56</td>
<td>6</td>
<td>41</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>14.36</td>
<td>2.56</td>
<td>14.18</td>
</tr>
<tr>
<td>Sample Variance</td>
<td>206.26</td>
<td>6.57</td>
<td>201.00</td>
</tr>
<tr>
<td>Range</td>
<td>50</td>
<td>10</td>
<td>46</td>
</tr>
<tr>
<td>Minimum</td>
<td>29</td>
<td>0</td>
<td>17</td>
</tr>
<tr>
<td>Maximum</td>
<td>79</td>
<td>10</td>
<td>63</td>
</tr>
<tr>
<td>Confidence Level (95.0%)</td>
<td>6.31</td>
<td>1.11</td>
<td>6.13</td>
</tr>
</tbody>
</table>

The fishing status of each informant was determined by whether they currently fished, and if so, if they fished “to sell” or fished just “to eat.” All informants fished to eat at some stage in their life, with 92% (22 informants) currently fishing to eat and 8% (2 informants) who used to fish for food, but no longer fish. Nine informants (37%) fished to sell, five (21%) used to fish to sell, and ten (42%) are not currently nor have they ever fished to sell (Figure 15). Of the participants who fished to sell, three were confirmed as licensed commercial fishermen either by the respondent themselves (mentioned during interview) or through the translator from the Fiji Fisheries Department. It should be noted that this question was not asked directly to participants, so whether or not the remaining six who fished to sell are licensed commercial fishermen is unknown.
3. Semantic network analysis results, topic 1: changes to marine resources

The U.S. Virgin Islands

Questions regarding potential changes to marine resources included: How do fish catches today compare to catches from the past (10 or 20 years), have the sizes of the fish and species you catch changed, has it become easier or more difficult to fish, and over the time of your experience have the fisheries changed (Appendix B)? The most semantically important concepts cited by respondents in the USVI fishing community in response to these questions were (listed in order of most shared responses):

1. fish,
2. size,
3. reef,
4. fishery,
5. fisherman,
6. people,
7. catch fish,
8. study,
9. sea, and
10. traps (Table 4).
Table 4. Most semantically relevant categories of USVI participants’ responses to questions related to changes in marine resources

<table>
<thead>
<tr>
<th>Category</th>
<th>Selection %</th>
<th>Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>fish</td>
<td>100.0</td>
<td>18</td>
</tr>
<tr>
<td>size</td>
<td>97.1</td>
<td>13</td>
</tr>
<tr>
<td>reef</td>
<td>33.3</td>
<td>6</td>
</tr>
<tr>
<td>fishery</td>
<td>27.8</td>
<td>5</td>
</tr>
<tr>
<td>fisherman</td>
<td>27.8</td>
<td>5</td>
</tr>
<tr>
<td>people</td>
<td>22.2</td>
<td>4</td>
</tr>
<tr>
<td>catch fish</td>
<td>22.2</td>
<td>4</td>
</tr>
<tr>
<td>study</td>
<td>22.2</td>
<td>4</td>
</tr>
<tr>
<td>sea</td>
<td>22.2</td>
<td>4</td>
</tr>
<tr>
<td>traps</td>
<td>22.2</td>
<td>4</td>
</tr>
<tr>
<td>boats</td>
<td>16.7</td>
<td>3</td>
</tr>
<tr>
<td>st. croix</td>
<td>16.7</td>
<td>3</td>
</tr>
<tr>
<td>shoot</td>
<td>16.7</td>
<td>3</td>
</tr>
<tr>
<td>climate</td>
<td>16.7</td>
<td>3</td>
</tr>
<tr>
<td>weather</td>
<td>16.7</td>
<td>3</td>
</tr>
<tr>
<td>overfishing</td>
<td>16.7</td>
<td>3</td>
</tr>
<tr>
<td>species</td>
<td>11.1</td>
<td>2</td>
</tr>
<tr>
<td>source (contextual)</td>
<td>11.1</td>
<td>2</td>
</tr>
<tr>
<td>diademas</td>
<td>11.1</td>
<td>2</td>
</tr>
<tr>
<td>time</td>
<td>11.1</td>
<td>2</td>
</tr>
<tr>
<td>spearfishing</td>
<td>11.1</td>
<td>2</td>
</tr>
<tr>
<td>cruise</td>
<td>11.1</td>
<td>2</td>
</tr>
<tr>
<td>sea arching</td>
<td>11.1</td>
<td>2</td>
</tr>
<tr>
<td>pantodon</td>
<td>11.1</td>
<td>2</td>
</tr>
<tr>
<td>coral</td>
<td>11.1</td>
<td>2</td>
</tr>
<tr>
<td>size of pantodon</td>
<td>11.1</td>
<td>2</td>
</tr>
<tr>
<td>evolution</td>
<td>11.1</td>
<td>2</td>
</tr>
<tr>
<td>pollution (contextual)</td>
<td>5.6</td>
<td>1</td>
</tr>
</tbody>
</table>

Figure 16. A semantic network of USVI participants’ responses to questions related to changes in marine resources

The concept of “fish” was the central theme discussed by all 19 participants, as indicated by the size of the “fish” node in Figure 16. This semantic network illustrates the strong semantic links
between this concept and the concepts of “size,” “reef,” “catch fish,” and “fishermen.” The thickness of the lines linking these semantic categories indicates semantic associations shared by five participant responses. The categories “fish” and “size” contained extracted terms and statements regarding the current size and abundance of fish, if changes have occurred over time, and if so why.

USVI participants had mixed responses when asked if the average size of fish caught today had changed. Some respondents felt that there was no difference in fish size today versus in the past (seven directly stated this). “…I have seen consistent sizes throughout the years,” (16VI) and “I go out there and I come in with the same amount of fish every year...” (01VI).

“I wouldn't say it's a change in the size and the species because [there are] big ones in all the species right now so that hasn't deteriorated in any manner. The size, to me, that's a two sided question because [off]shore I still catch my big Yellowtail, [big hinds, ] Old Wife] all [types of big fish]. All of these fishes are still up to top notch, just like [they] were in our days. [There is] no difference in the size. Inshore is different. You don't find the big fish [or] the abundance of fish inshore.” -15VI

A few participants felt that the size of fish landed does not accurately reflect the average size of fish in the population, explaining the role of restaurants in driving demand for a specific size of smaller fish.

“Everybody who owns a restaurant wants to buy [smaller] fish as a marketable plate sized fish, not have a fish that sticks out [over] your foam plate. So [smaller] you're not catching the super spawners which are [bigger] beyond that plate size [smaller], but you're catching the smaller ones... Port sampling and scientific data [measure] these smaller fish, but we're [fishermen] explaining to them that it's not a marketable fish so we don't catch the bigger ones. We catch what the restaurants want. Those bigger ones are there to keep spawning and keep multiplying over and over.” -16VI
Four respondents felt that the size of fish had changed over time. With three of the four participants stating that the size had decreased and one believing that the average size of fish caught had increased.

“…[R]ight now, the way I see it [the fish is getting scarce. [Y]ou could haul a hundred fish traps and you don't catch a hundred pound of fish, that's bad, bad, bad. You used to have thirty fish trap[s], [and] catch two, three hundred pounds of fish. Now, you can haul about a thousand fish pots to catch that...They [aren’t] catching much fish in the traps...[I]t [isn’t] getting better, it's getting worse.” -04VI

Participants who felt that the size had changed provided possible explanations for the change in fish size and abundance, citing spearfishing with scuba, pollution, and fish traps as their main concerns.

“...the only destruction with the bigger fish is because of [scuba] divers. They go down there and they can select [what size fish to catch]. They don't want to shoot a small fish. They rather shoot a bigger fish, [which are] basically our breeders, and that's why [] scuba diving commercially [is bad], it's very selective you know. “ -03VI

The threat of pollution was discussed in conjunction with the decline in fish (sizes and abundance) and coral reefs. “I don't blame overfishing for everything, [] pollution is the major factor. A lot of run-off, a lot of silt cover [impacts] the reef you know.” -17VI “Well the reef, a lot of reefs [are] dead.” -05VI

Fish traps were cited by a number of participants as the reason for the decline in the fishery. Participants expressed concern with either one or a combination of explanations: the durable materials traps are now being made with, the impact of traps on reef and benthic communities, and the number of traps being used.
“...back in the days when [] the traps were woven [] they were totally bio-degradable...But now, now the traps [] are braced with rebar and stainless steel crimp. That stuff lasts long, long, long, long, long time. A lot of the guys when the trap get old, they cut it away. The trap goes down and lands right on top of the reef now and [] stays [] there. If a storm pass[es] [] these traps would move around and do a lot of damage before they finally get [stuck] somewhere, or [fall] off the edge of the reef and into the [] sand bottom.” -02VI

“...[There has been an] increase[] in size of boat and the amount of traps, and [] that's [the cause of] depletion, I think it's basically coming for the abundance of fishers out there because you have a lot more stress [caused from] more traps being hauled in less time. In the olden days, we used to ha[ve] one trap...” -03VI

In the “people” semantic category, the issues of overfishing, changes in people’s attitudes towards fishing, and fishing pressure from people from other islands were addressed. “[P]eople [] don't care about the procedure or protecting the future of the catch, they just rape everything and catch as much as they can.” -18VI

“...I am glad we have more [fishing] licenses because if we didn't have that, we would have a big problem [] with having a sustainable fishery, because [there are] too [many] fishermen out there. A lot of immigrants, you know, people immigrating from other islands, and getting licenses, and [] bringing their habits here. So I'm glad we have fishing licenses right now, and [to protect] our fishing... ” -07VI

Note: The semantic category “guys” was deleted from the SNA of this topic. The word guys was used more as slang to refer to lots of different kinds of groups, and therefore did not seem to be a relevant category.
Fiji

The semantic analysis of the Fiji participants’ responses to questions related marine resources found the following concept categories to be the most semantically relevant:

1. fish,
2. fishing,
3. size of fish,
4. starting,
5. people,
6. concern,
7. weather,
8. future,
9. protected area,
10. beach, and
11. diving (Table 5).

Table 5. Most semantically relevant categories of Fiji participants' responses to questions related to changes in marine resources
The categories of “fish,” “fishing,” and “size of fish” were the most semantically relevant according based on the shared responses from Fiji participants (as illustrated by node sizes) (Figure 17). These concept categories shared the strongest semantic ties (with at least ten shared participant responses between categories). The category “people” also shared a fairly strong link (eight shared responses) to the categories “fish” and “fishing.” Both the “fish” and “size of fish” categories included numerous responses related to catching fewer and smaller fish currently than in past years. For example, “Before sometimes we go just half day and come back, we’d have lots of fish. But now it takes us one whole day to fish.” -01F “Before there used to be big fish, big sizes, long and big. Nowadays it's small and short. Small.” -07F

“Big changes, big changes [] [I]n the numbers [of fish caught] and the time, and size too. The coral trout [grouper] you don't get the bigger one, you know the big size, the fully grown ones like we used to, say 10 years ago. There aren't that many around now. Much less.” -02F
Seven of the twenty-four participants mentioned that it is more “difficult and/or a struggle” to fish now then in past years. The word concern was used by four respondents to express their feelings regarding the fishery.

“More people are fishing, but they aren't getting as much. The fish are getting smaller…[I’m] worried. Cause most of the time we catch plenty. Nowadays when we go out fishing we catch only a few fish. Less fish. I think it [would] be better if we stop catching the smaller kawakawa.” -14F Note: kawakawa is the Fijian name for camouflage grouper, *Epinephelus polyphekadion*.

While most participants agreed that the size of fish today versus 10 years ago had gotten smaller, four participants thought that fishing today was actually easier than in the past because of technological advances, with fiberglass boats and flashlights most commonly referenced. The “fishing” semantic category included these sentiments. “[Fishing is] easier for me because I got the tools like my boat and my net, and I got plenty of gear now.” -20F With that being said, the majority of respondents expressed concern that it had become more difficult to fish, because of the smaller catch.

Four respondents felt that the fishery was showing signs of improvement: “Even in the Naiqoro Passage there's a lot of fish starting to come back again. [] I've been diving there for about 12 years, sometimes I see more [] starting to come out [now]” –04F “Now [that the villages have] the marine protected area in front of them, they slowly starting to see fish coming back.” -13F Only one respondent’s comment included in the “starting” semantic category spoke to the contrary: “Right now the size is starting to get smaller and also the catch of kawakawa is decreasing now compared to past years…When we used to go to sea before there was plenty of fish.” -19F

Weather was mentioned by four of the Fiji respondents as a factor influencing the size of catch. This category was also semantically linked to the themes of “grouper,” “fishing,” “fish,” and “people” (Figure 17). “It depends on the weather. Good weather, plenty fish.” -15F “It depends
on the weather. In the cold weather I can catch plenty...” -24F “Before [there] used to be a lot [of fish]. It changes from big to small. It depends on the weather too.” -08F

The “people” concept category referred to individuals who fish and consume marine resources. Respondents mentioned people having to put in more effort today, and people using the duva root to poison and catch fish in the past. Respondent 16F talked about people becoming more “aware of conservation [] in regards to MPAs for the kawakawa” in response to “the number of fish [that have] started to [decrease].”

The “future” category, semantically linked to the “fish,” “fishing,” and “size of fish” categories, included comments of participants that were all notably optimistic. “I think the future will be good [for] future [] fishing generations.” -12F “[T]here is a good future for the generation to come, because they have seen they are reaping the benefits of the tabu area, that have been established now for five years.” -22F Other statements of support for protected areas were included in the “protected area” category. This category is linguistically linked to the “fish” and “fishing” categories and referenced tabu areas, i qoliqolis, and marine protected areas near villages. Most of the statements were positive, such as: “Now [that] they ha[ve] the marine protected area in front of [the village], they [are] slowly starting to see fish coming back.” -13F

Note: The concept categories “grouper” and “kawakawa” were merged, and so were “size” and “size of fish.” This was done to minimize redundancy.

4. Semantic network analysis results, topic 2: fish spawning aggregations

The U.S. Virgin Islands
USVI participants’ comments relating to FSAs were unprompted (see Methods) and typically came up in relation to discussions about closures of fishing grounds and the recent increase in the red hind population (for which the FSA site is now protected). The concepts categories shared by the most USVI participants are:

1. fish,
2. (closed) area,  
3. food,  
4. fishermen,  
5. closure,  
6. traps,  
7. water,  
8. boats,  
9. hind, and  
10. species (Table 6).

Table 6. Semantic categories of USVI participants’ perceptions of FSAs

<table>
<thead>
<tr>
<th>Category</th>
<th>Bar</th>
<th>Selection %</th>
<th>Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fish</td>
<td>1</td>
<td>38.9</td>
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</tr>
<tr>
<td>(closed) area</td>
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<td>5</td>
</tr>
<tr>
<td>Food</td>
<td>3</td>
<td>16.7</td>
<td>3</td>
</tr>
<tr>
<td>Fishermen</td>
<td>4</td>
<td>16.7</td>
<td>3</td>
</tr>
<tr>
<td>Closure</td>
<td>5</td>
<td>16.7</td>
<td>3</td>
</tr>
<tr>
<td>Traps</td>
<td>6</td>
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<td>3</td>
</tr>
<tr>
<td>Water</td>
<td>7</td>
<td>16.7</td>
<td>3</td>
</tr>
<tr>
<td>Boats</td>
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<td>Hind</td>
<td>9</td>
<td>11.1</td>
<td>2</td>
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<td>Species</td>
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<td>11.1</td>
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</tr>
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<td>People</td>
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<td>2</td>
</tr>
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<td>Fishing</td>
<td>14</td>
<td>11.1</td>
<td>2</td>
</tr>
<tr>
<td>Work (negative)</td>
<td>15</td>
<td>5.6</td>
<td>1</td>
</tr>
<tr>
<td>Engines (contextual)</td>
<td>16</td>
<td>5.6</td>
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<tr>
<td>Sponges (contextual)</td>
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<tr>
<td>Coral (positive feeling)</td>
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<td>5.6</td>
<td>1</td>
</tr>
<tr>
<td>Land (positive)</td>
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<td>5.6</td>
<td>1</td>
</tr>
<tr>
<td>Gear (contextual)</td>
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<td>1</td>
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<tr>
<td>Gorgonians (contextual)</td>
<td>21</td>
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<td>1</td>
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<tr>
<td>Periods (negative)</td>
<td>22</td>
<td>5.6</td>
<td>1</td>
</tr>
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<td>Market</td>
<td>23</td>
<td>5.6</td>
<td>1</td>
</tr>
<tr>
<td>Rope</td>
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<tr>
<td>Habitat</td>
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<td>1</td>
</tr>
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<td>Fishery</td>
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<td>5.6</td>
<td>1</td>
</tr>
<tr>
<td>Regulations</td>
<td>27</td>
<td>5.6</td>
<td>1</td>
</tr>
</tbody>
</table>
Figure 18. A semantic network of USVI perceptions of FSAs

As illustrated by Figure 18, the category of “fish” (see “fish” node) has a high density of semantic ties to other concept categories. Most notable are its links to the “(closed) area,” “food,” and “closure” themes. Note: while the “(closed) area” category included concepts related to areas closed to fishing, it also referred to the general term area, which did not denote a specific closure. This category had the strongest semantic association (shared responses from five participants) with the category “fish.” Categories such as “species” and “currents” appeared less relevant to the network, with only two semantic ties each.

Comments related to the “(closed) area” and “closure” categories were largely negative. USVI respondent 14 expressed such concerns:

“[T]here wasn't as much [] federal involvement as before. There weren’t so many regulations [] before. So it was a lot easier in the past. You know, [there were] simple regulations, but now it's you know, area this, seasonal that, so it's a little bit more complex. [M]aybe some of [] the area closures, seasonal closures are
warranted, and some I just think are ridiculous, and I think some of it was deceptive. For instance the Red Hind Bank was a deceptive thing. While I see it as necessary, you know, obviously for the spawning aggregation, it was given to them [fishermen] under the pretense of five years. It's been ten plus, so you set five, we've gone past five, maybe you should open it just three months out of the, out of the year and that's when I [will] talk about compromise.”

While the “(closed) area” category included many negative concepts, this category also captured a couple positive comments about areas that are closed to fishing. “It’s [closed spawning areas] good. Especially when they [are] spawning it's good.” -04VI

“Over the years, I have seen an increase in the red hind, [] I mean huge. We've seen huge red hind now and the numbers are very high. So that, that is good, because they closed the Hind Bank, about fifteen, twenty years ago. So that [] was very positive when they did that… I have seen an increase in Nassau Grouper lately. We have been catching quite a bit. So I believe they had [] a good spawning year for Nassau Grouper, and we're seeing the results of it now.” -07VI

The “food” category included unrelated statements about food. This category did draw attention once again to the role of restaurants and the demand for seafood, which increases pressure on the FSAs. “More hotels, more restaurants. Everybody want seafood.” -02VI

The “fisherman” category was (weakly) semantically linked by two shared responses to the categories of “government,” “fish,” and “water.” The link to the theme of “government” captures participants’ comments on fisheries management related to FSAs.

“I think that managing [fish] species right now has to take a drastic[] turn. In the past, managing a species or managing an area was determined or is determined by closing or shutting down a size of area to protect that species. I believe as a fisherman, and that's just my personal belief, that to protect a species they should just stop you from catching or selling this species until those months of whatever it takes
to spawn…[L]et's say, close [] three months or four months. Let's say, instead of closing a big area, they should just prevent you from catching or selling that species.” -19VI

The theme of fish “traps” was also relevant to the topic of FSAs (as it was for the marine resources topic). The “traps” category had six semantic links to other themes, but the majority of comments in this category related the negative impacts of traps on FSAs and the fishery in general, and the need for better enforcement.

“Education and enforcement[]. That's the only way [to] [reduce] traps…[C]ause a lot of these guys they're [] wealthy [] enough that they have big boats and hundreds of traps in the water, you know, so, I mean, set a limit. They got to set a, say like a limit on how much traps a fisherman can have. That's a must you know…and enforcement, they have to get out on these boats and bring everything up to compliance…You know, and the kind of destruction that these modern traps do to the ocean floor. [The] fish in there, they are protected, they grow up in there [protected area], and once they come out now, fishermen can catch them. To go inside [the protected area] and destroy all these corals…[T]hey should not allow anymore traps inside there.” -04VI

The category “boats” included additional statements about the lack of enforcement, with access to fishing grounds and FSA sites being the main factor. “I've never seen [] any boat patrol in the federal waters. Out there [people] pretty much do whatever they want [] because there's nobody around. DPNR have [] a couple boats, but they patrol just inshore, now and then, and they will only go offshore if something happen[s].” -02VI

Technological improvements to boats and fishing gear and the subsequent impacts to the fishery were also cited.

“You didn't have big engines, [] you only had small boats that went out with oars, some of them with small engines. So they didn't go far, and they had to wait for the
fish to come in to shore. So now [] it's changed. Well, like I say we have bigger boats, we have more electronic equipment[]. So we go further, we fish longer, we're more precise, we're more accurate with our fishing. We're deadly. [laughs]” -07VI

The categories “guys” and “example” were deleted from the analysis of this topic. “Guys” was used more as slang to refer to lots of different kinds of groups. Terms and phrases in the “example” category mainly included the saying “for example.”

Fiji
Fiji participants were asked questions regarding FSAs, such as: Do you catch certain species of fish only or mainly at certain times of the year, do you know if those fish caught are fat with eggs or milt, do any of the fish (that participants identified earlier in the interview process) aggregate to spawn, and do you think spawning aggregations are important to maintaining the fishery (Appendix C)? Concept categories semantically important to these questions include:

1. season,
2. grouper/kawakawa (kawakawa, grouper, and coral grouper are all included in this category),
3. fish,
4. catch,
5. protected area,
6. eggs,
7. spawn,
8. Naiqoro,
9. government,
10. idea, and
11. future generations (Table 7).
Table 7. Semantic categories of Fiji participants’ responses to FSA questions

<table>
<thead>
<tr>
<th>Category</th>
<th>Selection %</th>
<th>Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>season</td>
<td>79.2</td>
<td>19</td>
</tr>
<tr>
<td>grouper</td>
<td>58.3</td>
<td>14</td>
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<tr>
<td>catch</td>
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<td>fish</td>
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<tr>
<td>protected area</td>
<td>33.3</td>
<td>8</td>
</tr>
<tr>
<td>eggs</td>
<td>33.3</td>
<td>8</td>
</tr>
<tr>
<td>spawn</td>
<td>25.0</td>
<td>6</td>
</tr>
<tr>
<td>future generations</td>
<td>12.5</td>
<td>3</td>
</tr>
<tr>
<td>Naigoro</td>
<td>12.5</td>
<td>3</td>
</tr>
<tr>
<td>government</td>
<td>12.5</td>
<td>3</td>
</tr>
<tr>
<td>idea</td>
<td>12.5</td>
<td>3</td>
</tr>
<tr>
<td>Fiji</td>
<td>12.5</td>
<td>3</td>
</tr>
<tr>
<td>fishing net</td>
<td>8.3</td>
<td>2</td>
</tr>
<tr>
<td>reef</td>
<td>8.3</td>
<td>2</td>
</tr>
<tr>
<td>satala</td>
<td>8.3</td>
<td>2</td>
</tr>
<tr>
<td>Fisheries Department</td>
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<td>2</td>
</tr>
<tr>
<td>night diving</td>
<td>4.2</td>
<td>1</td>
</tr>
<tr>
<td>days</td>
<td>4.2</td>
<td>1</td>
</tr>
<tr>
<td>wrasse</td>
<td>4.2</td>
<td>1</td>
</tr>
<tr>
<td>spear fishing</td>
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<td>1</td>
</tr>
<tr>
<td>snapper</td>
<td>4.2</td>
<td>1</td>
</tr>
</tbody>
</table>

Figure 19. A semantic network of Fiji participants’ responses to FSA questions

The semantic network illustrates the Fiji fishing communities’ responses to FSA-related questions shared by at least 2, at most 19 respondents (Figure 19). The concept category “season” is shared by 19 of the 24 respondents, making it the most highly weighted category related to this topic. This theme was strongly associated with the semantic category
“grouper/kawakawa” (12 shared responses), “catch,” “fish,” “eggs,” and “protected area” (10 shared responses). The “season” category usually either referenced concepts representing a particular time of year when certain species of fish could be caught or the breeding season (or month) of a species. “[I]t's like before [in the past], there's a season where you normally catch them. Now it's [] getting less and less.” -07F “We only catch [grouper] [at] certain times...like a season. July, August, September.” -01F

The term “season” is linked to FSA management through the concept of seasonal closures. Understanding the timing of the FSA (represented by the category “season”) and where the spawning event is occurring (represented by the category “Naqoro”) is essential to protecting the spawning area. The category “Naqoro” specifically referenced the passage. Comments in this category included how the area is now protected during the grouper spawning season in July and August, that it is a good fishing ground, or that there aren't as many fish in Naqoro Passage anymore. “Naqoro, that's a protected area. [T]hey went diving the other day, and there's hardly any fish there. It's a tabu area. That's the poachers for you. Night diving.” -03F

The “government” category was linked to “catch,” “season,” “grouper,” “spawn,” and “Fiji” categories. It included Fiji participants’ comments on law and enforcement. “Now they have [] set up their enforcement by introducing a new law in the district, a village law, if anyone catches grouper they will be taken to task by the village.” -06F “[R]ight now people still hunting those types [of fish] in that season of spawning aggregation because there is no law...[T]he government [s]hould put a law so that we can stop the people from going out at that certain period during spawning aggregation.” -09F

The “grouper” category included kawakawa and coral grouper. This was a large concept category. Villagers in Kadavu and Ono demonstrated a preference for grouper (to eat and sell) and associated this species of fish with aggregate spawning. “Like the coral trout. They [people] are shooting the bigger ones, [because] they have a market for them you know in Suva.” -02F “Nowadays you hardly catch the groupers. Maybe if you go one day you might catch only one, but sometimes none at all.” -06F
“Catch” included comments in reference to months when the catch was particularly good, and if landed fish had eggs. This category also included the verb *to catch*, and the use of the word as a noun. “Local fishers they...know the season of kawakawa, they know the season of other spawning aggregation species, so they usually go out at those [] target seasons, because there's a probability that there will be lots of them for them to catch.” -09F

The presence of eggs in fish stomachs was discussed as a proxy for spawning. Participants were asked directly if they notice eggs in fish bellies when they catch or clean them, and if so, during what time of year. “We know this time of year the fish go to the reef to lay egg.” -20F
“[N]owadays June, July, August. That [is] their time for eggs.” -21F

Many of the participants demonstrated knowledge of when and where certain species spawn, with a number of respondents citing specific months when spawning occurs (as demonstrated in the previous quote by participant 21F). When asked directly about the protection of the spawning areas, many participants made comments in support of the protective measures. The “*spawn*” concept category included such responses as: “It's good it's protected, where they spawn.” -03F
However, most of the positive statements supporting the protection of FSAs were included in the “*protected area*” category.

The “*protected area*” category referred to marine protected areas, *tabu* areas, and *i qoliqoli* (similar to the “*protected area*” category for the marine resources topic), and included numerous statements in support of protected areas. “I was waiting for the idea for the elders to establish a marine protected area or *tabu* area for the breeding ground. [W]e are starting to see what we've lost come back. Some of the fish that have been overfished are starting to come back.” -16F
“Those areas [spawning aggregations] need to be a conserve area.” -19F “[T]hose areas [where fish spawn] should be protected.” -21F

The “*idea*” category mainly referred to the idea of FSAs (specifically to the term itself) or if a respondent had “no idea about spawning aggregations,” (09F) or “no idea what fish spawn where” (16F). This concept was used to gauge participants understanding of FSAs, and was semantically associated with “*protected area,*” “*spawn,*” and “grouper/kawakawa” (Figure 19).
Fiji participants once again discussed the importance of ensuring that there are resources for future generations. When respondents were asked what the future of the fishery will be like, many responded positively, citing the protected areas as a reason there will be more fish in the future. These comments are represented by the “future generations” semantic category “The place where [it] is known to be the spawning area, we need to preserve it for future generations so that the fish can [y] multipl[y], [y] spawn and reproduce.” -22F “I am thankful for the idea of a marine protected area because there is a breeding ground for the fishes to reproduce [y] so that there is fish for the [y] future generations in our village in the years to come.” -17F This same sentiment was expressed by numerous participants.

Note: The category “kawakawa,” was moved into the category “grouper,” and “aggregating species” was moved into the “spawn” category to minimize redundancy.

5. Semantic network analysis results, topic 3: local fisheries management

The U.S. Virgin Islands

Questions regarding fisheries management in the USVI included: How does managing the fisheries in the VI in the past compare to management today, were there things that worked well in the past, were there things that did not work well in the past, and are there things that do not work well today (Appendix B)? The most semantically important concepts cited by VI respondents were:

1. fish,
2. annual catch limits,
3. people,
4. regulations,
5. fishermen,
6. area,
7. enforcement,
8. closure,
9. enforcement officers, and
10. feel.
Other notable concept categories with lower semantic weights of association were “meetings” and “closure” (Table 8).

Table 8. Semantic categories of USVI participants' responses to local fisheries management questions

<table>
<thead>
<tr>
<th>Category</th>
<th>Selection %</th>
<th>Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>fish</td>
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<tr>
<td>annual catch limits</td>
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<tr>
<td>people</td>
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<td>regulations</td>
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<td>fisherman</td>
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<tr>
<td>area</td>
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<td>enforcement</td>
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<td>closure</td>
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<td>enforcement officers</td>
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<td>feel</td>
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<td>track</td>
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<td>job</td>
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</tr>
<tr>
<td>annual catch (negative)</td>
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<td>1</td>
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</tbody>
</table>
The issue of “annual catch limits” (ACLs) emerged as the prominent resource management theme in the VI, with strong semantic ties to the themes of “fish” (with an association of 16 shared responses between categories), “people” (with 14 shared responses between categories), “regulations,” “fisherman,” “enforcement,” and “closure” as shown in Figure 20.

“[T]here are still more regulations coming down the road [] annual catch limits and bag limits, and we're gonna have catch shares too I heard, that's coming next…. I think that we will be out of our job because a regulation that stop us from catching X species. So I think the government [is] overprotecting by doing so much closures. Every year they be coming up with a new one. I tell the scientists, give us something that we can make an honest living. We used to catch a million plus pounds of blue fish and now they want to give us I think it was 355,000 pounds and they're gonna still cut that down somewhere between 100,000 to 50,000, which is about 6 pounds per day per fisherman. Who can live on 6 pounds of fish per day when you have $150 to $200 worth of expenses in gas, $20 more in air, $10 in ice, and what it comes to it's about $400 just to go out fishing. And they're gonna give us 6 pounds of blue fish a day. We cannot live with that.” -18VI
“[W]e are working on [] quotas right now, accountable catch limits and quotas, and [it] depends what we end up with, and how it plays out, and when we get new trip tickets, which [are] catch report forms you know, and all that so we could have species specific data and all that. When we get all that in place we can manage our fishery a lot better and see where, how, you know, what we, you know, what is overfished and what is not overfished and that type of stuff. So if we get all that in place, we will have a better fishery.” -07VI

The “people” category included mainly negative responses as to how the current top-down management from the US mainland affects people, citing too many regulations, interfering with fishermen’s ability to earn a living, and people making management decisions in an environment in which they are unfamiliar. “Because they got too [many] rules and regulations concerning the fish, [] people [are] afraid to even eat fish now.” -11VI “[T]hey [are] messing up our business, [] it's hard for the people.” -01VI “[A] lot of people who don't understand how fishing is done here and they come down and they make regulations.” -19VI

The strong semantic ties from the “people” and “ACL” categories to the “regulations” category denotes the importance of this group of themes to the topic of management (Figure 20). Similar to the “people” category, the “regulations” category included general comments, mainly complaints, about the number and manner of fisheries regulations: “They are trying to catch as much as they can now cause in the back of their mind, they have a feeling that one day the federal government [is] go[ing] [to] come and put their foot down and will [end] the fishing...” -02VI “A lot of the fishermen them now just leaving fishing, and they going to get a job inland because it's so much rules and regulations now. They can't deal with it.” -06VI

Many VI participants’ comments expressed resentment that the federal government has control of the VI fishery. “That's why I hate Fish and Wildlife business.” -05VI “I'm only making two hundred dollars a week, and the federal government come in and tell me hey you got to go down to twenty traps and then you going catch two hundred pounds of fish and now you going make ten dollars []. You don't want it []. [I]t's a bitter pill that we all got to swallow.” -03VI
“They [CFMC] really don't give a shit about us over here [in St. Thomas] you know, and the Fishery Management, what have they managed? [I]f this fishery was properly managed, we would have a fishery today you know.” -09VI

“The [St. Thomas] Fisherman Association holds events to raise money to attend [CFMC] meetings where we go out there and we fight with the--when I say fight we go out to try to negotiate with the federal government and with our local government to try to come to some midway point where we can keep doing what we've been doing. And at the same time have a sustainable fishery, which all the fisherman are in favor for because without a sustainable fishery they'll be no future for the generation of fisherman and their families…We fight hard for what we do. Sometimes we feel that the federal government goes too far. We try [to explain to] them [that] in order to get what they want, they need to work with us. We're the ones [who] hold the knowledge...They have the degree from books, but we have the degree in the ocean. We're the ones that know what goes on, when it goes on, how it goes on. So we trying to get them [to actually come out on the boats with us, see what we do, gather the information… “ -12VI

Despite this shared sentiment, a number of comments seem to suggest that some participants feel the federal government should be controlling the fishery more strictly.

“Some days there were like twenty, thirty boats out there and most of them were not commercial fishermen...there were couple hundred thousand groupers and they've caught every one of them...I blame a lot of it on the federal government, cause this is your waters, you [the federal government] in charge of this. You have the fishery management council. -02VI

In exploring the categories of “fishing,” “fishermen,” “area,” and “enforcement,” the issue of fish traps emerged as another prominent resource management challenge. Many respondents had quite a bit to say in regards to fish traps and their negative impact on the environment. Examples of responses included in the “trap” category: “The thing is, what going on there is too many
fisherman, too much of traps” -05VI. “To manage the fishery now you need some kind of regulation on the amount of traps, and that's the only way I think you can go to manage that.” -03VI

“I am a council member now…so I am a part of protecting [the fishery] right now. I am also a harvester of the fish because I am a commercial trap fisherman. [] I would not like to see the resources get to a point where it's not sustainable anymore...So I am trying my best to…get [the] trap reduction going and limiting entry into the trap fishery.” -07VI

Review of the comments related to management presented a common theme of participants commenting positively on management in the past, and less positively on current management schemes.

“[From] the time they [federal government] start to put law and regulation on fishing business, the fishing business [has gone] down more and more... if they were to put in place more regulations [] on the amount of fish traps, the amount of fish you catch, or whether it [is a] closed [or] open season, [] what type of effect [do] you think those regulations would have on the fisherman and their livelihood? If the fishermen…put themself together and manage the place [] a lot of things going work better.” -05VI

Note: The categories “guys” and “example” were also deleted from the categories produced through the analysis of the responses to management questions.

Fiji
Questions regarding local fisheries management in Fiji include: What was managing the fishery in Kadavu/your village like in the past, how does it compare to how the fishery is managed today, is fisheries management important, and are you aware of the regulations issued by the Fisheries Department (Appendix C)? The semantic analysis of the Fiji participants’ responses to these questions resulted in the following categories being considered the most semantically relevant:
1. fish,
2. people,
3. protected area,
4. night diving,
5. regulations,
6. boat,
7. enforcement,
8. fishing,
9. rules, and
10. idea.

Other notable categories include “village” and “fuel” (Table 9).

Table 9. Semantic categories of Fiji participants' responses to local fisheries management questions
The concept category “fish” has the greatest semantic weight (12 shared responses), followed closely by the category “people” (with 10 shared responses). These two categories are strongly associated (6 shared responses) as indicated by the thick line linking the nodes (Figure 21).

“Fish” is linked to 11 other categories, with strong ties to the categories of “boat,” “fishing,” “regulations,” and “night diving” (5 shared responses).

The “people” category included responses relevant to management related to more people fishing now (so management is more difficult) and that people are starting to see the value/benefit of the protected areas. “People start to recognize that a community-based marine reserve could be started off just from a community decision.... It was really world-wide news for people to know that this thing started in Kadavu- a marine protected area that was community-based.” - 21F

“Right now people are aware of what's happening [] concerning the i qoliqoli. Also they are aware of the rules and regulations that have been put forward by the
Fisheries Department or the government. [B]ut some of the people seem[] to neglect or ignore what ha[s] been implemented by the government.” -16F

“Protected area” typically referred to an area protected from fishing, but in a few instances general references to an area, meaning a specific place (regulated or unregulated), were included in this concept category. Examples of the functions/combinations that had the most respondents for the “protected areas” category were “area and safe,” “area and night diving,” and “area and problem.” This category included participant responses such as: “It's good [to] have those tabu areas, the fish stock will improve.” -03F “Before there [were] no tabu areas, but now we are seeing a difference [since] the idea of tabu got brought up and was endorsed. Now the fish are starting to come near shore. Before we had to go far” -19F.

The issue of spearfishing while diving at night emerged as a prominent and commonly mentioned theme when discussing fisheries management in Fiji. After numerous participants brought up the recent ban on night diving unprompted (the question on night diving was not initially included in the interviews) and the Fisheries officer and translator requested additional information on the subject, a question regarding the night diving ban was added to the questionnaire. Many respondents cited the ban as an effective protection measure that simplified enforcement efforts. Now, a participant explained, if someone is diving at night, it is illegal. It doesn't matter if the diver is inside or outside of a protected area. The “night diving” semantic category is strongly associated with the “fish,” “regulations,” “night,” “enforcement,” “authority,” and “village” categories (Figure 21). “I support the idea of no night diving so that the fish can come back.” -23F

“I am] supportive of the idea of no night diving for the Province of Kadavu. Now the [fish] are coming near shore, so it's good the idea of night diving was banned, so it can protect their seas from exploitation and also from poaching from people inside and outside during night time…[T]here needs to be enforcement and information that can reach the villages, so they can keep track about the i qoliqoli and management. So that there will still be enough fish for future generations.” -22F
The “rules and regulations” categories examined the functions/combinations “regulations and don't know” and “rules and change.” This category included such participant responses as: “There is a need for rules and regulations to be implemented…All responsible authorities are not doing their job. [] [T]he people that enforce the law, are not there and there's a need to enforce the law.” -10F “There are rules and policies, but they couldn't enforce those rules those policies because they don't have the resources to carry out those policies.” -13F

Many of the statements related to rules and regulations touched on enforcement issues. The main issues included in the “enforcement” category were poachers from other villages and Suva, and the ineffectiveness of fish wardens (with a lack of fuel and sometimes boats to patrol as the main reasons). “But I have heard that there are poachers from other villages. But there is no more inside poaching, just outside poaching. This is a concern.” -16F “The fish warden cannot enforce those regulations cause there's no boat, no engines to carry out those work.” -08F “It's the fish wardens. But they [can’t] do much, because they can't always see [the protected area] from here when people come poach.” -08F Most of the comments included in the “boat” category relate to the lack of resources for effective enforcement. “The boat that they are supposed to police the protected area is not being used, it is being used for other things in the village.” -03F

The “village” category looked at the function/combination “village and problem,” “village and good,” and “village and night diving.” This category included such participant responses as: “Every village has a tabu area, so if there's no support from the village and the government and stakeholders and NGOs [then] we [will] not see the benefits.” -09F “Now it is better. Management tools [are] better. We have a portion of our i qoliqoli put aside to be a tabu by the directive of the elders and supported by the village members. So it's good now that there is a tabu.” -23F

Note: The “tabu area” category was merged with “protected area,” since they both refer to marine protected areas. The category “fishery” was deleted because it included terms that were already included in the category of “Fisheries Department.” “Diving” was deleted because it was repetitive to “night diving.”
6. **General trends of semantic network analysis for both locations**

Based on careful examination of the terms and responses included within the semantic concept categories previously mentioned, the following general inferences were made about the data and the participants.

**General state of the fishery**

When asked about the state of the fishery and if marine resources have changed over time, participants in the USVI had a mixed response, with a greater number of participants claiming that the state of the fishery was the same today as it was in the past (“past” ranging from 10 to 20 years depending on the age of the participant). It was suggested that it just appears fish caught today are smaller than in the past, because fishermen are targeting smaller “plate” size fish to sell to restaurants. Therefore, these smaller sizes landed do not accurately reflect the average size of the population.

Review of the semantic network and responses associated with highly relevant semantic categories revealed that the few USVI participants who did think that the size of fish caught were smaller attributed this to the increased number of fish traps being used currently. Non-point source pollution, mainly from development and runoff, was also cited by USVI respondents to have a negative impact on the inshore fishery.

The majority of people interviewed in Fiji felt that the number and size of fish caught today was smaller than in (10 or 20) years prior. In Fiji, poachers from Suva, too many people fishing, and long line operations were offered as explanations for the decline in the local fishery.

In response to what the future of their fishery would be like, the comments in Fiji were largely positive and upbeat. Many interviewees felt that the number (and size) of fish were “starting to come back,” citing marine protected areas and *tabu* areas as the cause. In the USVI, participants once again had mixed responses. Some felt the fishery had hope, because it really wasn't in as bad of shape as some people thought, or that with effective enforcement the fishery could come
back. Other respondents in the USVI made negative statements about the future of the resource citing the current management regime as the reason.

*FSAs*

In the USVI, many respondents were familiar with FSAs, and mentioned the grouper spawning aggregations a number of times without prompting. Those respondents who did talk about FSAs seemed to do so in association with an FSA closure. Some respondents demonstrated understanding of how fishing can impact FSAs, and of the research being conducted by the local university to understand these resources.

In Fiji, the respondent's familiarity with FSAs, especially with the term itself, varied. Some people interviewed were familiar with both the concept and term, and in a few instances even knew of someone who had caught a tagged fish as part of the research being conducted in Naiqoro Passage. Eighteen of the twenty-four Fiji respondents confirmed they catch fish only or mainly during one time of year, with many confirming that those landed (and cleaned) fish have eggs in their bellies (used in this study as a proxy for FSAs).

*Monitoring and enforcement*

In general, the fishing communities in both locations, especially the fishermen themselves, seem well informed of fishing regulations. Some of the participants who fish less frequently in Fiji appeared less familiar with the Fiji Fisheries Department regulations. Regardless to whether or not they were familiar with the regulations, the data presented in the semantic networks illustrated that many people in both Fiji and the USVI expressed concern with poaching and illegal fishing in protected areas and with the lack of enforcement. The most cited reason for inadequate enforcement in Fiji was the lack of resources, i.e. boat and fuel for patrolling or apprehending offenders, and the subsequent ineffectiveness of fish wardens. In the USVI, the lack of enforcement was also attributed to a lack of resources, mainly enforcement officers on the part of VI DPNR. Blame was directed at the ineffectiveness of federal and USVI territorial agencies to effectively manage the resources for which they are responsible.
In the USVI, ACLs and fish traps emerged as issues of concern for many of the respondents. The semantic network highlighted these themes, and review of the responses included in these categories revealed respondents greatest concerns as a lack of data to establish ACLs, the amount and the durability of the traps, and the environmental impact of lost (ghost) traps. In Fiji, the recent ban on night diving in Kadavu was a popular topic amongst participants. Many respondents cited this ban as an effective protection measure that simplified enforcement. One interviewee explained that the ban made enforcement easier, because if you saw someone fishing at night you knew it was illegal, whereas before the ban you could not be sure if they were fishing inside the protected area.

4.0 Discussion

1. Comparison of the results between communities

General state of the fishery
In comparing the responses between locations, many of the responses from USVI participants seemed to be more negative, with less optimism about the future of the fishery and the resources. In Fiji, the respondents used positive semantics to talk about future generations and how because of protected areas, the future of their fishery was “bright.” The concept of future is only discussed by one USVI fisher, as opposed to four participants in Fiji. This expression of negative feelings about the future may be attributed to the feelings of disempowerment experienced by members of the USVI community as previously discussed. Exploration of the relationship between feelings towards current resource management schemes and feelings towards the future could help to shed light on the different sentiments expressed by the fishing communities in the USVI and Fiji.

The relationship between members of the USVI fishing community and federal fisheries management should be further studied. Future research should expand on this study to investigate the belief expressed by some members of the community that their fishing efforts are not impacting the fishery. What does this mean for the U.S. Virgin Islands? Is there a link
between feelings of disempowerment/negativity and the inability for an individual to see themselves as part of the ecosystem where they could have an environmental impact?

In citing pollution and subsequent reef degradation as possible causes in the decline of the fishery, USVI participants demonstrated knowledge of ecosystem connectivity. Studies have shown that extensive coral bleaching, as experienced by the USVI in 2005, leading to a decline in coral cover can cause a reduction in fish diversity (Rothenberger et al, 2006).

It is not surprising that the issue of fish traps was identified by USVI respondents. The fish trap industry is one of the most valuable fisheries in the US Caribbean (Shivlani et al 2005). Historically, trap fishing has been the primary gear type in the USVI, and remains so today in the St. Thomas and St. John fisheries (Kojis and Quinn, 2006). Surveys indicate that there was a 500% increase in the number of traps (used by the same number of fishers) between 1930 and 2003 (Kojis and Quinn, 2006). The increase in the number of fish traps utilized, and the improved technology of trap construction has greatly impacted reef fish and benthic communities. Groupers, with their slow growth rate and sedentary behavior are particularly vulnerable to the impacts of fish traps (Shivlani et al, 2005). While protected areas help to reduce the detrimental impacts of fish traps within the protected area itself, some argue that they can lead to increased crowding just outside the protected area boundaries (Shivlani et al, 2005).

In Fiji, technological advances, most notably vessel engines, scuba dive equipment and flashlights, have allowed for greater access to fish, and thus a greater human impact on the fishery. While traditional fishing methods such as the use of the duva root to stun and capture fish have been phased out, subsistence fisheries in Fiji are now “faced with a range of modern pressures, [] and the introduction of modern fishing equipment” (Kuster et al, 2006). This concern was voiced by numerous study participants in regards to the increased fishing effort today, and support of the ban on fishing while night diving. Another potential impact is the increased access to boats designed by the US Food and Agriculture Organization in an attempt to promote the use of fishing grounds outside delineated i qoliqolis (Veitayaki 1998).
FSAs

It is important to note that the textual data/responses on the topic of FSAs were much smaller compared to the data on the other two topics. As previously mentioned, in the USVI participants were not directly asked to share their feelings on FSAs. While some participants still discussed FSAs, in avoiding this subject, the interviewer undoubtedly reduced the number of responses to this subject. In Fiji, although participants were asked about FSAs outright, many participants appeared hesitant to talk about the timing and locations of spawning aggregations. As a result, the smaller pool of shared responses to the topic of FSAs for both locations resulted in a smaller sample during SNA term extraction. This could have implications for the results.

Despite this smaller dataset, participants in both locations appeared knowledgeable on the subject of FSAs, especially their timing and locations. This local ecological knowledge is important and has been used by researchers and managers world-wide to identify, verify, and protect spawning aggregations (Sadovy 2007). Members of both the USVI or Fiji fishing communities appeared to consider FSAs an important resource; what is unclear from this study is to what extent the participants feel this resource should be protected.

Monitoring and enforcement

In the USVI, 16 of the 19 respondents used the words hard, problem, and/or issue when discussing fisheries management. The semantic network on this topic for the USVI also indicated that the strongest semantic link was between the “people” and “ACL” categories, followed by the “people” and “fish” categories and the “fish” and “ACL” categories. Participants’ association of the topic of local fisheries management with the themes of “people” and “catch limits/regulations” provides insight into their feelings of hardship and pressure from regulations. The “people” category included negative responses as to how management affects people. This is not a new perspective. In a 2009 study by Karras and Agar, St. Croix fishermen stated that the increasing number of regulations and closures had brought about severe economic hardship.

In Fiji, the words hard, difficult, and/or problem were used by only 12 of the 24 participants in response to the questions regarding management in Fiji. This occurred mainly in the context of the issues of poaching, night diving, the amount of fish, making a living, and people's mindsets.
In the semantic network for Fiji on this topic, the concept category “people” was strongly associated with the concept category “fish,” followed by a lesser semantic association of these terms to the category of “regulations.” Participants’ association of the importance of fish to people, with less emphasis on regulations, indicates a more positive outlook on local fisheries management.

The general sentiment of West Indians feeling overrun and overpowered by people from the US mainland (discussed earlier) was illustrated by a few of the USVI comments in regards to the top-down federal fisheries management system. “[T]hey come from the States, they make rules that you can't fish here, you can't fish there…with these rules, it, it ain't like years ago you could have just go out outside and drop a line and catch fish. Now they telling you what fish you could catch and what you cannot catch.” -06VI

Members of the St. Thomas Fishermen’s Association reaffirmed this sentiment with their written testimony submitted to the Committee on Natural Resources, U.S. House of Representatives in response to catch shares: “We do not support application of catch shares in the Virgin Islands until such time as systemic problems within the NMFS/CFMC/Territorial Government nexus are resolved and we could be involved in a relationship with a trustworthy partner in guaranteeing sustainable management of Virgin Islands Resources” (www.stfavi.org, 2010).

“You have made it abundantly clear that the SEFSC is not interested in ANY suggestions or proposals originating from fishermen. The supposed ‘cooperative process’ which you claim to be underway is only between NMFS stock assessment scientists to the exclusion of all interests affected by ACL decisions” (STFA 2009 statement to Dr. Bonnie Ponwith, Science Director, SFSC).

In Fiji, the threat from another group was not directed towards the management agency (as it was in the USVI), but towards people from other distant villages and Suva who they believe to be poaching. The integration of customary and contemporary management measures, and the involvement of the community in fisheries management has allowed for “more efficiency in the
management of fisheries resources, because it involves people and how they relate to each other and to the fisheries resources within their areas” (Veitayaki, 1998).

While this assimilation of customary and contemporary management measures can lead to effective management, the slow disintegration of some aspects of Fijian culture within the village structure affects compliance and enforcement of fisheries regulations. As regulatory power moves beyond the traditional authority within village boundaries to government entities such as Fiji Fisheries Department, the traditional cultural system of management based on social structure, respect, retribution for non-compliers, and the concept of sacred ground becomes less effective. While it seems poaching and illegal use of tabu areas are not new threats, the ineffectiveness of fish wardens (regardless of the reason) and customary restrictions may be attributed to this shift in authority.

ACLs and night diving were identified as the prominent fisheries management themes by USVI and Fiji participants respectively. While these are both important management issues, I think it is interesting to note that these are issues/topics that had either been at the forefront of the discussion in terms of fisheries management or recently implemented in the case of the ban on night diving. Based on this observation, it would make sense that these topics dominated participants’ conversations in the respective locations. The semantic networks clearly illustrate the participants’ association of these issues to the topic of local fisheries management (Figures 20 and 21).

Overall, the responses from participants related to local fisheries management seemed quite different between Fiji and the USVI. However, it is interesting to note the similarities between Fiji and USVI participants’ comments related to monitoring and enforcement challenges.

2. Limitations and challenges in methodology

The snapshot that is a result of this method of data collection and analysis does not represent all members of the fishing communities in each location. Because randomized sampling was not used in this study, it is unknown if this sample is representative of the fishing communities. This
research is also time bound and geographically focused, which is important to consider when attempting to extrapolate themes identified in this study to other fishing communities.

**Challenges specific to the USVI (Ortiz, 2012):**
There were several challenges and limitations involved in this study during the data collection process; the first being the identification of key informants to initiate the snowballing interview process. In order to alleviate this issue, leaders in the St. Thomas fishing community were asked to suggest primarily individuals from the St. Thomas Fishermen’s Association to begin the interviewing process. Another challenge faced throughout the interview process was the reluctance of individuals to participate in the study. Three attempts was the maximum number of times participation was encouraged. If at that point an individual still resisted participation in the study, he/she would be considered a point of contact in the fishing community, but not part of the knowledge representation assessment. At some points, an individual referred to as highly knowledgeable and suitable for an interview was deceased. Funding resources and time limitations also presented challenges.

**Challenges specific to Fiji**
Little or no documentation exists of village residents (with the exception of licensed commercial fisherman), therefore the snowball technique was utilized to identify fishers in the selected villages as potential interview candidates. The majority of the Fijian villagers do not own a telephone, and cannot be contacted ahead of time to schedule an interview. Access to villages is also limited due to the lack of roads. Villages are reached by boat, and as a result interviews needed to be conducted with whoever was available during the limited visits. If identified informants could not be reached for an interview, the chief was revisited for additional participant recommendations.

While intercept sampling, conducted at appropriate hours (after regular fishing hours), would also have been an effective method of identifying potential interviewees, entering a village and approaching people without proper introduction would not have been culturally appropriate. Appropriate protocol includes, but is not limited to, being introduced by another village member or with consent from the village chief. Snowball sampling, with direct approval and direction
from the chief, could facilitate acceptance within the village community and lead to high rates of interviewee participation. With the help of the chief’s *turana ni koro* (communications officer), the chief is aware of the day-to-day activities of the village, and who is where when.

While attempts to minimize biases were made, numerous potential biases may have occurred. Before the interview began, interviewer bias may have already occurred. The principle investigator was a young western woman in Fiji working with researchers on the Naiqoro Passage spawning aggregation site. The purpose of the village visits were twofold: to interview fishers to learn about their perceptions of their marine resources and management strategies, and to provide information about spawning aggregations and the research being conducted by Dr. Yvonne Sadovy, University of Hong Kong and SCRFA. In asking about FSAs during the interviews the P.I. was expressing an interest in the subject. Fijians are generally courteous and polite, and therefore may have been inclined to offer responses they thought the interviewer would want to hear.

In interviewing fishers recommended by the chief, the sample population may have been biased by the chief’s opinion of who would be a successful interview candidate or by the chief’s influence (as some interviewees may have been hesitant to respond counter to the chief’s often publically known beliefs). Some of the interviews were conducted following a kava ceremony (a traditional welcome/presentation ceremony involving the mildly narcotic kava drink) in the chief’s direct audience. Having the chief present during the interview process most likely influenced the fishers’ responses out of both respect for the chief and humility as a guest in someone’s home.

Even if a chief was not present, there were often other people present during an interview. This may have made the person being interviewed uncomfortable, affected the participant’s responses, and changed the way someone listening (who was waiting to be interviewed next) may have responded when it was their turn to speak (Silverman, 1997). Language bias may have also occurred. There were a few instances where the participant contradicted themself, stating that the fish are bigger today then in the past, and then later making the statement that they are concerned for the fishery because the size of fish are smaller today. While the participant may
have been providing these responses intentionally, they most likely indicate a misunderstanding of the question being asked or a language barrier.

Many of the interviews were conducted in English, but a translator was on hand if a participant was not comfortable speaking English, preferred to speak Fijian, or needed some translation assistance to understand a question. Two translators were used during the study (see Methods). One of the translators was a Fisheries Department officer. This could have been another potential source of bias. How many fishers modified their responses to the questions due to his presence as an authority figure? This bias may have been especially influential during the questions that involved issues of regulation compliance. There were also instances where this translator seemed to lead the participant’s response. While this probably was done with the best of intentions, it may have affected the data.

In the USVI data, the “study” semantic category included the West Indian use of the word *study*, as in to pay attention to. “That's because they ain't *studying* the time that they catch the fish in different areas.” -01VI The PI’s familiarity with the West Indian dialect helped with understanding and interpreting the USVI fishers’ comments. The PI however is not familiar with Fijian language and has limited cultural understanding. While the Fiji data was in English, there are potentially many cultural and linguistic subtleties that the PI may have overlooked.

*Pros and cons of semantic network analysis using SPSS Text Analytics for Surveys 4.0.1*

NVivo 9.0 and SAS Text Analytics software were explored (though not exhaustively) as potential data analysis software programs. While these programs may have been effective in identifying emergent themes, NVivo functioned more as a data organizational tool, and the image results produced by SAS were lower quality than the networks produced by SPSS Text Analytics for Surveys 4.0.1. While manual qualitative analysis could have been conducted, this study sought to explore the linguistic associations between concepts and words, and their shared use. An important strength of semantic network analysis is that it allows users “to focus on both concepts and the strength and structure of their connectivity” (Alexandridis et al, 2009). Therefore, utilizing SPSS software seemed like the more appropriate analysis technique.
SNA “…automates the process of quantifying textual responses while allowing the user to manually intervene and refine results” (IBM Corporation, 2010). This statement represents both the pros and cons of this method.

A benefit to using this software is that it automates the process of quantifying textual responses, which can improve consistency, especially if you have a large dataset and more than one person is manually analyzing the data. For example, if ten different people analyze the data, the outcome will be ten different results. Hypothetically, the same process can be done using the software, except now it is a semi-supervised/unsupervised computer-based process, which can be more objective in the sense that if you (or ten different people) run the program ten different times you get the same results. “It moves to a more objective interpretation of the classifications.” (Alexandridis, per. com.).

While this makes sense in theory, sometimes (based on the parameters chosen by the user) the results simply don’t make sense. Gross misrepresentation of the data can occur (as illustrated by Figure 22). It is fairly obvious that the themes french jazz clubs and jazz clubs are unrelated to fisheries management in Fiji. Based on the parameters selected, the software miscategorized the text. The software makes decisions using Artificial Intelligence based on natural language processing and multiple dictionaries and libraries. It simply classified the data in a manner that was not appropriate for this study. This is where it’s essential for the user to intervene and manually refine results. Even when the results made sense, each theme and category were carefully confirmed manually by the PI. IBM advertises this software as a quick and reliable alternative to more traditional categorization techniques, which are “time-consuming, tedious, and expensive” (IBM, 2010). In its product description, IBM states that major themes from the text can be identified without having to read responses word for word. However, this example illustrates the risk in relying solely on an automated process.
Another drawback is the lack of transparency of how terms are categorized. Unless you witness the analysis process or have access to detail documentation of the methodology, it is difficult to deduce what specific parameters were chosen and steps were taken to produce the final results. Procedural descriptions often do not provide enough information. The final take away is that placing too much weight on the software itself with less emphasis on the process, can be detrimental, especially in light of using this data to guide fisheries management decisions.

3. How can this information be used in FSA management?

Characterizing collective themes within a community related to natural resources is an important step in determining the most appropriate management option. Combining semantic knowledge representation tools, such as the software applied in this study, with qualitative social science methods represents one possible approach to understanding the relationship between social and natural systems. While this combined qualitative and quantitative modeling technique does not provide a solution to how best to integrate fishermen’s’ perspectives into fisheries management planning, it can be a useful tool in providing a snapshot characterizing the social system, with the
result of enhanced understanding of the resource management issue and its anthropogenic and environmental context.

This is particularly relevant given the current direction of NMFS to incorporate sociocultural data collection and research into fisheries management (Abbott-Jamieson and Clay 2010). The 1996 reauthorization of the MSA and the creation of National Standard 8 (16 USC 1802 §3 (17)), called for conservation and management measures that “take into account the importance of fishery resources to fishing communities in order to provide for the sustained participation of such communities” (www.nmfs.noaa.gov/sfa/magact/index.html). This methodology presents a way to give voice to fishermen, assess the social environment of the fishing community, and build on the demographic data currently presented in the Fishing Community Profiles compiled by NMFS (www.sefsc.noaa.gov/socialscience_memo.jsp). Demographic data and other objective characteristics, which only provide a snapshot in time of a partial set of data, are simply no longer sufficient (Hall-Arber et al, 2009, Orbach, per. com.). An artifact of this is the similarity between the demographic data of the USVI and Fiji participants, despite the many differences between these communities and the fact that study participants were selected by different PIs.

Semantic networks, which identify commonalities within the pool of respondents, can help guide resource management decisions and direct where effort should be targeted. High levels of semantic agreement between informants often indicate “collective social dynamics” (Alexandridis et al, 2010). As shown in this study, semantic analysis identifies themes with shared responses and higher homogeneity, which can be useful when trying to determine where the greatest impact can be made and where to direct fisheries management attention. For example, understanding which regulations, such as the ban on night diving in Kadavu & Ono, are supported by individuals within a community is useful information when planning for future regulations. Shared support often coincides with increased compliance. Since enforcement has been identified as a problem for fisheries management in Fiji, measures that are more likely to foster community support will be more successful in the long run.

While not unique to this methodology alone, important big-picture themes can emerge with the application of this methodology. For example, the theme of plate-sized fish that emerged from
the USVI data drew attention to the common practice of fishermen targeting smaller fish in response to restaurants’ demand for fish that fit nicely on a plate. The socio-economic relationship between restaurants and fishermen has been influential to the USVI fishery since the 1950s with the development of the tourist industry (Stoffle et al, 2011). This practice of targeting plate sized fish needs to be factored into stock assessments based on fishery dependent data collection methods, such as Commercial Catch Reporting and Trip Interview Programs, otherwise estimates of fish stock may be too conservative (Rothenberger et al, 2008). “There is growing recognition that [knowledge held by local fishermen] can provide an excellent source of information that can complement fishery data collected through conventional approaches, for example past abundance patterns of target fish” (Silvano and Valbo-Jorgensen, 2008).

What is useful and unique to semantic networks is the how these big-picture themes are identified and represented. If I were to run a basic text frequency query, night diving would probably still emerge as the prominent management theme for Fiji and annual catch limits and fish traps as the prominent themes for the USVI. However, with the networks, not only are these concept categories identified (denoted by the size of the nodes), but upon a brief examination of the graphic, the user can determine the relationship of these themes to other identified themes, and the strength of those relationships (as denoted by line thickness).

Community characterization through SNA can also be used to initiate and facilitate communication and dialogue between stakeholders (the fishing community and FMC members and other fishery managers). The semantic networks can be used as a visual tool to describe perceptions framing the management issue. These visuals can be used to guide discussion during this communication process. This methodology can also be used to enhance communication between science disciplines, most notably, social and physical sciences.

Facilitated communication using SNA could occur before a draft FMP or amendment is created during the initial public hearings and comments period. Data from studies of fishing communities or specific issues would be presented and then discussed. This would take place in addition to the standard public hearing comment period, and would allow for more free-form discussion (rather than the three minute/person public comment period that is currently in place).
Another option would be to take the textual data from the public comments during that initial hearing in addition to those submitted during the public comment period, and analyze them using the SNA methodology described in this study. The results from the analysis of those comments could then be used as a platform for facilitated dialogue during the public hearings which take place during the 45-day public comment hearing once a draft FMP or amendment is complete (Wallace et al., 2008).

The recommendations on how fishermen can get involved in the management process identified in the NOAA-funded publication, *Fisheries management for fishermen: A manual for helping fishermen understand the federal management process*, are helpful, but highlight the common complaint that fishermen’s involvement in this process is limited and efforts are often one-sided (Wallace et al., 2008). Under the current system, if a member of the public wishes to express an opinion or weigh-in on a management plan, he or she must either write a public comment, make a phone call, and in some cases conduct fairly extensive research. Incorporating SNA of the fishing communities’ comments and perceptions, and creating an open platform to discuss those results, would change the nature of how social science is currently integrated into management planning.

In the USVI for example, based on research conducted by the University of the Virgin Islands (backed by USVI F&W), the CFMC hosted public scoping sessions in 2004 to obtain stakeholder input into the possibility of seasonally closing the Grammanik Bank spawning aggregation. Stakeholders included commercial fishermen, scientists, and management and enforcement agencies. These sessions were later followed up by another public forum of fishermen and managers, where three different closure boundaries were presented and discussed (Nemeth per. com.). Based on fisher input, the smallest MPA boundary was selected, and in 2005 the NMFS implemented an emergency 3-month seasonal closure, which went into effect from Feb 1 to Apr 30, 2005. This seasonal closure was written into law in the federal register in Oct 2005 (NOAA, 2005). Utilizing the methodology presented in this study during this process of informal dialogue between fishers and Council could have improved upon the success of that event. During initial scoping sessions fishers’ comments and perceptions will be recorded and
later analyzed. The semantic network results would then be presented to the assembly during the second round of public forums, and used as a tool to guide dialogue.

This methodology would not take the place of direct communication between fishers and managers, but rather serve as a way for managers to say “this is what we took away from what was said, are we hearing you accurately?” It is a starting place, rather than an end. Consensus among collaborators is not the goal, rather the process is about providing those who participate with the opportunity to share information and educate each other (Hall-Arber et al, 2009). For example, participant data from the USVI suggests that the fishing community is not united in their opinion of whether or not fishing effort has negatively impacted the fishery over the years. Those opinions disassociating fishing effort with negative impacts to marine resources are not in line with the perspectives of many fisheries managers. This methodology could lead to a clearer understanding of how fishers’ perspectives differ from those actively managing the resource.

5.0 Conclusion

The technique outlined in this study does not provide a solution of how best to integrate fishing community perspectives into fisheries management planning. It can be a useful tool in providing a snapshot characterizing the social system, with the result of enhanced understanding of the resource management issue and its anthropogenic and environmental context. This is an important step in determining the most appropriate management option. It is essential to recognize that placing too much weight on the software itself with less emphasis on the process can be detrimental, especially when using this data to guide resource management decisions.

The integration of social and biological data for more effective fisheries management requires innovation and the exploration of “outside of the box” ideas/methodology. The application of this automated natural language processing software to transform unstructured responses from fishing community members into quantitative data is a creative avenue to present social science data. The goal is to present socio-cultural data “succinctly while retaining the value of a qualitative approach” (Hall-Arber, 2009). Communication network research is currently “a very
active area of research in a variety of scientific disciplines, including Physics, Biology, Artificial Intelligence and Mathematics” (Hoche et al, 2006). However, the application of communication science, and more specifically SNA, to social sciences within a natural resource management context is a relatively novel approach. Additional case studies applying this methodology in this field are needed, as are studies exploring the use of these results as a stakeholder communication tool.

Based on the application of this methodology to the case studies of FSA management in the USVI and Fiji, a number of general conclusions can be made. 1) The sentiments expressed by participants in the USVI were more negative with regard to the expected future state of marine resources and current fisheries management regimes than those expressed by participants in Fiji. 2) Participants in Fiji recognized the impact of fishing on the fishery, while USVI participants had mixed opinions on the affects of fishing on the fishery. 3) Participants in both locations expressed concern with illegal fishing and enforcement issues, but differed in their feelings on the source of these problems. 4) Prominent fisheries management issues differed between locations. USVI participants identified annual catch limits and fish traps as the most pressing fisheries management themes, and Fiji participants discussed the ban on night diving. 5) While participants in both locations demonstrated knowledge on the location and timing of FSAs, their true sentiments on the importance of protecting FSAs was difficult to gauge based on the information collected from this study.

Management that builds on the knowledge of fishermen is more likely to be successful than regulations imposed by a central authority (Silvano and Valbo-Jorgensen, 2008). While neither the USVI or Fiji is prepared to rely fully on the community for fisheries management direction, the integration of fishing community perceptions into management planning and identification of resource management themes (such as the themes identified for the fishing communities in the USVI and Fiji) is a productive step towards bringing the community into the process.

The need for more effective methods to integrate the human dimension in fisheries management will continue to grow as holistic management measures, such as ecosystem-based management, gain traction. The critical takeaway is that only by understanding the integrative dynamics of
collective, attitudinal, and social/institutional interactions of fisheries systems will stakeholders be able to assess how to integrate humans into natural resource management.

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## 7.0 Appendix

### Federal Area Closures

<table>
<thead>
<tr>
<th>Closed Area</th>
<th>Island</th>
<th>Closure Time</th>
<th>Prohibited Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCD (Hind Bank)</td>
<td>STT</td>
<td>YEAR ROUND</td>
<td>No fishing for any species year round, No Anchoring</td>
</tr>
<tr>
<td>Grammanbah Bank</td>
<td>STT</td>
<td>Feb 1 – April 30</td>
<td>No fishing with pots/traps, bottom longlines, gillnets or trammel nets year round. No fishing for any species except HMS during closure time.</td>
</tr>
<tr>
<td>Mutton Snapper Spawning Agg</td>
<td>STX</td>
<td>March 1–June 30</td>
<td>No fishing with pots/traps, bottom longlines, gillnets or trammel nets year round. No fishing during closure time.</td>
</tr>
<tr>
<td>Red Hind Spawning Agg</td>
<td>STX (Lang Bank)</td>
<td>Dec 1 – Feb 28</td>
<td>No fishing with pots/traps, bottom longlines, gillnets or trammel nets year round. No fishing during closure time.</td>
</tr>
</tbody>
</table>

Appendix A. Federal fishing area closures for the USVI, prepared by Shenell Gordon, DPNR/DFW
Historical Ecology and Cultural Heritage of the USVI Fishery Communities

Interview Process Protocol

1. Introduction to the project
   - Read and discuss project description, goals and aims. Request feedback. Note any points made by participant

2. Informed consent
   - Read statement
   - Ask if there are questions, concerns etc. Discuss them. Note points made by participant.
   - Participant and interviewer sign and date the document. If consent is not agreed, terminate the interview. Make sure you thank the participant for their patience.
   - Interviewer hands page 3 to participant.

3. Set recorder, and start recording conversation.

   - Gender: For the record, you are male/female...
   - Age: What is your age?
   - Ethnicity: What is your ethnicity?
   - Education: Do you have any formal education?
   - Marital Status: Are you married?
   - Family size: how large is your family?
   - Years in fishing profession: how long you believe you have been part of the St. Thomas fishing community? Was it a family tradition?
   - Is fishing today helps support your family? Does anyone in your family uses fishing as a livelihood?

5. Questions – Part 2 – Historical overview
   - Do you believe that over the time of your experience, the professional fishing and fisheries in St. Thomas has changed? How?
   - Can you think one or two more important things that changed in the St.Thomas/VI fishing community? How things changed, and why do you think they changed?
   - What do you remember in terms of fish catches from the past? Did the fishes and sizes changed? Did it become easier or more difficult?
   - Have market prices changed? How do you prepare your fish for sale? Who are your clientele?
   - Are there any fish species and sizes that you remember being part of regular catches and are becoming rare today?
Appendix B. USVI interview guide

- Do you own a boat? What size? Is it locally made?

- Do you think the environment is changing? How? How about hurricanes or other weather or seasonal changes that affect fisheries?

- Have you ever had fish poisoning? Do you know of any ways to treat it? What are some of the ways you have heard that allows you to tell a fish has been poisoned?

- What do you value from the past that was or still is part of the identity of the St. Thomas fishing community?
  - If it no longer exists, why this happen, and what has been lost?
  - If it is still exists, how important is to protect this part of the community identity?

- How would you describe from your life experience your relationship with the environment and the marine resources?

- How difficult was in the past, and is today to manage the fisheries in St. Thomas? How this is important for maintaining the livelihoods and fishing community culture in the island?
  - Were there things that worked well in the past?
  - Were things that did not work well in the past?
  - Are things that do not work well today?

- Overall, what does being a member of the St. Thomas fishing community means? How does this make you feel? What it is that makes it special?

- Overall, how happy you feel from:
  - Being or lived a part of the past history of the fishing community in St. Thomas
  - Being a valuable member of the St. Thomas fishing community today.
  - To continue being a valuable member of the St. Thomas fishing community in the future.

Interviewer notes for part 2:

- Encourage participant to remember and talk as much as possible.
- Encourage them to tell a story.
- If their answer is short, try to elaborate further.
- Use the information provided to query further in their remembering of the past.
- Ask about what they think other people in the past believed or thought about.

6. Closure and post-questions

- Ask if they have and want to share any photographs, or any archival material that they want to share from this era.
- Ask if they think there are other fishing community members they know of and they recommend for (a) interviewing; (b) having archival material that they might wish to share with us.
- Thank them very much for their participation, and stop the recording.
Kadavu Fishers’ Perspectives:  
Marine Resources, Fish Spawning Aggregations, & Management  
Interview Process Protocol

Introduction to the project. Discuss project description, goals and aims.

Informed consent. Read statement. Ask if there are questions or concerns. Request verbal consent

Make note of:

1. Interviewer and interpreter:
2. Date and time:
3. Location of interview (koro and tikina):
4. Gender:

Start recording.

Section 1: Respondent Identification and Background

5. What is your age?
6. What koro are you from?
7. Do you have any formal education?
8. Are you married?
9. How large is your (immediate) family?
10. At what age did you start fishing?
11. Do you fish for food, to sell, or both?
12. How important is fish that you catch for food and for selling/cash. Which is more important?
13. What is your primary fishing method (gear type)?
14. Do you own a boat or have access to a boat?

Section 2: Fishery profile

15. What are the top 5 most important species that you catch? Species name? (Show fish ID chart)
16. What would you say your typical catch per daily trip is currently (weight in standard measures)?
17. How does that compare to fish catches from the past?
   a. Typical catch per daily trip 5 years ago
   b. Typical catch per daily trip 10 years ago
18. Has it become easier or more difficult to fish? If so, explain how (e.g. longer at sea, travel further, etc.) and why do you think this has happened?

19. What is the size of the fish you typically catch (currently)? Has the average size of fish caught changed?
   a. If yes, why do you think?
   b. If yes, do you think this change in size of fish caught is a problem?

20. Are there any fish species that you remember being part of regular catches and are becoming rare today?
   a. Does the disappearance of certain species concern you/do you think it is a problem? If so, why?

21. Do you catch certain species of fish ONLY or MAINLY at certain times of the year (i.e. not at any other time)?
   a. Do you know if those fish caught are fat with eggs or milt?

22. Do any of the fishes that you identified (as your top species) aggregate to spawn? (Explain “aggregation” and “spawning” and ask for them to identify species).

23. Over the time of your experience, have the fisheries changed? If so, how?
   a. (If so) what do you think are the causes (changes in fishing method/gear-type, easier access/boats, weather events etc? If multiple causes are given, which is the most important/responsible for the change?)

24. Since you started fishing, do you think more or less people are fishing overall in your community and why?

25. Do you think the fishing community in the village has changed? If so, how (over what time period) and why do you think? (male vs. female, young vs. old etc)

26. How people in the village perceive fishing?

Section 3: Fisheries Management

27. What does fisheries management mean to you? Are you familiar with the concept of management?

28. What was managing the fishery in Kadavu (or your village) like in the past (~20 years ago)? How does it compare to managing the fishery today?
   a. Were there management methods that worked well in the past?
   b. Were there methods that did not work well in the past?

29. Do you think fisheries management is important for maintaining the fishery and the livelihoods of fishing community?
Appendix C. Fiji interview guide