**Local Ecological Knowledge of Coral Reef Ecosystems:
A Case Study of Bequia, St. Vincent and the Grenadines**

By:

K. Lindsay Copland

**Thesis submitted to the Faculty of
Graduate Studies and Research in
partial fulfillment of the requirements
for the degree of Master of Arts**

Department of Geography and Environmental Studies

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2009**

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ABSTRACT

Local ecological knowledge (LEK) is increasingly recognized as a useful source of data for conservation and co-management of marine resources. This study presents an analysis of the LEK of coral reef ecosystems on the island of Bequia, St. Vincent and the Grenadines, where significant increases in tourism development are underway. Local naming systems were documented, showing that local people have their own distinct taxonomy based on morphology, habitat and economic value. Despite differences in the LEK of divemasters and fishers participating in this research, both groups demonstrated an understanding of ecosystems and environmental change in the coastal marine environment. Maps generated by participants demonstrate a distribution of healthy coral reefs that is absent in government and other official maps. The findings demonstrate that Bequians whose livelihoods depend on marine resources have a sophisticated understanding of coral reef ecosystems and the species within them that can contribute to conservation management.

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DEDICATION

I dedicate this work to Kurt, who showed me the way,

and to the people of Bequia.

LOCAL ECOLOGICAL KNOWLEDGE OF CORAL REEF ECOSYSTEMS: A CASE STUDY OF BEQUIA, ST. VINCENT AND THE GRENADINES.

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CHAPTER 1: INTRODUCTION AND RESEARCH QUESTION

“Keep remembering. That the ocean is the mother of the earth. And if we destroy the mother of the earth, we destroy the earth. We destroy ourselves.”

- B.K. 2006.

Saint Vincent and the Grenadines (SVG) is a Caribbean tourist destination whose environmental resources are in good condition compared to other Caribbean states (Metzger, 2003). One of the tourism resources that allows SVG to compete with other Caribbean countries is the relatively healthy condition of its coral reefs (Metzger 2003). This is particularly true of the Grenadine island of Bequia, which boasts coral reefs as deep as 30 m. Part of the reason for the relatively good condition of SVG's reefs is that it does not draw as many tourists as other Caribbean countries (Metzger, 2003), and therefore the environment is not as overexploited or degraded. In addition to being tourist attractions, coral reefs support productive fisheries (Mohammed et al., 2003; Turner et al., 2007) and are centres of marine biodiversity (Ruppert and Barnes, 1994; Sumich, 1992; Sotka and Thacker, 2006).

However, SVG plans to increase tourism in the country (Metzger, 2003), and associated development projects may have an impact on SVG's coastal marine resources. There is a significant risk that unmanaged coastal development will destroy marine ecosystems (Price and Price, 2003). Several authors have documented the Vincentian trend that development projects associated with tourism are destructive and do not yield the expected economic benefits (Price and Price, 1998). Examples they provide of such development

include the recent construction of a cruise ship dock on the island of St. Vincent and hotel construction on all the Grenadine islands. These factors coupled with the worldwide degradation of coral reefs resulting from climate change and other human impacts (Nurse and Sem, 2001; Ben-Tzvi et al. 2004; Hardman et al., 2004; Gardner et al., 2005; Donner et al., 2007) and the worldwide depletion of commercial fish stocks (Young, 1999), indicate that coastal marine ecosystems in SVG are threatened. Tourism development in SVG runs a risk of not only degrading that which makes it unique as a Caribbean tourist destination but also reducing biodiversity and compromising its fishery.

Relatively little ecological research has been conducted in SVG to date. Furthermore, the scientific literature on reef ecology tends to focus on species that are convenient research subjects and not those that are economically important to coastal communities (Sale, 2002). Data are also lacking on many aspects of marine ecosystems, such as life history dispersal characteristics for most species (Aswari and Lauer, 2008). This lack of Vincentian ecological data may hamper attempts to document emerging ecological damage and impede the development and implementation of techniques to mitigate damage to coral reef ecosystems during the construction of new tourism facilities and infrastructure. As such, decisions pertaining to the development of new tourism infrastructure may be made with little regard for their impact on marine ecosystems. By incorporating local ecological knowledge (LEK) into conservation and management plans, SVG could counteract these shortcomings and achieve improved conservation and management outcomes.

The purpose of this research is to investigate the local ecological knowledge (LEK) of islanders concerning coral reef ecosystems in two communities on the Grenadine island of Bequia and to explore how the LEK of islanders can contribute to the development of conservation and management strategies. LEK of coral reefs was the overall aim of this study, but this was explored in more detail through a focus on more specific topics. The objectives of this research are to:

- i) provide an overview of livelihoods of the study populations and their use of coastal resources;
- ii) document the local naming system for marine species in preparation for interviews and focus groups;
- iii) investigate the LEK of islanders concerning coral reef ecosystems and the species that inhabit them, the relationships between species and to develop a food web based on Bequian LEK;
- iv) investigate knowledge of seasonal events such as migrations and spawning aggregations;
- v) document local knowledge of how coral reef ecosystems have changed over time on Bequia, including coral bleaching, declines in species abundance and a mass mortality event affecting reef-associated fish in the Eastern Caribbean;
- vi) use locally derived maps to document local spatial knowledge and add local detail to government maps; and

- vii) document local perceptions of the degradation and damage to coral reef ecosystems due to human activities or natural events.

More broadly the research aims to provide a better understanding of the distinctive characteristics of local ecological knowledge of marine ecosystems in coastal communities in the Caribbean. I also examine how Bequian LEK differs from “scientific” knowledge. Finally, I discuss which methods are best suited to the study of the LEK of coastal marine resources in Bequia.

The potential for LEK to contribute to effective natural resource management can only be realized if LEK systems are first carefully and thoroughly documented (Davis and Wagner, 2003). While this research was not undertaken with the intent to contribute to a particular resource management strategy, or community-based conservation or development plan, it constitutes a hopeful first step in the documentation of Bequian LEK for incorporation into such activities in the future and to provide insights into collection methods for LEK or marine species and ecosystems.

1.1 Local Ecological Knowledge and Debates Concerning its Use

LEK research is increasing, to some extent in connection with the increase in popularity of interdisciplinary and participatory research (Robertson and McGee 2003; Castree, 2001; Campbell and Vainio-Mattila, 2003; McConney et al., 2003). However, there are several factors to consider when undertaking LEK research. Local ecological knowledge is one of several related forms of

knowledge, and the distinctions between them should be scrutinized to ensure the proper approach. Furthermore, LEK is not universally accepted as a valid data source by natural science researchers and resource managers (Walters, 1997; Mauro and Hardison, 2000; Robertson and McGee 2003; Nyhus, et al., 2003, Simeone 2004; Ames, 2007; Johannes and Neis, 2007; Kalikoski and Vasconcellos, 2007). Some of the reservations against accepting LEK as a valid data source are related to the methods used to study it (Davis and Wagner, 2003).

Furthermore, not only are some natural sciences researchers not prepared to accept LEK as valid in and of itself, those that are may not have the training to best integrate it into ecological research (Campbell and Vainio-Mattila, 2003) or perhaps even collect it. One reason LEK research is not accepted by scientists because of a lack of attention to methodology and rigour, particularly with respect to participant selection (Davis and Wagner, 2003). Another factor is the divide between natural science researchers and those in the social sciences. In the Eastern Caribbean context, McConney et al. (2003) indicate that agencies responsible for social services, welfare and poverty alleviation seldom have a working relationship with coastal management authorities. Managers of coastal and marine resources may have a natural science education that omits policy issues such as poverty, and McConney et al. believe this knowledge gap needs to be addressed. These factors are examined in this section.

1.1.1 Types of Knowledge

There are several related forms of knowledge mentioned in the literature that are recognized as distinct from western or scientific knowledge, such as indigenous knowledge, traditional ecological knowledge, and local ecological knowledge. These forms of knowledge are similar enough that some consider them to be interchangeable with each other and with other terms (Krech, 2005; Walters, 1997). Other authors make clear distinctions between these three types of knowledge, although there are conflicting definitions.

Indigenous ecological knowledge has been defined as a complex of knowledge, practice and belief belonging to indigenous peoples with an assumed continuous historical and cultural connection to place (Berkes et al., 2000; Robertson and McGee 2003). Traditional knowledge, on the other hand, is defined by the Convention on Biological Diversity (2004) as the knowledge of both indigenous and local communities, as having a cultural component, and being transmitted orally from generation to generation. Berkes (2004) provides a similar definition of traditional ecological knowledge as a multigenerational, cumulative body of knowledge, practice and belief. Traditional knowledge is also linked to a specific place or a region (Krech, 2005). Cruikshank (2003) describes this linkage by stating that landscapes themselves may act as archives of traditional knowledge, where memories can be effectively stored. Further, she states that cutting people off from places that they are knowledgeable about (e.g. by creating protected areas) will result in the loss of traditional knowledge. In

contrast, local ecological knowledge has been defined by some researchers simply as knowledge of a particular group of people about local ecosystems, and may not assume a multigenerational or a significant cultural connection (Walters, 1997, Robertson and McGee, 2003).

Although these knowledges are similar in that they are the knowledge of local people or communities and not generated by scientific researchers, the differences between these definitions raise some considerations for this research. One is the extent to which the population of Bequia is indigenous. Although the definition of “indigenous peoples” is somewhat contested, it may be characterized by such factors as descent from the occupants of a territory prior to an act of conquest; possession of common culture and land; exclusion or marginalization from political decision making; claims for collective and sovereign rights that are unrecognized; and most importantly, indigenous self identification (Mauro and Hardison, 2000). SVG does possess an indigenous population that meets most if not all of these criteria. The indigenous population is quite small. According to SVG’s 1991 census data, the number of Caribs in SVG was 3,347 out of a population of about 106,000 and is believed to be declining (de Albuquerque and McElroy, 1999). However, Caribs are concentrated in distinct communities on the island of St. Vincent (Kirby and Martin, 2004). Few if any indigenous Caribs live on Bequia and are not targeted by this research.

“Non-indigenous” Bequians, whether they be descended from slaves or plantation owners, may have ancestries that go back several hundred years and have significant knowledge about their environment. Therefore the study of

exclusively “indigenous” knowledge on the island of Bequia for ecology-related research is inappropriate. Bequians possess unique ecological knowledge about coral reefs because they live and work in proximity to them and depend upon them. Spearfishers and divemasters who visit underwater ecosystems daily will observe these ecosystems, as their livelihood is tied to them. Recent immigrants will also conduct such observations while diving or fishing and may accumulate significant ecological knowledge.

To a certain extent, distinguishing between LEK and scientific knowledge is a false dichotomy, especially in coastal areas, as people from all over the world arrive and interact with local people and have shared their cognitive models with residents (Walters, 1997). LEK is not unchanging (Poepoe et al., 2007), and traditional ecological knowledge includes diverse sources of information, including western science (Alessa et al, 2008). The knowledge of Bequians may thus be considered to be a hybrid of local and outside sources of information such as the Internet, which is relatively inexpensive and widely used on the island.

In order to ensure that I am not biased against knowledgeable individuals in my selection of participants I will follow Walters’ (1997) example and focus my attention on local ecological knowledge as opposed to indigenous or traditional knowledge.

1.1.2 Trends in LEK research

Although local knowledge has been dismissed by some natural resource researchers and managers, interest in LEK research is increasing. In some cases, the use of local or traditional knowledge may be mandated. For example, in the Canadian context, federal legislation such as the *Species at Risk Act* (Species at Risk Act, 2002) and treaties with First Nations require the incorporation of traditional knowledge into management plans (Smith, 2003b). Another driver may be the Convention on Biological Diversity. This is an international convention on conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of the benefits from the use of genetic resources (Convention on Biological Diversity 2004). It requires that countries that are Party to it:

shall, as far as possible and as appropriate . . . respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity and promote their wider application with the approval and involvement of the holders of such knowledge, innovations and practices and encourage the equitable sharing of the benefits arising from the utilization of such knowledge, innovations and practices (Convention on Biological Diversity, 2004 c);

In addition to the legal measures that require the incorporation of traditional and local knowledges, some researchers are finding that these knowledges can contribute valuable ecological data. LEK and related forms of knowledge have been found to be useful for the identification of species, compiling species inventories, the classification and identification of habitat, and

effective rapid identification of habitat types (Hernandez-Stefanoni et al. 2006). LEK of fishers can be used to fill in historical gaps (Spens, 2007; Jones, 2007). More importantly, local perspectives often include a broader vision of the ecosystem than scientific perspectives (Klintenberg et al., 2007). They have a longer temporal component than short-term scientific studies, as the knowledge base of the community is typically based on generations of empirical observation of the natural environment upon which local people depend to meet their basic needs (Alessa et al., 2008). Local knowledge and related forms of knowledge have better resolution at local (community) and fine (individual) scales than models that apply to regional and global scales, such as climate change models (Silvano et al., 2006; Turner et al., 2007; Alessa et al., 2008). The issue of scale is extremely relevant for small island states such as SVG. Furthermore, successful ecosystem management requires an understanding of the knowledge, perceptions and motivations of resource users (Turner et al., 2007).

In some cases, the use of LEK and other similar forms of knowledge may also be born out of necessity. Where there is a paucity of scientific information, LEK may be the only available source of historical ecological information (Robertson and McGee, 2003; Johannes and Neis, 2007). As previously stated, coral reef data are lacking for SVG. McConney et al. (2003) also state that government capacity in Caribbean fisheries is so limited that the responsibility for science and management of coastal resources often resides in only a few individuals who cannot provide the best information on their own; consequently, they may need to rely heavily on resource users for detailed knowledge of the

resources. Some researchers now maintain when scientific knowledge is lacking, LEK is worth investigating even when it seem unreliable; where LEK disagrees with scientific literature, the discrepancies may provide new insights to be investigated (Silvano et al. 2006; Johannes and Neis, 2007).

1.1.3 The Role of LEK in Interdisciplinary and Participatory Approaches to Conservation and Resource Management

There is an increasing trend toward the use of participatory approaches to conservation and resource management, such as community-based conservation (Campbell and Vainio-Mattila, 2003) and co-management (McConney et al., 2003). The use of local ecological knowledge (LEK) has in fact been identified as a crucial factor in the success of such participatory and interdisciplinary conservation and management schemes (Walters 1997; Mauro and Hardison, 2000; Robertson and McGee 2003; Nyhus, et al., 2003; Campbell and Vainio-Mattila, 2003; McConney et al, 2003; Simeone 2004; McConney et al., 2007). Incorporation of LEK with “established scientific information” (Robertson and McGee, 2003, 276) leads to resource management approaches that are better adapted to ecosystem dynamics, that improve scientific understanding and enhance policy implementation (Robertson and McGee, 2003).

Within the field of ecology, this trend toward interdisciplinary research is linked to three main conceptual shifts that have recently occurred within the field:

1) a shift from reductionism to a systems view; 2) a shift to include humans as part of ecosystems; and 3) a shift away from command- and-control expert-based conservation approaches to participatory approaches (Berkes, 2004).

Conservation and development narratives have been merging, a process that was accelerated with the Brundtland Commission Report of 1987 (Campbell and Vainio-Mattila, 2003). Natural science disciplines such as biology, ecology and conservation science have begun to shift toward more inclusive participatory and community oriented approaches to conservation (McConney et al., 2003; Berkes, 2004). Development organizations have increasingly incorporated environmental concerns into policy, and conservation organizations have acknowledged the development needs of local people (Campbell and Vainio-Mattila, 2003). Community-based conservation is now a dominant theme in conservation policy statements of international organizations such as the World Conservation Union (IUCN) and the Worldwide Fund for Nature (Campbell and Vainio-Mattila, 2003).

Exclusionary and top-down modernization approaches to conservation, development or environmental management that ignore local ecological understandings often fail (Berkes, 2004; Lauer and Aswari, 2008) and it is possible that the shifts described above are linked to such failures. For example, exclusionary methods, such as marine protected areas, which exclude most people from ecologically fragile areas have been historically used to achieve conservation objectives (Campbell and Vainio-Mattila, 2003; Holt, 2005). Marine protected areas can be a useful tool to protect critical areas of the marine

environment from exploitation (Guenette and Alder, 2007). However, selection of marine protected areas without consulting local resource users may result in resistance from the local community, especially if the protected area results in interference in local subsistence activities (Scholz et al., 2004; Aswari and Lauer, 2008). Such top-down approaches have been criticized for a variety of reasons, including the pragmatic concern that they do not incorporate the human dimension into ecological issues, resulting in resistance (e.g., illegal harvesting) which in turn requires a disproportionate increase in enforcement effort (Campbell and Vainio-Mattila, 2003). These failures can undermine conservation goals (Campbell and Vainio-Mattila, 2003). Integrating natural and social science approaches into conservation efforts such as the selection of marine protected area sites can yield positive biological and social results (Aswari and Lauer, 2008). Interdisciplinary and participatory initiatives are therefore important alternatives for the likely success of conservation objectives.

In keeping with these trends, co-management is a participatory resource management approach that has been advocated for the management of marine resources in the Caribbean (McConney et al., 2003). It is described by McConney et al (2003) as the sharing of responsibility and authority for the management of resources between government and stakeholders. Co-management encompasses a continuum of approaches that range from consultation through to community control (McConney et al, 2007; Armitage et al., 2007). To be effective and sustainable, management within the coastal areas of small island states like SVG should adopt a co-ordinated multi-sectoral

approach, taking account of the needs and potential impacts of complementary and competing industries including agriculture, fishing, manufacturing, recreation, shipping and tourism (McConney et al, 2003). In a co-management arrangement, the local and traditional ecological knowledge of resource-users will be incorporated into planning and management (McConney et al 2007, Armitage et al, 2007). Among the benefits of co-management is improved protection of resources (Armitage et al, 2007).

In their assessment of four co-management schemes in the Caribbean, McConney et al. (2007) described how some schemes had failed to live up to their promise. However, they did not criticize the validity of the data provided by community members; the failures were rather attributed to a breakdown in the relationship between government and the community. The authors further point out in the case of the failed Barbados fishery co-management, other feasible co-management options will have to be researched, as government command and control systems are weakly enforced and have not resulted in compliance or success.

LEK has a role to play in the inclusion of humans as part of the ecosystem and the shift toward participatory conservation and management. However, effective recognition of fishers' knowledge into science and management is contingent upon improved collaboration and increased mutual understanding between fishers and natural and social scientists (Haggan et al., 2007).

1.1.4 Validity of LEK

Although some natural sciences research highlights the value of local or traditional knowledges for conservation and resource management, it is not always accepted by the scientific community as a credible data source (Walters, 1997; Mauro and Hardison, 2000; Robertson and McGee 2003; Nyhus et al., 2003, Simeone 2004), or “locals” are not recognized as being knowledgeable (Walters 1997). In response to such claims, Bojorquez-Tapia et al. (2003) point out that the use of expert knowledge in conservation planning can also be called subjective, incomplete, imprecise, biased and value-laden. They further remind us that decision criteria generated by different experts in a group may be contradictory or incompatible.

Some researchers say that it is advisable to validate fishermen’s LEK (Silvano et al, 2006). Robertson and McGee (2003) claim that in order to gain acceptance with the scientific community, local ecological knowledge must be cross-referenced or verified wherever possible. They state that since many natural scientists criticize local ecological knowledge as not being scientifically credible, cross-referencing or validation must be undertaken if one wants to gain maximum acceptance among natural scientists and political decision-makers. Validation can occur through verification with other kinds of evidence (Robertson and McGee 2003), verification between participants, or verification against researcher observations (Valbo-Jorgensen and Poulsen, 2000). When LEK disagrees with scientific literature, these discrepancies may provide new insights

to be investigated (Silvano et al. 2006). In cases where scientific knowledge is lacking, even unreliable-sounding LEK is worth investigating further (Silvano et al. 2006).

Other some researchers claim that since LEK is valid in its own right, and it need not be validated (Poepoe et al, 2007). The act of cross-referencing LEK does not, however, mean that local knowledges are not valid in and of themselves. Rather, the process of validating local knowledge should be undertaken to meet the requirements of a wider audience including natural sciences academic community and government agencies. Researchers must not only recognize the value of local knowledge but also understand it and document it so as to make possible a harmonious and complementary cohabitation of the systems of knowledge (Assembly of First Nations of Quebec and Labrador, 2005).

1.1.5 LEK Research Methods

In fisheries research, the use of participatory, ethnographic, qualitative methods is linked with successful outcomes (Kuyuk et al., 2007; Meeuwig et al., 2007). Tropical, small-scale, multi-species fisheries are prohibitively expensive and notoriously difficult to manage using Western models that require extensive quantitative data collection (Hickey, 2007). The emphasis on management ideals such as maximum sustainable yield is unrealistic under these scenarios (Hickey,

2007). Incorporating LEK into tropical fisheries management provide an alternative to these approaches.

However, not only do natural science researchers question the validity of LEK as a data source, but the way in which it is researched also influences its acceptance. Davis and Wagner (2003) point out that LEK research suffers from an overall lack of attention to methodology. Although they recognize that social scientists are well positioned to contribute to LEK research, they criticize social researchers for an insufficient focus on method. They find that published studies fail to provide detailed descriptions of data collection techniques, which “impedes the development of methodologies sophisticated and rigorous enough to withstand the level of scrutiny to which they will be subjected within applied resource management and development settings” (468).

As an example, Davis and Wagner (2003) focus on the methods by which local “experts” are selected. They say that snowball methods can result in bias, because unpopular yet knowledgeable members of the community might not be referred to the researchers. They state that it is essential to design and conduct LEK research in a manner most likely to produce research results that will thoroughly represent the breadth, depth and comparability of LEK. Without this degree of rigour, they claim that knowledge that may be sound in its own right maybe discounted as anecdotal and therefore irrelevant in a resource management setting. “Anything less in LEK research will achieve little but discredit for social research and fatally compromise the ability of local people to achieve voice and agency” (Davis and Wagner, 2003, 466).

In order to select knowledgeable participants in a rigorous manner, Davis et al.. (2004) conducted a random survey in their community of study to identify local experts, and only selected “experts” who had been recommended by two or more survey participants. However, this may not be practical in all research settings.

Davis and Wagner (2003) provide guidelines as to what they consider to be a minimally acceptable description of fieldwork methodologies. This includes:

1) an account of why the research was being carried out and whether it was directed towards issues of resource management, development planning, or other purposes; 2) an account of the time period during which research was carried out; 3) a description of the research instrument(s) used to gather information and, 4) an account of the number of individuals included in the study in comparison to the total population of the communities and/or resource-user groups involved (Davis and Wagner 2003, 470).

Overall, the lack of attention to method in the social sciences may be partly responsible for LEK’s lack of support in the environmental science community. However, it is important to note that the lack of emphasis on method in social science research is also of concern to social scientists and researchers who employ qualitative methods (Dwyer and Limb, 2001). It is also likely that environmental scientists undertaking LEK research may not be using appropriate methods. Just as Davis and Wagner (2003) criticize social scientists for too much attention to epistemological issues at the expense of method, it is possible that environmental scientists do not consider these issues enough when engaging in LEK research. Campbell and Vainio-Mattila (2003) suggest that natural scientists

do not have the training to integrate LEK with scientific knowledge. An additional concern of mine is that natural science researchers may dismiss the validity of LEK when it is collected by qualitative methods despite the fact that their preferred quantitative methods may not be the most suitable tools for LEK research. Ultimately, rigorous attention to methodological issues will improve the standing of LEK research with audiences that are unfamiliar with it.

1.1.6. Local Ecological Knowledge of Marine Environments

With respect to the study and management of marine resources, LEK is considered critical in accessing new, ecologically and environmentally detailed information leading to a better understanding of marine ecology, improvement of fisheries resource assessments, and the development of more effective management policies (Davis et al., 2004). The first studies of fishers' knowledge of marine fishes was published about 40 years ago (Silvano et al., 2006). However, since then fishermen's LEK has been mainly overlooked or dismissed by biologists, and it is only recently that the potential of LEK to advance fisheries science has been widely recognized (Silvano et al, 2006).

Within the field of fisheries research, fisher's knowledge can effectively inform fisheries management and conservation (Baird, 2007; Kalikoski and Vasconcellos, 2007; Kuyuk et al., 2007; Meeuwig et al., 2007; Sultana and Thompson, 2007; Williams and Bax, 2007). Silvano et al. (2006) note that fisher's LEK has been useful to better understand local fishing practices, gather new

biological information about fish ecological aspects (e.g. migration, feeding habits and reproduction), and improve impact assessments. Experienced fishers possess a high level of knowledge regarding fish populations and marine ecology historical change (Davis et al., 2004; Scholz et al., 2004; Silvano et al., 2006; Turner et al., 2007). Scholz et al. (2004) found that fishers' assessment of certain fish stocks matches the state manager's assessment of those stocks. Such knowledge of marine environments is related to the level of dependency on marine resources (Turner et al., 2007).

While LEK is gaining popularity in fisheries research, there are few studies relating to the LEK of corals and coral reefs. One example is Turner et al.'s (2007) study involving interviews with fishers who predominantly use spearing and hook-and-line techniques. They examined local awareness of change in live coral cover, presence of coral bleaching (a coral disease), abundance of crown of thorn starfish (a deleterious species), and an awareness of the ecological impact of the changes they observed. Absent from the discussion are the inherent difficulties of gaining understanding across the air-water interface. While fishers using above-the-surface techniques may have significant knowledge of the fish species they fish, this knowledge cannot be complete without underwater observation.

1.2 Social Approaches to the Society- Environment Relationship

Although this study collects ecological data, the data also have an important social component as they reside with community members. It could be said that LEK is on the interface between society and the environment. As LEK is collected by interacting with local people, it is best studied using a social approach and best collected using the qualitative methods developed by social scientists. However, this approach is rarely taken by natural science researchers. This may explain to some extent why sustainable development and participatory or community-oriented approaches to conservation and management are criticized.

One aspect to consider when conducting LEK research is the extent to which natural systems and human systems are separate. Historically, it has been assumed that "nature" or the environment is external to, and different from, society (Castree, 2001). This epistemological separation has resulted in a disciplinary divide (Escobar, 1996; Reed and Mitchell, 2003), with the natural sciences maintaining jurisdiction over the environment and social sciences studying society. Geography has remained one of the key disciplines dedicated to exploring the relations between humanity and the environment (Castree, 2001). However, the extent to which these systems are separate is a subject of debate, and whether one can truly say that there are natural systems completely devoid of human influence.

Escobar (1996) points out that although the trend toward interdisciplinary research may prove useful in bridging the divide between society and the environment, a lack of "epistemological vigilance" (Escobar, 340) has resulted in environmental themes remaining firmly within the domain of natural science disciplines, precluding the potential creation of "alternative ecological realities" (Escobar, 340). Berkes (2004) describes how this epistemological reconciliation of ecology and the economy (or perhaps, more broadly, social sciences) is proving difficult. For example, the results of the community-based conservation approach have been mixed, and this has led to debates about the approach's merits - whether it is flawed, or simply implemented improperly. To address this situation, some researchers now advocate a social approach to the study of the society- environment interface (Castree, 2001; Berkes, 2004). Local Ecological Knowledge is one such interface.

In addition to the methodological issues addressed previously, a possible reason for the lack of success of community-based initiatives is the conceptual approach to the research or project. Castree (2001) describes taking a social approach to the study of the society-environment relationship. This approach maintains that nature is inescapably social; it is defined, delimited and even physically reconstituted by societies. The social and natural are so intertwined that they cannot be separated, either in thought or in practice (Castree, 2001). Castree advocates that social approaches to the society-environment relationship must include a consideration of social constructions of nature, which is lacking in many fields. He points out that environmental discourses cannot be

ignored; it is not really possible to step outside of discourses in order to find out "what's really going on' . . . We have to live with the fact that different individuals and groups use different discourses to make sense of the same nature/s . . . whose discourse is accepted as being truthful is a question of social struggle and power politics." (Castree, 2001, 12). This awareness must inform research design and the way in which the researcher approaches the researcher – participant relationship (Castree, 2001).

The idea of taking a social approach to the study of the society - environment relationship has merit, especially if one subscribes to the view that participatory and community-based approaches to conservation or management fail because the approaches are improperly applied. Natural scientists tend to engage in research that is overwhelming positivist, quantitative and empirical, and they may be ill-equipped to deal with qualitative data and other epistemologies. Certainly it would appear that natural scientists do not take a reflexive approach nor do they problematize the researcher-researched relationship. For example, Valbo-Jorgensen and Poulsen's (2000) work concerning local ecological knowledge of fish in the Mekong is devoid of such considerations. While they describe their data collection methods and their means of validating LEK, they do not explore their relationship with their informants nor the potential impacts of that relationship on the informants or on the responses they receive. Walters (1997) illustrates this problem with a particularly stunning example of western experts swooping into an Indonesian fishing village and, after a two-day display of their technical data-gathering

methods, expecting the villagers to contribute to the ecological assessment in progress. These lacunae no doubt impact researchers' ability to effectively study the society- environment relationship and to properly gather local knowledge data. From a resource management perspective, McConney et al. (2003) have also pointed out that resource managers in the Caribbean are almost always exclusively trained in natural sciences, and tend to avoid working with poverty alleviation services which might compromise the effectiveness of conservation and management arrangements.

Finally, some researchers support a more social approach to conservation because many environmental problems simply do not lend themselves to the conventional ecological approaches. They "cannot be separated from issues of values, equity and social justice" (Berkes, 2004, 624). In this context, the notion of an objective, disinterested expert no longer makes sense, and a social approach to the research must be undertaken (Berkes, 2004). This echoes Castree's assertion that nature is inextricably social.

This research takes a social approach. If nature is "inescapably social" (Castree, 2001), then LEK is especially so, because the collection of LEK data is done through social interactions. Consideration for the ways in which "nature" and other environmental terms are socially constructed had an important bearing on this study, for different cultures may construct terms like nature and environment in different ways (Demeritt, 2002). This was an important consideration for the choice of methods for this research. Unlike a more structured survey, the qualitative methods used afforded more opportunity to

explore differing constructions and enhance understanding of species,
ecosystems and environmental change between researcher and participant.

CHAPTER 2: STUDY SITE DESCRIPTION: SAINT VINCENT AND THE GRENADINES, BEQUIA AND THE COASTAL ENVIRONMENT

It would appear that this is a pivotal time for SVG. The country has in recent years emphasized tourism development (Metzger, 2003). Careless development could destroy that which makes SVG unique, and negatively impact islanders' livelihoods, especially fishers and the diving industry. Furthermore, attempts to preserve local ecosystems might be hampered by a lack of SVG-specific ecological literature. LEK could prove useful in filling this knowledge gap.

In order to help preserve its unique tourism attractions and maintain its fisheries, SVG must preserve its coral reef ecosystems. Given the country's desire to boost the economy and reduce poverty, this will have to be accomplished through a sustainable development approach. In order to do so, SVG would have to engage in participatory and community-based conservation and management schemes, and to be successful these must include the incorporation of LEK at the outset.

This chapter describes the study site for this research, the island of Bequia in SVG, based on a review of published documents and my own observations during the course of my field research. As it is important to establish a prior understanding of the ecosystem for which LEK is being studied, this chapter also describes coral biology, coral reef ecology, coral reef health and threats to these ecosystems, again based upon both academic literature and my own reef surveys.

2.1 Bequia, Saint Vincent and the Grenadines: Study Site Description

The population of SVG is approximately 109,000 (Fisheries Division, 2003a; Grossman, 1998). The country is made up of the main island of St. Vincent¹, and the chain of the smaller Grenadine islands (see Figure 1). The Grenadines include 32 small volcanic islands and cays, of which seven are relatively large and inhabited: Bequia, Mustique, Canouan, Mayreau, Union Island, Petit St. Vincent and Palm Island (Fisheries Division, 2003a). Bequia is the northernmost of the Grenadine islands. It approximately 23 km² in area, and it is located approximately 14.5 km south of the island of St. Vincent (Canadian International Development Agency², 1992c) making it easily accessible from St. Vincent by ferry. In 2006, a sign posted by the ferry dock indicated that the population of Bequia is 6,000, which is higher than other populations estimates (Woodrow, 2008). As census data for Bequia is often aggregated with the other Northern Grenadine islands including Mustique, Balliceau and Battawia (Ministry of Finance, Planning and Development, 2001) it is difficult to corroborate these population figures. However, the figure of 6,000 may include temporary residents on the island, who may be expatriates who own vacation homes on the island, or who may be original residents who now spend most of their time abroad.

¹ In order to distinguish between the island and the nation, I will refer to the country as a whole as either St. Vincent and the Grenadines or SVG, and to the island as St. Vincent.

² This is one of the few sources available that provides and extensive assessment socio-economic and historical aspects of SVG.

Figure 1: Map of Saint Vincent and the Grenadines, showing approximate locations of marine conservation areas in red.

2.1.1 Physical and Socio-Economic Characteristics.

SVG is a small island state. It has limited natural resources, poorly developed infrastructure, limited funds, human resources and skills, and is moreover vulnerable to natural disasters and extreme events such as hurricanes (Nurse and Sem, 2001). Inhabitants of small island states like SVG are also highly dependent upon coastal living spaces and many livelihoods are based on coastal resources (McConney, et al., 2003).

The gross national income per capita in SVG in 2007 is 4,210 USD, and the gross domestic product (GDP) was 550,000,000 USD (The World Bank, 2008). The GDP growth is 6.7 % (The World Bank, 2008). In 2006, the life expectancy at birth in SVG was 71 years (The World Bank, 2008). The U.S. Department of State (2008) reports that the adult literacy rate in 2004 was 88.1 %, the infant mortality rate in 2006 is 17/1,000, and the unemployment rate in 2004 was 12 %.

The country experiences two main seasons; a dry season from December to April, and a wet season from June to November (Fisheries Division, 2003a). During the year, temperatures range between 18 and 32 °C. (Fisheries Division, 2003a). The winds are roughest from December through February (Canadian International Development Agency, 1992b), and the hurricane season is from June to September (Kirby and Martin, 2004).

SVG is exposed to the freshwater plume of the Orinoco River in Venezuela, which extends seasonally across the Caribbean basin from August to October

(Cherubin et al., 2006; Fisheries Division, 2003b). The plume brings excess debris and increased algae, which uses up more oxygen in the water (Fisheries Division, 2003b). In Bequia this has been referred to the “black water” or “dirty water” by local residents, as the plume appears to bring algae and silt with it, making the water appear greener and reducing visibility.

SVG is also influenced by hurricanes, which can cause significant damage to coral reefs. Table 1 summarizes the hurricanes that have affected SVG since 1990.

The main economic sectors in SVG are agriculture (Grossman, 1998) and tourism (Metzger, 2003). Bananas are the primary export crop (Grossman, 1998). Agriculture predominates on the island of St. Vincent. In contrast, Bequia has few flat lands, poor soil quality and sporadic rainfall, and so has little agriculture (Canadian International Development Agency, 1992c). As there is no running water available on the island, rainwater is captured in cisterns, and during the dry season water may be shipped in from St. Vincent.

Despite Bequia’s small size, it has several communities (Figure 2) which remain distinct (Canadian International Development Agency, 1992b). Many communities still retain the names of estates that were present on the island as far back as 1831.

2.1.2 History and Cultural Makeup

Livelihoods and LEK of Bequians and other Vincentians is situated within a history of conflict, colonization and slavery. When conducting cross-cultural

Figure 2: The island of Bequia and surrounding cays, showing communities of study. Modified from Ordnance Survey (1990).

research, it is important to consider how history has influenced the cultural makeup of the country and of Bequia as part of the negotiation between researcher and participant. The legacy of historical events continues to influence attitudes today.

Table 1: Hurricanes affecting SVG from 1990 to 2006. Based on data from the National Hurricane Center (2008).

Year	Hurricane	Effect on SVG
1990	Arthur	Tropical storm warning for the Grenadines
1995	Iris	Tropical storm warning issued for SVG
1999	Lenny	Reports of damage from SVG.
2000	Joyce	Tropical storm warning for SVG
2001	Chantal	Tropical storm warning issued for SVG
2002	Lili	Landslides killed 4 people on St. Vincent
		Tropical storm warning for all of SVG
2004	Earl	Brought tropical or near tropical storm conditions to St. Vincent and the Grenadines.
2004	Ivan	In SVG, 50 homes were severely damaged, with 2 homes washed away into the sea. More than two thirds of residents lost power. Damage is estimated at more that \$40 million USD. Tropical storm and hurricane warnings issued.
2005	Emily	Struck nearby Grenada. There were reports of roof damage in SVG. One fatality on nearby Grenada. Hurricane and tropical storm warning issued for SVG.

SVG was originally settled by Arawaks (Parry et al., 1987). The Caribs are thought to have arrived in SVG in 1000 AD (Fraser, 2002). Bequia itself was uninhabited before 1720, although it was used by Caribs from St. Vincent (Price, 1988; Canadian International Development Agency, 1992c). In time, the Spanish, English, French and Dutch all squabbled over the West Indies, with several islands changing hands multiple times (Parry et al., 1987), and SVG was no exception (Price, 1988; Kirby and Martin, 2004). This political uncertainty coupled with the geographical distribution of the region's myriad islands and cays permitted piracy to flourish in the region (Parry et al., 1987). Ownership of SVG was ultimately granted to Britain in the Treaty of Versailles in 1783 (Parry et al., 1987).

SVG was home to Amerindian Caribs (also known as Yellow Caribs or Kallinagoes) and Black Caribs (or Garifuna) descended from shipwrecked or runaway slaves (Kirby and Martin, 2004). The increasing numbers of English settlers on St. Vincent took over the best sugar lands held by the Caribs (Kirby and Martin, 2004). The resulting Carib war ended in the surrender of the Black Caribs in 1796, most of whom were subsequently sent to Roatan in 1797 (Kirby and Martin, 2004). A few Caribs remained on St. Vincent, and these communities remained distinct until at least the 1950s (Kirby and Martin, 2004). The displacement of indigenous people from SVG indicates that it is appropriate to focus on LEK as opposed to other related forms of knowledge.

The so-called "sugar revolution" in the Caribbean dramatically changed the racial composition and social structure of the West Indies (Parry et al., 1987).

Bequia was no exception. The high demands of sugar production required the imported labour of transported persons and African slaves (Parry et al., 1987, 69). Parry et al. (1987) describe the impact of the resulting unique mix of cultures in the Caribbean. They say that West Indians are an imported people in a largely “imported environment” as all domestic and some wild animals and most cultivated plants were introduced. Efforts to communicate between people of a diversity of cultures gave birth to Creole language (Parry et al., 1987, 69).

When the slave population working Bequian plantations was emancipated in the 1830s, the land on Bequia remained in the hands of a few planters (Canadian International Development Agency, 1992c). As sugar cultivation proved unsuccessful, efforts were made to cultivate cotton and arrowroot, without success (Price, 1988; Ward, 1995). By the 1860s, Bequians became involved in maritime activities, and whaling, which remains culturally significant on the island today, was introduced in 1875 (Price, 1988; Canadian International Development Agency, 1992c; Ward, 1995). A schooner building industry flourished from 1921-1965 (Canadian International Development Agency, 1992c).

In 1966, SVG entered into a free and voluntary association with Britain as an Associated State (Parry, Sherlock and Maingot, 1987), and attained independence in 1979 (John, 2002).

It has been noted that there are deep divisions in SVG between peoples of European, African and Asian descent, complicated by divisions between residents of different islands (Parry et al., 1987). Skin colour was socially significant until the 1970s (Price, 1988). Although racial tensions are far less

evident on Bequia today than might be expected, there remain distinctions between residents of Bequia and residents of St. Vincent (or “the mainland”). Despite the fact that Bequia today is connected to St. Vincent and the Southern Grenadines by large modern ferries, and to the rest of the world through cellular phone networks and wireless internet connections, Bequians continue to distinguish themselves from the residents of other islands.

While no census data are available indicating the racial make up of the island’s population, informal conversations with community members indicated that many individuals possess extremely varied ancestries. Not only are there descendants of emancipated slaves and plantation owners, but sailors and immigrants from around the world have settled and intermarried on Bequia. Some individuals I met told me they have ancestries spanning five or more nationalities. Bequia is also home to immigrants from other Caribbean nations, Europe and North America. As such, the notion of a homogeneous cultural population is inapplicable.

Vincentians distrust government agencies, including those with jurisdiction over the marine environment, (Canadian International Development Agency, 1992b). The historical events described here seem to indicate that this distrust may have deep roots. This is an important consideration for negotiating the research relationship.

2.1.3 Tourism

Tourism is very important to SVG, but tourists spend very little time on the large island of St. Vincent, where most of the country's population is concentrated (Metzger, 2003). Instead, most visitors arrive on St. Vincent and quickly make their way to the Grenadine islands, where most tourism dollars are made.

One informant indicated that the first tourists came to Bequia from St. Vincent when the Frangipani hotel opened, around the late 1950s. There were no ferries, so local schooners would bring them over. The first ferry to connect Bequia to St. Vincent in 1971 was a Bequia built schooner, the Friendship Rose, which carried people and cargo, including precariously loaded vehicles (Quashie, 2006). The schooner was only outfitted with a motor after it was becalmed for eight days between St. Vincent and St. Lucia (Quashie, 2006). Bequian was therefore relatively hard to access until the introduction of the modern ferries which are in place today.

In the 1970s, the Minister of Tourism indicated that SVG intended to steadily increase hotel capacity while integrating tourism with other sectors of the economy, and with new investors blending with the existing infrastructure (Mitchell, 1989). The speciality of the country was small hotels serving local cuisine using local ingredients (Mitchell, 1989). In the 1980s, tourism replaced agriculture as the most important economic sector in SVG (Metzger, 2003). By

1992, the Bequian economy was very dependant upon tourism (Canadian International Development Agency, 1992c).

Since the 1990s, the government has placed an increased emphasis on tourism, but SVG does not have the experience of other Caribbean countries that have been in the business for decades (Metzger, 2003). The Ministry of Tourism claims that their focus is on ecotourism (Metzger 2003). (Ecotourism may be defined as travel to natural areas that minimizes ecosystem impacts and provides local people with a financial stake in conservation (Young, 1999)). There are indications that the country would like to encourage large scale mass tourism (Metzger, 2003). This is evidenced by the construction of a cruise ship dock on the main island of St. Vincent and of a large resort on the island of Canouan respectively, and the construction of a new international airport on St. Vincent with a longer runway to accommodate direct flights from North America.

2.1.4 Fisheries in Bequia and SVG

Coral reefs support fish assemblages, which in turn support fisheries (Mohammed et al., 2003; Turner et al., 2007). Although not the most important economic sector of SVG, the fishery is a significant component of the Vincentian economy, and main source of livelihood for 5% of the national workforce (Fisheries Division, 2003a). Fishing tends to be concentrated in certain communities. For example, in the early 1990s in the fishing community of Paget Farm on Bequia, one third of the workforce considered fishing to be their main source of income (Canadian International Development Agency, 1992 a). Fishing

is also considered an important form of economic diversification, and can also help to support a lucrative tourism economy where revenues stay in the country rather than flowing out (Canadian International Development Agency, 1992 a). In addition, it has been recommended that the importance of fish taken by subsistence fisheries, many of which may depend on reef habitat at some stage of their life cycle, should be more fully recognized by developers and government, as subsistence fishing is a major hedge against severe poverty (Canadian International Development Agency, 1992a).

Nationally, catches and fishing effort have increased since the 1960s. The inshore fishery, which includes reef species, is more significant than the offshore fishery. Non-fish species such as Caribbean or spiny lobster (*Palinurus argus*), queen conch (*Strombus gigas*) and West Indian sea egg urchin (*Tripneustes ventricosus*) are taken by divers (Mohammed et al., 2003). Lobster and conch, which are particularly lucrative, are showing signs of overexploitation in the Caribbean (Riclet, 2001; Mohammed, 2003; Fisheries Division, 2003a), as evidenced by declining catches and shift in species abundance toward deeper water.

Vincentian fishing vessels are mainly powered by outboard gasoline engines, of 40-65 horsepower and from three to nine metres in length (Fisheries Division, 2003a). The small size of the vessels indicates that the Vincentian fishery is primarily a small scale, inshore fishery.

Vincentian fishers use a variety of gear, including seine nets, bottomlines and palong, which is a fishing line with a multitude of hooks (Fisheries Division,

2003a). Spearfishing with the use of snorkelling gear is used to catch reef fish and reef-associated pelagic species (Fisheries Division, 2003a). One of the study participants indicated that spear fishing with masks first began 50-60 years ago on Bequia, when they first saw snorkelling equipment used by skin divers from Guadeloupe. Initially, Bequians made their own masks and swam with fish harpoons until the first spear guns became available in the region. Spear fishing with snorkelling gear is a widely practised fishing method on Bequia today.

Fishing techniques are dynamic, and the gear used by fishermen has changed over time. For example, in 1992, the use of scuba for catching lobster and conch was common, despite incidences of decompression sickness (Canadian International Development Agency, 1992b). By 2006, however, the use of scuba for fishing was in decline, and lobster pots (which are wire box-shaped traps) were seen as a safer and more effective alternative (Fisheries Division, 2003a).

Although not a major theme of this research, this study did consider the importance of locally caught fish as a source of inexpensive food for coastal communities. Fish are not the major source of protein in SVG (Grossman, 1998), but the Vincentian Fisheries Division (2003a) states that 96.7% of Vincentians eat fish. They reported that preferred species were robins, jacks, snappers and kingfishes, which are all pelagic species (i.e., living in the water column, not on the sea bottom or on the reef). The Fisheries Division also states, however, that people in coastal areas consumed more reef fish than those in interior areas, and they believe that this difference in fish that are eaten may be due to availability as

opposed to preference. Bottom-dwelling fish, including reef fish, make up about 10 % of the local market.

Fresh fish consumed on Bequia comes from a variety of sources. Commercial fishers sell the majority of their catch to trading vessels at sea, and return to the Paget Farm fisheries station with only a few fish to take home or to give to neighbours and relatives. Tradition dictates that commercial fishers must also bring back fish to give to people who help them pull their boats out of the water and onto the boat ramp. Furthermore, some Paget Farm community members frequent the fisheries station docks in the hopes of getting free fish. The fish brought back to the docks by commercial fishers constitutes a form of community support. A few Bequians periodically catch fish using seine nets to sell at the Bequia fish market. Subsistence fishers will catch fish for household consumption using spear guns, fish pots, or other kinds of gear.

There is concern that fishers' livelihoods in SVG are threatened by overexploitation (Fisheries Division, 2003a). Much of the fish and invertebrates taken by commercial fishers are exported to other Caribbean countries; lobster and conch in particular are frequently traded with boats from Martinique, often illegally (Mohammed, 2003). The main market for fish is Martinique (Fisheries Division, 2003a), however in recent years Vincentian fishing practices have not met EU standards. The result is a moratorium on sales of fish from SVG to Martinique. Fishers indicated that they are resisting the required changes in fishing practices as they are difficult to implement. For example, the EU requirement that fish be placed on ice immediately after they were caught is

problematic, as coolers would take up too much space on the small fishing boats. In the meantime, the fishers say SVG has been able to sell its catch to Grenada, and it is likely that much of the harvest still finds its way to Martinique through informal channels.

Like fishers elsewhere, Bequian fishers have a longstanding distrust of the Fisheries Division and government in general (Canadian International Development Agency, 1992b). Fishers claim that they face several difficulties, such as increases in fuel prices. They feel that instead of supporting them and finding solutions for these difficulties, Fisheries Division decisions are made to “bring them to heel.” This is exacerbated by the failure of several development projects, such as the incomplete marina in Ashton Harbour, Union Island which caused environmental harm, and a development scheme to sell boats to fishers at a price that was perceived as being higher than what other governments were charging.

The Fisheries Act of SVG includes several measures for the protection of marine resources. It identifies nine marine conservation areas, two of which are off the coast of Bequia. These conservation areas are indicated in Figure 1. The use of spear guns is prohibited in these areas. The Fisheries Act also stipulates the seasons for taking turtles and spiny lobster (*Panulirus argus*).

2.1.5 Scuba Diving Industry

There is a paucity of literature about the Vincentian coastal environment and the scuba diving industry that operates there, and this is one of the reasons SVG was chosen for this research. Thus it is difficult to use scientific literature to describe Bequian coral reefs. Similarly, scuba diving is not highlighted in most tourism guides. However, on those rare occasions that diving in SVG has been mentioned in tourism literature, the reports have all been favourable (Showker, 2006; Anderson et al., 2005). None mention negative environmental impacts that local people are concerned about.

Notwithstanding some environmental degradation, Bequia possesses coral reefs that are in excellent condition when compared to the rest of the Caribbean. This is true of other Grenadine islands as well. The reefs in the Tobago Cays Marine Park in the southern Grenadines are particularly significant attraction to yacht-based snorkelers and scuba divers.

Divemasters on Bequia indicated that different clients hope to see large charismatic species such as sharks, while others look for “critters” such as invertebrates and bottom-dwelling, camouflaged fishes. In addition to sighting specimens from certain species, however, some tourist divers hope to see large schools of fish, or colourful, healthy coral; others want to do deep (below 20 m) dives and are pleased that they have coral to observe at these depths.

2.1.6 Communities of Study

Two communities were the focus of this study: Port Elizabeth and Paget Farm.

The town of Port Elizabeth located on Admiralty Bay is the main commercial and administrative centre for the island (Canadian International Development Agency, 1992b). The island's clinic, post office, police station, customs office and district council offices are located in Port Elizabeth, and this community is also home to several schools, supermarkets and internet cafes. Admiralty Bay itself is a natural harbour that makes the island a draw for yachtspeople (or "yachties" as they are known locally), and the ferry dock is located in Port Elizabeth, making the town the first point of entry for many visitors. Port Elizabeth and its neighbouring communities are commonly called "the harbour" by islanders.

Port Elizabeth is also where the majority of restaurants and nightlife are found. As a result, it draws residents from other communities on the island for business or for entertainment. In the evenings a mix of tourists, permanent residents and expatriate residents will typically gather together in the restaurants and bars.

Foreign ownership of businesses in Port Elizabeth increased in the early 1980s (Price, 1988). Although it was beyond the scope of this research to conduct an analysis of business ownership in 2006, it appeared that many businesses in Port Elizabeth were owned or operated by immigrants to Bequia.

Bequia's fish market is located in Port Elizabeth. Every few days a boat arrives in the morning with fish captured nearby with seine nets. Typical catches include non-reef species such as robins (*Decapterus* spp.), snappers (*Lutjanus* spp.) and small tuna (*Thunnus* spp.).

There are several scuba diving operations in SVG, and the two on Bequia are located in Admiralty Bay, each with several divemasters who lead outings. Most divemasters on Bequia are local. One dive shop proprietor is an American immigrant.

In contrast, Paget Farm on the south side of the island is the main fishing community on Bequia. Paget Farm has a long-standing maritime tradition, including whaling, commercial fishing, boat building and maritime trade (Canadian International Development Agency, 1992a). There is also a long, ongoing history of underemployment in this community (Canadian International Development Agency, 1992a).

There is very little tourism in Paget Farm and no facilities or infrastructure that would attract them (Price, 1988; Canadian International Development Agency, 1992c). Although Bequia's small airport is located very close to Paget Farm, arriving visitors pass through the community typically without stopping and stay elsewhere. Paget Farm is renowned for being the most separate and insular of the Bequian communities (Price, 1988; Canadian International Development Agency, 1992a). Inhabitants tend not to travel around Bequia, and are more likely to travel to other islands in the Grenadines or to St. Vincent than they are to go

across Bequia to the harbour (Canadian International Development Agency, 1992a).

Price (1988) indicates that Paget Farm residents were hostile to outsiders during his research in the early 1980s, and other Vincentians told me that Paget Farm fishermen could be “rough”. Therefore I felt it was important to be properly introduced into the community. It was my experience, however, that the Paget Farm reputation is probably outdated. I never encountered any hostility, though fishers were initially distant and it took significantly longer for me to establish trust with members of this community. Ultimately, the only “roughness” encountered was a propensity toward colorful language, to which I soon became accustomed.

In Paget Farm there is no fish market, as fishing is such a prevalent occupation households acquire fish from family members or friends.

Spear fishing is quite common in Paget Farm, and is especially common among younger men. Scuba gear was used to take lobster and conch (Canadian International Development Agency, 1992a), but the Fisheries Division noted in its 2003 report that its use was declining, and by 2006 its use in Bequia had become uncommon. Fishers stated that this decrease is the result of increased incidences of decompression sickness in the community. Lobster and conch are no longer found in safe, shallow water, and many Paget Farm fishermen expressed a concern with safety, as most people know a fisher who has lost his livelihood as a result of decompression sickness. Lobster pots are also now in use, a fairly new innovation which have only been in use since approximately 2001. Conchs, however, are still taken with scuba gear. During the course of this

study, I only observed scuba gear being unloaded three times at the Paget Farm fisheries station, and it was only used to fish conch.

Many Paget Farm fishers have held other occupations. One individual claimed that 80-85% of the fishers in Paget Farm have some experience as sailors in the shipping industry. However, many fishers claim that fishing in Bequia not only offers them an unparalleled quality of life, but provides them with a better wage than other occupations.

2.1.7 Study site selection criteria

There are several factors that make the island of Bequia distinctive and a suitable location for LEK research. At the national scale, SVG's shift from agriculture to tourism is recent. SVG has not as yet become environmentally overexploited, as it is slightly more difficult to get to than other Caribbean nations. As the country's existing airport cannot accommodate larger aircraft that can make the direct flight from North America, access must be made from a larger island such as Barbados. The country is now in the process of building infrastructure, such as a new international airport, to accommodate greater numbers of tourists.

Development projects can cause the destruction of commercially important fish stocks, lower biodiversity and lower tourism at the local scale (Price and Price, 1998). SVG appears to have a history of development projects associated with tourism that are destructive and do not yield the expected

economic benefits. Price and Price (1998) have made efforts to document this trend in SVG, indicating that the 1990s was the most destructive decade in Vincentian history. They describe large-scale development plans made without public consultation of sociological impact assessments, and the undertaking of numerous development projects that caused environmental damage and yet were never completed. They implicate money laundering as a primary cause. Although speculative, this last concern should not be dismissed, as former Vincentian Prime Minister James Mitchell (1982) wrote that corruption and incompetent administration consumed significant portions of aid money in SVG, and that in the early 1980s more Mafia money passed through SVG's banks than the country's total annual budget. There are also several examples of completed projects that caused locally significant environmental damage and that did not yield the anticipated economic benefits (Price and Price, 1998; Hearn, 2002; Metzger, 2003).

At the time of field research in 2006, SVG was securing funding to commence construction of the new international airport on St. Vincent. The government announced its intention to sell off all the remaining crown land on the Northern Grenadine island of Bequia (at prices that no Bequian could afford) to finance the project, prompting a town meeting that I was able to attend. The cultural changes the island would have to face resulting from an influx of foreign landowners coupled with the cost to future generations of Bequians might have been more palatable to the islanders had the airport project not appeared to be so ill conceived. A frequently expressed local opinion on Bequia was that the new

location of this international airport was too far from the Kingstown ferry dock on St. Vincent. Since most tourists only pass through St. Vincent in order to get to the Grenadines where the bulk of the country's tourism infrastructure lies, there was concern that this new airport location might actually discourage tourism in the SVG.

The sale of Bequian crown land proposed in 2006 was expected to result in a construction boom on the island, and to have a drastic effect on the Bequian people and to the culture of the island (People's Action Alliance of Bequia, 2006). At the time of writing, it appeared that most of the lots had been sold. Furthermore, the St. Vincent and the Grenadines Ministry of Tourism and Culture website (2008) indicates that two new hotels are also being built on Bequia, and development involving an existing hotel is planned. Construction projects such as these could have serious impacts on coral reef ecosystems through sedimentary run-off into the sea during construction and increased sewage dumped into the sea once construction is complete.

It is possible that improved public consultation and the implementation of co-management approaches could lead to improved outcomes of such development projects. In the absence of a thorough Vincentian historical ecological record, an important component of these consultations will be the collection of LEK. Although Metzger (2003) has stated that Vincentians in general do not comprehend what effects environmental degradation might have on them personally, she claims that Bequia is an exception in that there are local, small scale environmental efforts there. This seemed to indicate that more

knowledgeable participants may be found on Bequia, and is one of the reasons this island was chosen as the site for this study.

Selection of communities of study on the island of Bequia was based upon the availability of potential participants. All of the scuba dive operators are located in Port Elizabeth, so this was why it was chosen as a community of study. Paget Farm was chosen because this community is where the majority of Bequian fishers live, has a large number of spearfishers, and is where the fisheries station on the island is located. The Paget Farm fisheries station is where many of the Paget Farm fishers pull up their boats, and so is a logical place to meet the largest number of spearfishers on the island.

2.2 Scientific Knowledge of Caribbean Coral Reef Ecosystems

For thousands of years, humans have gathered and fished for coral reef organisms for food and other items (Hodgson, 1999). Coral reefs are also the habitat of many species that are important to the Vincentian fishery (Mohammed et al., 2003). Recently, exploitation of reefs worldwide has increased as medicinal compounds have been identified from reef dwelling organisms, and reef-related tourism has expanded (Hodgson, 1999). Reefs also provide storm protection to coastal areas behind the reef, as the irregular seaward projections of the reef alternating with sand-filled pockets aid in dispersing wave energy (Ruppert and Barnes, 1994).

Coral reefs are under threat worldwide (Gardner et al., 2005). Many reefs are facing rapid changes in composition, including dramatic decreases in coral cover, often coinciding with increase in macroalgae, and the loss of formerly abundant coral species (Gardner, 2005). In the Caribbean, coral cover has decreased by 80% over the past three decades (Gardner et al., 2003). The causes of coral decline are thought to include a combination of anthropogenic factors (e.g., overfishing, pollution and sedimentation), as well as natural disturbances such as hurricanes and tropical storms, and climate change (Gardner et al., 2005). There is evidence, however, that the removal of recent key stressors may yet allow Caribbean coral reefs to recover (Gardner et al., 2005).

Although Bequian coral reefs are in relatively good condition, these problems are evident there too. As there is little scientific documentation of the past condition of Bequian reefs, there is little baseline information to compare the present condition of coral reefs to their previous state. The study of LEK can help to provide a historical record of coral ecosystems as well as present environmental conditions, which will provide a better understanding of how these Bequian ecosystems are changing.

2.2.1 Coral Biology

The following description of corals is taken from Ruppert and Barnes (1994). They describe corals as sessile invertebrate organisms, meaning they

are permanently attached to the substrate upon which they grow. The majority of coral species are colonial organisms, each colony of coral comprising many individuals called polyps. The stony corals are the reef-building corals. Each polyp in the scleractinian colony secretes calcium carbonate, which forms a solid structure called the skeleton upon which the colony lives and is left behind when the colony dies.

Stony corals are restricted to tropical and subtropical regions, and they require warm water (20°-28° C) and adequate light (Ruppert and Barnes, 1994). This means they can only be found where the water is very clear (Sumich, 1992). Stony corals also require a firm substrate or sea bottom upon which to grow (Sumich, 1992). In addition to decreasing the light transmission through the water column, increased turbidity, such as may be caused by coastal run-off or sediment stirred up by boat traffic, may impede coral growth by covering the sea floor with softer sediment, rendering it difficult for corals to find a suitable growing surface (Sumich, 1992).

Another group of corals, called gorgonians, common in the West Indies, are soft corals (a group also known as octocorals) (Ruppert and Barnes, 1994). These species have a calcium carbonate structure as well, but instead of forming a strong base for the colony, the calcium carbonate is a slim, jointed (and therefore flexible) rod in the centre of the colony (Ruppert and Barnes, 1994). Although these corals are not reef builders, they are often found on soft substrates in association with prime diving sites in SVG and are part of the attraction to tourists.

2.2.2 Coral Reefs

The term “coral reef” is used in the scientific community to denote both the physical structure of the reef, as well as the ecosystem that thrives there. Thus it is important to be familiar with these ecosystems prior to engaging in research of the knowledge of these ecosystems. Ruppert and Barnes (1994) define coral reefs as calcium carbonate rock formations which support a great array of marine plants and animals. They are formed when slow growing stony corals and other organisms (such as red coralline algae) secrete calcium carbonate, building the framework material for the reef. Reef growth is influenced not only by the accumulation of calcium carbonate, but also by destructive processes. Any exposed surface of the coral skeleton is quickly attacked by boring organisms, eventually fragmenting large corals.

Reefs provide crucial ecosystem services (Sotka and Thacker, 2006). Reef topography is highly irregular, and contains a multitude of holes and passages of all sizes in which live a variety of animals - shrimp, crabs, snails, worms, and fish (Ruppert and Barnes, 1994; Jones and McCormick, 2002). The availability of shelter will influence the abundance of reef fishes (Jones and McCormick, 2002), and this is likely the case for other organisms as well. As a result, coral reefs are centres of marine biodiversity and are the most complex of marine ecosystems (Sumich, 1992; Ruppert and Barnes, 1994; Harmelin-Vivien, 2002; Sotka and Thacker, 2006). Coral reefs are home to species belonging to a range of functional groups, including planktivores, grazing and browsing herbivores, and

carnivores that eat coral, sponges, crustaceans or fish (piscivores), and specialist cleaners that eat parasites on other fish (Chittaro and Sale, 2003),

The fact that a coral reef is both an ecosystem and a physical calcium carbonate structure has implications for LEK research, as this dual aspect adds an extra level of complexity to discussions involving coral reefs.

2.2.3 Coral Reef Health

One of the topics under investigation in this study is the local understanding of coral reef health. When Hodgson (1999) writes about coral reef health, he defines it as “a general concept that refers to a balance in the ecosystem that may be shifted by e.g., disease or human activities” (Hodgson, 1999, 345). Ben-Tzvi et al. (2004) indicate that there is little consensus within the scientific community as to what comprises reef health, and that many of the indicators suggested by a variety of authors cannot alone be accepted as reliably representing reef community health. However, some of the suggested indicators include the ratio between living and dead corals (mortality index), the size-frequency distribution of corals (as the proportion of small corals may indicate recruitment of new colonies on the reef), and percentage of live coral cover of the reef. Ben-Tzvi et al. (2004) advocate that rather than attempting to determine a precise indicator of reef health, researchers should focus instead on the trend of a reef’s health – is health increasing, or decreasing. It is evident that the concept of coral reef health has very little bearing on the physical calcium carbonate structure of the reef, and everything to do with the ecosystem that lives there.

The differing scientific definitions of reef health and reef damage highlight the importance of considering differing perspectives, and the plurality of knowledges and interpretations. To make an accommodation for the subjective nature of these definitions, Figures 3 through 6 have been included to show some examples of damaged and healthy coral reefs in the Grenadine islands. Figure 3 shows a reef topography that could be considered healthy, including significant live hard coral cover (the grey, round structures are live coral), soft corals and clear water. Figure 4 shows an example of a colourful reef that may be considered attractive to tourist divers. In order to consider this healthy, one cannot rely strictly on live hard coral cover; the only live hard coral in this photo are the pale patch at the top of the photo, the grey patch below the lobster, and green patches of zooites along the bottom. However, there are also soft branching corals and colourful sponges that would make this section of reef attractive to tourist divers. The rest of the area is covered with sponges and colourful algae. Figure 5 shows an example of a reef that may be considered damaged. The sea floor appears as if it were littered with stone or concrete. These are in fact the skeletons of dead hard corals. A few small patches of live green hard coral are evident, but the rest of the green are algae and the calcium carbonate skeletons. Finally, Figure 6 shows a close up of dead coral, which is covered in algae and silt or sand. The flash has reflected off silt suspended in the water, which reduces light transmission and underwater visibility.

Figure 3: Example of a reef that may be considered healthy. St. Vincent and the Grenadines, 1999

Figure 4: Example of a colourful reef that may be considered attractive to tourist divers. St. Vincent and the Grenadines, 1999

Figure 5: Example of a reef that may be considered damaged. St. Vincent and the Grenadines, 1999.

Figure 6: Close up of damaged coral. St. Vincent and the Grenadines, 1999

2.2.4 Threats to Coral Reefs

Stony coral colonies grow slowly, the rates ranging from 10 cm / year to as slow as 0.3 cm / year (Ruppert and Barnes, 1994). Therefore corals take a long time to recover from damage, rendering these ecosystems quite fragile. In the Caribbean, decline of coral reefs threatens fisheries and tourism sectors, which provide a livelihood for millions of people, and the safety of coastal areas in the region (Pearce, 2003). Although some of the damaged reefs in the Caribbean show signs of recovery, the pioneer species are often soft corals that do not make new reefs (Pearce, 2003).

There are many threats to coral reefs, and it appears that a mixture of human and natural causes contribute to their decline. These include marine pollution (e.g., sewage, which can also stimulate the growth of large algae), toxic pollutants, oil and marine debris (Sumich, 1992). Additional sources of destruction include overfishing of key species (Hodgson, 1999); physical damage from fishing, cruise ships and divers; erosion and deposition of topsoil into the sea following deforestation; and record high sea temperatures resulting from El Nino events and climate change (Pearce, 2003). Hurricanes and tropical storms, however, are perhaps the most obvious and frequent disturbances to coral reefs, influencing both their structure and function (Gardner et al., 2005). Finally the mechanical damage caused by divers and snorkelers as they inadvertently come into contact with corals is of increasing concern when coupled with all of the

other threats, especially considering that many scuba diving operators offer unsupervised dives (Barker and Roberts, 2008).

A significant threat to corals is coral bleaching. When exposed to high temperatures or other stresses, corals turn white because they lose their symbiotic algae (Hardman et al., 2004; Sotka and Thacker, 2006). Corals that have been stressed are more susceptible to the condition, and bleaching can result in coral mortality (Hardman et al., 2004). Recent research indicates that sunscreen is an additional cause of coral bleaching (Danovaro et al., 2008). The condition may also be caused by increased turbidity (i.e. sediment in the water) (Hardman et al., 2004).

On a global scale, coral bleaching events have been strongly associated with severe El Nino – Southern Oscillation (ENSO) events (Sotka and Thacker, 2006), and with climate change (Donner et al., 2007). Mass bleaching events have been documented worldwide (Hardman et al., 2004; Sotka and Thacker, 2006). A study by Donner et al. (2007) shows that abnormally high sea surface temperatures caused mass coral bleaching in the Eastern Caribbean and tropical Atlantic in 2005. The authors note that this period of high temperatures may also have contributed to the strong hurricane season that year. They predict that increases in thermal stress events such as these is expected to cause further mortality and accelerate the decline of Caribbean coral reefs by a combination of increased bleaching events and hurricane activity.

CHAPTER 3: RESEARCH DESIGN

The research was carried out between March 22 and June 16, 2006. This period was chosen to capture the end of the tourist season and the end of the lobster fishing season, so that I could observe how the community operates and uses its key coastal resources, and how activities change as the community shifts into the slower summer season. Although many Bequians leave the island at the start of summer to pursue seasonal work in North America or Europe, reducing the number of available participants, it was easier for community members to participate in the research without the pressures of the peak tourist and fishing seasons.

While conducting this research I lived in two communities. Initially, I stayed in Mount Pleasant. Although it was somewhat removed from both Port Elizabeth and Paget Farm, I had been offered a place to stay with a former classmate, and so it was a good place to stay initially. Eventually, however, I felt it would be worthwhile to move closer to my communities of study. My local contacts indicated that it would be more appropriate for a woman alone to live close to Port Elizabeth. I was able to find a place in Belmont, a community located a ten minute walk away from Port Elizabeth.

This chapter describes the methods used to document local ecological knowledge. The approach involved the triangulation of several methods including participant observation, ecological surveys, focus groups, interviews and mapping exercises. One set of methods draws mainly from ethnobiology

methods (Martin 1995) and Participatory Coastal Resource Assessment (PCRA) method described by Walters (1997). A second set of methods draws from underwater survey methods such as Reef Check (Hodgson, 1999).

Prior to describing the methods, however, this chapter also examines some of the criticisms of the methods used in LEK research, and other factors that influenced the approach to this research, namely the difficulties inherent in studying the LEK of underwater environments and issues of reflexivity in qualitative research.

3.1 Building Trust

An important part of this research was the establishment of trust between myself and community members. Building trust is particularly important when community members and researchers come from different epistemological backgrounds (Berkes, 2007), as was the case in this study. Researchers have indicated that building trust with a community is a lengthy process, and is dependent upon the researchers' continued presence in the community (Kruse et al., 1998; Phelan, 2007). With no previous research experience in the area, I had to conduct familiarization activities in the community to build relationships with community members. Some of these activities also served as ecological surveys or participant observation activities, but some of this time was unstructured,

When making initial contacts in the communities of study, I had to take several factors into account. SVG's history is one of slavery, and community

members informed me early in my research that as late as the 1970s clear racial distinctions were maintained on Bequia. As a white outsider in this community, establishing trust took time. Additional factors included my gender and the community's distrust of government.

Of the two communities I studied, establishing trust with the divemasters in Admiralty Bay was an easier task. Divemasters are not exclusively male, and divemasters on Bequia are accustomed to dealing with foreign clients on a daily basis. Furthermore, as I was a diver myself, I paid several scuba dives as part of my ecological surveys of the coral reef environment, and so was able to provide some monetary benefit to the divemasters in Admiralty Bay by patronizing their businesses.

Building trust in the Paget Farm community was more challenging. There tends to be a culture of distrust between fishers and fisheries managers (Scholz et al, 2004; Ames, 2007). Every attempt was therefore made to present myself in a neutral position in relation to the Vincentian Fisheries Division. On the one hand, I wanted to present myself as an independent researcher. On the other, I made sure that community members understood that I did have permission from a government body to be there. Building trust at the Paget Farm location was also difficult because fishers are overwhelmingly male, and the fisheries station docks tend to only be frequented by local men. Many times when I visited the docks not only was I the only outsider, but I was the only white person and the only woman. Finally, the fisheries station is a busy place, and it was important not to be in the way, especially since there was no economic benefit I could offer to

this community. It took time to build relationships to the point where it was appropriate for me to ask them to participate in this research.

Adopting a reflexive approach to this research, including an examination of researcher positionality, went hand in hand with establishing trust in the communities of study. Declaring the position from which one writes helps to lead to more sound analyses rather than attempting to conduct disinterested research and fail to acknowledge its partiality (Johnston et al., 2000). Abu-Lughod (1993) points out that positionality is inevitable. She does not characterize this as a handicap, but rather emphasizes that positionality must be made explicit and fully explored to better understand research findings. I found that this approach was crucial also for establishing relationships with participants.

I was initially introduced into the Bequian communities in Admiralty Bay and Paget Farm with the assistance of a former park manager and the director of the local non-governmental organization Small Islands' Voice. After I was introduced, I became better acquainted with the divemasters by conducting participant observation activities in Admiralty Bay, where the island's two dive operations are located, and by accompanying divemasters on outings.

I was subsequently introduced to the Paget Farm fishing community with the assistance of the fisheries extension officer based at the Paget Farm fisheries station, who himself was a Paget Farm native. He introduced me at first to those fishers who he felt were the most knowledgeable. While observing fishers returning to the fisheries station, however, I met more members of the Paget Farm commercial fishing community who agree to participate in the

research. I also extended open invitations to meetings in the Paget Farm community, which drew in additional fishers.

3.2 Participant Selection

One area of criticism for LEK research methods concerns participant selection. LEK researchers generally consider it important to select participants who are knowledgeable about their environment (Valbo- Jorgensen and Poulsen, 2000; Nyhus et al., 2003). Random selection of participants often is not preferred, because this presupposes that knowledge is evenly distributed throughout the population (Davis et al., 2004). Researchers have also questioned the extent to which knowledge of recent migrants is valid or valuable, and criteria to use for predicting whether or not a person was knowledgeable (Davis and Wagner, 2003, Nyhus et al., 2003). There is little information available on this subject. Nyhus et al., (2003) conclude in their research of local wildlife knowledge among the people living near Way Kambas National Park in Sumatra that individuals with one or more parents who are not from the local vicinity did not possess sufficient local knowledge for their study. However, their study was quite narrow in scope, and did not concern species that local people actually use. It is plausible that migrants to SVG who rely upon ecological goods and services might be just as knowledgeable about changes in biodiversity and abundance and ecological health as people with exclusively Vincentian ancestry.

I selected participants from among fishers and those involved in the scuba diving sector of the tourist industry for participation in the interviews and focus

groups, as these two groups were those that had the most opportunity to observe coral reef ecosystems, either directly or indirectly. Throughout this study I refer to the group of workers in the scuba diving sector as divemasters in order to distinguish between them and fishers or other community members who may use scuba or free diving for other purposes. The term “divemaster” refers to a professional scuba diving designation recognized by scuba certification organizations such as the Professional Association of Diving Instructors (PADI). Divemasters have been trained to lead groups of divers, and all dive instructors must first become certified as divemasters. Thus, the title of divemaster is unique to professionals in the recreational scuba diving industry, and includes not only instructors, but also non-instructors who are qualified to lead groups of divers. Divemasters spend a considerable amount of time diving on coral reefs, and also routinely provide information about coral reefs and reef species to their clients.

Time constraints did not allow for the selection of experts in a systematic way as recommended by Davis and Wagner (2003). Instead, I used the participant observation activities to meet participants, and then used a combination of snowball and opportunistic selection to include additional participants. While the group of fishers selected was not statistically representative, the participants nevertheless include a range of knowledgeable informants and are a valuable source of information. In contrast, the majority of active divemasters on Bequia participated in this research.

I was able to secure the participation of several very knowledgeable informants. A total of 14 participants were involved in focus groups and

interviews. Six participants were divemasters, and eight were fishers (although one participant had been involved in both occupations). As multiple livelihoods are common on Bequia, I have to the extent possible focussed on the participants' current or most recent occupation. Most participants were born on Bequia or on other Vincentian islands. At the time of research, all participants had lived on Bequia for ten years or more. Many participants had lived or taken seasonal work abroad. All participants' first language was English, though many speak with local Vincentian dialectical characteristics. Additional participant characteristics are presented in Table 2.

Table 2: Summary of characteristics of interview and focus group participants. It does not include additional informants who participated in other meetings.

Occupations	Number of participants	Active / retired	Community of operation	Gender	Total
<u>Divemasters:</u>	6	6 Active	1 Clifton, Union island 5 Admiralty Bay	1 female, 6 5 male	
<u>Fishers:</u>				8 male	8
Subsistence	2	2 Active	1 Admiralty Bay, 1 Paget Farm		
Commercial	7	5 Active, 1 retired	1 Friendship Bay, 6 Paget Farm		
Grand Total					14

Participants for the two fishers' meetings included a mix of interview participants and other community members, some of whom I had never met

before. Participants were all fishers, and each meeting drew approximately 15 participants.

While LEK research is often characterized by the selection of community elders as participants, there were few elders among these participants. Both scuba diving and spear fishing is typically undertaken by younger people. I estimate that two participants were over 60 years of age, and the rest were between 30 and 50 years of age.

There are approximately 5,000 commercial fishers in SVG (Fisheries Division, 2003a). Although the exact number of fishers on Bequia is not known, it is clear that the number of fishers participating in this research represents a small proportion of the fishers on Bequia. However, the range of observations provided by these participants is indicative that this small proportion of fishers is not a significant concern. At the time of study, there were seven active divemasters on Bequia during the period of study, and perhaps about 15 more in all of SVG. The six Bequian divemasters participating in this research represents a significant proportion of this resource-user group on the island at the time of the field research.

Given that both fishing and scuba diving are male-dominated livelihoods, it is not surprising that only one participant was female. I have chosen to use only male pronouns when referring to all participants in the interests of participant confidentiality.

3.3 Considerations for the Study of LEK of Marine Environments

Some of the unique challenges that are presented when studying the LEK of underwater environments which affect the ability to observe underwater ecosystems and the safety of both the participants and the researcher. The documentation of local knowledge of marine systems is potentially more problematic than similar studies of terrestrial ecosystems that can be observed directly. The physical barrier of the air-water interface is a challenge to overcome, especially since viewing underwater ecosystems directly is only possible with the use of scuba equipment or by free-diving. In many cases, observations made by resource users are indirect. However, resource users can still derive meaningful information about underwater species and ecosystems. For example, fishers can gain knowledge of marine food webs from examining fish stomach contents when they are cleaned (Davis et al., 2004). Valbo-Jorgensen and Poulsen (2000) were able to learn about fish life cycle information such as migration and spawning and basin-wide information on key Mekong fish habitats by using group interviews and individual interviews with local fishers, supplemented with the use of a photo flip-chart of important Mekong fish species.

However, resource users who work under the water may be in a position to have broader knowledge of marine ecosystems than those whose activities are conducted above the surface of the water, as direct observation of the underwater environment can be made with the use of scuba and snorkelling equipment. Vincentians participate in the recreational scuba diving industry, and

many fishers free dive (i.e. breath-hold underwater diving) with spear guns, so some resource users may spend enough time underwater to be able to observe reef ecosystems over time.

Another challenge in conducting coral reef research is the fact that there are relatively few established rapid quantitative and qualitative techniques for assessing social bases of reef use (Bunce et al., 1999) and there are few other methods that could be adapted to the study of LEK of coral reefs. Bunce et al. (1999) do point out that rapid rural appraisal techniques and participatory rural appraisal techniques are gradually being adapted to the marine environment, particularly in fishing and coastal communities, but that these adaptations are not widely documented. Their study of the socio-economic framework of Montego Bay Marine Park in Jamaica used rapid rural appraisal, in which they elicited information from local people for subsequent analysis, but did not investigate local understanding of what was happening under the water.

3.3.1 Safety Considerations

There are important safety concerns associated with scuba and free diving that influenced how this research was carried out. I conducted cursory ecological surveys using snorkelling or scuba equipment to familiarize myself with the local environment. These were similar to rapid rural assessment techniques. However, both scuba and free diving carry risks for the diver, such as decompression sickness and blackout. In order to practice safe scuba diving, the divers must

maintain a constant awareness of their depth, air consumption, equipment status and their diving partner's safety, and any attempt on my part to request additional guiding could have proven to be a distraction for the diver and may have placed the participant in danger. I therefore did not enlist the help of any local "guides" to point out species of concern during these dives, as this might have exposed them to some degree of risk. Although scuba divemasters do point out species of interest to their clients, I did not ask them to find any particular species for me. However, I discussed aspects of the dive in detail afterwards. In effect, these were informal interviews focussing on species of interest and evidence of environmental change.

3.4 Social Construction of Ecological Terminology

I found that I had to consider the language I used with local people very carefully. In addition to learning and using local names and phrases of Vincentian "dialect" (as it is referred to locally) in order to communicate clearly with participants, I also needed to consider the way in which nature, environment, and in fact any ecological terminology is socially constructed. As a biologist, I was used to thinking of ecological and natural science terms as each having fixed definitions. As a new geographer undertaking LEK research, however, it became clear that I could no longer operate under this assumption. A consideration of the different constructions of nature and environment, and how they may differ from the researcher's construction, was a core component of the reflexive process.

There are three reasons why consideration for the socially constructed nature of environmental terms was important for this research. First, as has already been explained, different cultures may construct "nature" and "environment" in different ways, and using broad, more abstract conceptualizations can result in misunderstanding between the researcher and participants and misleading interpretations of local people's responses to my questions.

Second, environmental terminology can be very technical and distinct from vernacular terms, often beyond the experience or interest of the average member of the public. For example, Hunter and Brehm (2003) found that participants may indicate that they are not concerned about large - scale environmental problems (or their associated terminology) despite the fact that they care immensely about the local impacts stemming from these problems. It was my experience that an initial reaction to some of my questions was "I don't know". However, when explored in a little more detail or when questions were phrased differently, the participants were willing to share their knowledge of species and interpretations of environmental processes.

Finally, environmental discourses frequently involve antagonistic dualisms between heroes and villains that may detract the participants from accurately reporting how environmental change has affected them (Adger et al, 2000). Metzger (2003) points out that local environmental awareness in SVG is generally low, with the exception of the Rastafarians, who are directly opposed to Western consumerism but who are also often viewed as lazy by other

Vincentians. Furthermore, SVG has an aboriginal subsistence whaling operation and takes pilot and humpback whales (International Whaling Commission, 2002; Mohammed et al., 2003). These two factors led me to believe that being an “environmentalist” may be construed negatively by some participants, and may be conflated with either being anti- whaling, anti-development or opposed to the alleviation of poverty.

Taking the above concerns into consideration, I chose methods to allow for the exploration of multiple meanings associated with environmental terms.

3.5 Data Collection Methods

This research employed triangulation of several methods. Mixing methods improves understanding between the researcher and the researched and encourages local perspectives, and cross-checking the results (Kalibo & Medley, 2007). Ultimately an improved understanding of resource diversity is achieved (Kalibo & Medley, 2007). One set of methods draws from mainly from ethnobiology (Martin 1995) and from the Participatory Coastal Resource Assessment (PCRA) method described by Walters (1997). PCRA focuses on resource assessment from the perspective of local coastal resources users and involves extensive participation of local resource users. It includes gathering documented information, observing the local resource system, gathering local knowledge and discussing, verifying and correcting information with community

members. Additional methods include underwater ecological survey methods adapted from existing reef survey methods and local mapping exercises.

Although some researchers conduct the different methods in a specific sequence (Martin, 1995; Walters, 1997), so that the environmental survey and participant observation phases inform the interviews and focus groups that follow, in this case it proved to be more practical for the methods to overlap. This flexible approach enhanced the building of trust between myself and participants, facilitated triangulation between the interrelated methods, allowed me to take advantage of unique participant observation opportunities as they arose, and to continuously update interview questions and to confirm interview and focus group results throughout the course of the study. Instead of a fixed progression from one method to the next, several methods were performed concurrently in the second half of the field season.

3.5.1 Ecological Surveys

Ecological surveys were conducted to provide a better description of the study site and to increase my familiarity with the Bequian coastal marine environment. These also helped to provide the basis for interview and focus group questions that were relevant to Bequians. I conducted a cursory ecological survey each time I accompanied dive operators and fishers on scuba dives and snorkelling expeditions. I conducted 12 dives with the use of snorkelling or scuba gear in several locations around Bequia, and four additional dives around Union

Island and the Tobago Cays Marine Park in the Southern Grenadines for comparison, and to provide a basis for focus group and interview questions. A list of the ecological surveys is in Table 3. The aim of these surveys was not to quantify the condition of the reefs or make any conclusions about the condition of Vincentian reefs, but rather to familiarize myself in a general way with local coral reef ecosystem condition and composition. Ecological surveys were predominantly conducted off the coast of Bequia, but a few were conducted off the coast of other Grenadine island for comparison. For the dives using scuba equipment, I accompanied local dive operators and divemasters. For the snorkelling surveys, I accompanied local commercial or subsistence fishers. As a result, the ecological surveys also provided an opportunity to observe how divemasters and fishers use the resource, and provided an opportunity to interact with community members before and after the dive or snorkel, each ecological survey may also be considered as a participant observation activity.

Table 3: Ecological surveys conducted in St. Vincent and the Grenadines, 2006.

Date	Dive / Snorkel	Location
March 27, 2006	Snorkel with subsistence fisher	Harbour, Admiralty Bay, Bequia
March 28, 2006	Snorkel with local dive operator	South side of Admiralty Bay, Bequia
March 28, 2006	Snorkel with local boat tour operator	Ile a Quatre
March 29, 2006	Dive with local dive operator	South side of Admiralty Bay, Bequia

Date	Dive / Snorkel	Location
March 30, 2006	Dive with local dive operator	West Cay, Bequia
April 4, 2006	Dive with local dive operator	West Cay, Bequia
April 8, 2006	Dive with local dive operator	Tobago Cays Marine Park
April 8, 2006	Dive with local dive operator	Tobago Cays Marine Park
April 10, 2006	Dive with local dive operator	Tobago Cays marine Park
April 10, 2006	Dive with local dive operator	Clifton Harbour, Union Island
April 10, 2006	Dive with local dive operator	Tobago Cays Marine Park
April 12, 2006	Snorkel with subsistence fisher	Harbour, Admiralty Bay, Bequia
April 13, 2006	Snorkel with subsistence fisher	South side of Admiralty Bay, Bequia
April 22, 2006	Dive with local dive operator	West Cay, Bequia
April 25, 2006	Dive with local dive operator	North west coast of Bequia
April 25, 2006	Snorkel with subsistence fisher	Industry Bay, Bequia
May 24, 2006	Snorkel with commercial fisher	Ile a Quatre

There is no standard survey method designed to simply familiarize a researcher with coral reefs. First, there is a lack of consensus with respect to underwater survey methods for reef fishes by reef ecologists (Sale, 1991;

Samoilys and Carlos, 2000). Secondly, existing scuba-based methods involve the use of transects, which was impractical for this research. Transects would require me to interfere with the divemasters' normal operations while I was diving with them, and must also be conducted at specified depths which cannot be achieved with the use of snorkel equipment. As such, I chose to modify the Reef Check protocol (Hodgson, 1999), a transect-based survey method which has gained a high degree of popularity with volunteer recreational divers wishing to participate in research. Although it is a widely used and highly promoted ecological survey method, the global scale of the initiative and the focus on shallow depths (i.e., maximum 15 m) make certain aspects of this protocol inappropriate for the study of Bequian reefs, which can be found to depths of 30 m.

However, some of the regional reef health indicators used by Reef Check were valuable in helping me to familiarize myself with Bequian reefs. I used some of the indicators to provide a framework for surveying Vincentian reefs, and then added other indicators based on information obtained during conversations with community members while conducting participant observation. This provided me with a baseline from which to derive focus group and interview questions and for validation of LEK.

I used the following indicators of reef health for my ecological surveys. The first five are taken from Hodgson's (1999) Reef Check protocol:

1. Presence and relative cover of fleshy algae is an indicator of marine pollution. Unpolluted reefs will typically show fleshy algae cover of 10%

or less. I did not record specific measurements, but noted whether the cover appeared to be greater than 10%.

2. Presence or absence of lobster (*Panulirus argus*), grouper (Serranidae) and grunt (Haemulidae) species. Low numbers or absence of these commercially harvested species (which are also of importance to local subsistence fishers) are indicators of overexploitation.
3. Abundance of the black spiny sea urchin (*Diadema antillarum*). High numbers of this algal grazer are a secondary indicator of an imbalance of fish populations.
4. Percentage of live hard coral cover. I compared Bequian hard coral cover to the Caribbean mean of 21% can indicate the relative health of Bequian reefs. I did not record specific measurements, but noted whether the cover appeared to be clearly greater than or less than 20% during scuba dives and snorkelling excursions.
5. Abundance of encrusting sponges. A high abundance of encrusting sponges can be an indicator of increased nutrients resulting from marine pollution. Less than 5% encrusting sponge cover is typical of healthy reefs in the Caribbean. I did not record specific measurements, but noted whether the cover appeared to be greater or less than 5%.
6. Presence or absence of other species that are locally of commercial importance. These species were snappers (Lutjanidae), parrotfish (Scaridae) and pelagic species which may occasionally venture near the reef.

7. Presence of coral disease, in particular coral bleaching and black band disease. It was confirmed during the participant observation phase that these two diseases were present in SVG.
8. Presence of species consumed locally. These species include the West Indian sea egg urchin (*Tripneustes ventricosus*), angel fish (Pomacanthidae), squirrelfish (Holocentridae), blare eye (*Priacanthus arenatus*), surgeonfish (Acanthuridae), and triggerfish (Balistidae).

3.5.2 Participant Observation

Conducting participant observation activities prior to other data collection methods is recommended to generate interview questions, to become familiar with the communities, to build trust and to increase the likelihood that research questions are culturally appropriate (Martin, 1995; Walters, 1997). This was crucial not only for learning the local taxonomy, but also to learn how Bequians talk about the environment.

Participant observation activities were conducted with many community members, and involved participation in an assortment of community activities. I met with local fishermen at the Paget Farm fisheries station on a regular basis, observing that portion of the catch they brought home and often conducting informal interviews. On three occasions I accompanied fishers from Paget Farm and Admiralty Bay using snorkel equipment while they were spear fishing off Bequia for food for their families. On one other occasion I accompanied a

subsistence fisher from the Belmont community as he checked his fish traps. I also went to the Bequia fish market periodically to see what catch was brought in, and joined in community events such as the Bequia Easter Regatta, a beach clean up in Paget Farm with a youth group, and a town hall meeting. Table 4 describes these activities in more detail.

Participant observation of dive operations first involved meeting with divemasters, and later involved accompanying divemasters with their clients to determine how diver operators make use of the reef resource. In order to observe how they typically operate, I only joined scheduled groups of recreational divers, and did not schedule any private dives. I simultaneously conducted ecological surveys while taking care not to interfere with the dive plan. These ecological surveys are detailed in Table 4.

Table 4. Participant observation activities conducted in St. Vincent and the Grenadines, 2006. In addition, the ecological surveys in Table 3 also provided opportunities for participant observation.

Date	Number of participants	Activity
March 23, 2006	N/A	First visit to Paget Farm Fisheries Station, Bequia, to be introduced to the fisheries extension officer and the fishers' community, and to observe fishing activities.
March 26, 2006	1 Organizer Approx. 12 participants	Attended youth beach clean-up, Paget Farm, Bequia, to meet community members and to learn about environmental issues on the island.
March 28, 2006	1 boat tour operator Approx. 10 community members	Visit to Ile a Quatre to compare it to Bequia, and to observe how local community members make use of the uninhabited islands around Bequia.

Date	Number of participants	Activity
April 2-3, 2006	3 Bequian community members	Visit to Mustique to compare this privately owned island to Bequia and explore how approaches environmental protection differ.
April 8, 2006	2 members of the Sustainable Grenadines Project	Meeting with two members of the Sustainable Grenadines Project, Clifton, Union Island, to explore environmental issues faced by the Grenadines.
	1 fisher	Meeting with fisher, Ashton, Union Island, to gain background information on fishers attitudes with respect to fishing and the environment, and the challenges they face.
April 25, 2006	1 fisher	Accompanied subsistence fisher while emptying his fish trap, to observe how the trap operates and to view what kind of fish were taken.
April 27, 2006	3 fishers + fisheries extension officer.	Visit to Paget Farm Fisheries Station, Bequia, to meet with fisheries extension officer and to observe fishing activities. Discussed the daily routine at the Fisheries Station, the condition of the coastal marine environment with fishers.
May 2, 2006	2 fishers	Visit to Paget Farm Fisheries Station, Bequia, to observe fishing activities. Discussed environmental change in the coastal marine environment around Bequia.
May 4, 2006	1 fisher + fisheries extension officer.	Visit to Paget Farm Fisheries Station, Bequia, to observe fishing activities and to meet with fisheries extension officer. Discussed conch fishing with a fisher.
May 5, 2006	2 fishers	Visit to Paget Farm Fisheries Station, Bequia, to observe fishing activities.
May 9, 2006	N/A	Visit to Paget Farm Fisheries Station, Bequia, to observe fishing activities.

Date	Number of participants	Activity
May 10, 2006		Visit to the fish market in Port Elizabeth, Bequia, to record the species sold and to meet the fishers that supply it.
	N/A	Observation of fishing activities, Paget Farm, Fisheries Station, Bequia
May 11, 2006		Visit to the market in Port Elizabeth, Bequia
	2 fishers	Observation of fishing activities, Paget Farm, Fisheries Station, Bequia. Discussed fishing methods and sea conditions. Began organization of the first fishers' meeting.
	1 student and 1 community member	Discussion with University of West Indies student and community member regarding environmental change in Admiralty Bay and decrease in diving activities.
May 12, 2006	5 fishers and 1 divemaster	Visit to Paget Farm to attend community charity event. Discussed fishing livelihoods with participants.
May 13, 2006	N/A	Visit to the fish market in Port Elizabeth, Bequia
May 16, 2006	1 staff member	Meeting at the Vincentian Fisheries Division office in Kingstown for fish catch data and background information on Vincentian environmental issues and the fishing industry.
May 17, 2006	1 fishers + fisheries extension officer.	Visit to Paget Farm Fisheries Station, Bequia, to observe fishing activities. Discussed weather conditions and observed fishing gear repair.
May 18, 2006		Visit to Paget Farm Fisheries Station, Bequia, to observe fishing activities.
May 19, 2006	N/A	Visit to the market in Port Elizabeth, Bequia

Date	Number of participants	Activity
May 22, 2006	6 community members	Outing with fisher's family to Petit Nevis, during which I snorkelled with family members as they spearfished for the meal.
May 24, 2006	3 fishers	Visit to Ile a Quatre during which we discussed the marine environment, and I conducted the algae identification exercise.
May 31, 2006	N/A	Visit to Paget Farm Fisheries Station, Bequia, to observe fishing activities.
June 1, 2006	N/A	Fish market, Port Elizabeth, Bequia Observation of fishing activities, Paget Farm, Fisheries Station, Bequia
June 2, 2006	N/A	Visit to Paget Farm Fisheries Station, Bequia, to observe fishing activities.
June 3, 2006	N/A	Visit to Paget Farm Fisheries Station, Bequia, to observe fishing activities.
June 6, 2006	N/A	Visit to Paget Farm Fisheries Station, Bequia, to observe fishing activities and to promote the second fishers' meeting.
	Approx. 60 community members	Attended town meeting in Port Elizabeth to address community concerns about the sale of crown land to support the new airport on St. Vincent. Community members in attendance from Port Elizabeth or neighboring communities.

Participant observation occurred throughout the course of the research, informing all of the other methods used. Outings were complemented with brief, opportunistic informal interviews, and semi-structured interviews with a small

number of local coral reef experts to investigate LEK of coral reef ecosystems and questions of access and control over resources.

One recurring topic of discussion was linking local names of fish and coral to species names with the aid of guide books. While the documentation of a complete Vincentian folk taxonomy was beyond the scope of this research, it was essential to learn common names used in SVG in preparation for the more formal interviews and focus groups. The corresponding scientific names and American Fisheries Society names (a widely recognized system of common names) of these species were verified with the use the Humann and Deloach guidebooks (2002a, 2002b, and 2002c)

Meetings were arranged with representatives of the Fisheries Division in Kingstown on St. Vincent and with the Bequia Fisheries Extension Officer, with members of the Sustainable Grenadines Project based in Union Island in the Southern Grenadines, with a representative of the fishing community in Union Island, and with researchers from the University of West Indies, Barbados, who were in SVG conducting research and field courses. Although these were not participant observations activities, as these individuals were not members of the communities of study, the meetings helped me become familiar with Bequia's coastal marine ecosystems and gain additional insights into how to undertake the research.

3.5.3 Interviews and Focus Groups

Interviews and focus groups were the main data-gathering methods. A list of the focus groups and interviews, along with the number of participants is in Appendix 1. Topics to explore identified before field work commenced, and participant observation was used to refine this list, ensuring their relevance within the Bequian context. Interviews and focus groups were used to investigate local perceptions of diverse aspects of coral reefs, including species classification, species composition and food webs. I also focussed on local understandings of coral reef ecosystems and environmental change such as decreased abundance of commercially and ecologically important species. I investigated some of the threats to corals and coral reefs that have been identified as issues of significant concern globally or in the Caribbean to assess their significance in my study area. I also targeted three primary environmental concerns: i) incidence of coral bleaching; ii) changes in abundance of *Diadema antillarum*, the black spiny sea urchin; and iii) a mass mortality event affecting reef-associated fish species in the Eastern Caribbean in 1999, also known as a fish kill. Finally, I reviewed and confirmed the local names I had documented during participant observation activities, again making use of the illustrated guide books to ensure that I had an accurate correspondence between local and scientific names.

Focus group and interview question design was informed by an awareness of the social construction of nature and environment. My approach was to ask participants about specific local resources that may be of importance to them,

and specific events that may have affected them rather than attempting to discuss more general environmental concepts. This also provided an opportunity to explore local definitions of environmental terms such as coral reef, coral reef health, and species decline.

I began with a divemaster focus group for two reasons. First, focus groups are an efficient way of gaining insight into the ways in which people construct environmental and social issues, and it also provides an opportunity for participants to share and discuss different points of view (Bedford and Burgess, 2001). Secondly, being a diver myself, I was more easily able to establish a rapport with the divemasters. In addition to being a good source of LEK, the divemaster focus group provided an additional base to refine my approach. One focus group with four participants was conducted with divemasters, and a follow-up focus group with two of these participants. The first was about 90 minutes in length, and was conducted in a meeting room in the district office, which I chose as a neutral setting. The second was a follow-up with two of the same divemasters approximately one hour in length, and was conducted at the participants' dive shop. Audio recordings of the focus groups were made, and I also took notes as a backup and to record non-verbal signals as recommended by Cameron (2005).

Semi-structured interviews were conducted with two additional divemasters and with commercial and subsistence fishers. These interviews expanded upon the findings from the first divers' focus group and over 20 opportunistic informal interviews conducted during participant observation.

Although I initially prepared interview guides listing the general issues I wished to cover (Appendix 2), participants' responses typically deviated from my these topics. In many cases, the interview took on a conversational turn, and topics were often addressed out of sequence from the interview plan.

As interview participants were either professional scuba divers or fishers who have different backgrounds, reside in different communities on the island, use the coral reef in different ways and even use different vocabularies for describing the underwater environment, I did not ask questions the same way each time. Instead, I tailored the interview to each individual participant, using my interview plan as a guide. However, I made a point of including all key topics and exploring definitions of environmental terms, phenomena that are easily observed by fishers and local perceptions of significant species or events. I avoided the topic of illegal resource use during both interviews and focus groups in order to eliminate any risk faced by my participants.

The topics included:

- Participants' definitions of coral, coral reefs and what constitutes healthy and damaged coral reefs.
- Participants' understanding of the causes of reef damage.
- Food web interactions. This was investigated by asking what different species eat.
- Evidence of coral bleaching. For this question, I showed participants an underwater photo of coral bleaching I had taken on one of my earlier dives.

- The abundance of black spiny sea urchin (*Diadema antillarum*), past and present.
- The change in abundance of commercially important or locally consumed species.
- The Eastern Caribbean fish kill of 1999.
- The seasonality of events and habits of coastal marine species.

In addition to interviews and focus groups, I hosted two meetings with fishers at the Paget Farm Fisheries Station to provide an opportunity to verify and correct information gathered using other methods. The fisheries station proved to be an ideal location, because despite the tensions between the fisheries department and the fishers, the station itself is treated like “home turf” by the fishers.

The meetings with the fishers also provided an opportunity to use other methods. During one meeting I asked the participants to draw a marine food web. However, they were reluctant to draw a food web, so ultimately I held the pen while following their direction, periodically confirming with the group that I was correctly representing what they were telling me. I asked the group how they learned about fish, and conducted group mapping exercises as described below.

3.5.4 Mapping Exercises

Researchers and resource managers often have difficulty integrating LEK with scientific knowledge. The use of local knowledge for mapping, however, has proven a successful way of integrating these different knowledges (Lauer and Aswani, 2008). Participatory mapping has the potential to investigate questions of land use and conservation (Smith, 2003a). Maps compiled by community members can help document current and past land use, provide additional detail to official maps, and collect information that can be used to defend the interests of disenfranchised groups (Smith, 2003a; Kalibo and Medley, 2007; Walters, 1997). Participatory mapping has been successfully applied to coastal marine settings (Walters, 1997).

I facilitated three mapping exercises with approximately 15 individuals in total. The first was conducted during the first fishers' meeting. I asked participants to draw on existing base maps where features of interest might be found, such as location of elkhorn coral, bleaching, hurricane damage, and artificial reefs. For this I followed Walters (1997) method of tracing of the islands with none of the place names included, from a 1:90,000 nautical chart of St. Vincent and the Grenadines. I chose to use charts at this scale showing the entire Grenadine island chain because many fishers had indicated that they fished throughout the Grenadines on a regular basis. The aim was to encourage meeting participants to provide their own toponyms. However, this approach was not entirely effective and required modifications. The fishers appeared unused to

aerial views of island geography, and kept asking me to give them the missing place names. I learned that their way of determining their position while at sea was to recognize the profile of the islands, and to triangulate position by marking features on the coastlines.

I modified the mapping method by placing tracing paper over the nautical charts, so that the place names and all the other features could still be seen, and re-introduced the mapping exercise at a second meeting with the fishers. Using this method, participants were able to orient themselves on the base map effectively. There were very few discrepancies between local and map toponyms. In some cases fishers offered an alternate place name, but the toponyms printed on the map were well known to all.

During the second divers' focus group, and one of the diver interviews, I asked divers to mark on a 1:10,000 map of Bequia the location of reefs, the areas where they take divers, areas where species of interest such as sharks and tarpons may be found, the location of living elkhorn coral and the location of hurricane damage around Bequia.

The different methods used were complementary, and together proved to be an effective way to document the LEK of the group of people who participated in the research. While perhaps not representative of all divemasters and fishers on the island, the data collected provide a multifaceted view of the Bequian marine environment and a revealing case study of LEK of coastal people of the Eastern Caribbean.

CHAPTER 4: LOCAL ECOLOGICAL KNOWLEDGE IN BEQUIA

Bequians have significant understanding of coastal marine ecosystems. They have a sophisticated folk taxonomy for many marine species and have an understanding of past ecological conditions and how these are changing. Bequian perspectives, however, were not always consistent among all participants due to the fact that ecological knowledge does not develop in a vacuum. Rather, it is embedded in local social norms (North, 1990). This was demonstrated in this research, as the results revealed two related but distinct knowledge systems in Bequia based on occupation. Divemasters and fishers have similar LEK, but there were certain differences in some cases and even conflicting perspectives.

The research results showed that Bequian local knowledge is focused on species relevant to each participant's livelihood. Furthermore, since the day to day activities of fishers and divemasters are generally based in Paget Farm and Admiralty Bay respectively, the LEK of participants also differed between communities. The two knowledge systems are similar, yet use different naming systems and have different perceptions of environmental change and its causes.

This chapter describes the similarities and differences between the LEK of divemasters and fishers. It then describes the collective LEK of coral reef ecosystems, the species that inhabit them, the threats to them, and changes in the marine environment. In order to maximize the acceptance of Bequian LEK by decision makers and the scientific community, as recommended by Robertson and McGee (2003), and to provide additional context I have where possible cross

referenced LEK with “scientific” definitions and knowledge of coral reef ecosystems in the Caribbean.

4.1 Divemasters and Fishers

One should not presuppose that knowledge is evenly distributed throughout a population (Davis et al., 2004). In this study, the divemasters and the fishers demonstrate different perspectives and types of knowledge relating to marine ecosystems. These different areas of expertise reflect the fact that people will focus on the aspects of marine ecosystems most relevant to their livelihood.

Commercial fishers primarily shared knowledge relating to the species they depend upon for their livelihood. This includes mainly fish species but also the two invertebrate species that are commercially important, the spiny lobster (*Panulirus argus*) and the queen conch (*Strombus gigas*). Fishers are also knowledgeable about the life history and changes in abundance of species that are eaten locally, such as blare eye (*Priacanthus arenatus*). Although fishers do have knowledge about non-commercial, non-food species, their expertise is concentrated on species that are harvested for sale or household consumption.

In contrast, the ecological knowledge of divemasters encompasses a wider array of taxa and of the ecosystem as a whole, perhaps because virtually all species are important for their livelihood. Moreover, their interaction with coral reef ecosystems is profoundly different, as they point out features and non-fish species that may be of interest to their clients. Divemasters report that their

clients, mainly tourists from Europe and North America, have varied tastes which include charismatic megafauna, (such as sharks and rays), healthy coral heads, and “critters” – invertebrates and camouflaged fishes such as seahorses (*Hippocampus* spp.) and frogfish (Atennariidae) that are usually only found on the sea floor or in crevices. Thus the wider focus of divemasters knowledge reflects a need to satisfy a wide variety of client tastes.

The knowledge of divemasters differs from the Paget Farm fishers in other significant ways. Although fully aware of local names, in general divemasters are equally comfortable using the American Fisheries Society (AFS) taxonomy with their clients. Divemasters also demonstrated greater knowledge of Caribbean-wide and global environmental change, while the fishers’ perspectives are more restricted to the Grenadines. Moreover, divemasters have many more interactions with foreign tourists in their day-to-day work, and also with University of West Indies class groups visiting the area who share their observations and knowledge. Although fishers’ knowledge focussed on a narrower array of species, they had more detailed knowledge of the species that were significant to their livelihoods.

There are also many areas of overlap in fisher and divemaster perspectives of coral reef ecosystems. Commonalities between the two groups include a recognition that certain species abundances are decreasing, a recognition of significant, long term environmental change, and an awareness that coral reef health in Bequia is declining. While at times difficult to distinguish,

the ways in which the knowledge of the two groups agrees and differs will be explored throughout this chapter.

4.2 Classification Systems: Folk Taxonomy

Investigating local naming systems was an important early step in this research, and helped guide the investigation of other topics. Bequians classify marine organisms according to a combination of economic designations, habitat and morphology.

Paget Farm fishers in particular use a distinctly local naming system. Therefore it was necessary to document the primary elements of their folk taxonomy in order to investigate their knowledge of coral reef ecosystems. The full listing of local names may be found in Table 5. Bequian terms was corroborated with the Fisheries Information Document (Fisheries Division, 2003a).

Throughout the rest of this chapter, I will use American Fisheries Society common names, except where noted.

In addition to the naming system, Bequians use several distinct, overlapping classifications based on economic criteria, morphological characteristics and habitat. While sometimes difficult to classify, two of the main, broad classifications of fish are “red fish” and “white fish.” These are primarily commercial designations, whereby the trading vessels to which fishers consistently sell their catch offer a better price for red fish. In general, white fish

Table 5: Bequian taxonomy of marine species, with American Fisheries Society common names and scientific names. Scientific grouping refers to the taxonomic family, except where indicated.

Bequian Term	American Fisheries Society name	Scientific name	Scientific grouping
Fish			
bait	silversides, herrings and anchovies	Atherinidae, Clupeidae and Engraulididae	Atherinidae (silversides), Clupeidae (herrings and sardines) and Engraulididae (anchovies)
spratt *	scaled sardine	<i>Harengula pensacolae</i>	Clupeidae (herrings and sardines)
angelfish	angelfish and butterflyfish	<i>Pomacanthus</i> spp., <i>Chaetodon</i> spp.	Pomacanthidae (angelfishes) and Chaetodontidae (butterflyfishes)
curolan	french angelfish	<i>Pomacanthus paru</i>	
rock beauty	rock beauty	<i>Holacanthus tricolor</i>	
doctorfish	ocean surgeon fish, blue tang and doctorfish	<i>Acanthurus bahianus</i> , <i>A. coeruleus</i> and <i>A. chirurgus</i>	Acanthuridae (surgeonfishes)
dolphin	dolphinfish	<i>Coryphaena hippurus</i>	Coryphaenidae (dolphinfishes)
mackerel	cero, Spanish mackerel and king mackerel	<i>Scomberomorus regalis</i> , <i>S. maculatus</i> and <i>S. cavalla</i>	Scombridae (mackerels)
bonita, skipjack	little tunny	<i>Euthynnus alletteratus</i> , <i>Thunnus atlanticus</i>	
kingfish	wahoo	<i>Acanthocybium solandri</i>	
gia	flat needlefish and houndfish	<i>Ablennes hians</i> and <i>Tylosurus crocodilus</i>	Belonidae (needlefishes)

* Common name provided by Fisheries Division (2003a)

** There was debate as to whether or not these were the same species.

Bequian Term	American Fisheries Society name	Scientific name	Scientific grouping
barracuda	barracuda	<i>Sphyraena barracuda</i>	Sphyraenidae (barracudas)
snook	southern sennet and guaguanche	<i>Sphyraena picudilla</i> and <i>S. guachancho</i>	
cavalli	jacks	<i>Caranx</i> spp., <i>Senola</i> spp., <i>Uraspis</i> spp, <i>Alectis</i> spp.	Carangidae (jacks)
greenback cavalli	bar jack	<i>Caranx ruber</i>	
roundhead cavalli	blue runner	<i>Caranx crysos</i>	
greenback cavalli*			
rainbow cavalli	yellow jack	<i>Caranx bartholomaei</i>	
horse eye	horse eye jack	<i>Caranx latus</i>	
black jack**	crevalle jack, black jack	<i>Caranx hippos</i> , <i>Caranx lugubris</i>	
amber cavalli	almaco jack	<i>Senola rivoliana</i>	
cavalli	cottonmouth jack	<i>Uraspis secunda</i>	
jack driver	African pompano	<i>Alectis ciliaris</i>	
salmon	rainbow runner	<i>Elagatis bipinnulata</i>	
cobbler	permit, palometa	<i>Trachinotus</i> spp.	
jackfish	bigeye scad	<i>Selar crumenophthalmus</i>	
robin	mackerel scad	<i>Decapterus macarellus</i>	
robin	round scad	<i>Decapterus punctatus</i>	
dodger*	round scad	<i>Decapterus punctatus</i>	

* Common name provided by Fisheries Division (2003a)

** There was debate as to whether or not these were the same species.

Bequian Term	American Fisheries Society name	Scientific name	Scientific grouping
boga	boga	<i>Inermia vittata</i>	Inermiidae (bonnetmouths)
Spanish robin	bonnetmouth	<i>Emmelichthyops atlanticus</i>	
bobby	bonefish	<i>Albula vulpes</i>	Albulidae (bonefish)
ten pounder	white mullet	<i>Mugil curema</i>	Mugilidae (mulletts)
grunt	porgies	<i>Diplodus</i> spp., <i>Archosargus</i> spp., <i>Lagodon rhomboides</i> , <i>Pagrus pagrus</i> , <i>Calamus</i> spp., <i>Stentomus</i> spp.	Sparidae (porgies)
	pigfish	<i>Orthopristis chrystoptera</i>	Haemulidae (grunts)
yellow grunt	porkfish	<i>Anisotremus virginicus</i>	
hungtooth	schoolmaster	<i>Lutjanus apodus</i>	Lutjanidae (snappers)
skipjack*	mahogany snapper	<i>Lutjanus mahogoni</i>	
snapper	red snapper and mahogany snapper	<i>Lutjanus campechanus</i> and <i>L. mahogoni</i>	
yellowtail	yellowtail	<i>Ocyrus chrysurus</i>	
red man	squirrelfish	<i>Holocentrus</i> spp., <i>Sargocentron</i> spp., <i>Neoniphon</i> spp. and <i>Myripristis</i> spp.	Holocentridae (squirrelfish)
piper	Spanish hogfish	<i>Bodianus rufus</i>	Labridae (hogfish and wrasses)
blare eye	bigeyes	<i>Priacanthus arenatus</i>	Priacanthidae (bigeye)
balahoo	ballyhoo	<i>Hemiramphus brasiliensis</i>	Exocoetidae (flying fishes)

* Common name provided by Fisheries Division (2003a)

** There was debate as to whether or not these were the same species.

Bequian Term	American Fisheries Society name	Scientific name	Scientific grouping
platefish	flounders	<i>Bothus</i> spp., <i>Engyophrys</i> spp., <i>Syacium</i> spp., <i>Paralichthys</i> spp., <i>Cyclpsetta</i> spp.,	Bothidae (flounders)
batfish	flying gurnard	<i>Dactylopterus volitans</i>	Dactylopteridae (flying gurnards)
grouper*	groupers	<i>Epinephelus</i> spp.	Serranidae (groupers and sea basses)
butterfish	coney (all morphs)	<i>Cephalopholis fulvus</i>	
graysby	graysby	<i>Cephalopholis cruentatus</i>	
sackfish	graysby	<i>Cephalopholis cruentatus</i>	
hind	rock hind*	<i>Epinephelus adscensionis</i>	
	yellowfin grouper, gag, comb grouper and marbled grouper	<i>Mycteroperca venenosa</i> , <i>M. microlepis</i> , <i>M. acutirostris</i> and <i>Epinephelus inermis</i>	
red hind	red hind	<i>Ephinephelus guttatus</i>	
rockfish	goliath grouper, nassau grouper, red grouper and black grouper (black morph)	<i>Epinephelus itajara</i> , <i>E. striatus</i> , <i>E. morio</i> and <i>mycteroperca bonaci</i>	
soakfish	yellowmouth grouper	<i>Mycteroperca interstitialis</i>	
trumpetfish	trumpetfish and bluespotted cornetfish	<i>Aulostomus maculatus</i> and <i>Fistularia tabacaria</i>	Aulostimidae (trumpetfishes) and Fistulariidae (cornetfishes)
needlefish	trumpetfish and bluespotted cornetfish	<i>Aulostomus maculatus</i> and <i>Fistularia tabacaria</i>	

* Common name provided by Fisheries Division (2003a)

** There was debate as to whether or not these were the same species.

Bequian Term	American Fisheries Society name	Scientific name	Scientific grouping
whitning	sand tilefish	<i>Malacanthus plumieri</i>	Malacanthidae (tilefishes)
chub	parrotfish	<i>Scarus</i> spp., <i>Sparisoma</i> spp.	Scaridae (parrotfish)
brown chub	yellowtail parrotfish (initial phase)	<i>Sparisoma rubripinne</i>	
parrotfish/ chub	queen parrotfish	<i>Scarus vetula</i>	
rainbow chub	rainbow parrotfish	<i>Scarus guacamaia</i>	
red belly chub	stoplight parrotfish (initial phase)	<i>Sparisoma viride</i>	
red chub	redtail parrotfish (initial phase)	<i>Sparisoma chrysopteron</i>	
specktail	stoplight parrotfish (adult)	<i>Sparisoma viride</i>	
hedgehog	burrfish, ballonfish, porcupinefish	<i>Chilomycterus</i> spp., <i>Diodon</i> spp.	Diodontidae (porcupinefish)
shellfish	cowfish, trunkfish	<i>Acanthociodon</i> spp and <i>Lactophrys</i> spp	Ostraciidae (boxfishes)
oldwife	triggerfish	<i>Balistes</i> spp.	
bastard oldwife	ocean triggerfish	<i>Canthidermis sufflamen</i>	Balistidae (triggerfishes)
pigfish	rough triggerfish, sargassum triggerfish and black durgon.	<i>Canthidermis maculata</i> , <i>Xanthichthys ringens</i> and <i>Milichthys niger</i>	

* Common name provided by Fisheries Division (2003a)

** There was debate as to whether or not these were the same species.

Bequian Term	American Fisheries Society name	Scientific name	Scientific grouping
leathercoat	filefishes	<i>Aluterus</i> spp., <i>Cantherines</i> spp. and <i>Monacanthus</i> spp.	Monacanthidae (filefishes)
goatfishes	goatfishes	Mullidae	Mullidae (goatfishes)
cream mullet	spotted goatfish and yellow goatfish	<i>Pseudupeneus maculatus</i> and <i>Mulloidichthys martinicus</i>	
goatfish			
conger	spotted moray, reticulate moray, purplemouth moray, goldentail moray	<i>Gymnothorax moringa</i> , <i>G. vicinus</i> , <i>G. miliaris</i> , <i>Muraena retifera</i> ,	Muraenidae (morays)
conger*	N/A	<i>Conger oceanicus</i>	
green eel	green moray	<i>Gymnothorax funebris</i>	
spika	goldentail moray (dark phase)	<i>Gymnothorax miliaris</i>	
seasnake	sharptail eel and goldspotted eel	<i>Myrichthys breviceps</i> and <i>M. ocellatus</i>	Ophichthidae (snake eels)
Sharks and Rays			
sand shark	nurse shark	<i>Ginglymostoma cirratum</i>	Rhincodontidae (carpet sharks)
stingray	southern stingray	<i>Dasyatis americana</i>	Dasytidae (stingrays)
sunfish	spotted eagle ray	<i>Aetobatus narinari</i>	Myliobatidae (eagle rays)
sea devil	giant manta	<i>Manta birostris</i>	Mobulidae (mantas)

* Common name provided by Fisheries Division (2003a)

** There was debate as to whether or not these were the same species.

Bequian Term	American Fisheries Society name	Scientific name	Scientific grouping
Stony corals			
ginger coral	staghorn coral	<i>Acropora cervicornis</i>	Acroporidae
antlerhorn coral	staghorn coral	<i>Acropora cervicornis</i>	
pan coral	elkhorn coral	<i>Acropora palmata</i>	
fire coral	fire coral	<i>Millepora</i> spp	Milliporidae
brain coral	brain coral	All species	Faviidae
Sponges			
sponge coral	sponges	All species	phylum Porifera
Soft corals			
sea fan / sea tree	gorgonians		order Gorgonacea
sea fan	sea fan	<i>Gorgonia</i> spp.	
black coral	black corals	Antipatharia	order Antipatharia
Sea Urchins			
sea eggs	sea urchins	Echinoidea	class Echinoidea
man 'o war sea egg	black spiny sea urchin	<i>Diadema antillarum</i>	
cobbler	black spiny sea urchin	<i>Diadema antillarum</i>	
white sea egg	West Indian sea egg	<i>Tripneustes ventricosus</i>	

* Common name provided by Fisheries Division (2003a)

** There was debate as to whether or not these were the same species.

Bequian Term	American Fisheries Society name	Scientific name	Scientific grouping
Crustaceans			
lobster	Caribbean spiny lobster	<i>Panulirus argus</i>	order Decapoda
soldier crab	hermit crab	<i>Petrochius</i> or <i>Paguristes</i>	
Molluscs			
conch	queen conch	<i>Strombus gigas</i>	order Gastropoda
whelk	N/A	<i>Cittarium pica</i>	
squid	squid	all species	order Teuthoidea
sea cat	octopus	all species	order Octopoda
Plants			
moss	algae and seagrasses	Includes all plants, such as <i>Sargassum</i> , <i>Halimeda opuntia</i> , <i>Thalassia</i> , <i>Syringodium</i> , <i>Ripocephalus phoenix</i> form <i>breviform</i> and <i>Dictyota</i> spp.	N/A

* Common name provided by Fisheries Division (2003a)

** There was debate as to whether or not these were the same species.

include fish species that inhabit the pelagic or open ocean zone, also known locally as “floating fish”. Red fish are those that usually have red scales either during the adult stage or at some part of their life stage, as is the case with certain parrotfish species that have a red juvenile colour phase. Many red fish happen to be bottom dwellers found on or near the reef, such as those known locally as parrotfish (*Scarus* spp. and *Sparisoma* spp.), butterflyfish (*Cephalopholis fulva*) and groupers (*Epinephelus* spp.), but the term also corresponds to the pelagic, commercially important snappers (Lutjanidae). In addition, the term “red fish” also includes reef-dwelling species that are not commercially important but that are red in colour and are consumed locally, such as “redman,” (Holocentridae) and “blare eye” (*Priacanthus arenatus*).

Another means used to classify fish is by habitat. The pelagic fish living are called “floating fish”, as they are found in the water column and avoid the bottom. The term “floating fish” is equivalent to the scientific term “pelagic fish”. The reef-dwelling fish and other bottom dwellers are collectively called “bottom fish”, and are generally equivalent to the scientific designation of “reef fish”. Although the category “reef fishes” defies a simple scientific definition, they can be described as those fish that are found on, and are characteristic of, coral reefs and including surgeonfishes (Acanthuridae), jacks (Carangidae), butterflyfishes (Chaetodontidae), squirrelfishes (Holocentridae) and parrotfish (Scaridae) (Bellwood and Wainwright, 2002; Mumby et al., 2006).

Another category of fish is “bait fish”. Bait fish is a broad term that includes several taxa of small schooling fish, including members of families Atherinidae,

Engroulididae and Clupeidae. These fish are range from 3.5 to 9 cm in length and many species of pelagic fish feed on them. They are used as bait by fishers. One of the larger examples that is also consumed by Bequians is “spratt” (*Harengula pensacolae*).

Interestingly, all marine plants and algae are collectively called “moss”. I confirmed this by showing one participant a variety of marine plant and algae species, and he informed me that all these were examples of moss despite the considerable morphological differences between these taxa. (The taxa used in this exercise include *Sargassum* spp., *Halimeda opuntia*, *Thalassia* spp., *Syringodium* spp., *Ripocephalus phoenix* form *breviform*, *Dictyota* spp. and an unidentified algal sample). The term “algae,” however, refers to all types of algae only.

In the absence of a more specific local name, participants differentiate different marine plant and algae taxa by description and also according to where it is found. For example, during the divemasters’ focus group, divemasters described a specific kind of algae:

R: - you wouldn’t see this algae, a lot of this, you normally see it in the harbour. How you describe it, it’s grey, thick kind of stuff . . .

L: Not the green stuff that is on the beach. It’s a different stuff.

This discussion demonstrates that the lack of a name does not mean that different taxa and species are not recognized or distinguished by participants.

Like their counterparts worldwide, Bequian divemasters use the category

“critters” to encompass a wide array of bottom-dwelling taxa. The term “critter” or “creature” is widely used in the recreational scuba diving community to denote reef invertebrates including crustaceans, tube worms (Serpulidae) and anemones (order Ceriantharia). Divemasters on Bequia also include camouflaged bottom-dwelling fish species such as seahorses (*Hippocampus* spp.) and frogfish (*Antennarius* spp.) in this category. What these taxa all have in common is that in order for a diver to see them, they must scan the sea bottom closely. As far as I could determine, there are no local names used by divemasters for the majority of these taxa. Divemasters used the American Fisheries Society names for these taxa, and not surprisingly, given the nature of their activities, fishers did not mention these species at all.

The Bequian system of local names used among fishers is based largely on morphology. Although it was beyond the scope of this research to determine to what extent the Vincentian groupings correspond to the scientific classification categories of order, family and genus, there were several examples of a Bequian term that corresponds to the families identified by the scientific taxonomy outlined by Humann and DeLoach (2002a). Examples include “cavalli” which corresponds closely to the family Carangidae, “chubbs” which designates the parrotfish family Scaridae, and “doctorfish” which corresponds to the family Acanthuridae. Members of family Mullidae are known as “goatfish” in both the American Fisheries Society and Bequian naming systems. This correspondence between scientific and local classification is not surprising, as scientific taxonomies are also to some extent associated with morphology. Conversely, the link between

classification is also demonstrated in the case of two scientific families, Aulostimidae and Fitulariidae, which share morphological similarities also share a single Bequian collective name.

Local names for individual species are most common for fish species that are important either commercially or for subsistence. The number of Bequian names is extensive, which could be taken as an indicator that a wide array of fish species are important to commercial fishing and to the local diet. In contrast, local names for individual species were lacking for species that were not harvested. For example, among the participants of this study, no terms was given for the damselfishes or for the blennies, all of which are groups of fish comprising small, colourful species sought out by visiting tourist divers. The lack of a local name, however, should not be taken as an indicator that islanders are not familiar with the species.

4.3 Local Understanding of Coral and Coral Reef Ecosystems

As coral reefs were the prime focus of this study, it was important to investigate local perceptions of them. As these ecosystems are built by stony corals (Scleractinia), it was also important to investigate local perceptions of these organisms. Definitions for “coral” and “coral reef” are difficult to define even in scientific terms. For example, scleractinian coral is living, and it grows. On the other hand, it also has a stony skeleton which remains when the coral polyps have died and which stays in place as part of the physical structure of a coral

reef. The scientific community recognizes the dual nature of a coral reef as an ecosystem and physical barrier. These aspects add a level of complexity to the study of local ecological knowledge of coral reefs. Although Bequians have very few local names for coral, the knowledge they shared with me indicated that local names are not always important. There is a lot of understanding about species for which local names are not widespread.

4.3.1 Bequian Definitions of Coral

Bequians use the term “coral”. Both stony corals (Scleractinia) and soft corals (Octocorallia, Antipatharia) were given as examples of coral. Although I was not able to elicit any consistent definition of coral, the responses of participants did demonstrate a detailed if partial understanding of the organism, with more emphasis on certain elements.

Participants recognize that coral is alive, that it grows and that it has a hard, stony component. Many fishers compared coral to being like a plant that grows. In one participant’s words, “it’s like a tree, but is a rock”. Scleractinian corals in particular were also described by a few fishers as being like a stone, or as being made up of stones that nevertheless grew. Several participants indicated that coral is delicate and easily damaged, and divemasters in particular pointed out that coral takes a long time to grow. One participant described coral larvae and how they affix to a substrate and grow into a larger structure.

With one exception, all participants recognize coral as something that is

alive. Most fishers referred to the coating of living polyps as “slime”, often reminding me that this slime can cause injury if one touches it. Although fishers did not describe scleractinian corals as colonial organisms, in which each polyp is an individual animal, they clearly recognize that the soft surface is alive, and that it can be damaged or killed. Some fishers also described the polyp cups, which are small skeletal structures that house an individual coral polyp. Interestingly, one participant compared them to petals.

Many fishers also described coral in terms of the habitat it provides for other organisms, naming specific fish taxa such as boxfishes (Ostraciidae) or parrotfish (Scaridae) that use coral as habitat. Another participant linked coral health to its ability to act as habitat. He described how lobsters chose a specific kind of coral as habitat, and that they would only use it if the coral were alive: “. . . lobster have special stone . . . Coral stone right? . . . And when the stone is brown, lobster like it. And when it is pale, as I tell you, they don’t go.”

There are some local names for corals. For example, the brain coral species (family Faviidae) are locally known collectively as brain coral. Elkhorn coral, a member of the genus *Acropora* which was once abundant in Industry Bay, is locally called “pan coral”. Divemasters and fishers alike recognize species with different shapes and colours whether they have local names or not.

4.3.2 Definitions of Coral Reef

As mentioned previously, coral reefs are ecosystems that support a wide array of animals and plants. However, a reef is also a calcium carbonate formation made from dead coral skeletons that can act as a barrier to wave action and boat traffic, and in the short term it maintains this function whether or not the coral on it is alive. These different aspects add another layer of complexity to the investigation of local knowledge of coral reefs.

Coral reefs were described by the participants in several ways: by the presence of scleractinian coral; as habitat for other marine organisms (fishers in particular focussed on the reef as habitat for lobster (*Panulirus argus*) and certain fish); as places where the water was shallow; and as a barrier. As one person told me, “. . . it breaks a lot of water, you know? . . . That’s what we call a reef. . . no big boats can go there.”

Overall, local fishers’ definitions of coral reefs are more subjective and “fuzzy” than academic definitions. The first divemaster focus group, however, provided a comprehensive definition of a coral reef. They defined it as an ecosystem containing both stony and soft corals on hard or soft substrates. They indicated that coral reefs are found at a depth of 15 to 100 feet³ (which is a depth range for coral reefs common around Bequia but very rare elsewhere), and are areas of high biodiversity providing habitat for a wide variety of fish and other organisms. Divemasters also discussed the different types of reef topography in

³ For this chapter, I have used local units. Divemasters often use feet as a measurement of depth, as many scuba depth gauges use imperial units.

Bequia, for example fringing reefs and patch reefs. They also stressed that reefs are an important source of livelihood for divers and fishers and important sources of food for local people, showing that they are defined in both ecological and human terms.

Participants were also asked what they would consider to be a healthy reef or a damaged reef. All participants defined a healthy reef as having a high abundance of fish or lobsters. Some fishers said that in a healthy reef, the corals will “have slime” on them, in other words having living polyps over the stony skeletons. This is consistent with some scientific concepts of reef health which equate health with percentage of live coral cover (Hodgson 1999). Divemasters also pointed to the presence or abundance of non-coral sessile invertebrates such as anemones (order Ceriantharia) and tubeworms (Serpulidae) as indicators of reef health. Their observations are consistent with scientific definitions of reef health.

A damaged reef, in contrast, was described by participants as a reef with significant amounts of dead coral (fishers describe this as reefs that lack “slime”) and a relatively low abundance or an absence of fish and lobsters. The presence of physical damage caused by hurricanes was universally acknowledged as being an indicator of a damaged reef. The divemasters also indicated that presence of coral disease would be an indicator of a damaged reef, as would an increased abundance of algae. Healthy coral reefs are valued by many participants because they provide important habitat for a wide range of species. One participant pointed out that it becomes difficult to find reef fish after a reef

has been damaged, as the fish no longer have anywhere to “hide”.

Divemasters were in agreement that the reefs in Bequia are relatively healthy compared to reefs elsewhere in the Caribbean based on either their own observations or comments from seasonal colleagues and experienced diving clients. Despite damage that has occurred to local reefs from recent hurricanes, they still feel that the reefs are in comparatively good condition for tourism. The members of the first divemaster focus group noted that tourists were even impressed with their most mediocre dive site located in Admiralty Bay and called Devil's Table.

4.3.3 Coral Bleaching

Although they did not have a name for coral bleaching, all but one of the 14 participants recognized bleaching events as being the loss of colour of the living coral polyps or “slime”. Some participants also remarked that the living coral no longer stings when it has turned white, and linked this to declining health. As one participant put it, when the coral stings, “it have life inside it”. One fisher indicated that marine organisms do not use bleached coral as habitat. Three participants ascribed a seasonal pattern to bleaching, that it occurs primarily during the summer when the water temperature is higher. One of these participants also correlated coral bleaching with the arrival of the “black water”, the local name for seasonal increase in turbidity caused by the plume of the Orinoco River. Some participants speculated that increased water temperatures

caused coral bleaching. Others stated that coral bleaching may also be caused by physical damage, and one stated that it is the result of algae smothering the coral. Some said that it is most common in the shallows, and divemasters in one of the focus groups said that it occurs at an estimated maximum depth of about 40 feet. Many of these descriptions are consistent with scientific accounts indicating that coral bleaching results in coral death, is related to increased temperature, sometimes correlated with hurricane damage, and inversely correlated with depth (Hardman et al., 2004; Sotka and Thacker, 2006; Donner et al., 2007).

Participants stated that Bequia has a low incidence of coral bleaching compared to other dive locations, but divemasters have noticed an increase in bleaching locally in the last few years. While many participants believe that corals can commonly recover from bleaching within three weeks to three months, divemasters have observed that recovery of bleached corals is now less common, and that coral death has increased as a result. For example, they claim that in 2005 it took too long for the bleached corals to recover, and that as a result they were taken over by algae. Several participants said that once the corals are taken over death seems to follow.

4.4 Coastal Marine Food Webs

Interaction between species is a core element of all ecosystems. Fishes in particular play a variety of functional roles in coral reef ecosystems, and are

directly involved in numerous reef processes (i.e. interacting with the movement of energy or material) (Bellwood and Wainwright, 2002). These processes are recognized by scientists and by local people alike. One objective of this research was to investigate local understandings of the relationships between species in the near-shore environment, and develop a food web based on Bequian knowledge.

A group exercise was conducted during one of the fishers' meetings, during which many trophic interactions were explored at once and drawn in a diagram. These results were reorganized into the food web represented in Figure 7. In addition, I was offered an unsolicited food web created independently by one of the fishers after the meeting (Figure 8). While these models are not definitive conceptualizations of a very complex ecosystem, they do provide insight into local perceptions of the interaction between species and a reflection of local understandings of coral reef ecosystem complexity.

The results are consistent to some degree with scientific accounts. Surgeonfish (Acanthuridae) are identified as herbivores (Harmelin-Vivien, 2002). Parrotfishes are also classified herbivores, but ingest calcium carbonate from coral along with plant material (Harmelin-Vivien, 2002). Barracudas (Sphyraenidae), rock hind (*Epinephelus adscensionis*), butterfly (*Cephalopholis fulva*) certain white fish such as cavalli (Carangidae), and certain red fish such as snappers (Lutjanidae) are identified as predatory in the scientific literature (Arias-Gonzalez, 1998).

Figure 7: Food web of the Bequian coastal environment based on information obtained during a meeting with Bequian fishers.

Both food webs focus on fish taxa, and more specifically fish that are economically important or that are consumed locally. Small fish such as damselfish (Pomacentridae) and blennies (Blenniidae) that are attractive to tourist scuba divers are conspicuously absent. Although squid are mentioned these are squid-shaped baits only. Top apex predators such as nurse sharks (*Ginglymostoma cirratum*) are also absent.

Both food webs demonstrate local knowledge of plankton as a food source, which was surprising to me given that most plankton is miniscule or microscopic. These food webs do not distinguish between phytoplankton and zooplankton, They also do not distinguish between sand and the organic material in sand that fish may be feeding upon. The food web produced at the meeting displayed cannibalism within taxa.

The food webs include both reef associated species and the pelagic “white fish”, demonstrating connectivity between the reef ecosystem and the open water ecosystem.

Both food webs represent several functional groups. There are several basal taxa which do not feed on other taxa. This includes coral, sand, algae and plankton. In fact, soldier crab in Figure 7 could be considered a basal taxa as well, as participants did not indicate what it ate. Herbivores (or grazers), planktivores, piscivores and corallivores are also features of both food webs.

The food web data are based upon participants’ empirical observations during day to day activities. Some participants stated that they had observed fish feeding naturally, some made deductions based on fish stomach contents (for

example, knowing that a fish ate coral because of the presence of sand in their stomach), and in some cases their knowledge was derived from the bait that they had observed certain fish to take. During an interview, a participant mentioned that some parrotfish will eat dead fish in contrast to scientific accounts which indicate that they are grazers and corallivores. Subsequently he talked about the bait fishers used to catch these fish, so it was unclear if the carrion eating he was talking about was natural behaviour or reaction to bait. Regardless of whether or not he had ever witnessed a parrotfish eating carrion naturally, the fact that they will take fish bait might logically have led him to assume that these fish would do that on their own as well. Ultimately, it must be recognized that when interviewing fishers, any questions regarding what a species eats will potentially include the baits it will take – even to the extent of including artificial baits – unless the interviewer specifically asks them to limit their answer to natural behaviours they have observed.

Interviews also expanded on feeding interaction data. Urchins were identified as herbivores by some participants, and one considered them to be coprophages (i.e. faeces eaters). Boxfishes (Ostraciidae) were identified as being both planktivores and herbivores. Lobsters were identified as scavengers. Divemasters, who were not present at the meeting where the food web exercise was conducted, provided more information relating to non-fish species. They indicated that octopi were mollusc eaters, and that bristle worms (Amphinomidae) would eat coral.

4.5 Maps and Other Spatial Data

Spatial data were collected during interviews and during a fishers' meeting. Three maps resulted from these mapping sessions, and combined with the associated discussions documented the spatial patterns of resource use, habitat and environmental threats. The information collected based on fishers' and divemasters' local knowledge is very distinct from two primary sources of existing cartographic information, Vincentian government maps and the international ReefBase database. (ReefBase is the official database of the Global Coral Reef Monitoring Network and the International Coral Reef Action Network).

The mapping exercises provided an effective vehicle to document local people's spatial knowledge. Two local maps of the island of Bequia were produced by divers, and one map of the Grenadines was produced by fishers during the second fishers' meeting.

A map compiling information from the two divemaster sketch maps is presented in Figure 9. Areas that divemasters consider important for their livelihood are indicated along the coast of the south western arm of Bequia, the entire western coast north of Admiralty Bay, and around Pigeon Island. These areas encompass fringing reefs, reef that form a fringe along the coast, and in many places cover steep underwater cliffs. Divemasters also mapped the location of snorkelling sites, of live elkhorn coral, of large charismatic species such as sharks and tarpons, hurricane damage, and the location of the Harbour Reef in Admiralty Bay, a reef that effectively no longer exists.

Figure 9: Map produced by divemasters, showing areas used by divemasters for scuba tours, hurricane damage, snorkelling sites, and places where elkhorn coral (*Acropora palmata*) is recolonizing. Basemap from UNEP-WCMC (2008).

Figure 10 Coastal resources inventory map of Bequia, SVG, showing reef, reef and sand mosaic and deep reef in red and pink. Modified from Fisheries Division (2003a)

Figure 11: Map of Bequia showing reefs, in orange. Reproduced from UNEP-WCMC (2008).

Figure 12: Results of group mapping exercise from the fishers' meeting, showing hurricane damage, algal blooms and areas that are important for fish. Basemap from UNEP-WCMC (2008).

When the divemasters' map of Bequia is compared to other maps of coral reefs around Bequia, significant differences are evident. What is most striking is that the areas that the divemasters indicate as important to the diving tourism industry, namely the fringing reefs on the north west coast of the island and the southern coast of Admiralty Bay, do not correspond to areas of significant coral distribution on either the Fisheries or the ReefBase maps. The Fisheries Division map (Figure 10), which is most readily available to policy-makers, depicts prominent reef areas on the south east coast of the island, in Industry and Spring Bay, and in Admiralty Bay. However, dives and snorkelling expeditions revealed that the large patch of coral in Industry Bay corresponds with an elkhorn coral (*Acropora palmata*) reef that is almost all dead. The reef in Admiralty Bay corresponds with Harbour Reef, the dead reef identified by participants in Figure 9. The reefs indicated on the Fisheries Division map are of are of limited value to the scuba diving industry, and probably have less value from a biodiversity or ecosystem perspective as well. Similarly, the map of coral from ReefBase (Figure 11) shows prominent reefs on the east side of the island only, which again correspond in many cases to areas with dead coral, and which are not areas upon which divemasters depend for their livelihood.

Because the reefs represented in the Fisheries Division and ReefBase maps (Figures 10 and 11) are patch reefs, they are more easily visible from an aerial view. It would appear that the map of coastal resources produced by the Fisheries Division relied on aerial or satellite imagery. As the areas indicated in

the divemasters' map are fringing reefs, they are less visible in an aerial photograph. Thus, one use for locally produced maps is that they may indicate more detail and more accurate information about areas that are economically important to the Bequian tourist industry and about the condition of the reef. The local mapping exercise indicates that official maps do not adequately take reef health into account.

The fishers' map generated from the meeting had a broader, Grenadine-wide focus (Figure 12). This map depicts three features that were of interest to participants: hurricane damage, areas where significant algal blooms are found, areas of important fish habitat. Interestingly, three out of the four areas of important fish habitat identified by fishers fall within the boundaries of Vincentian marine conservation areas indicated in Figure 1. (The fifth, southernmost area of important fish habitat they identified is in Grenadan waters.) Fishers indicated two locations characterized by significant algal blooms; the south side of Baliceaux island, and the south side of Savan Island. The fishers also indicated three areas that are important to fish: in the Tobago Cays, where there is some protection as a result of the establishment of the Tobago Cays Marine Park; Britania Bay off the island of Mustique; and at Ronde Island. Significant hurricane damage was indicated on almost all of the islands and cays in the Grenadine chain in the fishers' map. Although hurricane damage was always described as dramatic (some said it looked like a bulldozer had been along the sea floor), both divemaster and fisher maps indicate that recent, severe hurricane damage is only evident in discrete places. Finally, although all fishers recognized the place

names on the map of the Grenadines, they also provided two local place names. Ronde Island is known locally as Iley Ronde, and Caille Island is known as Iley Caille.

In addition to the mapping exercises, some spatial information was also obtained from interviews and focus groups. Hurricane damage was reported at Ile a Quatre and West Cay. Sea urchins are most common in Admiralty Bay, and the bay is also a breeding ground for octopi. Further afield, sea turtles are abundant further south in the Grenadines, in the Tobago Cays and at Union Island.

4.6 Local Descriptions of Environmental Change

Coral reef ecosystems are declining worldwide (Nurse and Sem, 2001; Ben-Tzvi et al. 2004; Hardman et al., 2004; Gardner et al., 2005; Donner et al., 2007). One of the objectives of this research is to determine the nature of environmental change to coral reefs near Bequia by documenting change as understood from the local point of view. The most important changes that I document are decreases in species abundance, coral reef degradation and the fish kill that affected the Eastern Caribbean in 1999.

While there were variations in the types and causes of change occurring in the region that were discussed by participants, all of the people who participated in this research recognized significant long term change in the marine environment. There was consensus that overall, reef health and the abundance

of important species is declining.

Participants described local scale environmental changes as well as local causes for those changes. For example, it was rare for participants to attribute declines of commercial fish species on foreign fishing vessels or climatic changes. By far, the most common cause of coral reef damage and species declines are tropical storms and hurricanes.

4.6.1 Changes to Bequian Corals and Coral Reefs

Divemasters reported that coral health around Bequia is decreasing. They report that their dive sites are starting to become affected to the degree that they are no longer as attractive to clients. One divemaster reported that the coral heads themselves were not as big as before. Divemasters also reported dramatic declines in *Acropora* coral species, especially elkhorn coral (*Acropora palmata*) in Industry Bay where stands of dead skeletons are widespread. This is an important species that has mostly died off around Bequia, and that is experiencing a Caribbean-wide decline (Zubillaga et al., 2008). Some divemasters, however, report that elkhorn coral may be starting to recover, as they have observed new colonies and indicated them on the sketch map.

Most participants identified different types of mechanical damage as the causes of damage to coral reefs (and, in many cases, the benthic marine environment generally). Most examples of environmental change listed by participants are quite localized in nature, but could have major cumulate effects.

The most significant cause of damage is wave action from storms affecting local reefs. Examples of human-induced damage include scuba divers and snorkelers causing mechanical damage by bumping against the reef as they dive, fishing boats scraping over coral and breaking it off, dredging, damage caused by yacht anchors, incautious use of spear guns and fishing nets, and dumping of trash on the reef (e.g. sail canvas, pots, bottles, cans, and even chemical glow sticks).

Participants familiar with Admiralty Bay on the west side of Bequia said that there used to be a series of coral reefs across the bay which they collectively called Harbour Reef. One participant indicated that he believed that this reef was made of the coral locally known as ginger coral (*Acropora cervicornis*) based on the dead coral fragments that wash up on the beaches of Admiralty Bay. Results of the mapping exercise with divemasters indicate that its former location was approximately 250 m to 500 m offshore from Lower Bay, and approximately 750 m in length (Figure 9). According to these informants, these reefs were destroyed over the years as a result of economic activities and infrastructure development including dredging in the harbour, siltation from ferry traffic and anchor damage from yachts. One participant deduced from the abundance of dead pieces of coral on the sea floor and washing up on the shore that the coral there must have been quite plentiful in the past. Today, the area is almost devoid of live coral.

Hurricanes were the main cause of environmental change mentioned by participants, and the most dramatic. As one participant put it, hurricanes will cause more damage than people ever could. During one severe storm, coral was torn from the sea bottom and piled onto the beach on Petit Nevis, one of the

uninhabited islands near Bequia, and in another case the sea bottom off West Cay was left flattened and lifeless as deep as 80 feet down. One participant expressed concern about the cumulative impact of successive hurricanes hindering the coral's ability to recover if they were hit too often over a short period.

Another significant environmental change observed by the participants is an increase in the abundance of algae, to the extent that it is smothering corals around Bequia and consequently affecting coral reef health. One divemaster reported that algae began to increase in the 1990s. There was no clear consensus on the cause of this increase. Waste water discharge from yachts was mentioned by several participants as causes of declines in reef health. Another attributed increases in algae in Admiralty Bay to the discharge from sewage hoses from beach-side hotels and restaurants that run down the beach directly into the sea. One participant indicated that increases in algae are the result of the decline in abundance of "cleaners" - in other words, grazer species that feed on algae and control its spread. A few participants also mentioned changes in current as being a factor.

4.6.2 Changes in Species Abundance

Overall, there are indications that Bequia has experienced decreases in abundance not only of species inhabiting coral reefs but further from shore as well. Participants named three indicators of species abundance decrease. The

first is a decrease in overall abundance in shallower waters. Secondly, many participants noted a decrease in size of specimens of certain species. Finally, many people also indicated that there has been a decrease in the size of fish schools. I will describe species declines in general, and then examine the decline of spiny lobster and black spiny sea urchins in greater detail.

Upset with the overall trend of degradation and declining ecosystem health, one participant indicated that everything is dying off: “. . . so everything is on the decline. . . Everything is on the down. Going down. Slowly but surely. . . it’s going down.” Another participant talked about the change in abundance of “bait fish” that school in the harbour. He explained that when he was in his late teens (about 20 years ago) there were more of the larger species of bait fish known as spratt: “. . . when I was a child, man, we used to take the coconut branches and – and sweep them on the shore!” This same participant also recalled that piscivorous pelagic fish species that would follow the spratt into the harbour were more numerous than in the past.

While it is now impossible to quantify the change in abundance, and some participants may tend to exaggerate resource abundance in the past, local people were consistent in their assessment of decreased abundance of marine species. Among all participants, only one did not feel that any declines had occurred. However, local perspectives relating to the significance of these declines were notably different between divemasters and fishers. Many fishers believe that decreased abundance is simply the result of the natural variability that they have witnessed many times in the past. The viewpoint that no long-term

species declines were occurring was expressed more often during fishers meetings, which drew a wider number of participants than the interviews, but this opinion was shared by about half the fishers participating in interviews. Fishers generally tended to downplay the magnitude of declines in species abundance. Some fishers emphasized short term fluctuations in the abundance of economically important species. They stressed that fish “bite with the moon,” meaning that they have higher expectations of catching fish during the full moon, and also used this term to express how they experience daily, monthly, and yearly variability they experience in catches of all species. This is not surprising, given the open nature of the pelagic marine ecosystem and mobility of fish. (It is of course important to remember that the reporting of declines in economically important species is potentially controversial. If reported, conservation actions could be taken that interfere with fishers’ livelihoods.)

All of the divemasters, along with less than half the fishers participating in interviews, believed that the declines in abundance of many species was part of a pattern of long term decline, and that action would need to be taken to reverse the trend.

The most commonly reported species abundance declines were for corals, turtles, “bait” fish, pelagic fish, reef fish (groupers (*Epinephelus* spp.) in particular), spiny lobster (*Panulirus argus*), queen conch (*Strombus gigas*) and the black spiny sea urchin (*Diadema antillarum*). Declines in turtle abundance were reported by two participants, and one characterized the decline in hawksbill turtles as sudden. There is no time frame associated with any of these changes

in abundance. Although there is some decline reported in corals generally, according to local informants, two species of *Acropora* corals have declined to the point of rarity.

Divemasters and some fishers expressed concern with the impact of the current fishing effort, and attribute decreased abundance of fish, lobster and conch to overexploitation at the local level affecting groupers (*Ephinephelus* spp.), red snappers (*Lutjanus campechanus*), barracudas (*Sphyraena barracuda*), and fish species overall. Divemasters also expressed concern that some of the species that are attractive to tourists are being impacted. Some of these are threatened by fishing for local consumption, such as angelfish (Pomacanthidae), nurse sharks (Rhincodontidae) and stingrays (*Dasyatis* pp.). They say angelfish are observed less often, and rarely in pairs as before. Divemasters say sessile organisms are pulled up by fishing nets causing damage to their dive sites. One of the divemasters indicated that fish pots were particularly damaging, as these traps are indiscriminate and may take inedible fish such as butterflyfish (*Chaetodon* spp.) that are valuable to the scuba diving industry. One fisher attributed fish declines to the use of spear guns and fishing with nets. Another ascribed a decline in rock hind (*Epinephelus adscensionis*) to be the result of the fish kill of 1999, described in greater detail below.

Surprisingly, declines in abundance were not attributed to foreign fishing but rather to local activities such as fishing with seine nets or the indiscriminate use of fish traps that result in unwanted bycatch.

A few participants reported decreases in size of fish schools. For instance,

barracuda school size has decreased. Parrotfish schools were described by one participant as having decreased from about 50-100 individuals per school to the current situation where by they are only sighted alone or in pairs. The divemasters commented that they are concerned that school sizes might decrease to the point that minimum viable spawning aggregations for some species no longer occur.

There are also indications that the distribution of certain species is shifting to deeper depths or farther from near-shore areas. They used to be abundant near Isle a Quatre, especially young ones, but now they are hardly ever seen there. Local people now find queen conchs in deeper water and farther from shore than in “long time days”, and divers have to go deeper and deeper to find them. Today, harvesting conch is much less profitable, as one often does not catch enough to pay for the fuel needed to reach the fishing ground. There are also increased risks to divers using scuba gear. One speculation for the decline locally is that the construction of the airport on Bequia in 1999 may have disrupted their habitat in the sandy bottom between Isle a Quatre and the south side of Bequia (see Figure 9). Another participant attributed the decrease in abundance to damage to habitat resulting from hurricanes.

Another key indicator of species decline is a reduction in the abundance of large specimens of a given species, which is a common result of exploitation (Jennings and Dulvy, 2005). Several participants said that there has been a significant reduction or disappearance of larger individual groupers. Similarly, one fisher stated that large parrotfish of up to 30 kg used to be common but now are

no longer seen. Others reported that the snappers that are caught now are generally smaller than in the past.

There were also a few reports of environmental recovery. Some participants reported that rock hind abundance has started to recover since the fish kill. Another person reported that the sand from the hurricane that clogged the lobster holes and reducing its habitat has started to clear. Four out of seven divemasters indicated that elkhorn coral has begun to recover in some areas.

4.6.3 Local Descriptions of Change in Species Abundance: the Case of the Spiny Lobster (*Palinurus argus*).

Spiny lobster (*Palinurus argus*) is one of the most economically important species in the Vincentian fisheries. Lobster used to be fished in Bequia by free diving or scuba diving in waters as shallow as 8 feet, but are now harvested at depths of 60 feet or more, leading to increased instances of decompression sickness among fishers. In response, fishers began using lobster pots (Figure 13) which became common in approximately 2001. Pots are checked several times a week.

The lobster fishing season in SVG is from September 1st to March 31st. Fishers described a record lobster catch for the 2004-2005 season, but the 2005-2006 season that overlapped with my field research season was quite disappointing. Fishers said that the catch was so low it was generally not worth the fuel to keep going out and checking the traps, especially given that fuel costs had risen. Many simply ceased lobster fishing before the season ended, which

was reflected in the stacks of idle lobster traps at the Paget Farm fisheries station in March.

One participant indicated that 12-15 pound lobster used to be taken, but indicated that lobsters of this size are no longer found. Several participants indicated that there were fewer lobsters, and that they are now found in deeper waters than before. Divemasters said that they typically used to see perhaps 20 lobsters during a dive, sometimes 20 in one spot. Now, they rarely see any, and they attribute this decline to overfishing. They also expressed concern that the younger lobster are being harvested at unsustainable levels, and one divemaster said that spawning females with eggs were not being thrown back as required by national regulations. If this is indeed occurring, it could have a dramatic impact on reproductive rates within a relatively short period of time.

Although many fishers acknowledge a decrease in lobster catches, some were reluctant to call this current situation a “decline” or that they are becoming “scarce”. However, they did provide an explanation for the trend for the past two years; lobsters hide in holes and spaces in the reef or among the rocks. After hurricane Ivan in 2004, however, many of these niches were filled in by sand shifted by the surge. As lobsters searched for new habitat, many fishers believed that lobster traps were mistaken for habitat. This accounted for the high catch taken in the 2004-2005 season. However, the low 2005-2006 catch was explained as either the result of too many lobsters taken the year before, or the fact that the remaining lobsters have moved away in search of new niches.

One fisher was adamant that in 2005-2006 he caught as many lobsters as

Figure 13: Lobster pots stacked onshore in March 2006. Paget Farm Fisheries Station, Bequia.

he always caught. He reminded me that “lobster walk with the moon”, and said that the catch may range anywhere from 50 to 300 individuals per outing due to natural variability. As an example, he pointed out that fish and lobster will leave a particular area if the habitat has changed. Ultimately, the question as to whether a perceived reduction in abundance is in fact a migration as opposed to a species decline ought not to be dismissed.

Participants had several suggestions for the recovery of lobsters. One fisher suggested that in order for lobsters to recover, a five year moratorium should be imposed. He said that this would also promote a greater respect for the resource among fishermen. Secondly, one fisher stated that lost or untended lobster traps could have a significant effect on lobster populations, because as lobsters die in an untended trap, more come in to feed on the carrion. As a solution to this problem, he suggested that pots be equipped with a closure that would decay with time, allowing lobsters to escape if the trap is lost and they will not be harvested.

4.6.4 Local Descriptions of Species Habits and Changes in Abundance: the Case of *Diadema antillarum*

I chose the abundance of the black spiny sea urchin *Diadema antillarum* as a topic to investigate because it suffered from a mass mortality event in the early 1980s throughout much if not all of the Caribbean, and because it is a grazer that appears to have an important role in keeping coral reefs clear of

algae (Lessios, 1988; Miller et al., 2003). In most of the Caribbean, recovery was slow at first, but by 2001 the species began to show indications of large scale recovery (Miller et al., 2003). This reduced algal abundance, and was expected to lead to a shift from algal dominance on coral reefs to coral dominance (Miller et al, 2003).

It was difficult to get much perspective on the die-off of black spiny sea urchins of the early 1980s from local people in Bequia, as most of those that participated in this research were not yet economically active during this time. Only one fisher recalled the dramatic die-off.

There was no clear consensus among participants regarding the current abundance of the black spiny sea urchin compared to previous years. Few fishers had much information to offer about this species, potentially because it is not important commercially or locally for food. The divemasters were able to give more information. Most of the divemasters identified that it was a grazer that clears algae from the reef as they feed. When urchins decline, they report that algae abundance increases, and species that do not normally eat algae start to feed on it, such as parrotfish and even lobster.

A few participants noted that urchins have been in the process of dying off again in the Caribbean during the past five years. Divemasters in the focus group specified that this more recent decline in the Caribbean is affecting not only the black spiny sea urchin but also the West Indian sea egg (*Tripneustes ventricosus*), which was still common in Bequia in 2006. The focus group explained that the West Indian sea egg died off first, then the black spiny sea

urchin declined, Subsequently, the black spiny sea urchin began to recover, and finally now the West Indian sea egg is recovering. They indicate that this was a Caribbean-wide phenomenon, which is consistent with available scientific information for Barbados (Parker and Pena, 2006).

4.6.5 Local Descriptions of the Fish Kill and its Causes

Fish kills are mass mortalities of fish, and these events have been known to occur in the Caribbean. The fish kill of 1999 affected only reef associated fish, the bodies of which washed up on the shore in large numbers throughout SVG and elsewhere in the southern Caribbean in 1999 (Willoughby et al., 2002; Fisheries Division, 2003b). This mass mortality was attributed to the arrival of the freshwater bacteria *Streptococcus iniae* in the depositional plume of the Orinoco River (Willoughby et al., 2002; Fisheries Division, 2003b). Other environmental factors included elevated sea water temperature, high phytoplankton concentration and reduced oxygen which contributed to the fish' susceptibility to the bacterium (Willoughby et al., 2002).

In St. Vincent and the Grenadines, significant mortalities were first observed by fishers in late August of 1999, and the fish kill was officially recorded by the Fisheries Department on September 2nd, 2002 (Fisheries Division, 2003b). Overall, thousands of pounds of fish washed up on shore (Fisheries Division, 2003b). During the event, fish landings dropped by 55%, the sale of fish at the Kingstown, St. Vincent market decreased by 75% (Fisheries Division 2003b). 25% of hotels and restaurants stopped buying fish, and 38% of

fishermen were severely affected (Fisheries Division 2003b).

Local accounts of the event describe how hundreds of fish washed up on Bequia's coastline, and that the timing coincided with the "black water", in other words the discolouration of the sea water caused by the Orinoco plume. One participant stated that the event lasted about one month. However, the divemasters described two separate episodes. The fish affected acted disoriented and had white gills and eyes, and a balloon sticking out of their mouth (probably the swim bladder). One participant described the fish' disoriented behaviour: ". . . the fish will – float. They don't know where they are going. . . they crazy. They don't know what to do. They don't know where to go."

Divemasters and fishers agreed that only bottom fish or reef fish (i.e., fish species that feed on the bottom) and the piscivores that feed on them were affected. Examples provided by participants included red snappers (*Lutjanus campechanus*), "chub" (*Scarus* spp. and *Sparisoma* spp.), "grunts" (family Sparidae), "hind" (*Ephinephelus inermis*), "butterfish" (*Ephinephelus fulva*), "rock fish" (*Mycteroperca bonaci*) and other groupers (*Ephinephelus* spp.), all of which are bottom dwellers. Most participants stated that floating fish, white fish, or "the fish that travel above" (i.e. pelagic species) such as mackerel (*Scomberomorus* spp), tunas (*Thunnus* spp.) and kingfish (*Acanthocybium solandri*) were not affected. This is consistent with the scientific literature (Willoughby et al., 2002). The information provided by local participants differed from the scientific account in one respect. The four divemasters in the focus group reported that certain

squid species were affected, as the cuttle bones were washing up on the shore. This taxon was not reported in Willoughby et al.'s (2002) description of the event.

There was no clear consensus on the cause of the fish kill. Some participants believed that a toxic substance had settled on coral or substrate and was eaten. Some descriptions were more specific, indicating that the causative agent was the deposition of mud, cyanide or mercury on the coral, which was brought to Bequia by the "black water". Some participants said that the cause may have been a toxic material dumped at sea.

A few participants said the effects of the fish kill were similar to incidences of poisoned fish in the north of the Caribbean. They said that a condition exists further north in which the reef fish themselves are not affected, but piscivorous species that eat them are. One participant claimed that the cause for this poisoning in the northern Caribbean was the presence of toxins from "copper bottom" boats. Although this sounds similar to environmental concerns reported by the scientific community regarding the toxicity of anti-fouling marine paints containing copper (Johnson and Gonzales, 2005), the poison affecting fish in the northern Caribbean may in fact be ciguatera. Ciguatera poisoning is the result of a toxic dinoflagellate (i.e. unicellular algae) that makes it way into the food chain by being consumed by reef grazers and accumulates in piscivorous fish (Canadian Food Inspection Agency, 2001). Regardless of its accuracy, the copper explanation for the fish kill is particularly of interest because two of the fishers that suggested this possible cause also clearly demonstrated an understanding of the process of bioaccumulation. The following passage

demonstrates this understanding:

. . . these fish get poisoned because when you have boats, copper boats and thing? . . . When the ship sink, and the algae that grows, on top. If you have . . . algae that grow on the hull. . . plants will suck it, when it's growing . . . and the small fish eat the algae, and the barracuda kind it likes, eat the small ones . . . that's how they contract the poison.

Only the divemaster focus group participants were aware of the scientific explanation that the fish kill was caused by the freshwater bacterium *Streptococcus iniae*. However, they were not convinced that this explanation was accurate, as they were skeptical about the scientific rigour of the scientific studies. They seemed to be more in favour of the dumping explanation, and one divemaster in the focus group claimed that many people think that the fish were suffering from central nervous system disorders. While the divemasters acknowledged that the timing coincided with the Orinoco plume, they questioned the causative agent, believing that there is a pollution-related cause as opposed to a natural bacterial cause.

Participants also noted that some species have not recovered from this event: "Certain species of fish, get scarce, since that fish kill, like rock hind . . . We used to catch that long time. Plentiful. . . No longer around here. Now you scarcely can see one. If you see one, very small."

Local descriptions of the Caribbean fish kill event of 1999 generally corroborate scientific studies, while local perspectives of the causes of this event may conflict with the scientific account. However, the conflicting perspectives

relating to the cause of the fish kill reveal that community members understand ecological processes and can propose reasonable alternative hypotheses.

4.7 Seasonality

One of the objectives of this research was to investigate seasonal events such as migrations and spawning aggregations.

There is apparently little seasonality with respect to fisheries species in SVG (Canadian International Development Agency, 1992b). This was supported by one fisher, who said that the fish he catches do not really have a season; however, he distinguished between seasonal migrations and irregular movements. He said that fish move away for a time, and speculated that this may be because something in their habitat “spoils” for them. However, one participant mentioned that fish are more common when the migrating seabirds return to Bequia. “Bird season” is January through April. Finally, he said that tuna came at a certain time of year, but did not say when.

Spawning aggregations were not really of concern to fishers because these events happen in deeper water, and so fishers do not “study them that much in the ocean”. Silvano et al. (2006) confirm that spawning events are difficult to observe. However, divemasters said that brown chromis (*Chromis multilineata*) form spawning aggregations at certain times, but this did not appear to be connected to time of year. They were not able to explain what circumstances trigger them.

Divemasters indicated that coral blooms are seasonal, occurring during the warm summer months. Finally, one of the divemasters noticed that the octopi had been quite active in the harbour in the spring, and were frequently out of their dens. By the time of the focus group (April 2006), however, they were “back in their holes”.

CHAPTER 5

DISCUSSION

D: Well, I () the importance of the coral reef. I mean, it's the source of our life, you know? And without that, we're not going to have anything else. Pretty much everything feeds off of coral. In one way or the other. The other fishes eat the little fishes that feed off the coral, without that, the coral, there's nothing. It's fragile. Delicate. It takes something like twenty years for some species to grow an inch. It takes a lifetime for them to get where they are. We've got to do everything in our power to, to maintain it.

L: And without it my daughter can't eat.

- Focus group excerpt, 2006.

Vincentian coral reefs provide a multitude of services, including protection of coastal areas from wave action, habitat for marine species fished both for the commercial fishery and for subsistence, and as a pillar of SVG's tourism industry (Ruppert and Barnes, 1994; Hodgson 1999; Metzger, 2003). Although its reefs are relatively healthy, Vincentian marine ecosystems are showing signs of stress and need to be managed with care. Coastal areas are particularly important to sustaining development in small island states, and integrated management approaches such as co-management are required to facilitate sustainability (McConney et al., 2003).

The anticipated development on Bequia can further impact its coastal marine ecosystems through sedimentary run-off into the sea during construction, and increased sewage dumped into the sea once construction is complete. In the face of these developments and other ongoing human impacts on the

environment, effective conservation and management appear more important than ever. Top-down management of SVG's fishery could be prohibitively expensive, while participatory approaches such as co-management could result in improved status of marine resources (Hickey, 2007; McConney et al., 2007; Armitage et al., 2007). Incorporation of LEK into these plans leads to resource management approaches that are better adapted to ecosystem dynamics and that enhance policy implementation (Robertson and McGee, 2003). The collection and incorporation of LEK into these approaches is an integral part of their success. LEK also helps fill in the many gaps in the scientific knowledge of Bequia's environment.

This chapter discusses the nature of local ecological knowledge of coral reef ecosystems among fishers and divemasters of Bequia, and highlights the potential role of LEK in conservation and in the co-management of marine resources.

5.1 The Nature of Bequian LEK

Metzger (2003) stated that Vincentians do not have much of an "environmental outlook". However, during the interviews and focus groups for this research, many participants revealed their concerns about threats to the marine environment, identified causes of environmental damage which were often rooted in local-scale activities, and some proposed solutions to the problems.

Bequians whose livelihoods depend on marine resources have a

sophisticated understanding of coral reef ecosystems and the species within them, particularly those species that are of interest to them. Several participants provided comprehensive definitions of coral reef comprising of many elements, including topography, habitat, ecology, and physical requirements such as depth and substrate. Local perspective on species, ecosystems and environmental change were often consistent with scientific perspectives. Where they differ, they provide fine-scale detail or update scientific and official knowledge. Food webs generated by Bequian community members demonstrate knowledge of microscopic ecosystem elements such as plankton and many reef functional groups.

Bequian knowledge can be used to identify significant examples of environmental change. For example, although algal blooms are a widespread concern, the fishers map in Figure 12 indicates that along the Grenadine island chain, hurricane damage may be a far more prevalent form of damage to coral reefs than algal blooms in SVG. Since 1990, SVG has had six tropical storm or hurricane warnings issued, and damage was reported to the National Hurricane Center five times.

Bequian LEK is also suitable for the generation of hypotheses, determining the extent to which global and Caribbean-wide events affect Bequia and the rest of St. Vincent and the Grenadines, and groundtruthing results obtained by other methods. One striking example is the comparison of the maps created by the divemasters and the map of Bequia taken from the Fisheries Division report (2003a), which demonstrates the limitations of government-made

maps. Small-scale (yet significant) damage such as anchor damage, and coral health cannot be detected by remote sensing. Furthermore, maps that do represent factors such as coral health may become quickly out of date.

Bequians have a complex naming system based on economic factors, habitat and morphology. Where local names for species are lacking, Bequians still demonstrate understanding of these taxa, and distinguish them by describing the differences between them. This approach was employed in particular for discussions relating to corals and coral reefs. Despite the fact that Bequians do not have a universal definition of a coral reef, participants provided extensive descriptions of these ecosystems or provided example of a location in which a reef may be found (which points to the importance of surveying the local environment before undertaking LEK research).

Two related knowledge systems were evident. One significant difference between the perspectives of divemasters and fishers is the extent to which overfishing is a concern. Fishers often downplayed species declines. Bequian fishers are used to a certain degree of variability in catch, and many do not view declines in catch as anything out of the ordinary. It has always been their experience that the fish return. They have witnessed individual coral colonies recover from bleaching, and have witnessed reefs rebound from hurricane damage, so they do not perceive anything particularly out of the ordinary. Although fish, lobster and conch are found at increasingly deeper depths, and coral bleaching is increasing, it is the view of many that this is part of a natural cycle. This is consistent with McConney et al.'s (2003) observation of a prevailing

attitude among Caribbean fisherfolk that there can be no resource problems since nature alone controls the dynamics of coastal and marine resources.

Divemasters, on the other hand, express more concern with the environmental changes that they see. There is no question that these perspectives are subjective; owing to the non-extractive nature of the divemasters' livelihood, they may be more inclined to express concern over declines. Many divers are younger – there are few “elder” divemasters, and so this group's perspective is more routed in events of the past two decades. Although they too have witnessed the recovery of coral colonies and reef ecosystems, they have also said that recovery is no longer a given.

It should also be noted that underplaying the significance of environmental change in Bequia is consistent with my observations that certain parts of Bequia's coastal marine environment in 2006 was in relatively good condition. Certain coral reef health indicators exceed the reported Caribbean average, and Bequia's reefs are still in prime condition for attracting tourists. When compared to my own experience with certain diving locations in Jamaica in the early 1990s, it is clear that the global devastation affecting coral reefs is not yet a major factor on Bequia. Finally, Bequian fishermen still make a good living selling their catch, which is destined for other Caribbean countries whose domestic fisheries can no longer support demand. Although this research indicates that Bequia is experiencing the first signs of significant environmental change, it is not surprising that some participants would be unconcerned.

Bequian ecological knowledge is hybrid in nature. It is based on local

empirical observations and local ways of conceptualizing the marine environment that passed down from generation to generation. It is also influenced and shaped by external sources of knowledge such as conversations with visitors to the island about conditions elsewhere, the internet and television. For example, a few participants made reference to the program “Deadliest Catch”, a series that was being aired at the time of research, profiling Alaskan king crab fishermen, and they drew parallels between the traps featured on the program and the lobster pots used in Bequia. Although all Bequians are exposed to visitors from around the world, divemasters have more of this exposure than fishers, as they take foreign clients out routinely. Divemasters have also been recruited in the past to participate in international initiatives such as Reef Check, or have been hired to take university class study groups diving, and as part of these dialogues have been exposed more to the theories of global effects on coral reefs, such as climate change. The knowledge of divemasters is more hybridized than that of fishers as a result of these interactions. Mapping exercises proved to be an effective way of integrating local knowledge with scientific knowledge. However, it is important to recognize that two factors influence collection of spatial data in this study. The first was the mobility of many marine species. Both fishers and divemasters emphasized the impossibility of predicting where mobile marine species could be on any given day. The second factor was the willingness of participants to share it with outsiders. Other researchers have found that fishers can be unwilling to share spatial information (Ames, 2007; Williams and Bax, 2007). Spatial data can be likened to a form of intellectual property upon which

their livelihood depends. It is not likely to be shared with outsiders unless trust has been established, and even then certain details will always be kept private. For example, fishers referred to a “bank of fish”, describing it as a specific location in which one could often find specific species. Yet no fisher ever revealed the geographic location of any bank. I concluded that fishers had a sophisticated awareness of the locations in which species could be found, but that they were unwilling to share it. Divemasters were more open about their concerns, worrying about the consequences of divulging the locations of their moorings, and that yachtspeople would use them for unsupervised diving, potentially causing damage to the divesite. Only when I indicated I was interested in overall areas they used would divemasters share with me the areas they considered important, and did not indicate the locations of their moorings.

Bequian LEK can provide considerable insight into past environmental conditions. However, the establishment of detailed chronologies and timelines was not possible. Ames (2007) also found that it was difficult to establish timelines and dates with fishers. In the Bequian case, it seemed Bequians are not as concerned with time, dates and chronologies as I was. Bequian “timelines” seem more relational than linear. Participants would say how a species used to be plentiful and refer to the time of their childhood or how things were during their parents’ time. For example, one person told me: “. . . when my father was growing up. I wouldn’t say my grandfather, that’s too far back”. On another occasion he talked about when his father was a boy, or when he himself was a boy, and then give his father’s age or his own to give me a point of reference.

Furthermore, the use of the Vincentian dialect of English may have been a factor. Vincentians rely heavily on the use of the present tense to describe past, present and future events. With respect to events such as hurricanes, fishers often referred to “the hurricane”, but did not specify which one, or the year. In many cases this seemed again to have been a result of the dialect spoken, with “the hurricane” meaning hurricane action in general, but in other cases the fisher was talking about a specific event that appeared to follow a specific hurricane. It is also possible that as years pass, these recurring events eventually blur in memory.

Finally, Bequian LEK is characterized by a local focus on the causes of environmental damage, such as yacht discharge and anchor damage. With the exception of hurricanes, which can have a dramatic local effect, larger scale causes such as climate change were never mentioned, despite the fact that I would have expected Bequians to be informed about this issue. This could be because Bequians are in a position to witness cause and effect on a local scale, and that this is the most significant to them.

When fishers express concern with overfishing, they point to their own actions in the near-shore environment, and not foreign fishing vessels. All of this highlights the local scale perspective of Bequian LEK, and possibly also to a willingness on the part of certain community members to recognize that their activities may contribute to environmental degradation around Bequia. This may further indicate a willingness of certain community members to become involved in participatory schemes such as co-management.

5.2 Collection and use of LEK

Some researchers have expressed frustration with the incorporation of LEK into management plans (Smith, 2003b). There are challenges associated with LEK research which make it difficult to integrate it into conservation or management plans. Some barriers to the accurate collection of LEK are the degree of understanding and the degree of trust between researchers and participants, as well as language, gender, as well as time constraints and other methodological issues.

This research offers some insight into how LEK can be integrated into conservation and management plans, as well as some insights into the choice of methods for studying local knowledge of coastal marine ecosystems.

5.2.1 Local Ecological Knowledge, Conservation and Management: the Challenge of Integration.

Local knowledge is an important component of participatory conservation and resource management projects. The use of local ecological knowledge (LEK) has been identified as a crucial factor in the success of participatory conservation and management schemes (Walters 1997; Mauro and Hardison, 2000; Robertson and McGee 2003; Nyhus et al., 2003; Campbell and Vainio-Mattila, 2003; Simeone 2004). Participatory and community-based schemes that include local ecological understandings have a higher likelihood of success, will have less resistance to them and will require less enforcement effort (Campbell and

Vainio-Mattilla, 2003; Lauer and Aswari, 2008). There are often multiple factors affecting a given environmental problem, and disregarding those identified by locals may lead to ineffective responses. The same can be said for the development of regulations that reflect local realities and needs.

Bequian LEK is especially valuable in identifying those aspects of the environment that are important to community members. For example, the wide array of divemasters' clients' tastes indicates that the integrity of the entire coastal ecosystem is important to the diving industry. To maintain Bequia's status as the site of some of the best diving in the Caribbean, conservation plans cannot focus only on certain key species; they would also have to incorporate maintaining healthy coral at all depths, and maintaining high abundances of schooling fish. The results would also suggest that it would be to the diving industry's advantage for conservation efforts to be extended across all diving areas, instead of focussing on the preservation of a few key sites.

Despite the useful insight that local knowledge can provide, some researchers express frustration with the integration of LEK with scientific knowledge. For example, in the Canadian context, federal legislation aimed at conserving species requires that traditional knowledge be considered as valuable as scientific knowledge, and treaties with First Nations require the incorporation of traditional knowledge into conservation plan or the co-management of resources. However, neither the documents themselves nor the governments that drafted them offer any direction as to how to scientists and resource managers can integrate traditional and scientific knowledges (Smith, 2003b).

Furthermore, agencies responsible for social services, welfare and poverty alleviation in the Eastern Caribbean seldom have a working relationship with coastal management authorities (McConney et al., 2003). Managers of coastal and marine resources usually have a natural science education that omits policy issues such as poverty, and the authors believe this knowledge gap needs to be addressed (McConney et al., 2003). It is therefore likely that integration of LEK with scientific knowledge may result in similar frustration.

Although there are no easy solutions to the problem of integration. The benefits of using local knowledge, however, indicate that these problems require consideration. Perhaps the most effective way to incorporate local knowledge into conservation and management is to have people directly involved in the development of environmental management decisions. This was the case with Phelan's (2007) study of tropical fish aggregations in Northern Australia. The successful integration of fishers' knowledge with catch data and biological information was contingent upon an initial consultation phase, during which community member's concerns were addressed, and the fact that the project biologist lived in the community, enhancing relationships with community members.

If these measures are not possible, then researchers should endeavour to collect the best quality data possible, and this can only be achieved with a careful consideration of methodology.

5.2.2 Choice of Methods for LEK Research

As has already been discussed, some researchers have concerns about a lack of attention to methodology in LEK research (Davis and Wagner, 2003). There is also a concern that LEK research may be undertaken without examining the impact the researchers themselves have on a community, and how this affects the ability for researchers to collect reliable LEK data (Walters, 1997). I also advance the concern that some natural science researchers may favour survey methods with easily quantifiable results, as these to a certain extent resemble the kind of quantifiable results they may be comfortable with rather than considering whether ethnographic methods might be more appropriate. LEK is difficult to quantify, and does not always conform to official or scientific frameworks. However, LEK is nonetheless valuable, and the negotiation of the relationship between researcher and researched should dictate the choice of methods.

Another factor is that knowledge and the articulation of that knowledge with an outsider are two different things. Participants were not always able to provide concise definitions or explanations for the species or phenomena they were describing. They were often able to find alternative ways to express their knowledge, such as by providing examples of the subject in question.

For this research, I chose methods that would afford the most opportunities to establish understanding between researcher and participants, to explore differing constructions of knowledge and to establish trust. I chose a

multifaceted approach which included interviews, focus groups, mapping exercises, and the collection of food web data during community meetings. A major consideration in the choice of methods included the socially constructed nature of environmental terms, and the establishment of common definitions. This was especially important for the concepts that are not straightforward, such as the definitions of coral and coral reef, and for the concepts of health and damaged reefs. These definitions provided important context for understanding the responses to subsequent questions. Ultimately, by being able to explore these definitions with each participant, combined with participant observations provided richness and, I would argue, a degree of understanding that cannot be captured using rapid survey methods.

Misunderstandings and contradictions can arise from a variety of sources. Triangulation of multiple methods is known to potentially yield contradictory results (Dwyer and Limb, 2001). I encountered significant differences in the LEK between the divemaster and fisher sectors and contradictions within them. During the course of the research, it at times became clear that there were misunderstandings of scale or scope during interviews, or what is really meant by words such as “decline” or “scarcity”.

Use of multiple methods is also useful should one method fail, or prove insufficient. For example, exploring trophic interactions of the coral reef ecosystem during one of the fishers’ meetings was much more effective than exploring these interactions through interviews and focus groups. The use of different methods over an extended period was also necessary to help

understand the differences in the types of knowledge of different people, and to discern where there are common interpretations and agreement between respondents.

5.2.3 Validity of Bequian LEK

In many cases, Bequian LEK corresponds with scientific accounts, if only loosely. Where it differs, participants sometimes offer interesting reasoning that is worthy of future exploration. Some LEK is consistent between participants, and where it differs tends to be a matter of perceived importance rather than contradictions in actual observed phenomena.

It is perhaps easy for scientists to dismiss the more fanciful sounding stories told by participants. However, dismissing these stories out of hand is short sighted; rather, they can be examined for the kinds of understanding they can reveal. For example, during the course of this research, one participant told a story about experiencing coral growing in his ears. This certainly seemed fantastical initially. However, as discussion with the participant progressed, he revealed a fairly comprehensive understanding of certain aspects of coral reproduction, namely that corals produce planktonic larvae that can settle on any surface and grow. Whether the story is true or not may be irrelevant. What is potentially more important is the participant's demonstration of his understanding of aspects of the coral reproductive cycle. I adopted a similar approach with another participant's explanation of fish poisoning from "copper bottom boats." as

this demonstrated that participant's understanding of bioaccumulation.

In this case as well as in many other situations, it became clear to me that local people have their own way of communicating their knowledge. This might involve using a metaphor or giving examples, rather than providing the dictionary definition that I was initially trying to obtain. This understanding of the nature of local knowledge can only be obtained by being open to the use of qualitative methods, which afford the possibility to clarify the seemingly impossible. This example also reveals that participants have an understanding of underwater ecosystem processes such as coral reproduction. This understanding facilitates communication between community members and resource managers, and can foster two-way learning and improved conservation and management outcomes.

As a small island state, SVG is at a disadvantage when it comes to using conventional scientific methods for the management of its coastal marine resources. Capacity constraints may lead SVG to adopt monitoring protocols that are not suited to its unusual coastal ecosystems. One example is the Reef Check protocol for gathering data on coral reefs. Reef Check posters are posted in Bequian dive shops, which may mean that this protocol has been used in SVG for coral reef monitoring. Hodgson (1999) claims that the Reef Check program could provide a method to detect broad scale changes on a global, regional and local scale; however, the fact remains that it is intended to be global in scope and results are intended to populate a global database. Reef Check only encourages data collection from 40 feet depth and 20 feet depth transects, and data collected

from deeper depths cannot be fed into the global database (Hodgson, 1999). However, many reefs in SVG have coral well below 60 feet depth, and in some cases near Bequia coral may be found at depths that exceed 30m. Thus, a strict adherence to the Reef Check survey protocol is not suitable for the assessment of Vincentian reefs, nor for the detection of local scale changes.

SVG needs to develop country-specific methods for assessment of coastal marine resources, and LEK should be an integral part of these methods.

5.3 Challenges for Co-management in Bequia and SVG

Although community-based and participatory approaches have a greater likelihood of success (Robertson and McGee, 2003; Aswari and Lauer, 2006; Armitage et al., 2007), there are challenges to overcome when implementing them. While not the focus of this research, these challenges are inextricable linked to environmental issues. There are also many conditions for the success of co-management initiatives (McConney et al., 2007; Pomeroy et al., 2003; Pomeroy, 2007). The failure of community-based management projects often originates from the ineffective implementation of co-management plans between local communities and government and non-government organizations at various levels (Aswari and Lauer, 2006; McConney et al., 2007). Furthermore:

“Government enabling policies and legislation are needed to support co-management initiatives. Government Staff needs to change their attitudes and behaviour in order to share power with community organizations. . . . There is an

imbalance in individual and community organization capacity and level of power which will need to be addressed.

- Pomeroy et al., 2003, 19.

Although it was beyond the scope of this study to examine the extent to which the social conditions for successful co-management are present in SVG, these factors are inextricably linked to resource use and some were addressed by participants during interviews and focus groups. It is worthwhile to share these perspectives. The challenges identified by participants include distrust of government by community members, tensions between St. Vincent and the Grenadine islands, poverty, education and enforcement.

“The status quo in the Caribbean is one of poverty” (Mitchell, 1982, 155). Relations of poverty and wealth are a major cause of ecological deterioration (Watts, 2000). While ecosystems scientists have documented how the activities of the poor cause environmental degradation, degrading practices are rooted in development processes (Escobar, 1996).

During the course of this research, poverty was raised as an issue; in fact, to ignore poverty in SVG as a factor in environmental degradation would be foolhardy. As one participant pointed out, taking an environmental stance in SVG can be seen as being “hard on poor people”, making it difficult for concerned locals to devise solutions when their neighbours object. He further pointed out that poverty will increase if environmental degradation is ignored. Another pointed out that development not only affects the environment, but human health as well. Participatory projects can initiate dialogue between community members, and identify areas of common concern for all.

Distrust between community members, particularly fishers, and government is prevalent and could interfere with co-management initiatives. This is consistent with the culture of distrust that exists between fishers and resource managers elsewhere (Scholz et al. 2004). This is no doubt bolstered by the history of failure of development schemes in SVG, such as those described by Price and Price (1998). Vincentian fishers do not feel that their concerns are heeded by the government. Another example of distrust is the suspicions held by some participants regarding the “official” cause of the 1999 fish kill, with one participant indicating that only a small number of fish were sent away for analysis, and he believed an overly hasty analysis of the data was conducted so that an answer would be available prior to the advent of the next tourist season. Finally, one participant stated that in order for positive environmental change to occur, people would have to “approach the government, not being afraid”.

Further, estrangement exists between St. Vincent and the various Grenadine islands. In one participant’s words, SVG is a “multi-island state. . . . And [there are] different people in every island. And so the people in St. Vincent, the majority does not know what’s going on in the Grenadines”. Most of the tourism infrastructure is located in the Grenadines, and therefore much of the country’s tourism revenues originate there. Yet the majority of the population is on St. Vincent, and political decisions that favour St. Vincent may be detrimental to the Grenadines. The construction of the new airport in St. Vincent is believed by many Bequians to be one such example.

Divemasters also pointed out that the Grenadine islands are a tourist resource that other countries capitalize on: “We are the base for the Martinique sailing community”. Given that the sailing through the Grenadine island chain is relatively easy, nearby countries such as Grenada, Martinique and Barbados use their proximity to the Vincentian Grenadines to market their tourism product, and revenues from boat rentals and tour operations go to the country of origin while SVG bears the environmental burdens posed by these tourists.

A few institutional changes were suggested by participants, which could be components of community-based plans. One indicated that the educational curriculum does not include the marine environment, and that schoolchildren are taught nothing of the marine resources which are so central to the country's economy. Others pointed out that although SVG does have appropriate environmental and fisheries regulation, there is currently very little enforcement capacity. They recommended an increase in enforcement activities, as there is little will or capacity for enforcement. One participant said that enforcement of the Vincentian Fisheries Act was “completely impractical”.

5.4 Concluding Remarks

Bequia has some of the best scuba diving reefs in the Caribbean, and fishers are still able to make a good livelihood. However, it has been exposed to some significant Caribbean-wide events, such as the die-off of the black spiny sea urchin in the 1980s and the fish kill of 1999, and development is increasing.

All of this contributes to the degradation of coral reef ecosystems. Bequia's underwater ecosystems have undergone significant changes in recent decades. The loss of Harbour Reef in Admiralty Bay is one example. The combination of yacht anchors and dredging out the bay to accommodate the ferry have effectively reduced the reef to rubble.

Participants in this research demonstrated an understanding of species and ecosystem processes that can contribute to the development of locally relevant conservation efforts. This indicates that a common understanding between locals and researchers, natural resource managers and decision-makers can be achieved in order to further aims of sustainability and conservation of coastal marine resources.

Bequian LEK, when properly investigated, can inform participatory and co-management schemes. Participants in this research proved to have extensive understanding of species that were important to their livelihoods or that were of personal interest to them, as well as an understanding of coral reef ecosystem dynamics. Their knowledge can provide national and local scale detail to documented ecologies of the Caribbean, which can in turn contribute to Vincentian-specific conservation and management

Although many participants that described negative environmental change around Bequia and are concerned for the future of coral reefs in SVG, some also expressed optimism that positive changes could be made. Most striking was the acknowledgement of the resilience of marine species; as one participant put it, "life in this harbour is determined to exist".

APPENDIX 1: INTERVIEWS AND FOCUS GROUPS

Date	Participant	Location
April 5, 2006	Fisher E.L. interview	Paget Farm Fisheries Station, Bequia
April 27, 2006	Divemaster focus group with four participants	Port Elizabeth, Bequia
April 29, 2006	Fisher R. Interview	Port Elizabeth, Bequia
May 9, 2006	Fisher S. interview	Paget Farm Fisheries Station, Bequia
May 19, 2006	Approximately 12 fishers.	Fishers' meeting, Paget Farm Fisheries Station, Bequia
May 29, 2006	Divemaster G. Interview	Clifton, Union Island
June 1, 2006	Divemaster D. Interview	Port Elizabeth, Bequia
	Divemaster focus group follow-up with R. & L.	Port Elizabeth, Bequia
	Fisher J. Interview	Paget Farm fisheries Station, Bequia
	Fisher E. interview	Paget Farm fisheries station, Bequia
June 3, 2006	Divemaster B. Interview	Paget Farm, Bequia
June 8, 2006	Approximately 15 fishers	Second fishers' meeting, Paget Farm Fisheries Station, Bequia
June 10, 2006	Fisher T. Interview	Paget Farm Fisheries Station, Bequia
June 12, 2006	Fisher B. Interview	Park, Bequia

APPENDIX 2: INTERVIEW AND FOCUS GROUP QUESTIONS

1.
 - a) What is coral?
 - b) What is a coral reef?
 - c) What does a healthy reef look like?
 - d) What does a damaged reef look like?
 - e) What kinds of things damage a reef?

2. What kinds of animals or fish eat:
 - a) algae?
 - b) Coral?
 - c) Other fish?
 - d) crustaceans?

3.
 - a) I have seen some coral that has turned white during my dives. Can you tell me how long this has been happening here?
 - b) Why is it happening?
 - c) How does it happen?
 - d) Why does it happen in some places and not others?

- 4) I have noticed a lot of dead Elkhorn coral (I back this up with a photo of elkhorn coral from the guidebook - one respondent so far has called this "pan coral". Elkhorn coral seems to be dying off all around the Caribbean).
 - a) When did it die?
 - b) Is there any sign of it regrowing?
 - c) Do you have any idea why this happened?

- 5)
 - a) I've seen the black spiny sea urchin around a lot. Has it always been this common?
 - b) (If it has declined) do you know why this might have happened?
 - c) what do they eat?
 - d) What happens in places where there are lots of them – how does the reef look? (getting at algae).

- 6) I usually see a couple of lobsters every time I go for a dive, but I hear that they are declining and the catch is low this year.
- a) How many did you used to see at a time when the lobsters were abundant?
 - b) why did they decline?
- 7)
- a) Have you noticed declines in other types of fish or animals? (i.e. West Indian Sea Egg, sharks, turtles, angelfish, others)
 - b) do you know why they declined?
- 8)
- a) I hear that there was a fish kill a few years ago. What kinds of fish died?
 - b) Have those kinds of fish increased in numbers again?
 - c) What do you think caused the fish kill
- 9) I have seen some areas underwater where the reef has been damaged by storm surge from the hurricanes.
- a) What species were affected?
 - b) What was it like there before?

For the Divers:

- a) What do divers (the clients) ask to see?
- b) How do accommodate these requests - does the dive location you choose change depending on what they are looking for?
- c) What kinds of fish do fishermen take from the reef?
- d) ... is this affecting the abundance of any species?

For commercial fishermen:

- a) What kind of fish do you take from the reef?
- b) What do you try to catch?

For subsistence fishermen:

- c) What are your favourite fish to catch?
- d) and why?
- e) Have you noticed any changes in the fish populations?
- f) How many pounds (?) of fish do you catch for your family on average?

10)

- a) Are some fish more common during certain times?
- b) Do you know why?
- c) Do the fish ever come together at certain times to mate (spawning aggregations?)

11) If I knew nothing about the coral reefs, and you could tell me one thing about them, what would you tell me?

12) Is there anything else that you would like to tell me?

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