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Marine Zoning in Saint Kitts and Nevis

A Path Towards Sustainable Management of Marine Resources

Report by:

Vera N. Agostini, Shawn W. Margles, Steven R. Schill, John E. Knowles, Ruth J. Blyther

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Shawn W. Margles

Participants in one of the project's workshops.

Steven R. Schill

The skilled staff from St. Kitts and Nevis Coast Guard played a key role in seabed mapping.

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EXECUTIVE SUMMARY

Human activities are placing increased and often conflicting demands on coastal and marine waters worldwide. As a result, important coastal areas are under intense pressure, threatening the biological diversity of marine habitats and the ecosystem services they provide, such as coastal protection, food security, tourism amenities and biodiversity protection. Marine zoning, one of the possible outcomes of a marine spatial planning process, has emerged recently as an approach to address these issues. The case for marine zoning is particularly strong in the Caribbean, but there are few examples to date of comprehensive marine zoning for tropical island nations.

This project initiated a marine spatial planning process and developed a draft marine zoning design for a small island nation in the Eastern Caribbean. St. Kitts and Nevis was chosen as the project site because it met a set of selection criteria, including that its government was aware of marine zoning as a useful management approach and was interested in applying it in their country.

The goal of this project was to lay the groundwork for future implementation of marine zoning in St. Kitts and Nevis by assisting in the development of a marine zoning design and providing a set of tools that could inform this and other management efforts. The project had two primary guiding principles: (1) rely on the best available science for making decisions and (2) engage stakeholders at all possible levels. The project team used the following process:

1. **Engage Stakeholders.** The project included more than a dozen formal and numerous informal meetings with diverse stakeholders and decision makers from government, community groups, the private business sector, and fishers' associations.
2. **Establish Clear Objectives.** Through a participatory process, stakeholders and decision makers defined a vision for marine zoning in their waters. This vision was used as a basis for all project activities.
3. **Build a Multi-objective Database.** The project team devoted significant resources to gathering, evaluating and generating spatial data on ecological characteristics and human uses of the marine environment. Three main approaches were used to fill data gaps: (a) expert mapping, (b) fisher surveys, and (c) habitat surveys.
4. **Develop Decision Support Products.** To help the people of St Kitts and Nevis to make planning decisions, finalize a zoning design, and implement a marine zoning plan, the project team produced a spatial database, georeferenced portable document format (PDF) files, a web-based map viewer, maps of fisheries uses and values, seabed habitat maps, compatibility maps, and outputs of multi-objective analysis.
5. **Generate Draft Zones.** As a culmination of the aforementioned activities, the project team created a marine zoning design that was reviewed by select government agency staff and stakeholder groups.

The draft marine zoning design and all of the project activities leading up to it have built a strong foundation for marine zoning in St. Kitts and Nevis. To build on this foundation, we recommend additional steps that the government and stakeholders of St. Kitts and Nevis can take to finalize and implement a marine zoning plan. Every effort should be made to continue this process of open debate between sectors that helped identify conflicts and means of co-existence between different users of the marine environment. By adopting marine zoning, the people of St. Kitts and Nevis can take action to ensure the sustainability of their ocean resources.

ACKNOWLEDGEMENTS

This work would not have been possible without the generous support of the United States Agency for International Development (USAID) and The Nature Conservancy's Global Marine Team.

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In St. Kitts: Ministry of Finance and Sustainable Development – Mr. Randolph Edmead, Mr. Graeme Brown, Mr. Eduardo Mattenet, and Mrs. Hughes; Ministry of International Trade, Industry, Commerce, Agriculture, Consumer Affairs, Constituency Empowerment and Marine Resources – Hon. Timothy Harris, PhD, Mrs. Anthony, and Mrs. Shez Dore-Tyson; Department of Fisheries – Mr. Joseph Simmons, Mr. Ralph Wilkins, and Ms. Hazel Richards; Ministry of Tourism and International Transport – Hon. Richard Oliver Skerritt; Department of Maritime Affairs – Mr. McClean Hobson; St. Kitts and Nevis Coast Guard – Captain Comerie, Captain Julius, Captain Lee, Engineer Lewis, and the crew of the Ardent; St. Christopher National Trust – Director Mrs. Jacquelyn Armony, Mrs. Kate Orchard; St. Kitts Tourism Authority – Mr. Randolph Hamilton. Our coordinator in St. Kitts, Mr. Patrick Williams. Special thanks to the fishers and fisheries cooperatives of St. Kitts including Mrs. Lorna Warner, Mr. William Spencer, Mr. Todville Peets, Mr. Theophelus Taylor, Mr. Melvin Gumbs, Mr. Dave Martin, Mr. Samuel Maynard, Mr. Jack Spencer, Mr. Marcus Spencer, and the numerous other fishers that participated in the fisheries mapping and verification effort; Mr. Kenneth Samuel of Dive St. Kitts; and John Break and Emma Grigg of Ross University.

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Steven R. Schill

1 INTRODUCTION

1.1 Clarifying Terms: Marine Spatial Planning and Marine Zoning

A wide range of activities are placing increased and often conflicting demands on coastal and marine waters worldwide. Future outlooks show that many of these activities are likely to accelerate in the next few decades (Millennium Ecosystem Assessment 2005). As a result, important coastal areas are under intense pressure, threatening the biological diversity of a wide variety of marine habitats and the ecosystem services that they provide (e.g., coastal protection, food security, tourism amenities, biodiversity protection).

Marine spatial planning has emerged recently as an approach to help better address activities taking place in the ocean and to integrate marine management strategies (Agardy 1999, Norse 2005, Russ and Zeller 2003, Sanchirico 2004). Also referred to as coastal and marine spatial planning (CMSP), marine spatial planning (MSP) is an umbrella term referring to an extensive planning process required for equitable and just management of a marine area to accommodate multiple activities and objectives (i.e., multi-objective planning). Marine spatial planning is much like land use planning except that it looks at how to more efficiently and sustainably manage marine resources instead of land resources.

A marine zoning plan is one of the possible outcomes of the MSP process (Ehler and Douvere 2009, Agardy 2010). A draft zoning design is an essential first step to developing a zoning plan. In a zoning design, the boundaries of zones are outlined in the marine space. When the design is translated into a zoning plan, acceptable uses or levels of use are defined for those marine spaces. A marine zoning plan is then implemented through a set of regulations that specify

allowable uses of the marine space in question. The suite of activities necessary to support the design and implementation of a zoning plan are described later in this report. Although marine zoning is often a central outcome of the MSP process, the two are not the same. Marine spatial planning is the framework that makes comprehensive marine zoning possible (Foley *et al.* 2010), and "zoning represents the doing to which MSP leads" (Agardy 2010). In a marine zoning plan, uses are allocated and management schemes are developed across space in an integrated fashion by including ecological, economic, and social considerations.

1.2 The Need for Marine Zoning

To date, marine protected areas and fisheries management tools have been the main approaches used to manage marine environments. The goals of these approaches are generally limited to particular species (e.g., fisheries regulations) or small areas that are considered to have particular environmental values (Agardy 2007, Agardy 2009, Agardy 2010). To accommodate multiple uses and manage cumulative effects in the marine environment, we must turn to tools that are wider in scope, such as marine zoning.

Scaling up from marine protected area (MPA) networks to marine zoning is considered by many an important milestone for achieving effective marine conservation (Agardy 2010). Marine zoning offers important benefits:

1. It will help achieve sustainable use of marine resources more effectively.
2. It is based on a recognition of the relative importance of ecological and use characteristics as well as environmental and economic vulnerabilities of marine spaces.
3. It will help address spatial and temporal mismatches between ecological and governance systems.
4. It will facilitate a shift away from the current fragmented approaches to ocean management toward more effective and integrated holistic management that addresses not only uses but also impacts on the ocean.

Marine zoning is currently being applied worldwide and efforts span a range of spatial scales from large, integrated sea-use management projects such as those in the China Sea and Australia's Great Barrier Reef to smaller-scale examples that essentially apply zoning to networks of MPAs like those in St. Lucia, Soufrière Bay in the Caribbean's Lesser Antilles, and the Bird's Head in Indonesia. Each effort is motivated by different goals and outcomes. Examples of marine zoning for small island states are unfortunately few and far between, mostly focused on MPA networks and generally poorly documented.

1.3 Selecting a Pilot Site for Marine Spatial Planning in the Caribbean

The case for marine zoning is particularly strong in the Caribbean. This area has been identified as one of the top five biodiversity hot spots in the world (Mittermeier *et al.* 2005, Shi *et al.* 2005, Myers *et al.* 2000), based primarily on the high number of globally important endemic species. A majority of residents in this densely populated region inhabit coastal zones and are heavily dependent on marine resources for their livelihoods. The economy and public health of the small island developing states (SIDS) of the Eastern Caribbean depend on marine and coastal ecosystems and the biodiversity which they support (Heileman 2005). Lamentably, the Caribbean's large endowment of biodiversity-rich marine ecosystems is being lost at an alarming

rate while coastal development continues to rise (Brown *et al.* 2007). A recent analysis published in the journal *Science* noted that the Eastern Caribbean was among the five regions worldwide showing the highest cumulative human impact on marine ecosystems (Halpern *et al.* 2008).

Main threats to nearshore habitats and the biodiversity that they support include poorly planned coastal development, land-based pollution sources, over-exploitation of fisheries resources, and global climate change. As a result, important biological systems are under intense pressure, threatening the biological diversity of the region's beaches, coral reefs, wetlands, mangroves, and seagrass beds, the marine life reliant upon them, and the important ecosystem services that they provide.

This project initiated a marine spatial planning process through the development of a draft marine zoning design for a small island nation in the Eastern Caribbean.

A number of different island nations in the Eastern Caribbean were considered as potential pilot sites for this project. A suite of criteria guided the project team in the selection of a pilot site for island-wide marine zoning. St. Kitts and Nevis (SKN) was selected as the pilot site as it met all of the following criteria:

- The project team has a presence on the ground.
- An existing or potential conflict between users/uses has been clearly identified and is deemed workable.
- The local government is aware of zoning as a useful management approach and is interested in applying it in their country.
- The project team has a good history of working with the local government.
- Relevant regional inter-governmental bodies are interested in zoning at the site in question.
- Potential for stakeholder engagement (both relationships and appropriate venues) exists.
- Potential policy instruments for implementation have been identified.
- Spatial information representing multiple uses exists.
- A rapid assessment of available data has been completed.

Shawn W. Margles

- Potential in-country sources of information have been identified, and relationships exist with appropriate individuals/agencies to help with data transfer.
- Relationships currently exist with stakeholder groups able to provide expert knowledge, and promising conditions exist for establishing new relationships.

1.4 Objectives of the Project

The primary objective of this project was to lay the groundwork to support future implementation of a marine zoning plan in the Federation of St. Kitts and Nevis and to assist in the development of a marine zoning design. To accomplish our objectives, we used two primary guiding principles:

1. Rely on the best available science for making decisions.
2. Engage stakeholders at all possible levels.

We prioritized choosing tools and methods for data collection and analysis that met the highest scientific standards, while engaging stakeholders and fostering buy-in and ownership. The outcome of this project was a draft marine zoning design, which engaged over 200 people over the course of a year in various activities central to its development.

This report outlines the process we used to develop the draft marine zoning design and concludes with a discussion of next steps that will enable the design to be translated into a marine spatial plan and ultimately lead to implementation. The information from this project can be used to inform other management activities in St. Kitts and Nevis, and the process used in this project can serve as a model for marine zoning in other small island states.

Steven R. Schill

The project included a series of meetings with government staff and stakeholders.

Steven R. Schill

2 THE CONTEXT: SAINT KITTS AND NEVIS

2.1 Geography and Physical Setting

The Federation of St. Kitts and Nevis is a federal two-island nation located in the West Indies (Figure 1). At 17° 20' N, 62° 45' W, it lies in the Caribbean Sea approximately one-third of the way from Puerto Rico to Trinidad and Tobago. The capital city of the federated state is Basseterre on the larger island of St. Kitts. The smaller island of Nevis lies about 3 kilometers southeast of St. Kitts, across a shallow channel called The Narrows. The coastline length of both islands combined is 135 kilometers, and the two islands are approximately 261 square kilometers in total area. The Federation's surrounding EEZ waters extend out to adjacent territorial waters (e.g., St. Eustatius and Anguilla) to cover 20,400 square kilometers with a shelf area of 845 square kilometers. The islands are volcanic in origin and have large central peaks covered in tropical rainforest. The surrounding flatter terrain is where the majority of people reside on both islands. The islands vary in elevation from a low of sea level to a high of 1,156 meters (Mount Liamuiga) on St. Kitts.

Capital	Basseterre
Official Language	English
Government	Parliamentary democracy
Independence	19 September 1983
Area	261 square kilometers (104 square miles)
Coastline Length	135 kilometers
Highest Point	1,156 meters (3,793 feet)
Population	51,300 (Density: 164 per square kilometer)
GDP (2009)	$726M (Total) $13,429 (Per capita)
Literacy Rate	98%

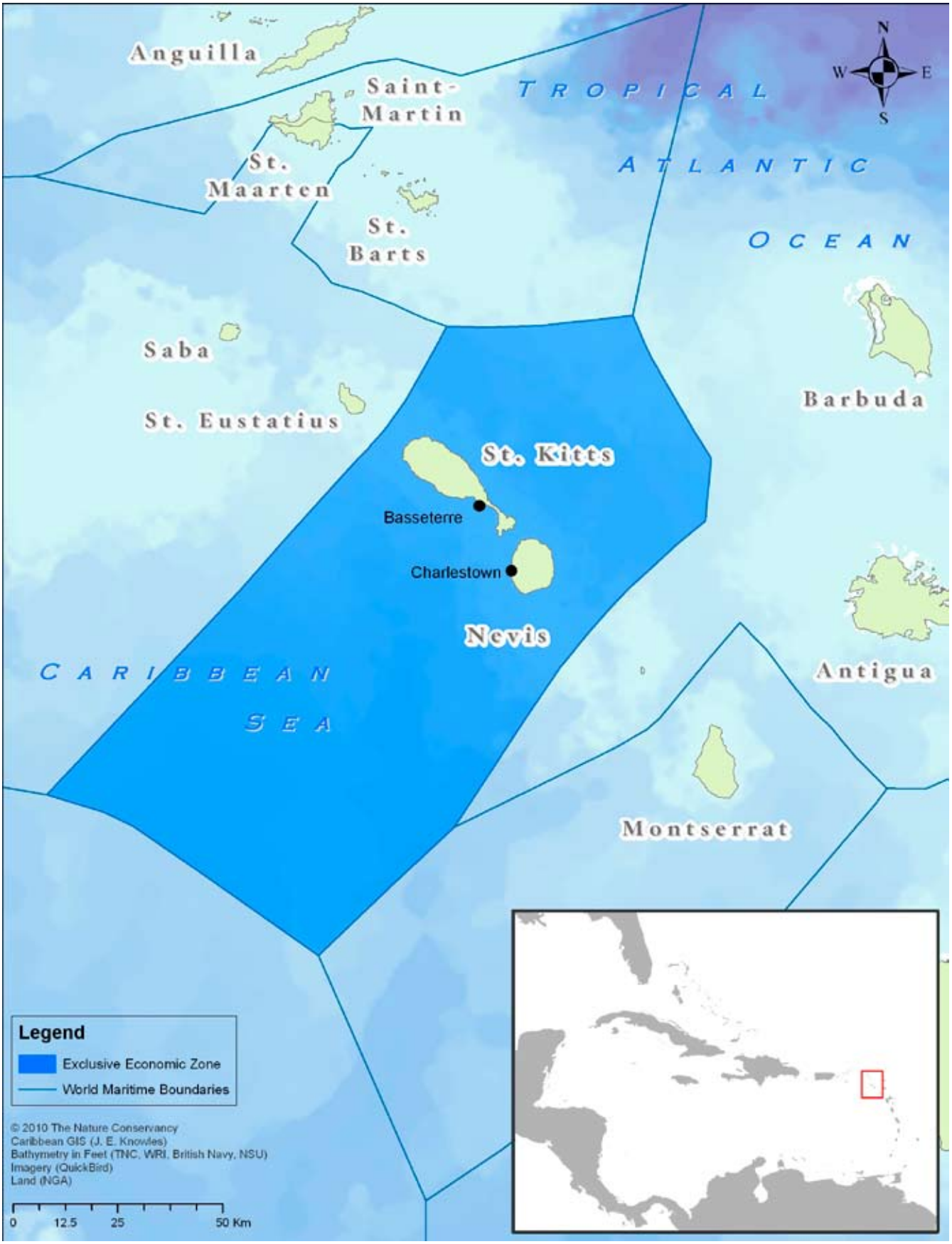


FIGURE 1. General Reference Map: The Federation of St. Kitts and Nevis is a federal two-island nation located in the eastern Caribbean. The Federation's surrounding exclusive economic zone (EEZ) waters extend out to adjacent territorial waters and cover 20,400 square kilometers in area with a shelf area of 845 square kilometers.

2.2 Marine Ecology

St. Kitts and Nevis has a relatively small ocean shelf area that surrounds both islands (Figure 2). On the western side of St. Kitts, the ocean shelf drops off steeply after reaching the depth of 30 meters. The shelf is covered primarily with bare carbonate sand, while healthy reefs and other coral structures cover a small percentage of the area (Figure 3). The small shelf area and relatively stable annual water temperature limits the marine biological diversity. Additionally, the minimal areas of upwelling restrict nutrient supply and subsequently the offshore fisheries. Coastal fisheries have declined sharply in recent years, and storms and anchoring have heavily damaged the reefs. Anecdotally, fishers have reported smaller catches of conch, lobster, and large pelagic and demersal fishes. Major threats to the marine ecology of the islands include coastal development, unsustainable fisheries practices, land-based sources of pollution, rising ocean temperatures, and the increasing intensity of hurricanes and other storm events.

Despite its small shelf area, St. Kitts and Nevis boasts a representative cross-section of Caribbean marine life, including endangered corals, marine mammals, fish species, and sea turtles. The diversity of corals ranges from species categorized as critically endangered by the International Union for Conservation of Nature (IUCN), such as staghorn (*Acropora cervicornis*) and elkhorn (*Acropora palmate*), to the more common finger coral (*Porites divaricata*). Complementing the hard coral varieties are an array of sponges and soft corals. Additionally, there are several large seagrass beds, most notably in the area between the two islands known as The Narrows. These seagrass communities are typically co-dominated by turtle grass (*Thalassia testudinum*) and manatee grass (*Syringodium filiforme*) and serve as vital breeding grounds for fishes and conch, including queen conch (*Strombus gigas*), which is regulated by the Convention on International Trade in Endangered Species (CITES). Migrant mammals, including humpback whale (*Megaptera novaeangliae*), sperm whale (*Physeter macrocephalus*), common bottlenose dolphin (*Tursiops truncatus*), rough-toothed dolphin (*Steno bredanensis*), and spinner dolphin (*Stenella longirostris*) are consistently present on an annual basis. Marine fishes number approximately 460 species, including 126 species that are threatened or endangered.

TABLE 1. Total area of seabed habitat types and coverage in coastal waters (less than 30 meters deep) around St. Kitts and Nevis. See Appendix B for a key to the benthic habitat classes.

Benthic Class	Hectares
Sand	16,351
Dense seagrass	3,098
Flat gorgonian hardgrounds	2,854
Dense macroalgae on hardground	2,774
Semi-consolidated rubble	2,595
Unconsolidated sand with algae	1,929
Hardcoral framework	1,578
Acropora palmata stumps	574
Sparse seagrass	370
Rugose gorgonian slope	258
Lagoonal mud	165
Algal reef flat	61

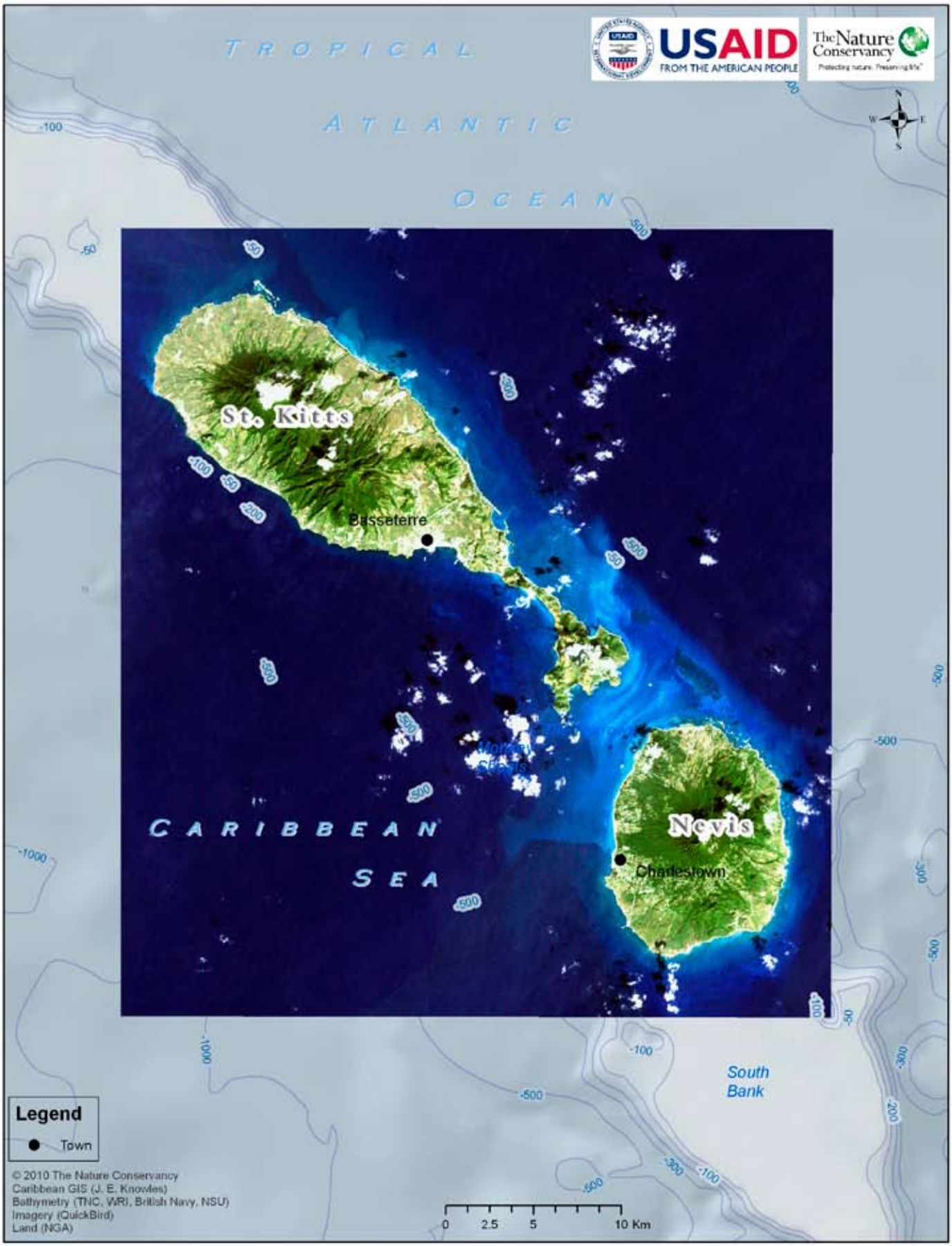


FIGURE 2. Satellite Imagery: Landsat ETM multispectral satellite imagery of St. Kitts and Nevis that was used as base map and for general reference during the project.

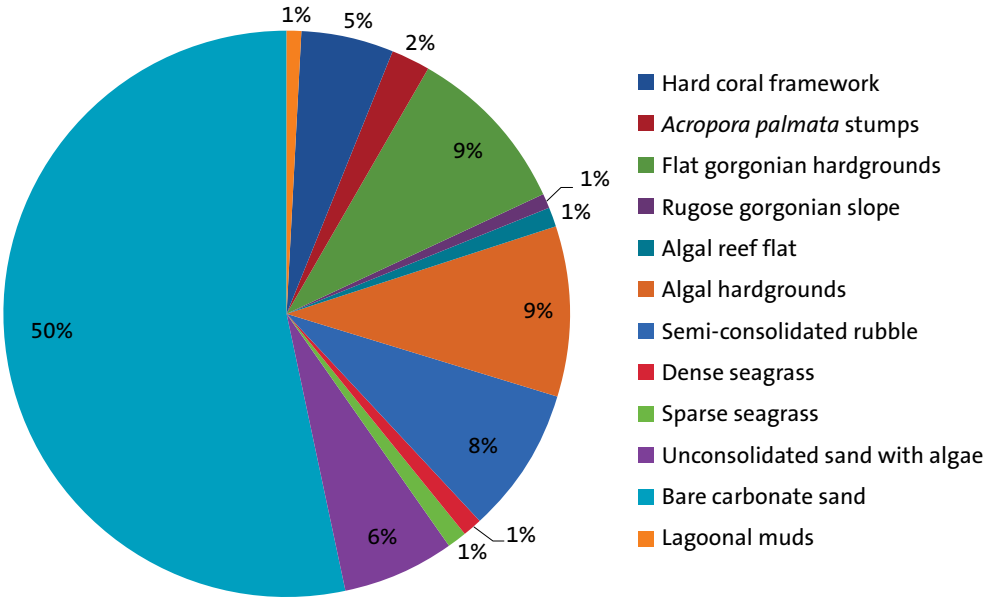


FIGURE 3. Benthic Habitat Classification: Near-shore (less than 30-meter depth) benthic habitat map of St. Kitts and Nevis showing the distribution of 12 benthic habitat classes derived from extensive underwater video sampling and multispectral image classification using high-resolution (2.5 x 2.5-meter) IKONOS and Quickbird satellite imagery.

Three species of sea turtles are known to nest on the beaches of St. Kitts and Nevis: hawksbill turtle (*Eretmochelys imbricata*), green turtle (*Chelonia mydas*), and leatherback turtle (*Dermochelys coriacea)*. The IUCN categorizes the leatherback and hawksbill turtles as critically endangered and the green turtle as endangered.

2.3 Historical Context

Carib Indians occupied St. Kitts and Nevis for hundreds of years before the British began settlement in 1623. Prior to British settlement, there was intense fighting between France and the United Kingdom for control of the islands and their resources. In 1967, the islands became an associated state of the United Kingdom with full internal autonomy. Initially, the island of Anguilla was associated with St. Kitts and Nevis. In 1971, however, Anguilla rebelled and was allowed to secede from the union in 1980. Anguilla returned to being an overseas British territory. St. Kitts and Nevis achieved independence in 1983. In 1998, a vote in Nevis on a referendum to separate from St. Kitts fell short of the required two-thirds majority. As of July 2010, the federation had an estimated population of 49,898, including approximately 12,000 people on Nevis.

2.4 Economy

Tourism and consumer product assembly are the main sources of income on both islands. In 2005, the gross domestic product from commercial fisheries was approximately $3.8 million (FAO 2006). Tourism has replaced the sugar industry, the traditional mainstay of the economy until the 1970s. Tourism has been reported to increase steadily (9.4%) between 2007-2008 (World Wildlife Fund 2009). Following the 2005 harvest, the government closed the sugar industry after decades of annual losses equivalent to 3-4% of gross domestic product (CIA 2010). To compensate for employment losses, the government has embarked on a program to diversify the agricultural sector and to stimulate other sectors of the economy, such as tourism, export-oriented manufacturing, and offshore banking. Like other tourist destinations

in the Caribbean, St. Kitts and Nevis is vulnerable to damage from natural disasters and shifts in tourism demand. The current government is constrained by a high public debt burden equivalent to nearly 185% of gross domestic product at the end of 2006, largely attributable to public enterprise losses.

2.5 Governance

The Federation of St. Kitts and Nevis is organized under the Constitution of 1983 as a parliamentary democracy. While it declared independence from the United Kingdom in 1983, it remains a Commonwealth realm with the Queen as its official Chief of State. A unicameral National Assembly with fourteen members makes federal laws and laws concerning St. Kitts. The Nevis Island Administration and Nevis Island Legislature perform executive and legislative functions on Nevis as provided for in the 1983 Constitution. The legal system in St. Kitts and Nevis is based on English common law.

Implementation of a comprehensive marine zoning framework will require due recognition and consideration of the authorities, obligations, and institutions currently in place in St. Kitts and Nevis that govern marine planning and management. The sources of these may be treaties, policies, and statutes. An analysis of current governance and political frameworks that present opportunities and challenges for implementation of marine zoning is presented in Appendix F.

2.6 Human Uses

The coastal waters around St. Kitts and Nevis are used for a wide range of activities. Tourism is presently the major economic driver, and stretches of the coast are dominated by coastal tourism development, private yachts, cruise ships, and associated water activities. Additionally, as elsewhere in the Caribbean, commercial and artisanal fisheries form a significant part of the local economy. Fisheries involve vessels of varying sizes and capacities, using a variety of gear types and fishing strategies and covering a large part of the coastal waters. Combined with the inter- and intra-island transportation needs of a small coastal state—including ferries, cruise ships, personal recreation vessels, and large industry vessels—within the limited shelf area of St. Kitts and Nevis, the result is a congested marine environment with mounting conflicts.

Shawn W. Margles

Fishing is an important part of the culture and economy of St. Kitts and Nevis.

Shawn W. Margles

Fishers provided information for mapping fishing areas around the islands.

3 GENERATING A DRAFT ZONING DESIGN

Designing and implementing a zoning plan requires a number of essential steps (Agardy 2010, Ehler and Douvere 2007, Klein *et al.* 2009, Crowder and Norse 2008, Douvere 2008), ranging from defining objectives and a strategic vision to drafting legislation and establishing a governance structure that will help support implementation. In this report, we describe the process that we used to develop frameworks to support implementation of a zoning plan for the waters of St. Kitts and Nevis, including the development of a draft zoning design. We document our efforts to address elements that are key to any marine spatial planning effort. However, this is not meant to be a comprehensive review of elements that will take a zoning plan from design to implementation. For a thorough discussion, we refer the reader to the wide range of publications that attempt to outline steps necessary to generate a zoning plan (e.g., Ehler and Douvere 2009, Beck *et al.* 2009). We also note that a policy analysis documenting important legislation and regulation elements for a zoning plan was part of this project (Appendix F).

The following activities are generally considered to be necessary for generating a marine zoning plan: (i) engage stakeholders, (ii) establish clear objectives, (iii) build a database that spatially represents marine uses (i.e., a multi-objective database), and (iv) generate tools to assist stakeholders and decision makers in considering options and tradeoffs (i.e., decision

support products) (Foley *et al.* 2010, Agardy 2010). These elements provide the foundation of any marine spatial planning effort and as such they should be carefully considered. Below we describe the suite of activities conducted during this project to provide a solid foundation for a marine zoning plan for the waters of St. Kitts and Nevis.

3.1 Stakeholder Engagement

To be successful, each element of a planning process—from designing draft zones to plan development through implementation—needs national and local champions. During this project, we carried out a number of activities to engage Kittitian and Nevisian partners and to ensure that every step of the project included perspectives of local partners. Table 2 presents a list of meetings held with main objectives and key participants.

The first step in the engagement process was to identify and meet with appropriate departments and government and community leaders to determine the level of interest in a marine zoning process and their willingness to commit to help move the planning process forward. Given the governance structure in St. Kitts and Nevis, this meant engaging with government ministries on both islands and determining how this project could facilitate communications between stakeholders across the islands. Key government departments included fisheries, planning, and tourism on both St. Kitts and Nevis. On the federal level, we consulted with maritime affairs officials, and in the non-government organization (NGO) sector we engaged with representatives from the St. Kitts National Trust and the Nevis Historical and Conservation Society. Individuals from these key government agencies, local NGOs, and the private business sector served as informal and formal advisors throughout the planning process.

We organized a series of workshops to reach out to varied government and community groups to ensure that the planning effort was based on in-country needs and desires for the federal waters of St. Kitts and Nevis. All of these meetings were carefully coordinated to include appropriate stakeholders. Target audiences varied from high-level government officials to community groups, the private business sector, and fishers' associations.

A Steering Committee guided stakeholder engagement, provided direction for the project, and reviewed and approved data and analyses (Table 3). The committee comprised representatives from government agencies (fisheries, planning, tourism, and maritime affairs) on both St. Kitts and Nevis, as well as local NGOs, fishers, tourism businesses, and dive operators. Steering Committee members served as focal points for disseminating information about the marine zoning plan to their agencies, organizations, and departments. Members of the Steering Committee also played key roles in other aspects of the overall effort, such as liaising with government and reviewing policy analyses.

Key to the success of the project was the selection of an in-country project coordinator to be responsible for frequent and direct communications with high-level government officers, board members of organizations, and individuals from the community. This allowed for timely updates on project development and input from local partners along the way, as well as important in-country workshop coordination. We also held a series of informal meetings to collect existing information, identify new information needs, and build in-country support.

TABLE 2. Table of stakeholder meetings.

Major Stakeholder Meeting/Activity	Date	Main Objectives	Major Outputs	Key Participants
Expert Mapping Focus Groups	September 28-October 2, 2009	To meet with a variety of interest groups and discuss the zoning project; get feed back on the proposed approach; map key marine uses via expert knowledge	Identification of interested persons, groups, and agencies; key marine uses mapped	St. Kitts and Nevis Departments of Tourism; Hoteliers Association; St. Kitts and Nevis Departments of Physical Planning Department; St. Kitts and Nevis Fisheries Departments; Maritime Affairs; Nevis Disaster Management; Port Authority; Energy Planning; developers; environmental consultants; St. Kitts Historical Trust; Nevis Historical and Conservation Society; dive operators
Project Kick-off Meeting	October 5-6, 2009	Conduct visioning exercise to identify main goals for St. Kitts and Nevis marine areas; identify major existing barriers to achieving goals and discuss possible strategies to overcome barriers	Articulated vision for categories of marine uses (meeting) report document); table of barriers and strategies (included in meeting report document)	St. Kitts and Nevis Departments of Tourism; Hoteliers Association; St. Kitts and Nevis Departments of Physical Planning; St. Kitts and Nevis Fisheries Departments; Maritime Affairs; Nevis Disaster Management; Port Authority; Energy Planning; developers; environmental consultants; St. Kitts Historical Trust; Nevis Historical and Conservation Society; Ross University
Fisheries Survey Development	December 15-16, 2009	To develop first draft of fishers survey	First draft of fishers survey	St. Kitts Department of Fisheries; dive operators
Benthic Habitat Mapping	January 5-14, 2010	To collect sea bed habitat video from entire shelf area of St. Kitts and Nevis; to provide capacity building opportunity for in-country partners; provide educational opportunity regarding project objectives and benefits to in-country fishers	Over 400 video samples from various locations around St. Kitts and Nevis (key data input into the benthic habitat product); active participation from in-country agencies and fishers	St. Kitts and Nevis Departments of Fisheries; St. Kitts and Nevis Physical Planning Departments; St. Kitts and Nevis Coast Guard; Nevis fishers
Key Interest Group Meetings	March 23-24, 2010	To meet with key interest group leaders to update them on project progress and get feedback on key issues	Meeting minutes	St. Kitts Department of Fisheries; Nevis Department of Fisheries; St. Kitts Physical Planning Department; Nevis Physical Planning Department; St. Kitts Historical Trust; Nevis Historical and Conservation Society; dive operators
St. Kitts & Nevis Fishers Cooperative Leaders Meeting		To update Fishers Cooperative Leaders on project progress and to get feed-back on proposed fishers survey and mapping exercise approach	Meeting minutes	Leaders from St. Kitts and Nevis cooperatives; St. Kitts and Nevis Fisheries Departments
Fisheries Survey Review		To review fisheries uses and values survey and get feedback from key leaders from the commercial fishing community	Revised fisheries uses and values survey and mapping tool	St. Kitts and Nevis Fishers Cooperatives leaders; St. Kitts and Nevis Departments of Fisheries; St. Kitts and Nevis Physical Planning Departments
Fishers Survey Training	April 13-16, 2010	To train in-country data collection team and key government agency staff on data collection and survey techniques	Trained in-country data collection team; increases government capacity on survey techniques and data collection methods	St. Kitts and Nevis Fisheries Departments

(continued on next page)

TABLE 2. Table of stakeholder meetings (*continued*).

Major Stakeholder Meeting/Activity	Date	Main Objectives	Major Outputs	Key Participants
Fishers Co-operative Meetings	April 13-28, 2010	To meet with fishers at their co-operatives to provide project information, describe purpose of interviews and mapping exercise; and provide an opportunity for questions	Meeting minutes	Members of Fishers Co-operatives from St. Kitts and Nevis; St. Kitts and Nevis Fisheries Officers; Fisher Cooperative staff
Fisher Interviews		To interview St. Kitts and Nevis fishers and map fisheries uses and associated values	Draft maps of commercial fisheries and associated values	St. Kitts and Nevis fishers; St. Kitts and Nevis Fishers Cooperative leaders; in-country data collection team (composed of key fisheries officers and Fisher cooperative staff)
Compatibility Matrix Meeting		To discuss compatibility of marine activities with stakeholders.	Compatibility matrix of marine targets	St. Kitts and Nevis Departments of Tourism; St. Kitts and Nevis Departments of Physical Planning; St. Kitts and Nevis Fisheries Departments; Maritime Affairs; Port Authority; environmental consultants; St. Kitts Historical Trust; Nevis Historical and Conservation Society; dive operators
Steering Committee Meeting 1		To establish project Steering Committee and discuss major decision points	Steering Committee established; major project decision points discussed; meeting minutes with action steps	Ministry of Marine Resources; St. Kitts and Nevis Departments of Fisheries; St. Kitts and Nevis Physical Planning Departments; St. Kitts and Nevis fishers leaders; Maritime Affairs;
Steering Committee Meeting 2		To follow up on action items from first meeting, review data inputs, generate initial zoning portfolio	Draft Steering Committee zoning portfolio map; meeting minutes with action steps	Ministry of Marine Resources; St. Kitts and Nevis Departments of Fisheries; St. Kitts and Nevis Physical Planning Departments; St. Kitts and Nevis Fishers Cooperative leaders; Maritime Affairs
Fishers Data Verification		To verify maps and information with fishers	Verified maps and updated final report on fisheries uses and values component	Fishers from St. Kitts and Nevis; St. Kitts and Nevis Fisheries Departments
Steering Committee Meeting 3		To review digitized Steering Committee Portfolio map, consider feedback from fishers obtained during data verification process, update portfolio as needed, and review policy outputs	Updated Steering Committee Portfolio map; meeting minutes with action steps identified	Ministry of Marine Resources; St. Kitts and Nevis Departments of Fisheries; St. Kitts and Nevis Physical Planning Departments; St. Kitts and Nevis Fishers Cooperative leaders; Maritime Affairs;
Final Stakeholder Meeting		To review project products, hand over data and information generated and collated during project and identify next steps	Data and information turned over to in-country partners and decision makers	St. Kitts and Nevis Departments of Tourism; St. Kitts and Nevis Departments of Physical Planning; St. Kitts and Nevis Fisheries Departments; Maritime Affairs; Port Authority; environmental consultants; St. Kitts Historical Trust; Nevis Historical and Conservation Society; dive operators

TABLE 3. Steering Committee Membership.

MARINE ZONING PLAN FOR ST. KITTS AND NEVIS

MEMBERSHIP OF PROJECT STEERING COMMITTEE – ST. KITTS

Agency/Organization	Member
Department of Physical Planning and Environment	Mr. Randolph Edmead (Director)
Department of Fisheries	Mr. Ralph Wilkin
Tourism Authority	Mr. Randolph Hamilton
Department of Maritime Affairs	Mr. McClean Hobson
St. Christopher National Trust	Mrs. Jacqueline Armony
Dive boat operators	Mr. Kenneth Samuels
Fishers	Mr. Oliver Spencer

MEMBERSHIP OF PROJECT STEERING COMMITTEE – NEVIS

Agency/Organization	Member
DPPNRE	Mrs. Angela Delpeche
Department of Fisheries	Mr. Lemuel Pemberton
Tourism Authority	Mr. Devon Liburd
Dive boat operators	Mr. Ellis Chadderton
Nevis Conservation and Historical Society	Mrs. Evelyn Henville
Fishers	Mr. Winston Hobson

3.2 Establishing Clear Objectives

A marine zoning effort should be guided by clear objectives and a strategic vision (Gilliland and Laffoley 2008, Crowder and Norse 2008, Ehler and Douvere 2007). Building these elements through a participatory process creates a strong basis for successful implementation of the zoning plan. The strategic vision and objectives for the St. Kitts and Nevis marine zoning plan were defined during a workshop early in the project (Table 2). Prior informal meetings with government officials, agencies, and stakeholders (Table 2) helped identify the right mix of participants for this workshop and the best approaches to facilitate this discussion. Participants varied from high-level government officials to representatives of community groups and fishers' associations. Information collected during this meeting provided important building blocks for the overall project (see Appendix A for a detailed report on this meeting). During this workshop, the participants discussed their vision for uses of the draft zones and management of their seascape, as well as objectives for education, regulation, and enforcement. Later, this project addressed some of these elements in detail, but a comprehensive treatment for each element was outside of the project's scope.

3.3 Building a Multi-Objective Database

Effectively managing a wide variety of uses across a seascape requires access to disparate types of information. One of these types of information is spatial data that shows the distribution of marine features and where certain marine activities take place. These spatial datasets are used

in a geographic information system (GIS), one of the key tools for marine spatial planning. Collating and integrating data on diverse human activities and the ecological systems that support them is not a simple feat. This process can require considerable time and resources, depending on data availability and the need to generate new data when gaps are identified. The scales of information are often very different, and integrating them to generate a balanced view of the system is complex. For this project, significant resources were devoted to gathering, evaluating and generating spatial information from a wide variety of sources. Special attention was devoted to ensuring a balanced representation across use sectors and ecological characteristics.

Spatial data provided from past mapping efforts were evaluated, and data gaps were identified. As is typical in most small island states, spatial data for the terrestrial realm in St. Kitts and Nevis was much more prevalent than data for the marine realm. Consequently, filling marine data gaps represented a major effort and contribution of this project. One clear gap was the lack of data on marine uses of the waters surrounding St. Kitts and Nevis. We used three main approaches to fill data gaps: (a) expert mapping, (b) fisher surveys, and (c) habitat surveys.

3.3.1 Expert Mapping

To ensure a wide representation of marine uses in St. Kitts and Nevis, information on the fisheries, tourism, industry, and transportation sectors was gathered during workshops and several days of meetings with representatives from each of these sectors. Data collected from these meetings were supplemented with existing and accessible data from independent research and regional datasets housed outside of the country. These efforts produced a representative and thorough collection of spatial data, which were reviewed and validated by in-country experts across all marine sectors.

To capture local knowledge, the project team spent two weeks in St. Kitts and Nevis working with groups and individuals to map consumptive and non-consumptive marine activities, as well as ecologically important areas. Team members met with over 30 individuals representing more than 15 organizations (Table 2). This data collection effort was designed to build upon the work completed under a previous Ecological Gap Assessment conducted for St. Kitts and Nevis. The project team developed a framework to track important and necessary data for a marine zoning process. Information was captured on paper maps and subsequently digitized and verified with local experts.

3.3.2 Benthic Habitat Survey

Previous data collected from benthic habitat surveys on St. Kitts and Nevis were too coarse in resolution or too limited in geographic extent to be useful for this project. Consequently, we conducted a mapping effort to produce the first high-resolution (2.5-meter) benthic habitat maps for the two islands' coastal waters (less than 30 meters deep). We collected data on 12 habitat classes using high-resolution satellite technology in combination with field measurements (Figure 4); for a detailed description of methods, see Appendix B. The clear waters of the Caribbean allow sunlight to reflect off the ocean floor at depths to 30 meters, providing a way to map underwater features and structures in areas as small as 2.5 meters. GPS-referenced underwater video clips collected in the field are used to "train" image-classification software to recognize patterns in the imagery that correspond to underwater habitat types.

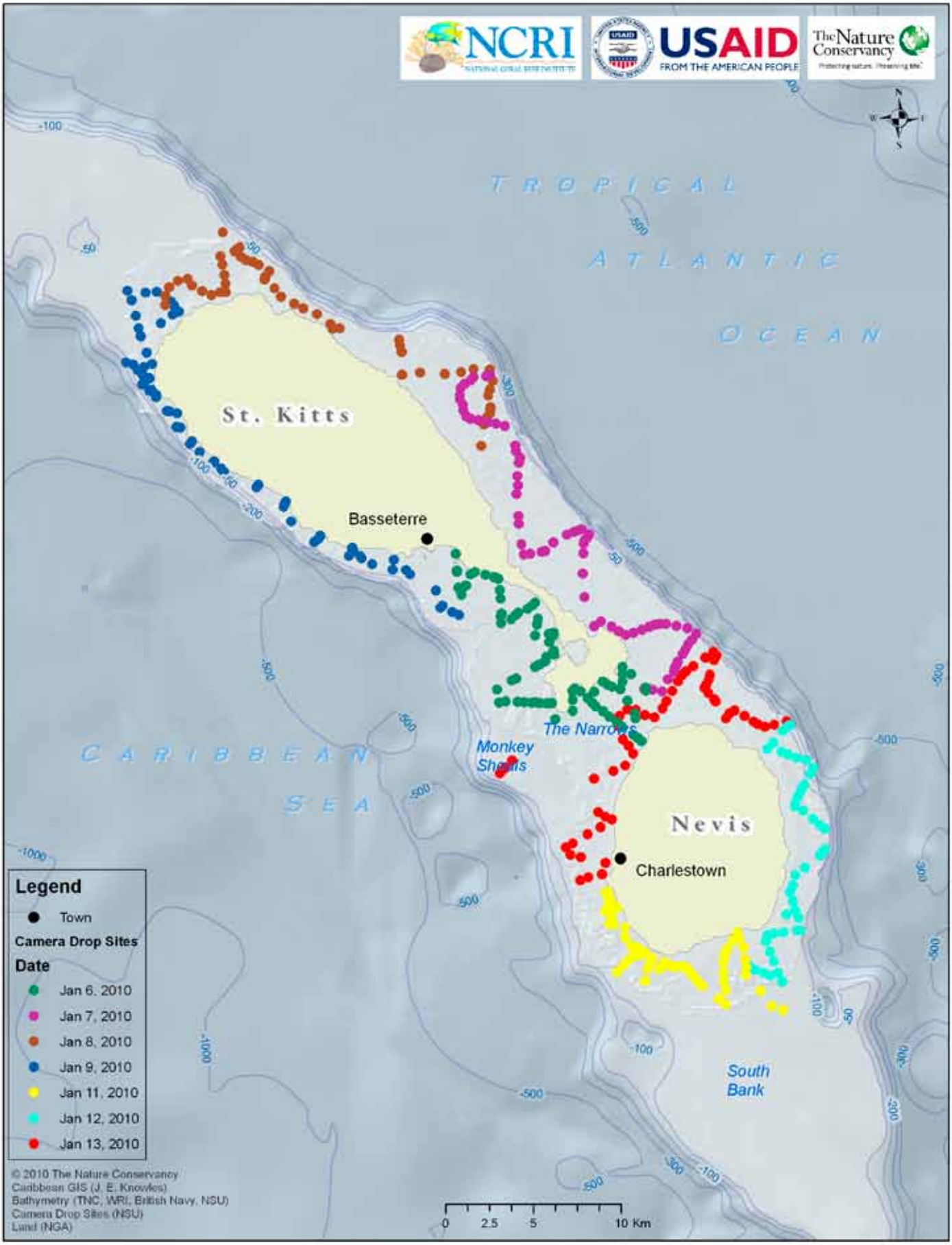
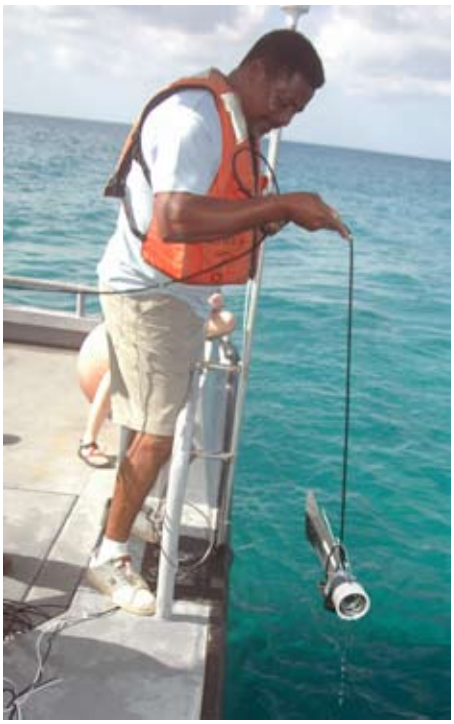


FIGURE 4. Camera Drop Sites: GPS locations of camera drop sites where underwater video was collected for each of the 12 benthic classes between Jan 6-13, 2010. The different colors represent the different dates that the videos were collected. These videos were interpreted and used to assist with the benthic habitat classification using the satellite imagery.



Steven R. Schill

Clive Wilkinson, Fisheries Assistant from the Nevis Department of Fisheries, pulling the underwater camera up after collecting a video sample for mapping of seabed habitats.

The underwater mapping effort was a collaborative effort of staff from The Nature Conservancy (TNC), Nova Southeastern University Oceanographic Center, and local government agencies. An underwater video system coupled with GPS and a depth-sounding device was used over the course of ten days aboard the St. Kitts and Nevis Coast Guard vessel *Ardent*. With this system, field crews collected more than 425 underwater video samples (Figure 5) of the narrow, 260-square-kilometer ocean shelf that surrounds St. Kitts and Nevis. For each video sample, the researchers recorded the GPS location, which enabled them later to match the underwater video samples to the same location on the satellite image. For each of the 12 benthic habitat classes seen in the video samples, scientists analyzed the corresponding patterns of light reflections seen in the satellite imagery. Because the patterns appear different for each depth and habitat class, these patterns can be used to map the entire seafloor for depths less than 30 meters. By taking this approach with advanced image-processing techniques, we produced detailed benthic habitat maps (Figure 4), showing the extent and distribution of each of the 12 habitat classes (e.g., coral reef, seagrass, sandy bottom, mud flat).

3.3.3 Fisher Survey

We conducted expert interviews with local fishers to collect data on the locations, distributions, and importance of commercial fisheries within the waters of St. Kitts and Nevis. This effort was a collaboration of staff from The Nature Conservancy, Ecotrust, and local government agencies and partners. An in-country coordinator was hired to advise on data-collection methods and to coordinate data-collection with the St. Kitts Fishery Department and the Nevis Fishery and Planning Departments. We collected data on ten fisheries: coastal demersals, coastal pelagic, deep shelf and slope, ocean pelagic, conch, lobster, shark, diamondback squid, turtle (which is caught legally during an open season), and bait. To identify the full spatial extent, relative value, and "socio-economic personality" of each fishery, we interviewed a representative sample of fishers from each fishery at the 12 major landing sites—five on St. Kitts and seven on Nevis (Figure 6). We used an interactive, customized, computerized-interview instrument, Open OceanMap, to collect geo-referenced data from fishers.

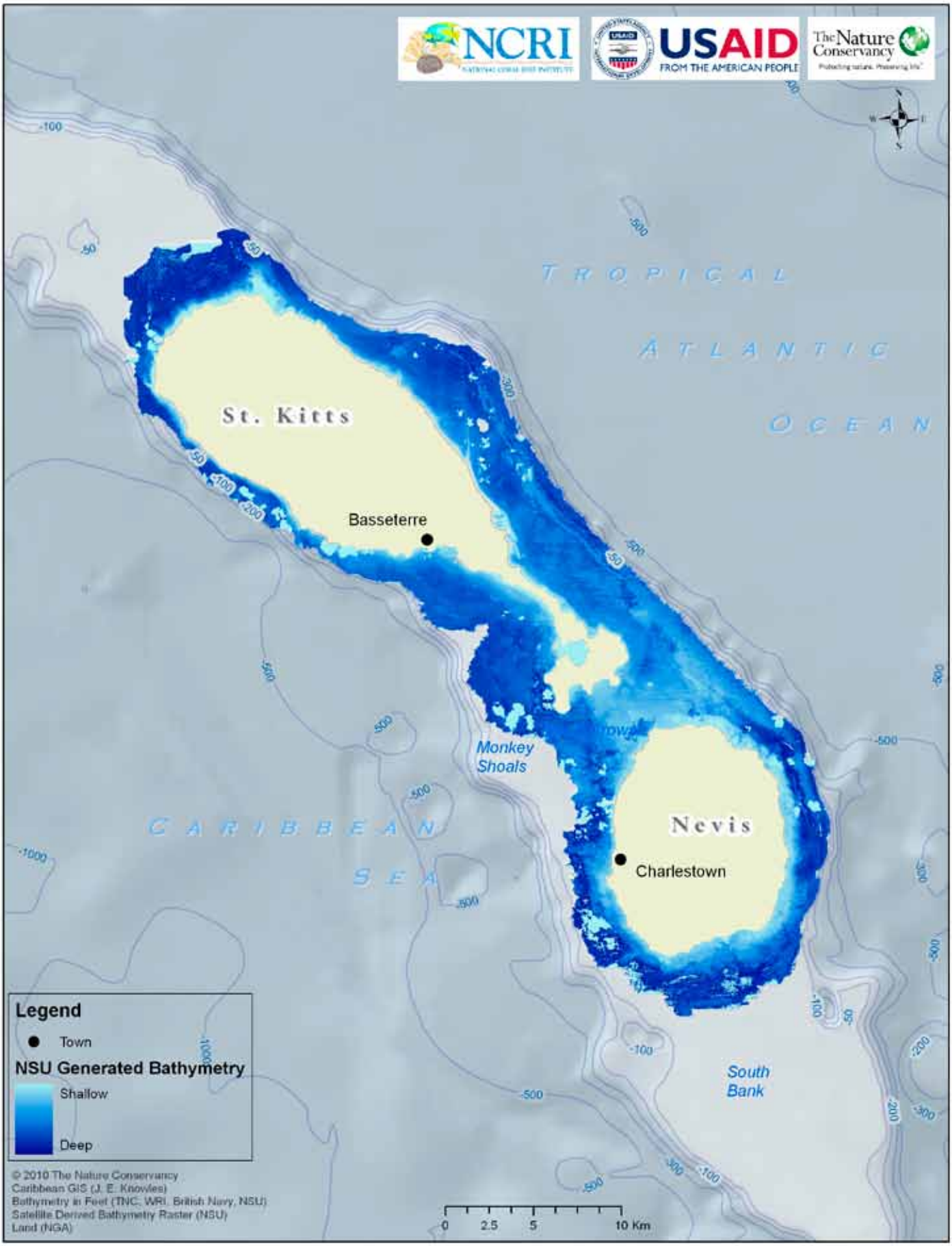


FIGURE 5. Bathymetry: Modeled bathymetry (ocean depths) of the near-shore areas (less than 30-meter depth) based on 2.5 x 2.5-meter satellite imagery. These depths were modeled using field-referenced depth sounding and correlated with multispectral imagery to provide an estimation of depth and assist with the classification of benthic habitats.

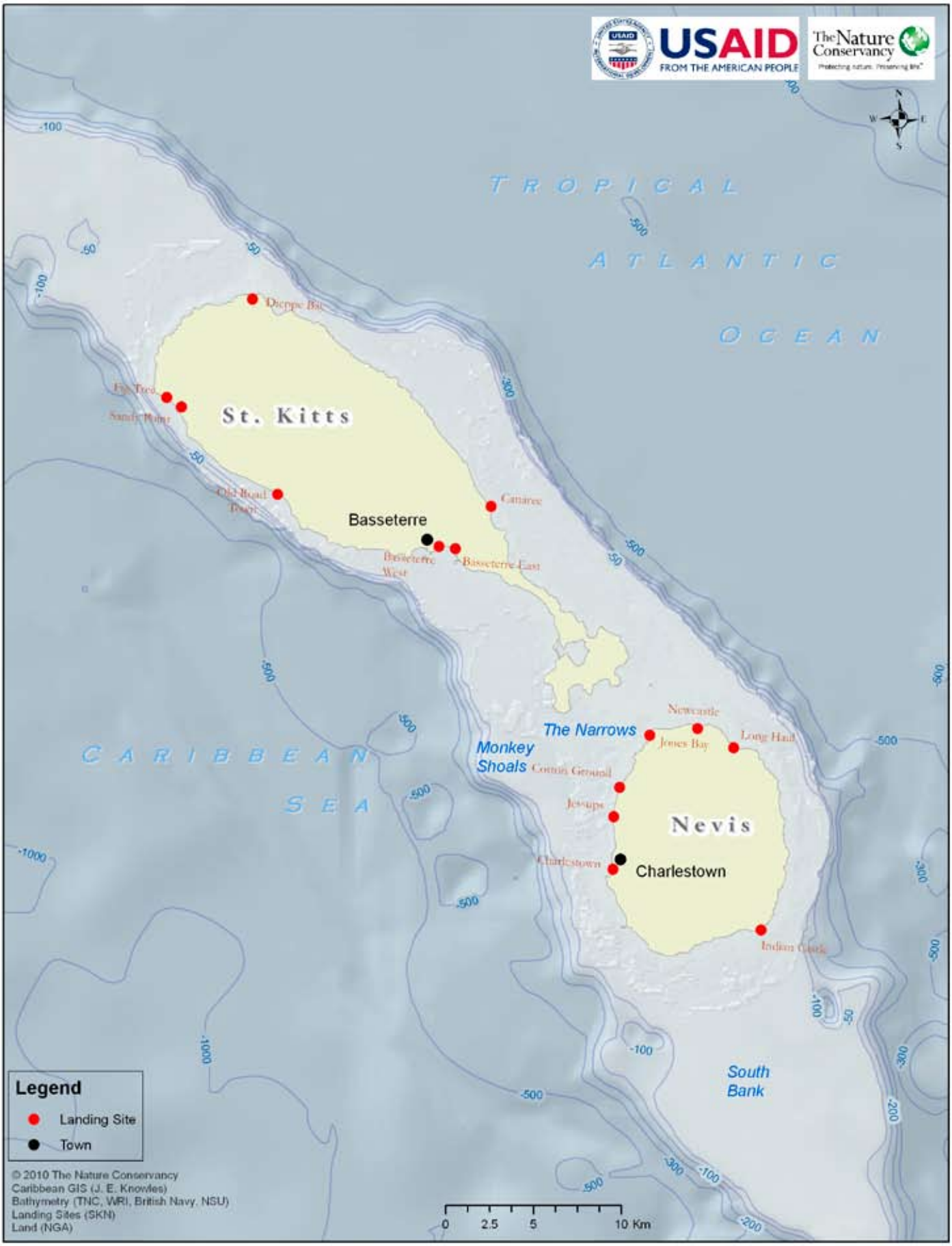


FIGURE 6. Landing Sites: Location of fish landing sites in St. Kitts and Nevis.

Open OceanMap is a computer application that uses a place-based designed survey as a basis to collect information on fishing. Participants are guided through a discussion about the fisheries in which they participate and are asked to indicate the locations, extents, and relative values of fishing areas. Interviewers use either a software tool (Open OceanMap) or a paper copy of the survey to map and record the values indicated by the interviewee. The in-country coordinator and a team of data-collection assistants were trained in the use of the computer application, interview methods, and data entry. They visited each major landing site between April and June 2010, interviewing a total of 114 fishers (51 on St. Kitts and 63 on Nevis). We aggregated information at the landing-site, island, and federation levels, and we produced maps to illustrate the extent and relative importance of each fishery. For a sample map, see Figure 7. Fishers reviewed and verified the maps in August 2010. We compiled data in a GIS and subsequently integrated the data into the project's centralized spatial database. In the analysis, we used data aggregated to the federation level. See Appendix D for a detailed description of the approach and methods used to collect, compile, and analyze commercial fisheries data in St. Kitts and Nevis.[1]

3.4 Providing Decision Support Products

One of the most important aspects of a successful marine spatial planning process is having access to and integrating complex information that will facilitate zoning decisions. A major aim of this project was to integrate complex information representing a variety of sectors and to generate a suite of products that will help the people of St Kitts and Nevis to make decisions, finalize a zoning design, and implement a marine zoning plan.[2]

Interactive decision support systems (DSS) are the future of marine spatial planning. They provide transparency and engage a diverse array of people in the planning process. Interactive DSS can capture, share, and compare many people's ideas about planning options, help people understand the real-world implications of different management regimes and environmental conditions, and reveal tradeoffs among possible management scenarios (Beck *et al.* 2009).

The marine zoning component of the USAID project leaves the country with a strong foundation for a variety of marine planning and management efforts, which even in isolation support the objectives of integrated multiple-use marine spatial planning and management. Each of the discrete products has a diversity of uses beyond marine zoning and can be utilized for efforts *inter alia* fisheries management planning and co-management arrangements, coastal zone management, climate change adaptation, protected areas planning and management, socio-economic analysis, maritime affairs, hazard mapping, and environmental protection. The major DSS products from this project were:

1. Spatial information products (i.e., spatial database, georeferenced portable document format [PDF] files, and web-based map viewer)
2. Maps of fisheries uses and values
3. Benthic habitat maps

[1] Note that data storage and reporting on fishing methods and spatially explicit information is conducted in a manner that maintains the confidentiality of sensitive information, with only the non-confidential portion of the information collected being made available to the public.

[2] This component of the integrated USAID project focuses on designing spatial decision support tools to facilitate zoning. Other components of the overall USAID project address policy and legislation, which are integral parts of implementation. The policy analysis is presented in Appendix F.

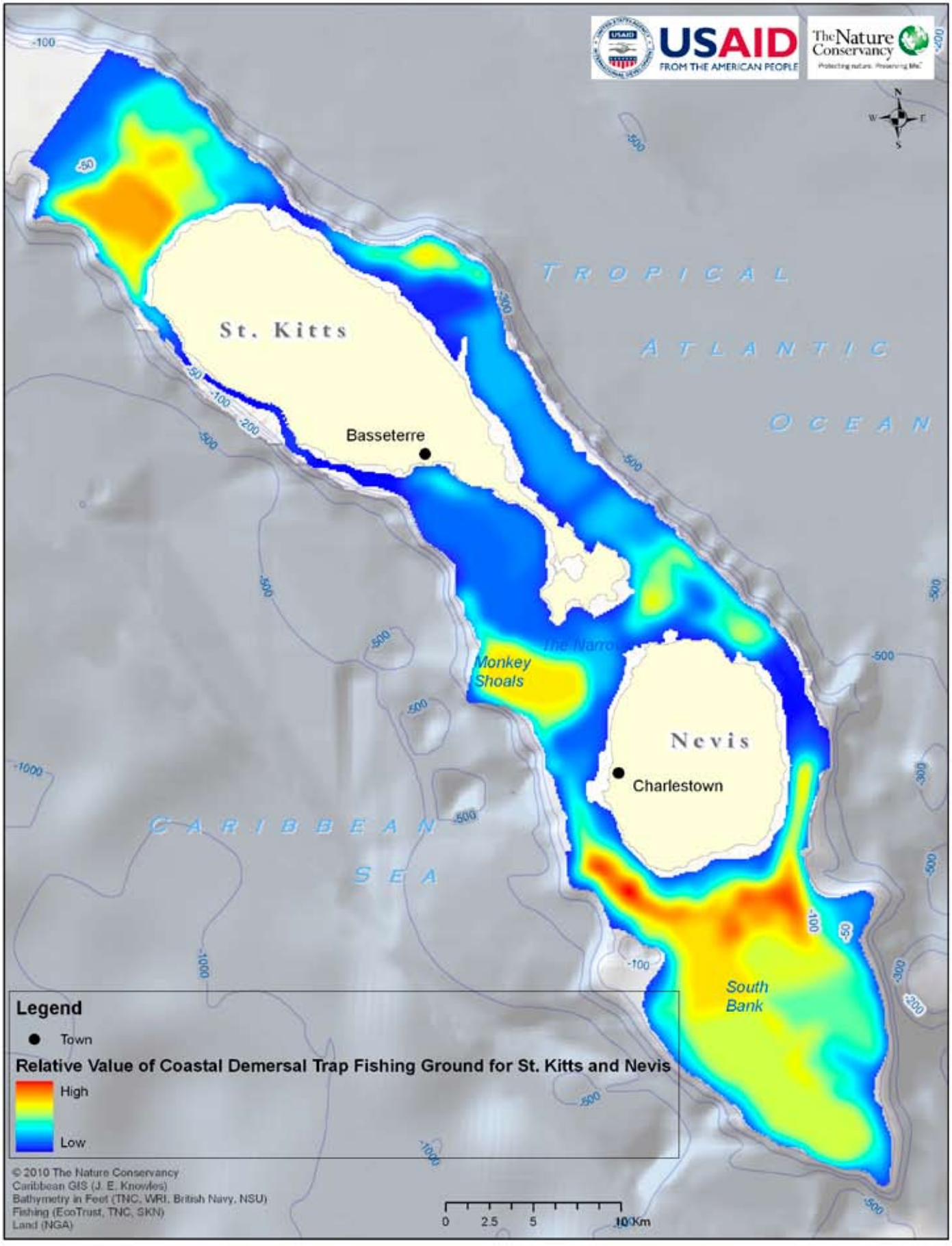


FIGURE 7. Sample fisheries uses and values map.

4. Compatibility maps
5. Outputs of multi-objective analysis

3.4.1 Spatial Information Products

An interactive database allows users and decisions makers to view and overlay different layers of information. This is invaluable in a decision-making process when a variety of scenarios and tradeoffs must be considered and there are a wide range of interests involved. Information must be stored in a manner that it is easily accessible, understood, and used. Given the wide range of technical knowledge that a diverse set of stakeholders and decisions makers is likely to have, it is important that decision support products accommodate a range of technical skills and understanding. To support the effective use of data, this project used three main modes for delivering spatial data: (a) a spatial database, (b) georeferenced portable document format (pdf) files, and (c) a web-based map viewer.

3.4.1.a Spatial Database

The spatial information collected during this project was organized and managed in an Environmental Systems Research Institute (ESRI) geodatabase format. A geodatabase is frequently used to store several layers of spatial data ("geo" means spatial and "database" refers to a data repository). The geodatabase allows for centralized data storage for easy access and management, and a range of sophisticated spatial analysis. A drawback to the geodatabase is that it requires a high-level commercial software license to fully manipulate and properly manage the data. For that reason, all spatial information was also stored and made available in ESRI's more universal shapefile format. The geodatabase and each shapefile include metadata about how and when the data were created and/or collected.

The project geodatabase comprises several base layers, imagery, and all other spatial information used in the project, including information on benthic habitats, fisheries[3], and spatial analysis results. The geodatabase and shapefiles will be housed and maintained by the GIS officers in each of the planning departments of St. Kitts and Nevis. The complete geodatabase will also be incorporated and maintained by The Nature Conservancy's Caribbean Program as part of the Caribbean Decision Support System (CDSS), a suite of data and tools designed to encourage sustainable living and biodiversity protection in the Caribbean (Huggins *et al.* 2007).

3.4.1.b Georeferenced Portable Document Format (PDF) Product

Complementing the data are corresponding map documents and georeferenced portable document format (geoPDF) files that provide a pre-defined symbology and overlay for easy access and viewing of GIS data. These documents can be viewed and utilized easily with free Adobe Reader software (http://get.adobe.com/reader) and the free TerraGo Toolbar (http://www.terragotech.com/products/terrago-toolbar).

The advantage of the geoPDF format is that the files are highly portable and do not require access to advanced technology or software. The TerraGo Toolbar allows users to embed

[3] Due to the confidential nature of some of the information collected from fishers, only a portion of this information is publicly provided and distributed. The data and information housed at the planning departments will include only aggregated information, which protects the sources and complies with the verbal agreement that was arranged with fishers during the interview process.

georeferenced comments[4] in the document. This facilitates the collection and collation of feedback from less technically savvy partners and provides a streamlined process for editing spatial data files. Several geoPDF files have been generated and will be provided to the fisheries and planning departments of St. Kitts and Nevis, and to the St. Kitts National Trust and the Nevis Historical and Conservation Society. Additional copies of these files are available and can be obtained by contacting the aforementioned agencies and organizations, or by contacting The Nature Conservancy via John Knowles (jknowles@tnc.org).

3.4.1.c Web-Based Map Viewer

For people who do not have access to GIS software, desire interactivity, and might not be able to use the georeferenced PDFs outlined above, we created an Internet-based map viewer at http://maps.tnc.org/SKN/index.html. It enables people with Internet access to view, display, query, and print maps of several important data layers including benthic habitats, zoning scenarios, and examples of the maps of fisheries values. The benefit of this product is that it requires no special software, only a standard Web browser, allowing a wide audience to review and provide feedback during a marine planning process.

3.4.2 Fisheries Uses and Values Map

Mapping of fisheries uses and values (summarized in Section 3.3.3 and described in detail in Appendix D) was a key activity in developing the draft zoning design. This mapping effort had three main outcomes. First, the approach and tools that we deployed were critical for engaging fishers, a significant and often under-represented stakeholder group in the planning process. Second, the results of this work supplied essential information pertaining to the extent and value—from the perspective of fishers—of the St. Kitts and Nevis fishing grounds. Third, the island- and federation-level maps and the summary of socio-economic information can be used in fisheries management and site-specific management, in addition to marine spatial planning.

Shawn W. Margles

Charles Steinback of Ecotrust verifies maps of fishing areas with local fishers.

[4] The TerraGo toolbar allows people to view a pdf that is georeferenced. This means that the TerraGo-generated document that they view can be imported into an ArcGIS platform and will be automatically spatially registered. The advantage of this type of document is that, for example, a partner can view a draft zone with Adobe Reader and embed comments in the document. These comments are automatically registered to the same spatial location as the base document. This means that with a TerraGo-enabled ArcGIS license, a user can import comments that are already spatially rectified. This facilitates the process for receiving feedback on proposed zones or when verifying spatial data.

Our survey approach created an opportunity for us to discuss the overall project with fishers and for them to communicate their preferences for marine management. After an extensive process to verify the preliminary draft maps with fishers, we printed final maps and provided them to cooperative leaders on each island, giving fishers direct access to the maps representing information that they had shared. These maps not only serve as a reminder to fishers about the zoning project, but they also help fishers visualize where their most valuable areas are. This understanding may enable them to better advocate for and protect their interests. This aspect became particularly useful when discussing with fishers what areas they would favor to protect as fishing areas and what areas they felt were acceptable to be managed for other objectives such as conservation or tourism. Fishers were able to see clearly on a map where their most important fishing areas were and then consider how the marine areas could be managed jointly to accommodate other objectives. This often led to an agreement that some areas could be better managed for conservation, tourism, or transportation, as long as their most valuable grounds were managed for sustainable fishing objectives.

3.4.3 Benthic Habitat Maps

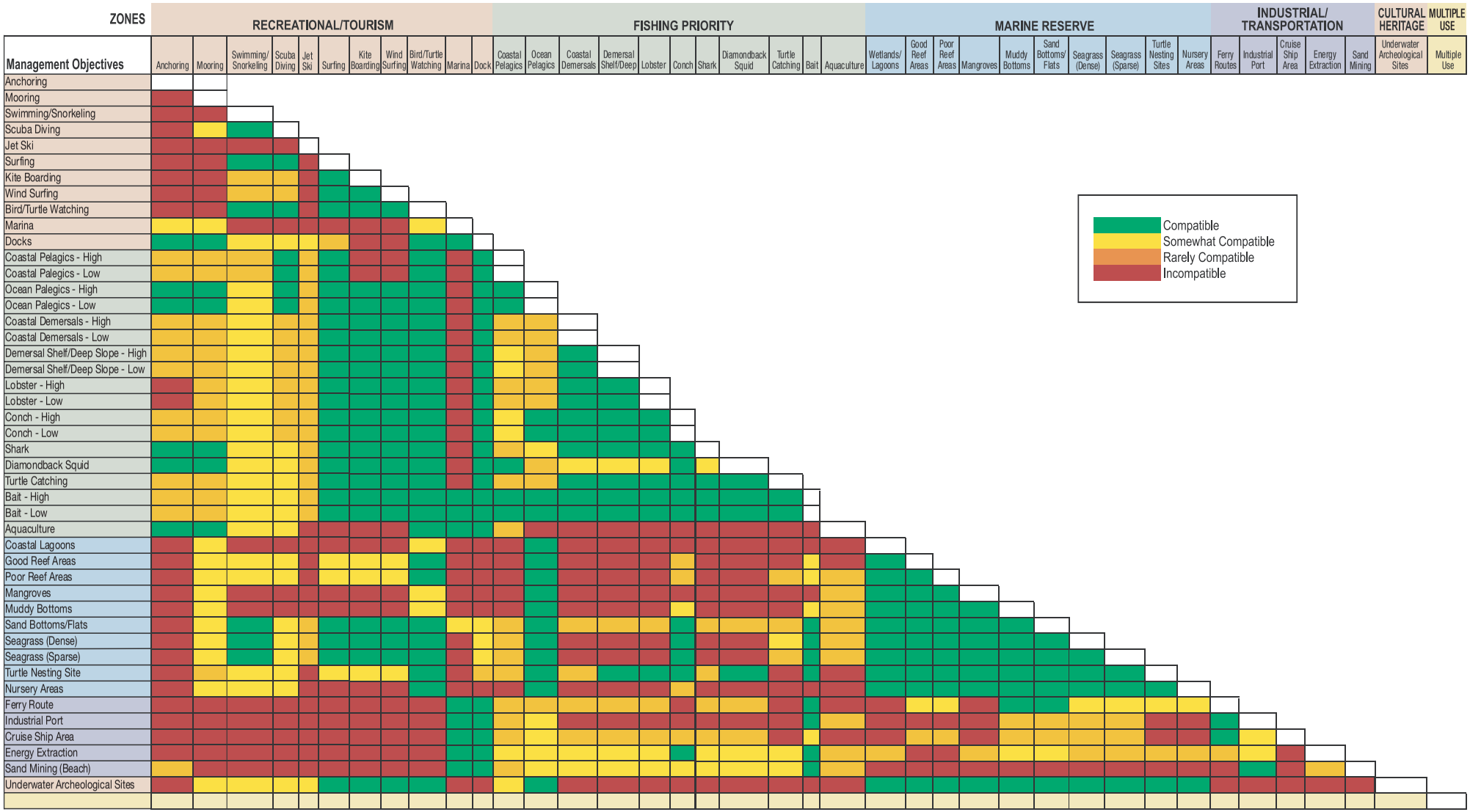
Based on the surveys of benthic habitats, we produced detailed marine habitat maps for coastal waters (less than 30 meters in depth) of St. Kitts and Nevis. These maps display the extent and distribution of 12 distinct benthic habitat classes. These data were used in multiple-objective analysis, and the resulting maps have versatility to be used for planning purposes by a variety of agencies and organizations. For example, these maps can be used to help identify areas potentially suitable for anchoring, environmental restoration or conservation, research, exploration, tourism (i.e., dive sites), and possibly coastal development.[5] These maps have been provided in electronic format to the departments of planning and fisheries on each island as well as the St. Kitts National Trust and the Nevis Historical and Conservation Society. The associated GIS shapefiles can be obtained from either planning department or directly from the Caribbean Program of The Nature Conservancy. For more details on the benthic habitat survey, please see Appendix B.

3.4.4 Compatibility Maps

Identifying where to allow or prohibit activities within a seascape can be challenging. Understanding how these activities interact is vital to determining uses that are compatible and those that are not, and how this plays out in space. To achieve this understanding in the context of St. Kitts and Nevis, we engaged stakeholders in an organized discussion (see the second workshop in Table 2) to document how compatible different marine uses were with one another. Discussion facilitators asked participants to focus on activities that were prioritized to be incorporated in the draft zoning design. The discussion resulted in a detailed matrix quantifying the compatibility of various marine activities into compatibility scores (see Table 4). We produced a suite of compatibility maps by correlating the compatibility scores with spatial information associated with each activity (see Appendix E). These maps became an integral part of the multi-objective analysis described below and will be invaluable for understanding the interactions between activities across the seascape. This understanding will play a key role when considering how to accommodate new locations for marine activities. For example, if a hotel wanted to create a new area for windsurfing, the department responsible for permitting this activity could reference the compatibility map for windsurfing and determine initially if this activity is compatible with existing activities in the proposed area. These maps have the

[5] It is important to note that these maps are part of a suite of decision support products. This summary is not intended to suggest that the benthic habitat maps alone would be sufficient to identify without question an appropriate location for any of the examples provided.

TABLE 4. Marine zoning compatibility.



potential to minimize conflict and greatly improve efficiency. As a result, they may result in cost savings when people seek to locate new activities within the seascape.

The compatibility maps are available through the planning departments on each island or can be obtained directly from the Caribbean Program of The Nature Conservancy.

3.4.5 Outputs of Multi-objective Analysis

To consider tradeoffs and make decisions, it is useful for alternative scenarios to be viewed spatially. So that a variety of actions across the seascape could be viewed spatially in an integrated fashion, we applied a new version of the popular conservation planning tool Marxan (Ball *et al.* 2009) called Marxan with Zones, released in 2009 (Watts *et al.* 2010, Watts *et al.* 2009). Given the complexity of integrating information on uses across space that characterize a wide spectrum of sectors, software tools such as Marxan with Zones can help facilitate this much needed integration.

Marxan with Zones is freely available decision support software that incorporates pre-determined "zones" to allocate resources and optimize the needs of multiple sectors across a particular space (Watts *et al.* 2009). Considering varying zones moves away from looking at space as either appropriate for one activity or not (e.g., an area for fishing or not for fishing, an area for conservation or not for conservation) and facilitates the consideration of all activities equally as part of the planning process. Unlike traditional zoning methods, Marxan with Zones employs a quantitative approach to finding the most optimal areas based on zoning needs. It is a tool able to take a very complicated problem and optimally assign areas in a study region to a particular zone in order to meet a number of ecological, social, and economic objectives, while minimizing conflict and producing the most efficient solution.[6] Outputs from this analysis can be represented spatially and enable users to consider different scenarios and potential tradeoffs.

To support the zoning decision-making process in St. Kitts and Nevis, we generated a series of scenario-analysis maps using Marxan with Zones (Appendix E). We provided these maps to the project's Steering Committee with a careful explanation of the map information, enabling the committee to delineate draft zones for consideration by a broader body of stakeholders. A full and detailed description of how the analysis using Marxan with Zones was set up and how the resulting outputs were interpreted and presented is provided in Appendix E.

3.5 Generating Draft Zones

In previous marine spatial planning efforts, we have found that the lines delineating marine zones must be considered carefully and typically are most effective when generated by those who will be involved in the management and enforcement of a plan. A top-down approach is seldom effective in these situations (Agardy 2010, Gilliland and Laffoley 2008). Instead, it is more effective to make scientifically sound information that has been collected in a participatory fashion available to managers and stakeholders, so that they are able to make informed decisions. In this project, we initiated this process during formal and informal meetings.

At a Steering Committee meeting (Table 2), we presented information collected during the course of the project and the suite of multi-objective analysis outputs. This step was a culmination of the aforementioned activities, which serve as the basis for generating a marine

[6] In this analysis, cost was calculated for each planning unit based on the compatibility of activities contained within the specified area. See Appendix E.

zoning design (i.e., stakeholder engagement, establishing clear objectives, building a multi-objective database and decision support products). Figure 8 shows the final draft marine zoning design based on that review.

The meeting began to lay out a clear process toward a zoning configuration that was feasible for all sectors, minimizing conflict and achieving goals in an optimal way. In addition, we talked with fishers about the draft zoning design produced by the Steering Committee. Overall, fishers recognized the mounting conflicts and in principle supported implementation of some closures, particularly on a seasonal basis. Additional meetings with the Steering Committee and stakeholder groups occurred as this document was going to print and are not reported here. Recommendations generated from these meeting are incorporated in the draft zoning design (Figure 8) and in the Discussion section of this document.

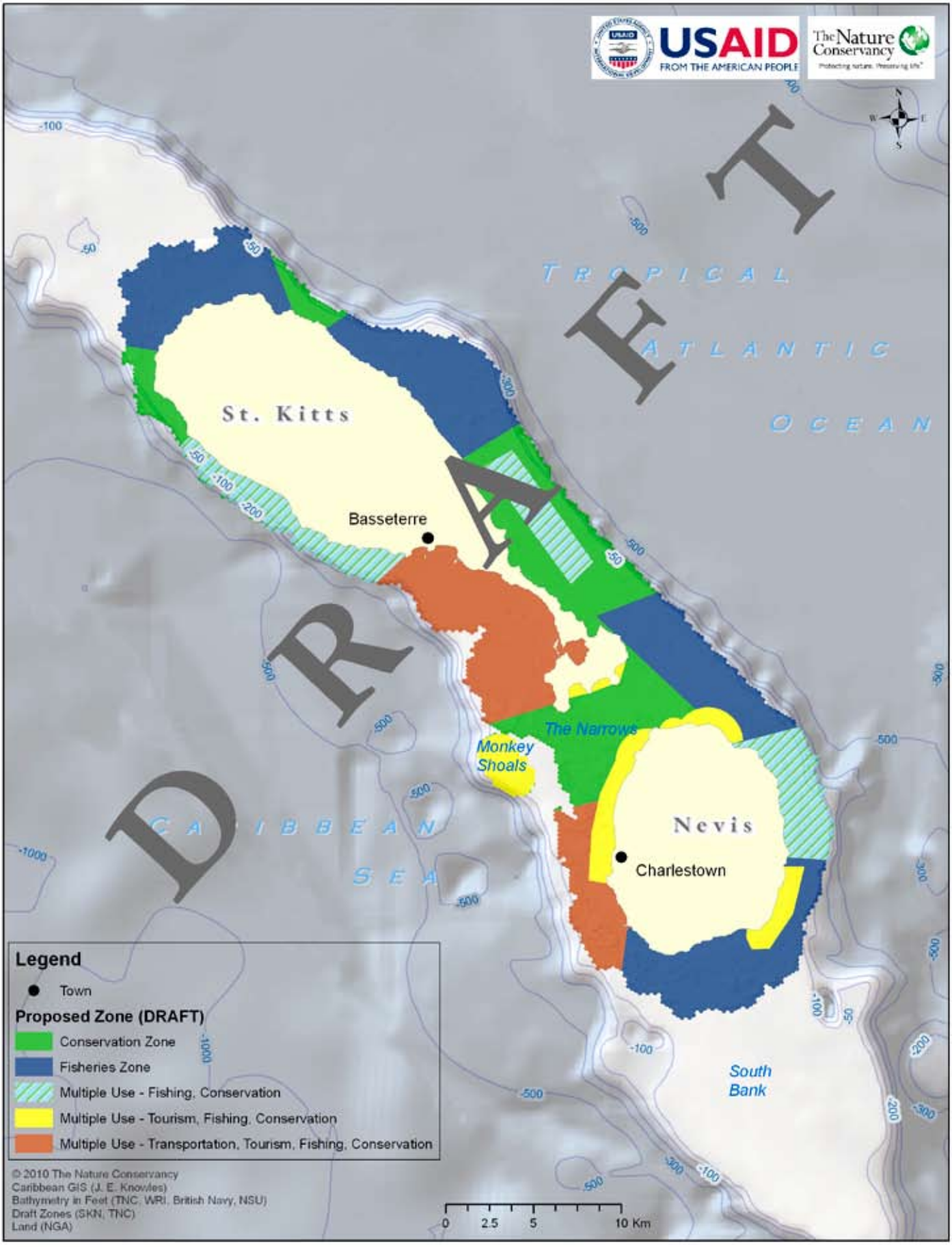


FIGURE 8. Final draft marine zoning design based on steering committee review.

Steven R. Schill

4 DISCUSSION

4.1 Putting Saint Kitts and Nevis on the Zoning Map Worldwide

The vulnerability of marine areas and the ecosystem services they provide is becoming more and more apparent. Human dependence and impacts on marine resources are on the rise. Ocean zoning is often invoked as a tool that will help slow the degradation and overexploitation of marine resources (Agardy 2010, Ehler and Douvere 2007, Klein *et al.* 2009, Crowder and Norse 2008, Douvere 2008).

In St. Kitts and Nevis, the need to address a number of management objectives under a common framework is apparent, and the marine zoning process initiated with this project holds great promise to fill this need. Zoning can serve as an integrative process in which "planners must recognize connections, including connections between different elements in an ecosystem, between land and sea, between humans and nature, and between uses of ocean resources or ocean space and the ability of ecosystems to deliver important goods and services" (Agardy 2010). It can also provide "the space for an open debate between different marine sectors, active in a certain area, in order to identify conflicts and means of co-existence between sectors—an objective deemed crucial for ocean management" (Barale *et al.* 2009). This project facilitated this integration and open debate between sectors and has laid the groundwork for increased dialogue.

Before this project, decision makers and stakeholders in St. Kitts and Nevis generally did not have an integrated view of marine systems, and little capacity existed for marine spatial planning. The decision support tools developed during this project enable stakeholders and decision makers to take an integrated view of the ocean. Ultimately, these tools could help the people of St. Kitts and Nevis to take a holistic approach to marine management and to make decisions resulting in sustainable use of their ocean waters.

4.2 Moving From Design to Implementation

The decision of exactly where and how marine uses should be allocated in space (a zoning plan) ultimately lies with the people of St. Kitts and Nevis through their government and management agencies. The decision support products developed in this project should be viewed as building blocks that collectively provide a foundation for a final zoning plan. No single tool provides the "golden key" to sustainable marine resource management. The suite of products discussed above can be used to support an in-depth public process started during this project, that analyzes both the spatial and temporal patterns of human activities in marine areas in order to achieve balanced requirements for ecological, economic, and social objectives. Inevitably, there will be multiple, cumulative, and conflicting uses of the sea. As a result of this project, each sector group – tourism, fisheries, conservation, industry, transportation – can develop a greater understanding about the need for solutions to be negotiated and a compromise agreed upon for the benefit of everyone. The decision support products developed during this project have already begun to facilitate such discussions.

The challenge for St. Kitts and Nevis will be to keep the process moving forward and arrive to a fully integrated marine zoning plan to support sustainable use of the ocean. Many other zoning efforts have ended at the planning stage without reaching the implementation phase (Agardy 2010). Activities conducted during this project can be leveraged to prevent a similar outcome in St. Kitts and Nevis. In the short term, we recommend that the people of St. Kitts and Nevis consider taking the following steps to keep the zoning process moving forward:

- Finalize the zoning design and describe specific uses allowed in each zone
- Officially adopt the marine zoning design
- Continue public and government engagement
- Continue to develop the governance framework (for important guidance on this see Appendix F) including working with Ministries to reaffirm high-level government mandate
- Complete the drafting of new legislation to support marine zoning (for important guidance see Appendix F)
- Integrate the outputs of this project into other sectors of government, especially coastal zone management, fisheries management, and protected areas planning

The role of the Steering Committee established during this project is vital. All activities outlined above should be coordinated by this committee. Its membership should be re-evaluated to ensure that private sector representatives are included.

A number of other longer-term activities to support implementation of the marine zoning plan will need to be considered (e.g., design a monitoring plan to help evaluate zoning plan efficacy, develop a budget for management operations). A full discussion of these is outside the scope of this document; for these we refer the reader to the wide range of publications that synthesize and document other zoning efforts worldwide (e.g., Day *et al.* 2007, Day 2008, Douvere 2008, Douvere *et al.* 2007, Gilliland *et al.* 2008).

4.3 Incorporating Expert Knowledge and Supporting a Participatory Process

Building a spatial database that represents uses and characteristics of an ocean space requires integrating a wide variety of information and is essential in a marine zoning process. For most small island tropical nations where financial resources are limited, such spatial data is typically inaccurate, out of date, or not available. This project deployed approaches that leverage local knowledge concerning marine space and the uses it supports, as well as tools that allow for a rapid assessment of ecosystem components. It demonstrates the types of approaches and tools that can be deployed to facilitate the collection of expert information. While detailed field surveys will be necessary to measure the status of ecosystem health for the waters of St. Kitts and Nevis, rapid assessment tools such as those used in this project (i.e., mapping of habitats and fishing values) allowed for a baseline description of where important habitats and uses occur.

For an ocean zoning plan to be achievable—that is, supported by user groups and feasible in the local context—the design process should be as participatory as possible. This project required a major commitment to engaging local communities and government agencies in the marine zoning process. To ensure participation, the project conducted activities ranging from stakeholder workshops to field data collection. These steps helped to engage key stakeholders and to forge important partnerships. The resulting in-country partner relationships were a key asset and greatly benefited the draft zoning design. Information flowed in both directions, both to and from the in-country project partners and the project team, an essential ingredient of any marine zoning process (Agardy 2010). With the decision support tools and draft zoning design now available, the process of engaging the public and developing a national appreciation for the ecosystem services provided by the ocean is more feasible. Support for the zoning plan from the general public will be key to its eventual success. The foundation developed during this project to facilitate community input and access to information (e.g., the establishment of a Steering Committee, printed maps, and interactive database housed in-country with multiple agencies and NGOs) can continue to be leveraged by the citizen of St. Kitts and Nevis and serve as a model for other places engaging in marine zoning efforts.

4.4 Challenges and Lessons Learned

One purpose for conducting this project was to uncover challenges that may be encountered during a marine zoning process and to develop solutions and recommendations that could be applied not only in St. Kitts and Nevis but in other places. This section describes challenges and lessons that this project identified for marine zoning.

4.4.1 Establishing In-country Partnerships

We invested a great deal of time and resources in forging relationships with government Ministries, their respective agencies, and stakeholders of St. Kitts and Nevis. These relationships were instrumental for many activities from project management to collection of data during field surveys. However, cultivating stakeholder involvement in every step of the process often diverted effort from other priorities such as scientific analysis. Initially, building and maintaining these important relationships was especially difficult because none of the core team members lived in St. Kitts and Nevis. This issue was resolved by adding an in-country project coordinator to the core team. Having a local counterpart with good government contacts was essential to

the effort. Similar projects should carefully allocate sufficient resources to build relationships, effectively engage stakeholders, and provide outreach to the general public. Finding a balance between ensuring a participatory process and maintaining leadership to reach the project's goals is tricky and should be considered carefully in these types of efforts. In addition, the government agencies for fisheries, planning, and other relevant areas of responsibility in St. Kitts and Nevis are stretched thin due to low number of staff and lack of funding available for staff positions. A serious need exists for additional government staff with expertise in marine resource management.

4.4.2 Conducting Stakeholder Workshops

We dedicated significant time and effort to planning and conducting three stakeholder workshops where essential elements of a zoning plan were defined. We took great care to deploy effective approaches to facilitate discussion, to engage stakeholders, to record their opinions and needs, and to incorporate the information into the decision support products. Bringing together such diverse interests and facilitating discussion among stakeholders was not a simple task. Future efforts should consider investing additional resources in planning and deploying appropriate facilitation tools. Furthermore, while our mapping and data-verification efforts were instrumental in building relationships with the fishers of St. Kitts and Nevis, we need to ensure more participation of fishers at stakeholder meetings. This will likely require providing options for meeting venues and for schedules that will accommodate everyone's livelihoods.

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Participants in the project kickoff meeting work on the St. Kitts-Nevis Vision Map.

4.4.3 Representing Habitats and Uses at the Edges

As mentioned earlier, the need to develop a zoning plan that would extend to the limit of the EEZ was identified by all parties early in the process. However, our ability to collect spatial data for habitats extending beyond the 30-meter depth contour line was limited given the scope of resources for this project. Future efforts should carefully consider this element and invest in

approaches and tools aimed at describing deeper habitats and offshore waters. In addition, the inshore boundary for our study area was defined as the farthest extent of seawater influence. While we did include information on sand mining and some other land activities that affect coastal waters, important influences such as watershed inputs and coastal development were not included. While we decided early on that these land-based influences were beyond the scope of this project, they need to be addressed at some point to improve the effectiveness of any eventual zoning plan. Approaches to human impacts and activities on coastal lands, short of including them in a full land-sea zoning plan, should be developed. Opportunities to leverage the current maritime boundaries project and a latent coastal zone management program should be considered.

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Coastal development is an important influence on the marine ecosystem. It was outside the scope of this project but should be considered as part of the marine zoning process.

4.4.4 Representing the Future Vision

An ocean zoning process is about creating a desired future, not just documenting present conditions (Agardy 2010). Although we dedicated considerable effort to helping citizens of St. Kitts and Nevis to define a shared vision (see first workshop in Appendix A), we struggled with spatially representing that shared vision and explicitly incorporating the vision into

quantitative and analytical tools. While the decision support products developed here are successful at representing current conditions, they are not effective at depicting projected uses of the ocean into the future. At present, there seems to be a disconnect in most zoning efforts between the desire to represent human uses and impacts into the future (including climate change impacts) and the ability to map projected distributions of system characteristics (both ecological as well as human uses) into the future. There is a need to develop practical examples of approaches that link current state and future vision for marine space. While ocean zoning represents a promising framework to do so, the lack of existing data and tools makes it difficult to address this need.

4.4.5 Integrating Ecological and Socioeconomic Data

Ecological and socioeconomic information need to be integrated to effectively represent the variety of uses occurring in the ocean and the habitats supporting them. Prioritizing the collection of a wide variety of information across this spectrum and integrating this information can be challenging. Making balanced decisions on investments of data resources, acknowledging the mismatch in scale between types of data, and making transparent choices to overcome this challenge is essential. This project filled important data gaps, prioritizing both ecological and socioeconomic information and conducting rapid assessment surveys to build the information base for zoning. The following strategic investments would strengthen this integration for future marine planning efforts in St. Kitts and Nevis:

1. Develop cost-effective methods and tools to map marine habitats beyond the 30-meter depth contour and on offshore banks.
2. Develop approaches for integrating data from a multitude of spatial scales.
3. Invest resources in describing the current state of ecosystem health, understanding the socioeconomic fabric of the islands, and monitoring ecosystem changes.

4.4.6 Using Systematic Conservation Planning Tools

The systematic conservation-planning tool applied in this project (Marxan with Zones) helped organize a wide range of information and assign actions to specific locations across the seascape. Like any modeling tool, Marxan with Zones presents a set of challenges and opportunities. There is a danger of such tools becoming a "black box" with choices and assumptions unclear to stakeholders, setting up a negative chain reaction against other decision support products. In order for these tools to be useful, it is important that they are applied in the most transparent manner, with stakeholder involvement in the definitions of key assumptions and parameters. The participatory process that took place during this project facilitated stakeholder input at a number of key analysis junctures, producing zoning scenarios that reflected community input. Facilitating that input proved to be challenging, as a transparent synthesis of underlying assumptions and necessary inputs is not simple to convey. A careful balance between leadership and stakeholder participation needs to be struck for this process to be productive. Future efforts should continue to strive to communicate the importance of balancing the two and to facilitate stakeholder discussions that support this approach.

The Marxan with Zones software represents a new generation of systematic planning tools in which multiple needs and desires of people are considered in one framework. While Marxan with Zones is an evolution of the widely used Marxan software and may seem similar in look and feel, the two have important differences in information requirements. In addition

to ecological data, Marxan with Zones requires a considerable amount of data on ecosystem services and people's desires regarding ocean uses. This difference needs to be considered carefully when evaluating data needs and the required resources for data collection and analysis. Model outputs are only as good as the data used to build them.

While the need to integrate ecological and socioeconomic information into conservation planning efforts is increasingly apparent, there are still few examples of projects that have done so with Marxan-based modeling for marine systems (Klein *et al.* 2009, Watts *et al.* 2009). We should continue to prioritize activities that identify, distill, and communicate lessons learned from these projects and that strengthen this type of integration. These efforts should include development and application of field survey tools such as the ones we deployed here, as well as spatial modeling approaches to supplement and integrate current datasets.

At the end of the day, it is important to remember that the outputs of these types of tools provide decision support and should not be considered the decision makers alone. For example, the model results that we provided in Marxan with Zones scenarios can reveal areas that are important for habitats and human activities based on specified goals across multiple sectors. They can also be used to identify important sites for management action, which can be especially useful for governments working with limited resources.

4.4.7 Matching the Scale of the Problem and the Solutions

There is a fundamental dilemma in ocean management: the scale at which we can readily practice effective management and the scales at which marine ecosystems operate are very different (Agardy 2010). This is a very common problem in small island developing states. Successfully achieving sustainable ocean use will require recognition of this problem, mobilization of resources to develop solutions, and leadership in driving change. The citizens of St. Kitts and Nevis are faced with this dilemma as a number of operational management scales exist, including a very island-specific approach to planning and management and two separate governance structures. This project has laid the foundation for a potential federation-wide approach to zoning the waters surrounding St. Kitts and Nevis. We strongly recommend taking a federation-wide approach, as this will be the only effective path to sustainable use of ocean resources. While we anticipate that there may be significant challenges during implementation, we do believe that the marine ecosystem of Saint Kitts and Nevis should be considered and managed as one space.

4.5 Looking to the Future

Thinking strategically and planning for sustainable use is imperative in today's overexploited marine systems. In St. Kitts and Nevis, the need to address multiple management objectives under a common framework is apparent, and the marine zoning process initiated with this project holds great promise to fill this need. This project helped to identify connections between humans and nature, and between uses of the ocean and the ability of ecosystems to deliver important goods and services. To fully understand these important connections, information such as use and characteristics of offshore habitats and current health of the marine ecosystem (e.g., coral reefs and fish populations) should be added to the information base developed in this project (see Section 4.4.5). Predictions of future conditions in the marine ecosystem of Saint Kitts and Nevis and the implications for resource management within the context of climate change should also be prioritized.

Efforts should also be focused on leveraging activities conducted during this project and the integrated platform that now exists, such as the spatial database. A strong coordinated public outreach program should be set in place and build on the range of stakeholder engagement activities conducted during this project. The role of the Steering Committee will be central to achieving these actions and should be carefully evaluated and refined.

All resource management takes continued effort and inputs. Marine zoning is still in its early stages in St. Kitts and Nevis, as it is throughout the world. Currently, the capacity of the country's marine management agencies is limited and needs to be addressed; co-management arrangements are one possible mechanism to help supplement this capacity. Ultimately, additional funding will need to be secured in order to move this process forward. Moving the marine zoning design generated for St. Kitts and Nevis to a fully implemented marine zoning plan will take a concerted effort on the part of government, user groups, NGOs, and the international community. Unfortunately, many zoning efforts stop at the planning stage and never move to the implementation phase (Agardy 2010). It is our hope that this will not be the case here. As a result of this project, the people of St. Kitts and Nevis have laid a solid foundation for sustainable marine resource management that can incorporate multiple uses and user groups. Every effort should be made to continue to support the process provided through this project for open debate among sectors that helped to identify conflicts and means of co-existence between sectors.

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