A Protocol for MPA Data Collection and Comparison: Case Studies in Temperate and Tropical Oceans

A Capstone Project
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in the
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Bachelor of Science

By
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To the ESSP Faculty:

Oceans provide many consumptive and non-consumptive uses, such as: food, medicine, jobs, recreation, education, cultural and historical resources, the cycling of nutrients, and biodiversity. Today our oceans are facing many significant problems, many of which are human caused. In order to manage our ocean resources, marine protected areas (MPAs) are established. The purpose of this capstone project is to propose a protocol for collecting detailed, site-specific information for MPAs so that this information can be compared and contrasted to other MPAs worldwide. This protocol is in the form of a spreadsheet, and it includes information on the location, establishment, physical and biological characteristics, human uses, negative threats, regulations, and management strategies. An "inventory" of MPAs is a valuable tool that would compliment the current efforts to protect and sustain our ocean resources, both ecologically and socioeconomically.

I have demonstrated how the proposed protocol for MPA information can be used by filling out a spreadsheet for seven case studies worldwide in temperate and tropical oceans. I used these spreadsheets to determine the major threats to each MPA and the management strategies that address these threats, to see if effective management is taking place. I also used the spreadsheets to compare similar threats in the seven MPAs and make suggestions on what management practices have been the most successful, so that these can act as a model to the MPAs that are not successful.

I have learned that every MPA has strong points and weak points. I think it is critical for MPA management teams to work together, sharing information so that effective management in similar ecosystems can act as models for the rest of the MPA world. It is through the collaborated works of many organizations and stakeholders that MPAs are effective.

The audience of this capstone project includes MPA managers, scientists, students and faculty in the field, and professional organizations that strive to achieve effective ocean management. I have had many personal emails and phone conversations, and a couple personal meetings with professionals in the field who have offered their suggestions and also inquired about my project, like Jane

Lubchenco and Renee Davis-Borne of PISCO (Partnership for Interdisciplinary Studies of Coastal Oceans) and Oregon State University, Kaya Pederson and Charlie Wahle of the MPA Center in Santa Cruz, Erica Burton and Sean Morton of the Monterey Bay National Marine Sanctuary, and Marjorie Ernst from NOAA. I have also contacted the editor of the MPA News (newsletter) who said he would be interested in my final project. This capstone started out as a graduation requirement, and it has turned in to an important part of my life. I would like to further my knowledge about effective ocean management.

My capstone project can and is going to be applied to the real world. Several scientists, the MPA News, the MPA Center, and NOAA would like a copy of my capstone report. I am offering real world suggestions on how to improve the effectiveness of MPAs. I would especially like to help provide information and suggestions to sustain fisheries while minimizing the economic damages to all stakeholders.

In going into this project, I didn't think MPAs were going to be a hard subject to study, since they are a hot topic in these days, but that has definitely changed. Although there is a lot of information available about MPAs, there is always a new policy, newsletter, meeting, environmental catastrophe, etc. happening, so you never stop learning (or working). I also didn't think that MPAs were so controversial. For example, I never realized the arguing and strong feelings that fishermen, scientists and management teams go through to fight for their cause. More surprisingly is the lack of communication between scientists and economists.

This capstone should be assessed in the Areas of Depth 3 (knowledge in the physical/life sciences) and 4 (application of economic/political knowledge).

Thank you for your time and all your help. I hope you enjoy learning about effective ocean management.

Sincerely,

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Abstract

Habitat degradation and depleting fisheries are a significant problem in today's oceans. Human impacts such as overfishing, destructive fishing practices, pollution and recreation have contributed to unhealthy marine ecosystems. These marine ecosystems are of great importance historically, biologically, and economically. Marine Protected Areas (MPAs) have been established to protect marine biodiversity, conduct scientific research and education, promote natural and cultural resources within a certain area, and reduce user conflict among stakeholders. In this paper, seven MPAs located throughout the world in temperate and tropical oceans are researched. A template spreadsheet was created for each MPA that provides detailed information including the location, biological, physical and ecological processes, human uses/economics, major threats to the site, and management regulations and strategies. These spreadsheets may be used by scientists and policy makers as a management tool when planning new and proposed MPAs, or when comparing existing MPAs. For instance, this paper uses the spreadsheet template to explore the major threats of each MPA in order to see if the management strategies successfully address the threats. In doing so, the management strategies addressing these threats, such as lack of regulation enforcement, have been compared to other MPAs with the same problem so that the best strategy for enforcing laws in an MPA can be shown as an example to others. The ultimate goal of this project is to help provide necessary information to MPA management teams via an information display protocol so that successful management of our oceans is practiced throughout the world.

1.0 **Introduction**

About 71% of the Earth's surface is covered by ocean. Since there is life throughout it, the ocean "constitutes the single largest repository of organisms of the planet" (Nybakken, 2001). In this large sink of life occur many marine ecosystems that provide invaluable goods and services to the rest of the world. Some of the most important resources that oceans provide for humans are food, jobs, medical resources, education, and recreation. Marine ecosystems like coral reefs and kelp forests also provide complex habitat and generate biodiversity. Less obvious, but vitally important, services of ocean ecosystems include global nutrient cycling, transformation, waste degradation and sequestration (Peterson and Lubchenco, 1997).

Marine ecosystems are generally very productive and diverse ecosystems, but they are continually subjected to threats from multiple stresses: habitat loss and degradation, pollution – including pesticides, sewage, heavy metals and oil, among others, global climate change, overexploitation, and species introductions. Impacts to coastal marine communities are often species-specific, but magnify in effect throughout the entire ecosystem because of complex inter-connected relationships between species at different trophic levels. Therefore, one species may have a direct or indirect effect on the ecosystem, which could lead to the loss of many species (Suchanek, 1994). For example, a whole kelp forest can be affected by the abundance of sea otters and sea urchins. In southeastern Alaska a study concluded that sea urchin biomass had decreased by nearly 100% in areas where sea otters had colonized, which allowed the rapid growth of the kelp forest (Nybakken, 2001). In similar areas with no otters, sea urchins can thrive and the entire kelp forest ecosystem can become unbalanced. In order to avoid the stresses that cause serious changes in an ecosystem, we need to continue to learn about marine ecological processes.

Throughout the tropical oceans of the world, coral reefs provide an invaluable resource to global populations of marine and human life. Their ecosystems and those they support are among the most diverse in the world. They are a renewable resource, in that they grow in time according to biological processes. Unfortunately, they are also severely threatened.

The health of tropical coral reefs and the more temperate ecosystems that we have here off the coast of California like kelp forests, rocky shores, and intertidal zones are crucial to the survival and sustainability of the marine life they support. Not only is biodiversity the issue at hand, but these ecosystems also provide a home for commercial fisheries, medical resources, cultural resources, income from tourism, and jobs.

According to the Food and Agricultural Organization, over two-thirds of the world's commercial fisheries are overfished or at their sustainable limits (Agardy, 1999). World population growth has increased so much that the demand for fisheries as a source of protein has turned in to a $95 billion dollar industry (U.S. dollars) (Alden, 1999). However, troubled fisheries are not the only concern in fisheries management today. Bycatch, unintentional species caught during commercial fishing that get thrown overboard injured or dead, accounted for one third of the annual marine fish caught it 1995 (Alden, 1999). Many of these bycatch species are threatened or endangered species, like the endangered Pacific green or black sea turtle, *Chelonia mydas,* in Estero Banderitas, Bahía Magdalena, Baja California, Mexico (Anderson et. al, 2001). Black turtles in this mangrove channel are often subjected to gill nets because the area is an important fishing ground for finfish (Anderson et. al, 2001).

The use of Marine Protected Areas (MPAs) can be an effective way to manage the problems of our oceans. MPAs are used as a management tool to protect and conserve marine biodiversity, to increase scientific knowledge of marine ecosystems, to protect endangered species, to enhance commercial and recreational activities, to reduce user conflict, and to enhance the long-term sustainability of the ocean's resources (National Oceanic and Atmospheric Administration (g), 2001 *and* Potter, 1994). These resources include not only natural resources but also cultural and historical resources, like shipwrecks and fossil beds. It is crucial that we recognize successful management strategies so that we can apply them to all marine areas that are under pressure for survival.

There are many different definitions of a MPA. For this study I will use the definition that is in President Bill Clinton's Marine Protected Areas Executive Order # 13158: "any area of the marine environment that has been reserved by Federal, State, territorial, tribal, or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources therein" (Clinton, 2000).

There are many different kinds of MPAs. They include the following: marine reserves, coastal sanctuaries, areas of special biological significance, ecological reserves, national wildlife refuges, national marine sanctuaries, national parks, ecological preserves, fisheries management zones, national seashores, critical habitats, national estuarine research reserves, and many others

(McArdle, 1997 *and* NOAA (h), 2001). They can be areas with no consumptive use or multiple use areas. They can also range in size and shape; Glacier Bay National Park and Preserve in Alaska covers more that 3.3 million acres (NOAA (g), 2001), while the Cordell Bank National Marine Sanctuary in California encompasses 526 square miles (NOAA (b), 2001).

Sometimes MPAs are established for the main purpose of protecting a highly endangered species, and as a result an entire ecosystem becomes protected. An example is the sixteen Dugong Protection Areas that were established in the Great Barrier Reef World Heritage Area in 1997 (gbrmpa.gov.au, 2002). Dugongs are considered to be vulnerable to extinction. The Dugong Protection Areas were established to protect dugongs from direct impacts like being hit by boats and being drowned by fishing nets. However, there were also indirect impacts to the dugongs. The important populations of dugongs that live in the Great Barrier Reef depend on the vast seagrass meadows as a main source of food. Unfortunately, human activities and pollution has caused decreased water quality that directly affects the growth and productivity of the seagrasses (gbrmpa.gov.au, 2002). This became a critical habitat to protect for the sake of the dugongs, and in turn the entire habitat is being protected from human impacts.

The very first MPA was established in the year 1879 in New South Wales, Australia (Davis, Feb. 2002). The majority of Royal National Park is terrestrial, but it lies at the coastline, so there is some intertidal habitat. The park consists of a variety of terrains, such as rivers, rainforest, cliff tops and beaches (npws.nsw). Mollusks are an example of a protected marine organism in Royal National Park (Davis, Feb. 2002).

The MPA system is still a fairly new science. Most MPAs have focused primarily on reef ecosystems in tropical oceans, while reserves with temperate species are less understood (Davis, Oct.1999). There are more than 660 MPAs that incorporate coral reefs today (Davis, Sept. 2001 (a)). The need for sustainable fisheries is obvious not only in coral reef ecosystems but also around the world. Marine protected areas (MPAs) are urgently needed to protect and conserve important species from overfishing and bycatch but also communities of marine organisms, ecological processes and the entire health of the ecosystem, which is critical to our world oceans' overall well being.

MPAs can prove crucial to the survival of threatened species, marine resources and habitats if they have the right management strategies addressing site-specific problems. Today many scientists are working on projects to find out just how well MPAs are working. But how do we evaluate the effectiveness of MPAs? It is not a simple question, but it is a necessary question to ask so that MPAs can be assessed in order to find out if they are working properly, which is the reason why they were established in the first place. Sometimes it can be easy to think an MPA is effective if the ocean area gets a lot of attention, perhaps from tourism. But without evaluation of management strategies, we cannot know for sure.

For example, marine reserves (zones closed off to all fishing) are often placed within an MPA to replenish fish stocks to a sustainable level. Though there is little information on the effects of reserves, there are some scientists who are finding out that marine reserves are indeed beneficial to fish stocks.

For instance, Dr. Callum Roberts, a biologist at the University of York, U.K., and his colleagues from the U.S. National Marine Fisheries Service and the University of the West Indies did a study that may provide sufficient reasons for global efforts to establish MPAs in response to declining fish stocks. In their study, they examined the fishery benefits, if any, from marine reserves. They focused their study on a five-year-old network of marine reserves off the Caribbean island of St. Lucia and an area off NASA's Cape Canaveral rocket launching site in Florida, which had been closed for almost forty years (Malakoff, 2001).

In St. Lucia, the Soufriere Marine Management Area (SMMA) was established in 1995, which includes a network of five marine reserves that include about 35% of coral reef fishing grounds (Roberts et al, 2001). These marine reserves were initially established because of the overexploitation of reef fisheries. Roberts and his team studied the reef fishery in the network of marine reserves for two 5-month periods, the first period being right after the SMMA was established, and the second period in the year 2000-2001, five years after the initial protection of the coral reef habitats (Roberts et. al, 2001). Two fish-trapping methods were used to collect data. A comparison was made in fish catches and catch per unit effort (CPUE) between the two study periods for the two primary forms of fishing gear used in the St. Lucia reef fishery. Their findings proved that marine reserves in the SMMA were effective. Catch per trip and CPUE both increased since the MPA was established. There was also increased biomass of commercially important reef fish in the reserve and in adjacent fishing grounds (Roberts, et. al, 2001).

In Florida, reserves were designated to prevent access to a rocket launch site, with the secondary goal to protect estuarine habitats and migratory fish species (Roberts, 2001). Their results from the two studies confirm that MPAs can play an important role in supporting fisheries:

> "Within 5 years of creation, a network of five small reserves in St. Lucia increased catches of artisanal fisheries by between 46 and 90%, depending on the type of gear the fisher used. In Florida, reserve zones in the Merritt Island National Wildlife Refuge have supplied increasing numbers of world record-sized fish to adjacent recreational fisheries since the 1970s" (Roberts, 2001).

In St. Lucia, many local fishermen who depend on fisheries as their livelihood were very upset when marine reserves were first put into effect in 1995, although the primary purpose of the reserves was to rehabilitate commercial reef fisheries. Before the reserves were established, these fisheries were severely overexploited, and replaced by smaller, less desirable fish (Roberts, 2002). Many fishermen at the time did not understand how closing off sections to all fishing would help them in the long run.

Although benefits from marine reserves do not come immediately for fishermen, giving the fish time to mature and reproduce before they are caught will increase size and abundance in the reserves and in adjacent areas in St. Lucia reef habitats. By studying fish stocks in the SMMA, Dr. Roberts and his team have evaluated the effectiveness of the MPA, and more importantly, proved that the MPA is effective in it's management strategies of a network of five marine reserves.

More locally, Benjamin Halpern, a graduate student with the Department of Ecology, Evolution, and Marine Biology at the University of California Santa Barbara, has focused his research interests in evaluating marine reserve effectiveness for the purposes of marine conservation and marine resource management. His research project, *The Impact of Marine Reserves: Do Reserves Work and Does Size Matter?* (Halpern, in press) includes an extensive assessment of the biological impacts (density, biomass, size of organism, and diversity) of organisms in 89 different marine reserves. His results concluded that all four biological impacts were significantly higher in the established reserves as opposed to the same areas before the reserves were made for carnivorous fishes, herbivorous fishes, planktivorous fishes/invertebrate eaters, and invertebrates. He also concluded that the impacts of reserves, such as the proportional differences in density or biomass, are independent of the size of the reserve. Halpern suggests that the effects of marine reserves increase directly with reserve size rather than proportionally (Halpern, 2002).

One local MPA that is currently being studied for the purposes of establishing a network of marine reserves are the Channel Islands, located about 25 miles off the coast of Santa Barbara, California (NOAA (h), 2001). This environment is special to scientists as well as its inhabitants because the islands are a meeting place for fish species from as far north as the Bering Sea, and as far south as Baja California (Davis, May 2001 (a)). The US federal government designated the area in 1980 as the Channel Islands National Marine Sanctuary (CINMS), mostly for protection against near-by ocean oil drilling. The current focus today is the loss of biodiversity and the steady decrease of fisheries.

In response to a request from the Channel Islands Marine Resources Restoration Committee, the California Department of Fish and Game (DFG) and the CINMS and have made a recommendation to establish a network of marine reserves throughout the sanctuary (State of California, 2000), (with the help of the CINMS Marine Reserve Working Group and the Marine Reserve Science Panel proposal) with the main goals of: ecosystem biodiversity, enhanced recreational and educational opportunities, a reference point for scientists to measure changes in the environment, and sustainable fisheries (State of California, 2000). Ecosystem biodiversity would include the protection of marine habitats, populations of interest, and ecological processes. In order to achieve sustainable fisheries, their goal is to integrate marine reserves into fisheries management. The current challenge today in managing and designating reserves in to this MPA, as well as MPAs elsewhere, is finding a way to integrate ecological research and monitoring so that socioeconomic losses are minimized.

The purpose of this project is to develop a framework for collecting information and exploring the effectiveness of management in new and proposed MPAs. In addition to data collection, this framework can help communicate the value of protecting marine ecosystems and all the resources they hold to the public and to stakeholders involved. The suggested framework includes an inventory of specific MPAs with information on each MPA such as location, establishment, physical and biological characteristics, human uses/economics, negative impacts/threats, regulations and management strategies. A sample framework spreadsheet outlining these specific categories will be available to MPA planners and managers as a comparative tool **(Appendix A)**. This spreadsheet can be filled out for any existing or planned MPA and compared with existing spreadsheets of other MPAs to look at the general trends and to facilitate effective management.

An inventory of this type can be used to help answer questions about MPA effectiveness. A second goal of this project is to address one pertinent question facing MPAs today: how well do management practices and policies address the specific threats facing an existing MPA? For example, most MPAs have many specific regulations and zones that pertain to fishing practices in order to sustain valuable marine resources and habitats that may be threatened or endangered. However, some MPAs are so large that they can't enforce these regulations because they don't have enough manpower and resources to do so properly. By using my spreadsheets as an information tool, they can be used to answer two vital questions regarding the health of an MPA. These questions are:

1.) What are the major threats to each MPA?
2.) Do the management strategies properly address the major threats to the MPA?

I am going to use my spreadsheets to answer these questions for each of the seven MPAs I have inventoried.

2.0 Methods

Template

Seven MPAs have been chosen as case studies for this project, three in temperate ocean and four in tropical oceans. Each of the seven MPAs have been researched in order to fill in the framework inventory proposed. I have made spreadsheets for each MPA that include detailed site-specific information. There is also a blank spreadsheet so that other MPAs or planned MPAs can fill one out in order to compare their sites to others around the world.

Filling in each section for the spreadsheets was done by doing research on MPAs, marine ecosystems, and each specific MPA case study. Research used included management reviews, websites, MPA News (a newsletter), scientific papers from journals and magazines, and current and past works done by scientists and organizations that have tried to answer similar questions. Personal contact was made with MPA advocates including Charlie Wahle, director of the MPA Center in Santa Cruz and MPA, MPA scientists from respected organizations like PISCO, (Jane Lubchenco and Renee Davis-Borne of PISCO and Oregon State University), and graduate students in the same field.

The categories for the spreadsheets include:

Location- description of location, latitude and longitude

Establishment- year of designation, who established the MPA, and primary and secondary agency responsible

Physical Characteristics- size of protected area, average temperature and salinity, maximum depth, coastal length, the number of overlapping MPAs, unique physical characteristics, and unique habitats found in the MPA

Biological Characteristics- diversity and endangered/threatened species

Human Uses/Economics- commercial and recreational fisheries, cultural resources, recreational uses, other uses within the MPA, leading industries along the coast, and stakeholders involved

Negative Threats- anything that threatens the health and well-being of the MPA

Regulations- commercial and recreational fishing regulations, what is prohibited, and marine zoning

Management strategies- strategies for water quality, public education/outreach, ecosystem monitoring, human interaction, resource protection, and research

Answering the specific questions for this project

For the purpose of this project, a few of the major threats in each MPA were identified, and the management strategies that pertain to those threats were examined to determine if they align with the threats. This information was gathered from using the spreadsheets that include details about the major threats that each MPA faces and what rules and strategies they have. By looking at the threats in each MPA, management strategies were compared to see if the two relate. This was done in more depth by reviewing research on the effectiveness of MPAs.

3.0 Results

Blank Template - See Appendix A

Cordell Banks National Marine Sanctuary

a.) **Background**

According to NOAA, Cordell Bank is one of the richest environments in the world. It was approved by NOAA to establish a NMS, and was designated on May 17, 1989 (NOAA (b), 2001), due to its unique geological, biological, and oceanographic resources. It lies at the edge of the continental shelf of California, about 60 miles northwest of San Francisco. The Bank is a part of a granite block that was created as part of the southern Sierra Nevada over 93 million years ago. Some of the sides of ridges and pinnacles have slopes greater than 80 degrees. The continental shelf (six nautical miles to the west of the Bank) drops down to a steep 6,000 feet (NOAA (b), 2001).

Cordell Bank is a designation ground for many migratory seabirds, fishes and marine mammals. Invertebrates can be found along the bank. CBNMS is currently used for commercial and recreational fishing, research and education. Since designation, the sanctuary has made progress in resource protection, research and monitoring, education, and visitor use (NOAA (b), 2001).

b.) Spreadsheet - See Appendix B.1

c.) CBNMS Major Threats:

Acoustics-

There has been an increasing noise problem within the sanctuary due to engine noise and the amount of commercial and charter activities that take place within CBNMS.

Degraded Water Quality-

Water quality in CBNMS has been degraded due to the close location of the heavy populated San Francisco Bay Area. Although CBNMS is an offshore site, trace-metals, oil spills and hydrocarbons are threats from the heavy vessel traffic in the sanctuary and the industries from the Bay Area. An estimated 1.4 + gallons of oil has spilled in the sanctuary since 1984, killing at least 13,000 seabirds all together (NOAA (b), 2001).

d.) CBNMS Management Practices:

Restriction of oil and gas exploration and extraction-

Restricting oil and gas activities and also the extraction of minerals, is a direct way to protect the seabed as well as the marine ecosystem from destructive actions. However, commercial fishing is allowed and seabed installation is allowed with permits and some restrictions (MPAs of the US, MPA Inventory, CBNMS), which is perhaps why one of the major threats to the sanctuary is seabed alteration.

Partnerships-

In order to research the causes and effects of oil spills and other water quality issues in CBNMS, partnerships have been made with other agencies like the Gulf of the Farallones National Marine Sanctuary's Beach Watch program and the California Department of Fish and Game's Office of Spill Prevention and Response (NOAA (b), 2001).

Gulf of the Farallones National Marine Sanctuary

a.) **Background**

Just a few miles off the coast of San Francisco, The Gulf of the Farallones National Marine Sanctuary protects a nationally significant marine ecosystem. It is home to 36 species of marine mammals, 54 species of birds, and 25 endangered or threatened species. The sanctuary provides many productive habitats, including near shore, estuarine, and intertidal. It serves as a feeding ground for the endangered humpback and blue whales, and a breeding ground for over half a million migratory seabirds and over one fifth of California Harbor Seals (NOAA (c), 2001).

The sanctuary was originally established because of concerns about oil drilling in the Gulf. Since it's designation as a NMS in 1981, the sanctuary has been successful in its educational and stewardship opportunities and it has reduced wildlife disturbances.

b.) Spreadsheet- See Appendix B.2

c.) <u>GFNMS Major Threats</u>:

Endangered/Threatened Species-

There are 15 threatened species, 17 endangered species, and 27 species of concern in the GFNMS (NOAA (c), 2001).

Sewage and Waste Discharge-

Waste disposal and sewage discharge are a major threat to GFNMS because it lies adjacent to the Bay Area.

Human Activity-

Recreational activities, low-lying aircraft, and heavy vessel traffic are threats to GFNMS.

d.) <u>GFNMS Management Practices</u>:

Regulations-

See Appendix B.2 for details on regulations. Examples of how regulations within the sanctuary have responded to threats are:

The ban of personal watercraft in sanctuary waters due to the destructive consequences it had on marine ecosystems and prohibiting the disposal of dredge material within the sanctuary (NOAA (c), 2001).

Alternative Uses of Sewage and Clean Dredge Material-

Clean dredge material can enter the sanctuary only to be used to restore wetlands. GFNMS and the City of Santa Rosa have worked for 10 years to come up with alternative uses for sewage – now the sewage system processes discharge for the use of irrigation and for recharging the aquifer that is used by the Geyser electrical company (NOAA (c), 2001).

Research, Monitoring and Public Education Programs-

The GFNMS has made many efforts in order to better serve the GFNMS. Efforts include two visitors centers, school programs and curriculum, newsletters, brochures, an annual lecture series, volunteer programs, and many research and monitoring programs like the Marine Mammal Population Assessment, the Sanctuary Education, Awareness, and Long-term Stewardship (SEALS), Rocky Intertidal Monitoring, and the Ecosystem Dynamics Study (NOAA (c), 2001).

Partnerships-

The GFNMS has partnerships with 5 education and research institutions, 6 federal agencies, 12 local and state agencies, and 14 nongovernmental organizations.

Marine Zoning-

Specific zones have been established in GFNMS in order to deal with heavy vessel traffic, human activities and to protect and promote biodiversity and ecological functions within the sanctuary, as it is home to the largest concentration of seabirds in the U.S. and thousands of marine mammals (NOAA (c), 2001). Zones include 11 Commercial Vessel Traffic Prohibition Zones, 11 Overflight Prohibition Zones, 1 Dredge Disposal Zone, and the overall protection of important habitats, feeding and breeding grounds (NOAA (c), 2001). See Appendix B.2 for details on zones.

<u>Additional GFNMS Strengths:</u>

- The GFNMS has more than tripled its budget since 1990, and staff has increased from one person to four people (NOAA (c), 2001).
- Two threatened species, the Grey whale, *Eschrichtius robustus,* and the American Peregrine Falcon, *Falco peregrinus anatum,* have been delisted since the designation of the GSNMS.
- A collaboration effort of seven state and national agencies has been made to enforce the regulations of GFNMS (NOAA (c), 2001).

Monterey Bay National Marine Sanctuary

a.) **Background**

The Monterey Bay National Marine Sanctuary is the largest marine sanctuary and the second largest MPA in the U.S. It encompasses over 5,000 square miles of ocean, and stretches along about 300 miles of California coastline. It was designated in 1992 after over a decade of hard work, including campaigning by the local citizens (NOAA (d), 2001). The unique geographical structure of the Monterey Bay (Monterey Canyon) provides an overlapping region where a wide variety of plants and animals thrive. The sanctuary is home to seabirds, fishes, sea turtles, marine algae, invertebrates, whales, sharks, pinnipeds, and sea otters. Some of these thousands of species are endangered or threatened (NOAA (d), 2001).

The sanctuary waters are subject to many human disturbances, including agriculture, commercial and recreational fishing, aquaculture, kelp harvesting, sand mining, commercial shipping and tourism/recreational uses. One of the major issues that the sanctuary is concerned with is the connections within the ecosystem and the connection between humans and the natural marine environment. Existing programs in the sanctuary include research, resource protection, education and outreach, and program support (NOAA (d), 2001).

b.) Spreadsheet- See Appendix B.3

c.) MBNMS Major Threats:

Degraded Water Quality-

Water quality in the MBNMS has been degraded by many factors, including contaminants from urban-based and agricultural runoff (street runoff, coliform bacteria, sediment, fertilizers and pesticides), toxins from sediment and wildlife, habitat loss, human health issues, old sewage systems, oil spills, vessel traffic and dumping, and altered rivers, streams and wetlands (MBNMS Water Quality Protection Program, 1996 and NOAA (d), 2001).

Overexploited Fisheries-

Many rockfish and nearshore fisheries are in danger of overexploitation. Six species of salmon or steelhead fish species are currently on the Federally Endangered/Threatened List, (NOAA (d), 2001).

d.) MBNMS Management Practices:

Fishing Regulations-

The MBNMS does not regulate fisheries.

Regulations Prohibiting Certain Actions- See Appendix B.3

Water Quality Protection Program-

The Water Quality Protection Program develops and implements strategies to address the water quality threats to the sanctuary while balancing the area's economic industries as well. The plan includes research and monitoring, regulation enforcement, public education, and technical assistance (MBNMS Water Quality Protection Program, 1996).

Agricultural and Rural Lands Plan-

The Agricultural and Rural Lands Plan is a collaborative effort to improve and protect the water quality in the sanctuary and surrounding watersheds. Those involved include the MBNMS, the MBNMS Water Quality Protection Program, six County Farm Bureaus, the Department of Agriculture's Natural Resources Conservation Service, Congressman Sam Farr, the California Coastal Commission, and local cities. The plan includes some of the existing management strategies of the regional, marinas and boats, and urban runoff monitoring programs. The plan has already installed bilge water pump outs and oil/water separator equipment at Monterey and Moss Landing Harbors (Ecosystems Observations, 2000). Another effort has been made to improve water quality in the MBNMS by a series of Model Urban Runoff Program Technical Training Workshops (Ecosystems Observations, 2000).

SIMoN-

The Sanctuary Integrated Monitoring Network (SIMoN) is a program that aims to identify and understand the changes that go in within MBNMS (NOAA (d), 2001). This extensive monitoring and data collection program includes the collaboration of local researchers, resource managers, educators and the public (NOAA (d), 2001).

Experimental Oculina Research Reserve

a.) **Background**

In 1984 the South Atlantic Fishery Management Council established the Oculina Bank Habitat Area of Particular Concern (HAPC) 15 to 30 miles off of Florida's east coast to protect the unique bank that is home to *Oculina varicosa*, a coral that is sometimes referred to as ivory tree coral (Smith, 2000). This closed the 92 square kilometer area to longlining, trawling, dredging, and trapping, as these fishing practices were proving to be destructive to the *Oculina* habitat (USGS, 1999).

Oculina Bank is a series of limestone pinnacles and ridges in which extensive *Oculina* colonies live on that support fish and invertebrate communities that are as diverse as tropical coral reefs. The dense populations of mollusks and crustaceans that live in this habitat serve as food for many commercial fisheries, such as different species of snapper and grouper, great amberjack, and red porgy (Smith, 2002). Gag grouper in particular is an important commercial fishery that spawns at the pinnacles annually (USGS, 1999). Because of the diversity of Oculina Bank, the *Oculina* reef ecosystem has been subjected to intense fishing (Smith, 2002). The gear has had a tremendous effect on the coral, and much of it is now just rubble.

In 1994, the National Oceanic and Atmospheric Administration (NOAA) approved a measure to expand the Oculina Bank HAPC in order to protect this fragile ecosystem from overharvesting and harmful fishing practices all together, as fisherman were still allowed to anchor and drop bait to the bottom. The newly expanded Oculina Bank HAPC was renamed the Experimental Oculina Research Reserve (EORR) and was closed to all bottom fishing for 10 years as an experiment to see if commercially valuable fish species such as groupers and snapper would rebound from the restriction of bottom fishing (MPAs of the US (g), 2002). In 1995 all anchoring was also prohibited in the EORR (Smith, 2000).

b.) Spreadsheet- See Appendix B.4

c.) <u>EORR Major Threats</u>:

Destruction of Coral Reefs-

Through decades of destructive fishing practices, like bottom trawling, bottom long lining, dredging, and anchoring, the endangered coral species *Oculina varicosa* habitat has been destroyed severely. *Overexploitation of Fish*-

Because the reef habitat has been crushed by commercial fishing practices, important fish populations have been reduced, for example, groupers and snapper fisheries (USGS, 1999).

d.) <u>EORR Management Strategies</u>:

Regulations-

All bottom fishing (commercial and recreational) and anchoring is prohibited in EORR because the coral is crushed and destroyed when bottom fishing occurs.

Research and Ecosystem Monitoring-

The National Marine Fisheries Service (NMFS), United States Geological Survey (USGS) and Florida State University conduct research observations and monitoring through the use of side scan sonar, video and photography, and sediment samples. Studies include estimations of fish populations and ecological processes of the reefs (reproductivity and larval transport) (USGS, 1999).

Habitat Restoration-

Scientists have been deployed various shapes and sizes of clusters of concrete (some that have coral attached to them already) in efforts of promoting new coral growth since 1995 (MPAs of the US (g), 2002). The most promising is a dome-shaped "reef ball" equipped with holes so that fish can swim through them. They are similar to the shape and size of an *Oculina* colony, and when released they already have coral attached. After one year of release into EORR, more reef fish were observed in the area than before the initial restoration (NOAA (f), 2001).

Florida Keys National Marine Sanctuary

a.) **Background**

There are 1,700 islands that make up the Florida Keys (NOAA (a), 2002). They are known worldwide for their coral reefs, even though they also support many significant underwater plant habitats like seagrass beds and mangrove forests. This diverse marine ecosystem provides a two billion dollar economy of tourism and commercial fisheries that Florida depends on (FKNMS, 1999). However, these reefs are vulnerable to the many anthropogenic pollutants that run into the water, the overharvesting of commercial fisheries, physical impacts, and tourist activities that are influenced and supported by the beautiful reefs themselves (World Resources Institute (b), 1998).

The Florida Keys National Marine Sanctuary was designated in 1990 and it includes 2,800 square nautical miles of water surrounding the keys. This sanctuary was established to protect the marine environments that support rich biological communities, recreational, economical, educational and historical values (FKNMS, 1999).

b.) Spreadsheet- See Appendix B.5

c.) <u>FKNMS Major Threats</u>:

Destructive Recreational Practices –

Warm tropical waters and beautiful coral reefs have contributed to tourism being one of the main economic industries in the Florida Keys. Boater accidents kill marine mammals, tourists snorkel and dive- touching, kicking, collecting and breaking coral, and destructive recreational fishing like spearfishing are popular activities.

Pollution-

FKNMS is subject to many forms of human caused pollution, including degraded water quality, sewage, pathogens and sediment. These factors have contributed to plankton blooms (resulting in the invasion of algae) causing the death and degraded ecosystems of fish, sponges, coral reefs, seagrass, and benthic communities.

A recent example of pollution in the Florida Keys was the 2,000 gallons of diesel fuel that spilled on January 3, 2002 when a shrimp boat grounded and the vessel broke (HC Studios, 2002).

Overexploited Fish-

Because the coral reef system is such an extremely diverse habitat (Appendix B.5, diversity and unique habitats), commercial fishing is one of the leading industries in Florida. Groupers, snappers, shrimp and lobster are just a few major fisheries of economic importance in the Florida Keys.

d.) <u>FKNMS Management Strategies</u>:

Marine Zoning-

The official definition of zoning according to the FKNMS Final Management Plan is “the setting aside of areas from specific activities to balance commercial and recreational interests with the need for a sustainable ecosystem.” The main goals of FKNMS marine zoning is to preserve biodiversity, to protect sensitive habitats like coral reefs, mangrove forests and seagrass meadows, and to reduce user conflict among stakeholders (FKNMS Zone Monitoring Program, Year 3, 2001). The different zones include Sanctuary Protection Areas, Special Use Areas, Ecological Reserves, and Wildlife Management Areas (see Appendix B.5 for details on zones).

Water Quality Protection Program-

The FKNMS Water Quality Protection Program is one of the sanctuary’s most comprehensive, long-term monitoring programs that exist in the Florida Keys. The main components of the program include monitoring of coral reefs/hardbottom communities, water quality, and seagrass communities. Population and ecosystem dynamics, biomass, catch statistics, effects of sea level rise, toxic contamination, mapping, and oceanographic trends are included in this program.

Research and Monitoring Program-

Research and ecosystem monitoring are necessary to establish documented and quantified information on the resources and ecosystems that exist in FKNMS, and how they interact. The FKNMS's Zone Monitoring Program and the Water Quality Protection Program (funded by the Environmental Protection Agency) has been gathering data for the past 5-6 years (FKNMS website, 2000). Now that data on water quality, coral and seagrass communities, and socioeconomic impacts of the FKNMS management plan has been collected, a Science Advisory Panel has been appointed to guide the next stage of the FKNMS Research and Monitoring Program. The panel consists of six independent scientists. The main recommendations of the panel are:

- To make immediate corrections to the degraded water quality in the benthic and nearshore communities
- Immediate determination of the causes of reef loss with monitoring and the evaluation of effectiveness of all corrective possibilities (examples: waste and storm water treatments)
- Identify and quantify sources of land-based stressors and the impacts they cause on reef and nearshore habitats, and human health (FKNMS website, 2000).

Great Barrier Reef World Heritage Area and Marine Park

a.) **Background**

The Great Barrier Reef (GBR) is the largest coral reef system in the world, with over three thousand reefs within 350,000 square kilometers of ocean (World Resources Institute (a), 1998). The Great Barrier Reef World Heritage Area and Marine Park is the second largest protected area (World Resources Institute (c), 1998), as it protects the entire reef network.

According to the World Resources Institute in Washington D.C., the GBR is not only the largest reef system, but also “the largest known marine repository of biodiversity”.

Although the GBR is under many environmental and human impacts, as it brings in over four billion dollars annually for Australia (Australia Environment), the MPA is a model of success. There is hope for the GBR because of multiple use management practices, input from stakeholders, enforcement of regulations and integrated planning for the sustainable use of its marine resources (World Resources Institute (a), 1998).

b.) Spreadsheet- See Appendix B.6

c.) GBRWHMP Major Threats:

Tourism-

Tourism and recreation is the main use of the Great Barrier Reef, with an approximate value of over $1 billion annually (GBRMP Authority, 2002).

Overexploitation of Fisheries-

Commercial fishing has taken a toll on the Great Barrier Reef. There have been increased fishing efforts, targeting of spawning species, destructive fishing practices like poisons and explosives, and bycatch of endangered species associated with commercial fishing in the Great Barrier Reef.

One example is the trawl fishing industry. Commercial shrimp fishing is done by the use of bottom trawling and longlining, which is not only exploiting fisheries and endangered species but also destroying the seabed structure and biodiversity (World Resources Institute (b), 1998).

Lack of Fisheries Data-

Even though the GBRWHMP regulates harvested fisheries through the use of permits, limited entry and quota, fishing gear and restricted fishing areas, they are concerned with the lack of information they have on things such as the status of fish stocks, the importance of recreational harvesting, and the survival of released bycatch (GBRMP Authority, 2002).

d.) GBRWHMP Management Strategies:

Integrated Management-

The GBRWHMP strives to create ecologically sustainable fisheries that are also economically and socially sustainable for all stakeholders. Strong integrated management involving stakeholder participation, educational programs, scientific research and monitoring, and collaborated enforcement efforts with other fisheries management agencies all contribute to a successful management plan for the Great Barrier Reef.

Fisheries and ecosystems are managed through zones that restrict fisheries activities in certain areas, proper monitoring and assessments of fishing impacts, and the use of new information and technologies to minimize ecological damages. Plans to develop Fisheries Management Plans are underway, in which commercial fisheries would do Fisheries Impact Research (GBRMP Authority, 2002).

Tourism Management-

Tourism and recreational activities are managed through the use of permits, marine zoning, restricted access and restrictions, certificate tourism staff training, strict enforcement of regulations, and Best Environmental Practices (GBRMP Authority, 2002). Best Environmental Practices is a summary of the best practices to use in the Great Barrier Reef when engaging in tourism and recreational activities, including fishing, fish feeding, whale, turtle seabird and dolphin watching, snorkeling, diving, reef walking, and anchoring and mooring. The summary emphasizes self-regulation instead of authority regulation (GBRMP Authority, 2002).

There is also an Environmental Management Charge that has been in effect since 1993. This charge is applied to all companies and individuals who make money from the Great Barrier Reef, and the money goes toward research and education programs (GBRMP Authority, 2002).

Soufriere Marine Management Area

a.) **Background**

The island of St. Lucia is located in the Caribbean Sea, in the Windward Islands, which is part of the Lesser Antilles (Soufriere Marine Management Association, 2002). Locals on St. Lucia depend on the natural resources that the island and ocean provide for their livelihoods. The diverse marine resources (248 species were found in a 1998 survey) along the coastal town of Soufriere are very valuable because they attract many tourists and they support many commercial fisheries, including snappers and groupers. However, competing human activities increased the pressures of this ecosystem. Many stakeholders got together and came up with an agreement about the area, which resulted in the Soufriere Marine Management Area (SMM Association, 2002).

The Soufriere Marine Management Area (SMMA) was established in 1995, which includes a network of five marine reserves that include about 35% of coral reef fishing grounds (Roberts et al, 2001). The five types of reserves include marine reserves (closed to fishing), fishing priority areas, recreational areas, yachting areas, and multiple use areas (SMMA Case Study). In order to be successful, management strategies must be aimed at conservation and sustainability.

b.) Spreadsheet- See Appendix B.7

c.) <u>SMMA Major Threats:</u>

Overexploited Marine Resources-

The reef fisheries in the Soufriere area are one of the most important industries of St. Lucia. Many commercial fishermen as well as subsistence fishermen depend on the Soufriere fishery as a source of income and food. Protecting the marine resources they have left is a critical necessity that all stakeholders agree on. Not only does the coral reef habitat and all the species that live inside provide income and food for fishermen and locals, the tourism industry also benefits greatly from the attention the beautiful reef provide.

User Conflict-

Soufriere has seen many conflicts between stakeholders, mainly between fishermen and the tourism industry, and between the fishermen and the management of SMMA. Tourist activities include snorkeling, diving, yachting, and recreational fishing. Conflicts between fishermen and the SMMA include disagreements on the marine reserves put in place that close off fishing to certain areas in order to rehabilitate fisheries.

d.) SMMA Management Strategies:

Marine Zoning-

The use of five different types of marine zones has proven successful in the management of SMMA. In order to rehabilitate and sustain the overexploited coral reef habitat and the reef fisheries, 35% of fishing grounds have been closed to all fishing and collecting in the form of Marine Reserves (Roberts, 2001). As stated previously, the benefits of marine reserves in SMMA have included increases in fish biomass and marine biodiversity (SMMA case study). Because marine reserves are closed to fishing, the protected fish have time to grow and reproduce more than they would if the area was open to fishing. The longer the reserve is in place, the more fish there are, and a spillover effect happens surrounding the reserve, resulting in an increase of fish in open-fishing areas (Roberts, 2001).

In order to decrease user conflict in SMMA, marine zones like the Fishing Priority Areas, Recreational Areas, Multiple Use Areas, and Yacht Mooring Areas have been established so that all users of the area have places to participate in their activities.

Regulation Enforcement-

Regulations are enforced by the use of registration for all boats and fishermen, as well as the issuing of identification cards for fishermen (SMM Association, 2002).

Human Conflicts-

The Department of Fisheries Extension has made many efforts to assure the success of the SMMA. The department tries to reduce user conflict by helping fishermen understand the economic importance of tourism, by mediating between fishermen who don't agree with no-take zones and the SMMA, and by consulting with fishermen to ensure their input in the policy-making process (SMM Association, 2002). By including stakeholder involvement, communication, and participation, SMMA has greatly reduced the risks of user conflicts before they start, which can result in overexploited resources and destructive user practices.

Public Education-

In order to help rehabilitate and sustain marine resources in SMMA, the department educates fishermen by holding workshops to train them on the latest fishing techniques and to provide them with important information from the Department of Fisheries. For example, fishermen are informed in the importance of using bigger mesh traps so that juvenile fish can escape (SMM Association, 2002).

Research-

Important research includes existing monitoring programs, the Soufriere Experiment in Reef Fisheries Sustainability (SERFS) fishery profiles, and a socioeconomic study of the Soufriere community (SMM Association, 2002). Other respected scientists from around the world are studying the effects of marine reserves in the reef fisheries (SMM Association, 2002).

Ecosystem Monitoring

Long-term ecosystem monitoring programs are valuable assets to SMMA because through monitoring they can determine the extent of damages by humans and natural catastrophes like hurricanes and global warming. Monitoring activities include sedimentation rates, water quality and salinity, coral reef growth/mortality rates, and fish landings (SMM Association, 2002). One example is the coral reef monitoring program that is guided by the Global Coral Reef Monitoring Network (GCRMN). A survey was done at depths of 3m and 10m at Malgretoute reef before and after Hurricane Lenny in 1999 (Smith, 2002). Results concluded that the percent of live coral as reef structure at 3 meters depth decreased by 50% after the hurricane (Smith, 2002).

4.0 <u>Discussion</u>

The goal of this project was to propose a framework for collecting detailed information on MPAs and to determine how that information may be used as a valuable tool for ocean management. Seven MPAs throughout the tropics and temperate oceans were researched to demonstrate how this framework would be useful. With this framework, the major threats and relevant management practices of each site were determined. The framework consists of detailed spreadsheets for each MPA.

An inventory like the spreadsheets provided in this project can be used to compare and contrast site-specific information for an MPA. The spreadsheets include information such as the basic properties, location, biological and physical characteristics, human uses, regulations and management strategies of each MPA. Scientific data and analysis is critical to effective management of MPAs. Without programs like Ecosystem Monitoring, Water Quality Programs, Volunteer Programs, and Management Plan Reviews, managed protected areas cannot be accurately surveyed, analyzed, and represented. In addition, the successful protection of MPAs from the many current and future human threats is difficult, or impossible, without effective management programs.

Each of the case studies in this project offers valuable management strategies that could be used as models for similar MPAs. Each MPA could learn from the successes and failures of others. Through the use of these spreadsheets, or other databases or inventories, MPA planners and managers can have available to them the information needed in order to create the most successful MPA possible. It is through the use of examples and lessons learned that effective ocean management is possible.

For the MPAs studied in this project, the most common threats were the overharvesting of fish, human impacts (e.g. pollution), and destructive fishing practices. Although the MPAs in this study share common threats, each have taken different strategies to address those threats. The following paragraphs give examples of common threats between the seven MPA case studies and offers suggestions about which existing management practices they can learn from. These alignments show how the MPA spreadsheet would allow MPA management teams to share information and better manage the area.

Overharvesting of fish threatens biodiversity, economics, and the overall health of marine ecosystems. For example, in the Soufriere Marine Management Area (SMMA), commercial fisheries are a critical marine resource. The fishermen depend on them as their main source of income. With the establishment of marine reserves, studies have shown that fish stocks have been replenished and tend to have a spillover effect on adjacent fisheries.

The strength of SMMA management is the integration of resource protection and involvement of all stakeholders. Although many fishermen in Soufriere do not like having closed fishing blocks, through educating them on the benefits of marine reserves, teaching them safer fishing methods, and involving them is decision making, SMMA has made the marine environment a more sustainable place. Because of the successes of SMMA, it has been used as a model in similar ecosystems in St. Lucia and other islands, like the Canaries/Anse la Raye Marine Management Area (SMMA case study). The proposed MPA spreadsheets would be a valuable tool for assisting the other MPAs when comparing the similar ecosystems, threats, and management practices of places like SMMA.

The successes of the marine reserves in the SMMA can also be used as a model for our local Channel Islands National Marine Sanctuary (CINMS), where overharvested fisheries are currently a major threat. There is a recommendation of a network of marine reserves in the CINMS to protect depleting fisheries. The goal is to implement reserves in a way that not only sustains fish stocks, but also the fishermen who depend on these rich areas economically. This is currently a big issue in California because the stakeholders are not in agreement with the recommended percent of the Channel Islands that would be closed off to fishing (30%). The fishermen are fearful of the economic stresses that will occur if such large portions of their fishing grounds are closed. By looking at a big database of information about MPAs like the spreadsheets in this project, the CINMS can find examples of MPAs with similar threats elsewhere that have seen the benefits of marine reserves, like the Soufriere Marine Management Area (SMMA). The studies that have been done in the SMMA have concluded that the establishment of a network of five marine reserves has given fish species time to grow and reproduce, having a spillover effect on adjacent fishing areas that are open to fishing. Therefore, fish stocks are being replenished and protected in the reserves, while fishermen are still catching the spillover fish in nearby open areas. Perhaps it would be beneficial for the CINMS to review the details and policies of this case study so that they can learn what strategies have proven successful. Learning from examples is a valuable way to implement good planning.

Human impacts were also a common threat to most of the MPAs. The increasing human population is not only creating a higher demand for seafood, but has increased coastal development, which can cause coastal erosion, landslides, increased pollution and runoff, and competition for space.

In the Monterey Bay National Marine Sanctuary (MBNMS) the pressure of humans on the marine environment has caused many problems for the sanctuary. One example is the impacts on tidepool ecosystems. Landslides have increased sedimentation on tidepools and nearshore ecosystems. In addition, there are an increasing number of people visiting the Monterey Bay, and many do not know the damages to organisms from walking on the rocks at the tidepools. This is just one ecosystem that is negatively impacted by humans, there are many more. Cruise liners will be starting to stop in the Monterey Bay soon, which is sure to bring even more destructive impacts to the Bay, like seafloor alterations from anchors, increased pollution, and destructive recreational activities. It is crucial that tourism industries provide appropriate information to teach visitors of the importance of sustainable sanctuary uses.

Lack of funding is another problem for the MBNMS. For example, there is lack of funds to implement such ecosystem monitoring programs like SIMoN and to provide boats to state and federal enforcement officers to enforce sanctuary regulations across the 5,300+ square miles of the sanctuary (NOAA (d), 2001). Perhaps MBNMS could look at the successful strategies of the Great Barrier Reef World Heritage Area and Marine Park (GBRWHMP) for ways to generate more funding for programs. For example, the use of the Environmental Management Charge to all users that makes a profit from the Great Barrier Reef supply the MPA with research, education, and management programs. The GBRWHMP is also a good example to the MBNMS of an MPA with an integrated management plan between many policy makers, resource managers, and local communities that can be applied to conserve entire MPAs on all scales. Since the Great Barrier Reef has more experience having so many tourists in the MPA (1.6 million visitors per day recorded for 1997) (GBRMP Authority, 2002), they have management strategies that particularly deal with this factor. These strategies include a certificate course for all tourism staff training, specified access through marine zoning, permits, and their Best Environmental Practices program. The spreadsheet for the GBRWHMP (Appendix B.6) includes all these management strategies, and could be a very appropriate tool for the MBNMS in dealing with the increase of tourism in the Monterey Bay.

Destructive fishing practices are also one of the biggest threats to ocean life today. Bottom trawling and longlining have devastating effects on the seafloor, ruining critical habitat to marine organisms, sometimes ones that are threatened or endangered of extinction. The Experimental Oculina Research Reserve (EORR) off the Florida Coast is a grave example of how destructive bottom fishing practices can destroy a reef habitat and the ecological processes that naturally occur there. *Oculina varicosa*, the fragile, branching coral that grows on the limestone pinnacles of Oculina Bank have been reduced to rubble due to commercial trawling and dredging for valuable reef species like groupers (USGS, 1999).

The major weakness of the Experimental Oculina Research Reserve (EORR) observed is the difficult task of enforcing the no-bottom fishing regulations. Although EORR carries strict prosecution of violations, it is hard for officials to see when illegal bottom fishing is occurring because it's 17 miles offshore (MPAs of the US (g), 2002). Authorities are aware of illegal activities but believe that it may be occurring at night, which makes it even more difficult to enforce no-fishing regulations. Efforts are currently being made to enforce fishing regulations in the EORR. For example, authorities will be requiring vessel permits and vessel monitoring systems (VMS) that allows the vessel position to be known (MPAs of the US (b), 2002). Perhaps the EORR can also use the example that the FKNMS uses in order to better distinguish the closed off areas: They have the different use zones differentiated by clearly marked buoys.

The Science Advisory Panel for the FKNMS has made the observation that the Research and Monitoring Program has shown clear positive trends in their data, so the program has worked (FKNMS website, 2000). This program should be used as a comparative tool for other MPAs that need baseline data of species and ecosystem functions. Perhaps this Research and Monitoring Program model would be beneficial for the CINMS to implement before they finalize where and what percentage of the MPA would be the most successful sites for marine reserves.

The program could also be useful to the GBRWHMP. Even though they have many regulations for harvesting fisheries in the MPA, they are concerned about the lack of information they have on the status of harvested fish stocks, the importance of recreational harvest on other species, and the survival rate of released bycatch individuals (GBRMP Authority, 2002).

A valuable contribution to the MPA world as well as to all scientists, marine managers, and the general public would be a worldwide inventory of MPAs. It could serve as a large-scale information base for the science and management world. This inventory would be accessible to everyone, perhaps on the web. Through research and personal communication with scientists about this idea, it was found out that there are inventories like this, but they are not complete just yet. They could take years to finish.

One example is the inventory the United Nations Environmental Programme (UNEP) World Conservation Monitoring Centre's (WCMC) Prototype Nationally Designated Protected Areas Database. This database, in collaboration with the IUCN World Commission on Protected Areas, includes over 35,000 protected areas, of which over 4,000 of them are marine protected areas (UNEP World Conservation Monitoring Centre, 2000). These MPAs are arranged in six different categories, separated by management objectives. These categories are Strict Nature Reserve, National Park, National Monument, Habitat/Species Management Area, Protected Landscape/Seascape, and Managed Resource Protected Area (UNEP, 2001). This Database includes general information such as the management category that it belongs to, size, location, date established, and related sites. Some MPAs have links to additional detailed information.

Another example of an existing ocean database is COMCI, the Catalogue of Oregon Marine and Coastal Information**.** COMCI was developed as part of a course at the Oregon State University (OSU) on Marine Reserves co-taught by Dr. Jane Lubchenco, Principal Investigator for PISCO. COMCI is a Meta database of extensive information including such categories as marine habitats, marine species, ocean uses and activities, coastal land use, fisheries, and oceanographic data for the Oregon coast. These topics are critically important to the MPA science and policy world. Brooke Simler of OSU is the COMCI coordinator. She is currently working on putting together a searchable web page for COMCI, so that the information can be available to everyone (Davis-Borne, pers. comm.).

Other various MPA databases have been established and are in the process of gathering information. One such existing database includes the MPAs of the United States Inventory. Under the United States Executive Order #13158 on MPAs, the National Oceanic and Atmospheric Administration (NOAA) and the Department of the Interior are developing a Marine Protected Areas Federal Advisory Committee (representing all stakeholders), the National Marine Protected Areas Center (directed to work collaboratively with all agencies and partners to provide a national system of MPAs), an MPA website (www.mpa.gov), and an inventory of all U.S. MPAs that is accessible from the MPA web site. The purpose of this inventory is to provide a large database of information that can be searched, queried and mapped (NOAA (e), 2001).

MPAs in the United States, like the Florida Keys, Cordell Bank, Gulf of the Farallones, and Monterey Bay National Marine Sanctuaries, are subject to ongoing reviews in order to assess effectiveness. For instance, the Cordell Bank, Gulf of the Farallones, and Monterey Bay National Marine Sanctuaries are currently under a Joint Management Plan Review. The Review is done together for all three sanctuaries because the same program manages them all and they are located right next to each other so they share many of the same resources and interests. The goals of the Joint Management Plan Review are to evaluate the effectiveness of the sanctuaries, update the management of the sanctuaries with new research and technologies, and to provide an opportunity for staff to work together with input from the stakeholders by holding public meetings to discuss concerns about the sanctuaries.

The Florida Keys National Marine Sanctuary (FKNMS) is also currently being evaluated in a five-year long update to the Management Plan, (FKNMS website). The Management Plan will be including a zone performance review in order to determine the effectiveness of the sanctuary zones. The updated Management Plan will include possible modifications to the zoning strategies if studies suggest they aren't as effective as hoped for (FKNMS website).

As can be seen in the above paragraphs, an MPA inventory such as the one demonstrated can be an effective tool for the review process. Besides management plan reviews of MPAs, there are a number of other ongoing efforts to evaluate the effectiveness of ocean resource management. This project aligns well with a number of other projects and could be used in conjunction with them.

An example of how the proposed framework of this project could compliment the works of others in the MPA world is with the usage of geographical information system (GIS) maps. GIS has been used by the California Department of Fish and Game to map MPAs and various marine habitats. These maps, in conjunction with the spreadsheets in this project, could be very useful tools for effective management because the size of an MPA and the specific habitats that exist is crucial information when planning how to manage the particular area. My spreadsheets or a similar kind of inventory of MPAs would be a valuable thing to use with GIS maps so that detailed information could be linked to specific areas of an MPA. With this combined information, perhaps management strategies would become more obvious in how to manage site-specific habitats and other characteristics.

A current effort that contributes to the importance of effective marine management is shown through the valuable work of the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO). PISCO is an interdisciplinary research program that studies the nearshore ecosystems along California, Oregon and Washington state coasts. Scientists from four universities participate in PISCO, Oregon State University, University of California, Santa Cruz, University of California, Santa Barbara, and Stanford University's Hopkins Marine Station. They conduct long-term monitoring of ecological and oceanographic processes by working in the field and the lab. Findings are applied to ocean conservation and management issues as well as for educational purposes for the public and for students (PISCO website, 2000).

Maria Kavanaugh, a PISCO Research Technician at Oregon State University, has initiated an Oregon MPA inventory. Her work includes a summary of MPAs that exist between the Oregon coast and federal waters (EEZ Zone) and spatially oriented maps outlying Oregon MPAs and documentations. She is working to finalize these pieces so that they can be posted on the PISCO website, perhaps this spring. The State of Oregon used Maria's inventory as a foundation in part of its MPA evaluation process (Davis-Borne, pers. comm.).

5.0 Conclusions

Marine protected areas are a huge topic in ocean resource management. There are many efforts all over the world working to improve the way that we conserve and protect these resources. Coordinating these efforts and sharing detailed information and practices would likely be the best way to achieve successful protection and management. This project is a way of improving the ongoing work of ocean management by offering a framework that would allow all MPAs to share site-specific information. Perhaps professionals in the field could offer ways to improve or build upon this framework so that it could be of more value to the management world.

The major threats and management strategies mentioned in this project are just a review. Each issue goes in to more depth than presented here. Also, there are many more threats and management strategies than presented in this report. For full detailed information on a specific MPA mentioned, it is suggested that you go straight to the source- the MPA itself. Each MPA is easily accessible on the web, where more contact information is available.

It should be noted that the suggestions on which MPAs might adopt the programs and management practices of other MPAs are observations. Perhaps some of the management strategies suggested in this project would not be feasible in certain ecosystems, climates, habitats, use areas, etc. For example, it was suggested that the CINMS use the marine reserve model that the SMMA has because they have been success in sustaining their fisheries while minimizing socioeconomic losses. SMMA exists in the Caribbean, which is a tropical ocean. The Channel Islands lie off the California Coast, which is a temperate ocean. The strategies and policies used in the tropics may not be realistic or possible to achieve in temperate ecosystems because they have very different habitats and species.

The main lesson learned from this project is that each MPA studied has effective management strategies that could be a useful model, and each MPA has ineffective strategies that could use the help of a good example. Through the use of the proposed data collection and comparison spreadsheets, the models and examples of successful ocean management could be displayed and shared between all managers and stakeholders involved. This would encourage the ultimate goal that we all have – to protect our oceans from degrading human activities, to be able to have multiple recreational and education uses within our oceans, to sustain marine resources while we reduce losses to all stakeholders, and to restore endangered ecosystems so that our oceans can be sustainable today and in the future.

6.0 Appendices

A Blank spreadsheet

B.1 Cordell Banks National Marine Sanctuary

B.2 Gulf of the Farallones National Marine Sanctuary

B.3 Monterey Bay National Marine Sanctuary

B.4 Experimental Oculina Research Reserve

B.5 Florida Keys National Marine Sanctuary

B.6 Great Barrier Reef World Heritage Area and Marine Park

B.7 Soufriere Marine Management Area

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