Under the Sea:

An evaluation of the establishment and continued effectiveness of the Galápagos National Park and Marine Reserve in Ecuador

by

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A PROJECT

submitted to

Oregon State University

University Honors College

in partial fulfillment of
the requirements for the
degree of

Honors Baccalaureate of Science in Biology
Honors Baccalaureate of Arts in International Studies in Biology (Honors Associate)

Presented May 27, 2011
Commencement June 2011

AN ABSTRACT OF THE THESIS OF

Danielle Asson for the degree of Honors Baccalaureate of Science in Biology and Honors Baccalaureate of Arts in International Studies in Biology presented on May 27, 2011. Title: Under the Sea: An evaluation of the establishment and continued effectiveness of the Galápagos National Park and Marine Reserve in Ecuador

Abstract approved:_____

Michael Harte

Conservation of natural resources has become a new watchword of the scientific community. While many terrestrial ecosystems are well protected, marine ecosystems have only recently come to the forefront. Marine Protected Areas (MPAs) have been introduced as a means of protecting biodiversity, commercial stocks, and ecosystem services. There are many social, ecological, and economic considerations to be addressed for a marine reserve to be effective from a biological and social perspective. In 1998 the Special Law of the Galápagos created the Galápagos Marine Reserve, and instituted a participatory management scheme for local and governmental cooperation in management. The foundations of the Special Law are strong, however many problems plague the islands, including rapid growth of the population and the tourism industry, and a great deal of non-compliance with reserve regulations in the form of violent protests and illegal fisheries. Feelings of legitimacy must be fostered among the local populations through significant improvements in education to enhance stakeholder participation, and increased funding to the National Park to allow for effective enforcement of the regulations. Increasing visitor fees is a potential source of new income to be used for park management and improving local resources, especially education.

Key words: Galápagos, Marine Reserve, Non-compliance, Legitimacy, Education

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Honors Baccalaureate of Science in Biology and Honors Baccalaureate of Arts in International Studies in Biology project of Danielle Asson presented on May 27, 2011.

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Acknowledgments

I would like to thank everyone who assisted me in the creation of this thesis. Special thanks to my mentor, Dr. Michael Harte, for his immense amount of help with finding resources and editing, my committee for much needed advice, and my parents, Steve and Silvia, my sister Kaitlin, and my fiancé Peter, for their continued support during my college career, without which this would not have been accomplished.

Dedication

This thesis is dedicated to my family for all of their help, love and support, and in memory of my beloved cat who helped me get through a great many stressful times.

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1. INTRODUCTION

In recent decades, the conservation of natural resources has become a new watchword of the scientific community (Redford and Richter 1999, Meine et al. 2006). Many of the planet's most beautiful and unique places are threatened, if not in danger of vanishing. Public sentiment around the globe is increasingly in favor of conservationist practices and preserving the environment for future generations (Redford and Richter 1999). Frequent failures in management and resource decline have led to a high demand for change (Angulo-Valdés and Hatcher 2010). As a result, many new policies and programs have been implemented in various countries in an effort to maintain and protect the myriad environments that exist on our planet, and reduce or mitigate anthropogenic effects. These policies include financial or other incentives to encourage sustainable practices (Niesten and Gjertsen 2010, Tolleson, Ross 20th et al. 2010), education, regulation of activities in certain areas or regions, attempts to relate conservation to poverty alleviation and livelihoods (Bawa et al. 2011), and the creation of protected areas such as nature reserves and national parks (Leslie 2005, Pollnac et al. 2010, Gaines et al. 2010).

An environment previously overlooked has recently come into the conservation spotlight - the ocean. Once it was thought to be the last great frontier, a seemingly bottomless resource; now we are realizing that the many resources we extract from our oceans are not endless (Roberts et al. 2005). The Millennium Ecosystem Assessment

asserted that marine and coastal ecosystems are among the most threatened on our planet (The World Bank 2006). Dozens of commercial fish stocks are depleted or on the verge of collapse (Myers and Worm 2003, Hilborn et al. 2003, Gutiérrez et al. 2011, Branch et al. 2011), and many marine ecosystems have been heavily impacted by many land- and sea-based anthropogenic activities (Leslie 2005, Halpern et al. 2006, 2007), including exploitation, pollution, climate change, habitat degradation or loss, invasive species (Leslie 2005) drilling for oil and natural gas, and laying cables along the sea floor. Most of these activities have little understood direct and indirect consequences to the health and stability of ecosystems (Sonnenholzner et al. 2007).

Frequently marine resource management focused on fisheries and the conservation of commercial fish stocks. From the 1960s to the 1980s the focus for marine conservation was the reduction of pollution, as the global fish catch was increasing and people were optimistic about the future (Roberts et al. 2005). Yet a shift has been occurring over the last 15 years to create conservation practices that encompass much more than pollution mitigation. This focus on fisheries management meant fisheries managers held the reins and responsibility for managing marine environments. Broader ecosystem and marine conservation concerns were secondary to fisheries management goals and this has led to a serious lag behind terrestrial conservation activities (Roberts et al. 2005). As times change, conservation solutions that have proven successful for terrestrial environments are now being implemented in the sea, in an effort to stem the tide of species decline and preserve the oceans for future generations. Although there are far fewer documented marine extinctions compared to terrestrial ones (Monte-Luna et al. 2007, Morton 2007, Briggs 2010), there has been a serious decline in

a number of species and this should not be a cause for complacency about marine conservation (Briggs 2010).

Terrestrial and marine ecosystems are very different and cannot be managed in the same way; some of the conservation methods can be altered and applied to the oceans, once the specific needs and differences among mediums is considered (Carr et al. 2003). Although many practices are in place, including incentives (especially economic) for sustainable practices (Leslie 2005, Niesten and Gjertsen 2010, Tolleson, Ross 20th et al. 2010) and building awareness of the value of biodiversity through education and outreach programs (Netumbo 2010), one that shows great promise for preserving and rebuilding marine ecosystems is that of marine protected areas (MPAs) (Halpern and Warner 2002, Botsford et al. 2003, Roberts et al. 2005, Claudet et al. 2006, Gaines et al. 2010).

The purpose of this thesis is to examine the policies and the public outreach and engagement efforts that were, and continue to be, involved in creating and maintaining the Galápagos National Park and Marine Reserve in Ecuador. This thesis will examine how conflicts between conservation and existing use rights were addressed during the establishment and continued management of the Galápagos National Park and Marine Reserve (GNPMR) in Ecuador, focusing specifically on the marine reserve. The aim of this report is to determine if the GNPMR is effective within the local context (i.e. existing use of the area, cultural views on the natural resources, the limited resources of the islands, etc.), with regards to the marine reserve, and, where appropriate, to suggest alternate directions to improve the effectiveness of the reserve.

1.1 Marine Conservation in the Galápagos

The Galápagos Archipelago is one of the most unique areas in the world, and its isolation has long helped the myriad species that live there thrive (Baine et al. 2007). Lying at the confluence of three major currents, the islands are home to thousands of species that live in ranges from the sub-arctic to the tropical. The Galápagos National Park and the Galápagos Marine Reserve have been established to protect this special archipelago and conserve the natural resources and the biodiversity of the land and surrounding oceans. Despite the good intentions of these organizations, many obstacles exist that are hampering their effectiveness and that of the GNPMR. The recently established marine reserve component of the park is suffering the most from ineffective government and little local compliance, exacerbated by problems like invasive species that are plaguing the land and seas of the archipelago as a whole (personal observation). Significant changes need to be made in how the reserve is managed and the people in charge, as well as increasing the education of the public, before the marine reserve can fulfill its potential.

1.2 Thesis Overview

This thesis examines MPA protection and local communities, using the GNPMR and the Galápagos Islands as a case study. I lived and took classes on the islands for 3 months, during which time I made general observations about the GNPMR and talked to local residents about their opinions and views on the government, the GNPMR, and

related issues. Secondary sources of information on the GNPMR are a large component of the remaining research, and I have read and analyzed literature pertaining to the creation, continued problems and successes, and overall status of the Galápagos Marine Reserve. These included government sources, such as the Special Law of the Galápagos, as well as official websites belonging to the Galápagos National Park and the Instituto Nacional Galápagos (INGALA) and documents from the Galápagos National Park discussing management plans of the past or for the future, reviews and discussions about marine reserves and their effectiveness, and similar sources. I also reviewed numerous peer-reviewed papers about the biological, social, and/or cultural aspects of the islands, as well as studies about other locations that related to issues faced by the islands.

2. MARINE PROTECTED AREAS

Many types of marine reserves and marine protected areas (MPAs) exist. MPAs can take many forms, from an area with slightly more regulation than the open seas, to a completely no take, no access, protected reserve; from one large reserve to a network of small protected areas surrounded by unprotected waters. A marine reserve is defined by the Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO) as "ocean areas that are permanently and fully protected from activities that remove animals and plants or alter habitats, except as needed for scientific monitoring (PISCO 2008, p. 1)." Thus, a marine reserve is an MPA in which extractive activity is specifically prohibited.

2.1 Why do we need Marine Protected Areas?

According to the IUCN, representative MPA networks should be established across 20-30% of the seas and oceans to adequately protect and manage the biodiversity and resources those environments provide (WCPA/IUCN 2007). There are many reasons to implement a marine reserve but three broad and all-encompassing ones come to the forefront: conservation and biodiversity protection, management of fisheries and commercial stocks, and maintenance of marine ecosystem services.

2.1.1 Conservation and biodiversity protection

The ecosystems of the world are extremely important to our survival in more ways than the provisions of food and physical resources. The vast and often unknown ecosystems are varied with an extremely diverse array of species and chemical and

physical interactions. From the microbes deep on the ocean floor to the blue whale, the largest living organism on the planet, the organisms and processes of the ocean impact the functioning of all ecosystems of the world, directly and indirectly. Marine biodiversity has been defined as "the variety of life in the sea, encompassing variation at levels of complexity from within species to across ecosystems (Sala and Knowlton 2006, p. 94)." The biodiversity of ecosystems affects their resilience and ability to resist change from outside factors (Levin and Lubchenco 2008, Palumbi et al. 2009), although this link is sometimes elusive and not direct (Duarte 2000). Biodiversity is also key to the functioning of ecosystems so they continue to provide both tangible and intangible ecosystem services, such as resource provision, protection, cultural and social services (Mace et al. 2005, Millennium Ecosystem Assessment 2005, Worm et al. 2006, Fowler 2008, Muchapondwa et al. 2009).

There has been a pattern of increasing losses in biodiversity in many ecosystems, and the ocean is no exception. Worm et al. (2006) found a trend of accelerating diversity loss in the ocean on a global scale, which is of serious concern because it predicts the global collapse of all currently fished taxa if trends continue unchecked. Furthermore the authors found that as diversity decreased, the potential for resource collapse increased, and recovery potential, stability, and water quality decreased exponentially, while biodiversity restoration resulted in increased productivity and decreased variability (Worm et al. 2006).

It must be noted that this study was highly controversial, not for the claims made about the effect of biodiversity on ecosystem health but rather the state of biodiversity and fish stocks worldwide (Murawski et al. 2007). Murawski et al. (2007) have disputed

the findings of Worm et al. (2006), and assert that the situation is not nearly as dire as Worm et al. proposed as well as criticizing their assessment methods. Worm et al. responded to these criticisms with justifications for their methods (Murawski et al. 2007). Again, the debate was regarding the dire predictions made by Worm et al. (2006), not disputing the claim that biodiversity loss would have significant consequences for ecosystems.

One of the most common actions taken to preserve and conserve biodiversity and ecosystems is the creation of a protected area to restrict human activities such as resource extraction. A huge number of protected areas, varying widely in size and type, exist in terrestrial realms. The numbers are far less for marine protected areas, especially no-take reserves. There are at least 5,880 MPAs worldwide, covering approximately 4.2 million km^2, or about 1.17% of the ocean, only a small portion of which are no-take marine reserves (Toropova et al. 2010), while almost 6% of terrestrial regions are fully protected (Carr et al. 2003). One of the main proposed goals of many of these MPAs are the protection, conservation, and promoting the increase of species and species biodiversity (PISCO 2008). A review of 80 reserves around the world by Halpern and Warner (2002) concluded that overall, marine reserves (defined as no-take areas where any organism extraction in any way is illegal) have rapid and lasting biological effects, and relative to reference sites population densities, biomass, average organism size, and diversity were higher within reserves relative to reference sites (Halpern and Warner 2002). Halpern and Warner (2002) also concluded that the establishment of marine reserves can return biological values to near average levels within 1-3 years, sometimes as little as six months, that these values persist through time, and are independent of reserve size. In

contrast, Claudet et al. (2008) found that reserve size and time since creation do matter. Larger reserves are generally more effective since they cover more area and allow for more protection of mobile species [though he does not analyze the effectiveness of a network made of many small reserves], than smaller non-networked reserves (Claudet et al. 2008). Nevertheless, it is generally agreed that MPAs enhance marine biodiversity and biomass (Cullis-Suzuki and Pauly 2010) when managed effectively.

2.1.2 Management of fisheries and commercial stocks

Many commercial fish stocks have been depleted to some extent, and some are on the verge of or have already collapsed, such as the Atlantic cod. A large number of collapsed species do not show recovery after fishery pressure has been removed, even after long periods of time which may indicate population shifts to less desirable alternative states (Roberts et al. 2005). Myers and Worm (2003) estimated that predatory fish biomass is only at 10% of pre-industrial levels, and that that number could be even lower since many of the declines in large predatory fish populations typically occurred before surveys of fish populations began to be widespread. They also noted that in many locations catch rates began high for newly fished species or areas but dropped precipitously within 10 years, and now sustain only relatively low levels of fishing pressure compared to initial rates, and some areas were abandoned altogether (Myers and Worm 2003). Although the average exploitation rate has declined in the past decade, 63% of fish stocks worldwide still need rebuilding (Worm et al. 2009), and in 2005 26% of stocks in the US were overfished (Hilborn 2007), and 30% worldwide are over currently overexploited (Gutiérrez et al. 2011).

The combined force of the increase in fishing pressure and fishery stock collapse has made fisheries managers and marine conservationists pause to reconsider management methods used in the past. A response to the problem has been an increase in the use of marine reserves - defined as no-take zones - instead of traditional management practices (Halpern and Warner 2002, White et al. 2008). Several studies have been performed that demonstrate the introduction of some form of MPA in conjunction with other fisheries management practices is advantageous to the fishery as a whole by helping fish stocks to recover and grow when fishing pressures are removed from key areas (Molloy et al. 2009). There is also evidence that marine reserves help support and enhance nearby populations outside the reserve through spillover (Roberts et al. 2001, Molloy et al. 2009), and that no-take reserves can enhance species size, abundance, and diversity (Molloy et al. 2009, Gaines et al. 2010). Roberts et al. (2005) maintain that extensive marine reserves should be introduced into fisheries management strategies to aid in the recovery of depleted stocks (Fogarty 1999, Roberts et al. 2005). It must be noted that an MPA on its own is only of limited benefit and will only shift the fishing focus from closed to open areas. Along with an MPA there needs to be a reduction in levels of fishing intensity and other management practices (Fogarty 1999).

Fisheries management can also be used indirectly to minimize bycatch of ecologically important species, thus controlling the effects of trophic cascades on commercially important species. Myers et al. (2007) analyzed shark populations in recent years using past and present survey data and noted significant global declines in many species, ranging from 40% in mako sharks to 89% in hammerhead sharks, with potentially a 99% decline of sand tiger sharks in Chesapeake Bay between 1974 and

2004. The demand for shark fins and meat has increased in recent decades, leading to increased exploitation, and many species are often caught as bycatch in other fisheries in high numbers. The loss of these and other apex predators from the ecosystem could have strong cascading effects (Myers et al. 2007).

The Exuma Cays Land and Sea Park (ECLSP) in the Bahamas is an excellent example of the potential of marine reserves to mitigate or reverse the effects of heavy fishing stresses on an area. It was established in 1958 and closed to fishing in 1986 (Nash 1999, Chiappone and Sealey 2000, Mumby 2006). As a result of this closure, the abundance of Nassau Grouper, a primary predator, is seven times higher than in three other areas of the archipelago (Mumby 2006), and there is a concentration of conch estimated to be 50 times greater than other areas of the islands (Nash 1999). It has even been estimated that there has been a spillover of 10 million conchs to areas outside the reserve, worth potentially US $25 million (Nash 1999). This area will not survive if managed in isolation from outside areas that potentially provide a source of larvae (Chiappone and Sealey 2000), but the ECLSP is a prime example of the benefits marine reserves can provide to fisheries management.

2.1.3 Maintenance of ecosystem services

Marine ecosystems provide a number of services for human populations around the world. The term "ecosystem services" refers to the habitat, biological, and system properties or processes of the ecosystem that are of meaningful benefit to humans. These include ecosystem goods, such as food, and services, such as waste assimilation (Costanza et al. 1997, Rudd 2007). The Millennium Ecosystem Assessment (2005)

specifically lists four categories of ecosystem services, provisioning services, regulating services, supporting services, and cultural services (Millennium Ecosystem Assessment 2005, Cognetti and Maltagliati 2010). Establishing an MPA can aid in preserving marine ecosystem services through the maintenance of ecosystem biodiversity and health (Mace et al. 2005, Millennium Ecosystem Assessment 2005, Worm et al. 2006, Fowler 2008, Muchapondwa et al. 2009).

Since many of these services are indirect, it can be very difficult to determine exactly how much they are worth. Many people judge the usefulness and value of something by how much money it can save them or is worth, so valuing ecosystem services can be a critical piece to encourage conservation. Costanza et al. (1997) estimated that 17 ecosystem services for 16 biomes were worth between US $16-54 trillion per year. These services included atmospheric and gas regulation, climate regulation, water regulation and supply, disturbance regulation (storm protection, flood control, etc), nutrient cycling, waste control, and many more, as well as recreational and cultural services (Costanza et al. 1997).

Currently the ability of many of earth's ecosystems to provide these ecosystem services is in jeopardy. The Millennium Ecosystem Assessment determined that about 60% of the ecosystem services they examined are being degraded or used unsustainably, in both marine and freshwater systems (Millennium Ecosystem Assessment 2005). This is unfortunate because marine ecosystems provide an immense amount of resources and support for human lives, activities, and practices, especially considering that 44% of the world's population lives within 93 miles of the coast (Raheem et al. n.d.). The marine realm, and all the various ecosystems that fall under that category, provide recreation,

climate regulation, food (fishing resources), coastal protection from storms, tourism income, waste recycling, resource extraction (such as oil and gas), and much more, to the benefit of humans (Peterson and Lubchenco 1997, Levin and Lubchenco 2008, Palumbi et al. 2009, Cognetti and Maltagliati 2010). For example, it is well known that the ocean plays a large role in the carbon cycle and atmospheric carbon sequestration (Peterson and Lubchenco 1997).

These services can translate to large amounts in financial terms; in the small archipelago of Zanzibar it is estimated that marine ecosystem services account for 30% of the Gross Domestic Product, 77% of investments, and a significant amount of foreign employment and exchange (Lange and Jiddawi 2009). It has been estimated that, worldwide, estuaries can provide water purification and waste treatment services worth $2500/acre/year, natural hazard regulation services worth $332-$1,634/acre, recreation and ecotourism services worth $42-$6,254/acre, food in the form of capture fisheries worth $55-$1,831/acre, and more (Raheem et al. n.d.). Beaches can provide erosion regulation worth $31,131/acre/year, and recreation and ecotourism services worth $16,946/acre (Raheem et al. n.d.). While the value of ecosystem services varies greatly depending on the service and location, there is no doubt that maintaining ecosystem services can be worth thousands to trillions of dollars per year or more (Costanza et al. 1997, Millennium Ecosystem Assessment 2005, Remoundou et al. 2009, Raheem et al. n.d.). Establishing an MPA to protect the biodiversity of ecosystems can ensure continued benefits to humans from ecosystem services, and the short term costs of establishing an MPA pales in comparison to the potential benefits that can come from protecting these services.

2.2 Challenges in establishing and operating MPAs

Many countries have begun to take the initiative to create these MPAs, although in the past MPAs have been put in place without much understanding of the actual impact they are having on the areas they are meant to protect (Halpern and Warner 2002). Some MPAs have been implemented in areas that have deteriorated too far to be effectively restored. Others are in the right place ecologically but the public and local stakeholders do not support their designation and ignore the rules. Still other MPAs work just as intended. A great deal of commitment is required to ensure the success of an MPA network, on local, national, and international scales. It often can be very difficult to unite these levels into a cohesive and efficient unit.

Ecologically it can sometimes be very difficult to identify the necessary strength of regulations needed for an MPA. In many areas there has already been extensive use and resource extraction, so no true baseline about the natural state of the ecosystem can be established (Fogarty 1999).

Willingness of local populations and governments is also a huge factor in the successful implementation of a reserve. Often communities don't want or are unable to accept the high short term social and economic costs associated with establishing a no-take reserve (Worm et al. 2009, Bartlett et al. 2009), or establishing a reserve goes against the cultural norms (Bartlett et al. 2009).

Part of the difficulty in establishing MPAs is the range of management options available, and differing definitions of protection (The World Bank 2006, Angulo-Valdés and Hatcher 2010). The World Bank estimates some 30 different types of MPAs in use

around the world, all using varying ways of managing one or more of the four main frameworks that, according to them, an MPA is generally designed for: biodiversity and habitat conservation; multiuse sustainable marine management; management of extractive uses; and culture-ecological and social protections, to protect heritage land/seascapes and traditional use rights (The World Bank 2006). These MPAs are categorized under different names depending on the region, and a marine sanctuary in one location is a marine reserve in another, depending on local definitions. Generally the most restrictive form of an MPA is a no-take MPA or marine reserve, defined as a marine area in which all resource extraction is prohibited, except as needed for monitoring or research purposes (Halpern and Warner 2002, Jones 2007, Rudd 2007, PISCO 2008).

The IUCN provides MPA guidelines that it considers critical to developing successful and effective MPA networks. MPAs networks are defined by the International Union for the Conservation of Nature as "A collection of individual marine protected areas operating cooperatively and synergistically, at various spatial scales, and with a range of protection levels, in order to fulfill ecological aims more effectively and comprehensively than individual sites could alone (WCPA/IUCN 2007, p. 3)." They include eight ecological criteria of network design, six practices for establishing networks, four broader considerations to ensure successful MPA integration into the social system, and five key elements to make MPAs happen and be effective (WCPA/IUCN 2007). For the complete checklist of criteria provided by the IUCN, see Appendix A. While the IUCN has defined these criteria as important for creating an MPA network, they can also be applied to a single large reserve such as the GMR.

2.2.1 Ecological criteria

The eight ecological criteria of network design are representativeness, replication, viability, precautionary design, permanence, maximum connectivity, resilience, and size and shape of the reserve. A marine protected area network must represent the full range of marine and coastal biodiversity, as well as the physical environment. To ensure survival and viability during cycles of variation all habitats should be self-sustaining, replicated, and evenly distributed throughout the network, ideally in locations that are independent from other activities in the area (WCPA/IUCN 2007). A precautionary design approach should be taken, in which decisions are made based on the best data available rather than delaying to wait for more information, and the design is flexible to allow for alterations as new data becomes available (WCPA/IUCN 2007). Any design needs to provide for effective conservation and resource renewal in the long term, and should attempt to enhance and maximize connections between individual, regional, and further widespread MPA networks. The MPA should be designed to absorb shocks and maintain stability, especially in the face of long-term and large-scale stressors, and an appropriate size and shape needs to be implemented for the region of the MPA that will best allow it to withstand and minimize impacts from shock and disturbance (WCPA/IUCN 2007).

2.2.2 Best practices for planning and implementing MPA networks

The practices for establishing networks are very straightforward: clearly define network objectives, establish long-term political commitment and will, encourage

stakeholder participation, make best use of available information, develop integrated management frameworks, and employ adaptive management techniques (WCPA/IUCN 2007). Before any successful plan can be reached a network plan must be designed that defines the economic, ecological, and socio-cultural objectives of the network to ensure the most beneficial plan for all stakeholders. Long-term political commitment and will is also key, and commitment must be established early and maintained to prevent the occurrence of a "paper park," which is designated on paper but not enforced (WCPA/IUCN 2007).

Stakeholder participation is critical and must be included from the beginning of any planning process to enhance information exchange, foster accountability, reduce mistrust, and foster a sense of ownership about the MPA, thus increasing the effectiveness. In line with precautionary design, any MPA plan should include the best socio-economic, scientific, and traditional ecological knowledge available and use adaptive management techniques to allow for adjustments when new information becomes available (WCPA/IUCN 2007). Integrated management frameworks need to be developed and a hierarchical planning and management structure should be put in place to help coordinate and improve management across jurisdictional boundaries (WCPA/IUCN 2007).

2.2.3 Broader considerations needed to put MPAs in context

Several broader considerations need to be taken into account when designing an MPA network. The IUCN denotes these considerations as economic and social, spatial and temporal, scientific and information management, and institutional and governance

considerations (WCPA/IUCN 2007). Any network design must be properly integrated into the economic and socio-cultural setting of the area to ensure fair resource allocation. Spatial and temporal considerations become very important in light of this, and MPA designers need to address ecological processes, resources and impacts that extend beyond MPA boundaries, and address the concept of "shifting baselines" - current baseline data may already be in a disturbed state and historical states should be considered (WCPA/IUCN 2007). Appropriate plans and tools need to be developed and employed when designing and monitoring MPAs, and planners and designers should also ensure standardization, synthesis, storage, and access to information among networks. Finally, effective linkages and communication lines across jurisdictions must be maintained and legal authorities and frameworks need to be developed and clarified for MPA success (WCPA/IUCN 2007).

2.2.4 Key elements needed for MPAs

The five key elements the IUCN deems most important for effective MPA establishment and management are political will and leadership; public education, communication, and awareness; monitoring and assessment; sustainable financing, and compliance and enforcement (WCPA/IUCN 2007). Political will and leadership is critical in MPA success, and managers need to develop the necessary contacts and linkages and be prepared to forge a compromise when conservation policies are politically improbable. Education and outreach can change and enhance the attitudes and behaviors of the public about conservation and management practices and objectives, and a strong communication plan that considers the characteristics of the stakeholders is

necessary to promote cooperation and understanding (WCPA/IUCN 2007). Monitoring and assessment of the MPA allows for the determination of progress and builds a knowledge base to use for improving management practices in the area. These practices must be built into a reserve from the outset to ensure proper effectiveness however, and should include sites outside the network. Substantial funding is necessary from local, national, regional, and international agencies and a successful MPA must at least be able to cover the minimum level of recurring costs needed to achieve conservation goals, and managers must ensure cost-effective use of funds (WCPA/IUCN 2007). To encourage compliance "network planners must make it more profitable and preferable for the public to comply with the MPA network regulations than not to comply (WCPA/IUCN 2007, p. 15)." Education and encouraging compliance should be the first course of action, followed by enforcement when necessary.

3. CASE STUDY BACKGROUND: THE GALÁPAGOS ISLANDS

Figure 1: Map of the Galápagos Islands. Map retrieved http://archive.idrc.ca/books/899/208ovied.htm.

The Galápagos Islands are one of the most unique areas in the world. This isolated island chain comprised of 13 big islands, 6 small ones, and 107 islets and rocks, lies about 1000 km west of the coast of Ecuador and covers an area of about 8000 km^2. Relative to other island chains the Galápagos are very young, with the oldest island being a mere 5 million years old. The archipelago has an incredibly unique ecosystem structure, largely due to the fact that it sits at the convergence of three major currents, the

Peru Current, the Cromwell Current, and the Panama Current. The Peru Current, a northern extension of the Humboldt Current, brings cold sub-Antarctic water along the west coast of South America. The Cromwell Current flows eastward and brings cool, high-nutrient water along the equator at around 100m depth, which then rises to sea level after reaching the Galápagos Plateau. The Panama Current arrives seasonally from the north-east and consists of warm, low nutrient water. These three currents meet and combine among the islands, creating many different environments, with differing water temperatures and nutrient levels, within a single archipelago. As a result, animals from many different climates, from penguins to tropical reptiles and warm water corals, live on the Galápagos Islands. In no other place in the world can penguins and corals co-exist (Baine et al. 2007).

The islands are home to a number of endemic, native, and endangered species. Between 5,500 and 6,000 species have already been identified, and it is estimated the islands could have as many as 7,000 to 9,000 (UNEP/WCMC 1981). Many of these species are endangered or threatened. As of 2006, 16 species of mammals birds, and fish native to the Galápagos were recognized on the IUCN Red List of Threatened Species (Edgar et al. 2008), and all the endemic flora of the islands was added to the red list in 2001 (UNEP/WCMC 1981). Many more species are on the red list that are present not only on the Galápagos Islands but also in many other places in the world. In 2006 there were an additional 25 endemic fish, mollusc, echinoderm, coral, crustacean, and macroalgal species not included on the red list that complied with threatened species criteria (Edgar et al. 2008).

3.1 The Galápagos National Park and Marine Reserve

In 1936 the Galápagos National Park (GNP) was created by Executive Decree 31. The boundary was ratified by Decree 17 in 1959, to include almost all the islands, and the boundaries were finally established and management began in 1968 (UNEP/WCMC 1981, Bremner and Perez 2001). The Charles Darwin Foundation for the Galápagos Islands (CDF) was established by UNESCO in 1959 as a non-profit international research organization (Charles Darwin Foundation 2006), and is jointly supported by the Ecuadorian government, the IUCN, and UNESCO. Funding comes from a variety of international conservation bodies and private donations (UNEP/WCMC 1981). The CDF's written agreement with the Government of Ecuador stipulates the CDF will "collaborate with Ecuadorian scientific institutions, provide periodic written reports to the Government on research results, and lend support to Ecuadorian educational and scientific institutions...furthermore the CDF is required - under the Special Law of the Galápagos - to provide advisory support to the INGALA council...to promote the effective management of the Galápagos National Park and Marine Reserve (Charles Darwin Foundation 2006, p. 10)."

Many studies of the marine environment had been performed, the most notable of which are those of G. Wellington, who recommended the creation of a marine park and the extension of the size of the protected zone around the islands (UNEP/WCMC 1981). In 1971 the Marine Reserve baseline was ratified by Official Registry 265, creating a 7,990,000 ha area by joining the outermost points of the islands. In 1984 the islands were declared a UNESCO Biosphere Reserve, and 2 years later the Galápagos Biological Marine Resources Reserve (GMRR) was created by Executive Decree 1810-A, which

extended the protected waters to all waters within 15 nautical miles of the baseline, as well as creating immigration controls and a quarantine system (UNEP/WCMC 1981, Bremner and Perez 2001).

In 1987 a zoning plan was drafted, and a management plan for the GMRR was approved in 1992. The GMRR was extended to 40 nautical miles in 1998 with the publishing of the Law of the Special Regime for the Conservation and Sustainable Use of the Province of Galápagos, which created the Galápagos Marine Reserve (GMR), but the law was not enforced. In 2001 the marine reserve was included within the World Heritage area along with the islands, and the islands were listed as endangered by tourism, immigration, and invasive species in 2007 (UNEP/WCMC 1981). Although named the Galápagos Marine Reserve, technically the GMR is an MPA but not a reserve according to the standard definition, since it allows some extractive activity. However I will continue to call it the Galapagos Marine Reserve throughout the remainder of my thesis as that is the official name.

The Galápagos National Park and Marine Reserve protects approximately 14,066,514 ha; 766,514 ha of land (97% of the islands) and 13,300,000 ha of water, from -180m underwater to 1,707m (Wolf Volcano on Isabela Island) (UNEP/WCMC 1981). The stated goal of the GMR is "...Protect and conserve the marine-coastal ecosystems and biological diversity of the archipelago for the benefit of humanity, local populations, science, and education (Parque Nacional Galapagos 2004, p. 2)." There are six activities regulated by the park that are allowed in different zones designating various areas of the GMR: tourism, artisanal fishing, scientific investigation, recreation, community use, and education (Parque Nacional Galapagos 2004).

The zone designations are Multiple Use Zones, Port Zones, and Limited Use Zones. The Multiple Use Zones allow fishing, science, conservation, navigation, and patrol and rescue maneuvers (Parque Nacional Galapagos 2004, UNESCO 2010). They encompass the deep water inside the baseline. The Port Zones encompass the water around the 5 ports in the archipelago: Puerto Ayora, Puerto Seymour, Puerto Baquerizo Moreno, Puerto Velasco Ibarra, and Puerto Villamil. These areas are intensely used and represent the base of operations for economic activities (Parque Nacional Galapagos 2004). The Limited Use Zones contain the coastal and shallow waters, and promontories that rise above the water, as well as any waters over 300 meters deep. This zone is subdivided once again into three zones: Comparison and Protection, in which only scientific and educational activities are allowed; Conservation and Non-extractive use, in which aquatic tourism is cultivated (diving, snorkeling, whale watching, etc.) as well as scientific investigation and educational activities; and Conservation, Extractive, and Non-extractive use, in which all the regulated activities are allowed (Parque Nacional Galapagos 2004). In addition, each zone can have Special Temporal Management Areas set aside for experiments or recuperation, and certain activities are restricted in these areas (Parque Nacional Galapagos 2004).

3.2 The Galápagos Special Law and the Instituto Nacional Galápagos

The Galápagos Special Law is a scheme for the conservation and sustainable development of the Galápagos, which establishes an administrative legal regime by which various bodies manage those aspects of human and natural resources relevant to the Galápagos Islands, to develop a strategy to "achieve both environmental and socio-

economic sustainability (Witt 2000, art. 4)." The law applies to all the land area of the islands including the populated areas as well as the GNP; the marine reserve; the special protection area, the geostationary orbit and the submarine base and platform (Witt 2000).

On March 18, 1998 the President of Ecuador and the National Congress officially signed the Special Law of the Galápagos, designating the islands and 40 miles of surrounding waters a protected area. This law was groundbreaking in that one of its main goals is that the reserve is to be managed through a participatory management system, meaning local stakeholder groups as well as government organizations have a say in how the reserve is managed. The Law extended the boundaries of the original Galápagos Marine Resources Reserve to 40 nautical miles around the islands and prohibited industrial fishing; only tourism and artisanal fishing are allowed ("Home" n.d.).

The Special Law also established regulations related to the transport of introduced and invasive species as well as instituting residence controls to reduce migration. Tourist fees were designated to support the GNP service, the Quarantine Inspection System, aspects of the Ecuadorian Navy relating to the reserve, and municipal governments, and tax incentives were introduced to promote local hiring. The Law was written in language that would allow for future significant educational reform on the Galápagos and INGALA, the Instituto Nacional Galápagos (Galápagos National Institute) was established in 1980 with the new charge of coordinating policies and planning on the islands ("Home" n.d.).

The Special Law dictates that levels of planning exist within the management framework of the Galápagos Islands. The provincial or regional planning will include a plan the will seek, within the framework of the Special Law, the integration and

reconciliation of all bodies responsible for the respective province or region. The plan will include

> "among other things, guidelines for sustainable development of the province, guidelines for the protection of the environment, and guidelines for achieving the following aims:
>
> 1. Application of total control of introduced species, both in protected areas and in urban and rural areas, in accordance with the definition in the glossary of the law;
> 2. Improvement of the levels of education and training of the population;
> 3. Promoting social well-being and a lifestyle consistent with the sustainability strategy of the insular Region; and,
> 4. Promoting the stabilization of the population. (Witt 2000, art. 5a)."

A further planning level concerns protected areas and dictates that planning of protected areas and sectors will be managed by bodies and agencies with expertise in the territory as it is allocated by the Special Law. "Each plan will include an analysis that demonstrates compliance with the Regional Plan (Witt 2000, art 4b)" and each plan is examined by the INGALA Technical and Planning Committee, who decide if any problems exist with the plan and offer suggestions and guidelines for changes (Witt 2000).

As laid down in the Special Law, INGALA is the technical advisory body to institutions on the Galápagos who require it, as well as being responsible for regional and land use planning (including approving policies relating to health infrastructure and motor vehicles and machinery) and budget approvals. They also provide technical assistance and funding to institutions in need, and attend economic activities of the local populations which are compatible with the provisions of the Regulation, and carry out

investigations when needed (Witt 2000). The INGALA Council Institutional Coordination Committee is composed of the Governor of the province of Galápagos, The provincial prefect of Galápagos, The Director of the GNP, and a representative of the consortium of the municipalities of the Galápagos (Witt 2000). The technical and planning committee of the INGALA council consists of "delegates from the Ministry of State of the environment, the Ministry of State for foreign trade, industrialization, fisheries, and tourism, the Provincial Council of the Galápagos, the GNP, the consortium of Galápagos municipalities, and the Ecuadorian Committee for the conservation and protection of the environment CEDENMA (Witt 2000, art. 27)."

The Director of the GNP is responsible for overseeing all plans and policies implemented within the GNPMR. The Special Law stipulates that the Director must be at a "professional level in one of the branches of natural science (Witt 2000, art. 44)" with at least five years experience in the administration and management of protected areas.

The inter-institutional management authority of the park is at the national level. It "establishes policies for the GMR, approves plans, monitors and evaluates management tools, supported by principles of conservation and sustainable development (“About participatory management in the Galapagos” 2009)," and its members include

1. "The Minister of State of the environment...
2. The Minister Secretary of State for defense;
3. The Minister of State for foreign trade, industrialization, fisheries and tourism;
4. The Provincial Chamber of Tourism of the province of Galápagos;
5. The President of the Union of Artisanal Fishing Cooperatives from the province of Galápagos; and,
6. The Sector of conservation, science and education, of the province of Galápagos. (Witt 2000, art. 34)."

The Charles Darwin Foundation is also charged to act as an advisor, with a voice but unable to vote (Witt 2000).

The special law also stipulates guidelines for any plans on managing the marine reserve. All management plans must include discussions on zoning and resource use; measures and mechanisms for the protection of vulnerable marine species and ecosystems; bans, controls, and other manners for the conservation of marine species, resources, and ecosystems; the regulation of the market and transport of nationally caught fishery resources in the reserve; discussions on fishing and artisanal vessels allowed and definitions of basic descriptions of activities allowed in the reserve; definition of the mechanisms and procedures for developing the fishing calendar and fishery regulations; controls of tourism, fishing, and other activities; evaluating environmental impacts on the marine ecosystem; descriptions of tourist purposes allowed in the GMR; the levels of participation and local groups through the participatory management board; methods of monitoring, coordination, and control of the activities between public institutions; and requirements for performing scientific research within the reserve (Witt 2000).

One of the most significant pieces of the Special Law is that it created a participatory management board that includes members of all the stakeholder groups on the islands, which is responsible for issues related to the administration and management of the GMR (Witt 2000). This includes analyzing and making recommendations on issues including zoning, proposed regulations, marine management plans, integration of land, and the identification of research needs (Baine et al. 2007). All resolutions proposed by this body must be passed by consensus, which hopes to create and ensure cooperation and compromise between all groups to satisfy all parties. The permanent members of the

participatory management board include representatives from the Galápagos Artisanal fishing sector; the Provincial tourism house; the conservation, science, and education sector; the Galápagos National Park; the naturalist guides of the Galápagos; and the Charles Darwin Station (Witt 2000). Currently the position for the conservation and education sector is not filled (Heylings and Bravo 2007, "About participatory management in the Galapagos" 2009).

The Special Law sounds good in principle, establishing a number of regulations to promote the well-being of the local human populations and the environment. However, a number of problems present themselves when we examine the situation on the islands.

4. CURRENT ISSUES AND PROBLEMS ON THE GALÁPAGOS

The Galápagos Islands are currently facing many threats to biodiversity and the health of the ecosystems and human populations. Several problems are outside the immediate control of the local management agencies and communities, such as increasingly frequent and strong El Niño events. However, the most pressing problems are a direct result of past actions and management practices on the part of the local communities and the government. The issues ultimately come down to a lack of balance between the needs of the ever-increasing populations of the islands and the needs of the myriad species native and endemic to the islands. In 2007 the IUCN added the islands to the list of World Heritage Sites in Danger (UNEP/WCMC 1981, France-Presse 2007, Gonzalez et al. 2008) due to increasing pressures from tourism (UNESCO 2010), although on July 29, 2010, the islands were removed from the list (UNESCO 2010).

The Galápagos ecosystems are very fragile (UNESCO 2010), like many other oceanic island systems, for reasons such as their high numbers of endemic species, small size and lack of regular natural species introductions from other areas. Approximately 95% of their original fauna and flora remain, thanks to their isolation, relatively late discovery, and lack of an indigenous human population (Ruttenberg 2001, Whiteman et al. 2005, Gonzalez et al. 2008). These ecosystems are currently under stress from a number of anthropogenic activities and natural sources, which in turn is threatening the health of the human populations. The most pressing threats to the Galápagos, exacerbated by anthropogenic activities, include invasive species, accelerating economic

and population growth, increased local conflict, conflict regarding conservation issues, and dysfunctional management (Charles Darwin Foundation 2006).

It is by the following areas that I determine the effectiveness of the marine reserve. Based on the stated goal and the regulations that have been implemented, the GMR should be far more effective than it is. The following problems are either exacerbating or causing much of the ineffectiveness of the GNPMR.

4.1 Invasive species

The Galápagos are suffering from a myriad of invasive plants and animals. About 24% of endemic plants and 50% of endemic vertebrate animals are considered endangered, and most of the problems with invasive species have developed within the last 20-30 years (Charles Darwin Foundation 2006).

Fortunately for the marine reserve, most of these species are terrestrial. However, for a system like the Galápagos, which has numerous small islands grouped together rather than a single or few larger landmasses, a delicate balance exists between the marine and terrestrial environments, and a significant alteration the environment on land could have unforeseen consequences for marine species.

Of great concern to is the prospect of diseases transmitted by introduced species, especially since endemic populations typically have less resistance (Bataille et al. 2009). Potentially the greatest threat to the avifauna of the Galápagos is invasive avian diseases (Whiteman et al. 2005) such as avian pox *Avipoxvirus* spp., and avian malaria *Plasmodium relictum*. In an ecosystem where many of the avian species feed and have close biological interactions with the sea this terrestrial invader could begin to have

significant indirect impact on the ocean. The Southern House Mosquito *Culex quinquefasciatus* was detected on the Galápagos Islands in 1985, and is particularly troubling (Whiteman et al. 2005, Bataille et al. 2009). It can bite both humans and birds to transmit exotic disease agents like avian malaria and the West Nile Virus, which has yet to enter the Galápagos system but feasibly could in a matter of time (Whiteman et al. 2005). Currently INGALA has restrictions and regulations in place, such as fumigating incoming flights, in an effort to avoid the introduction of these diseases.

Some of the most charismatic Galápagos species include the Galápagos penguin, the Galápagos Cormorant, and Blue and Red-Footed Boobies, all of which could potentially be infected. The penguins in particular show low genetic diversity but high gene flow among island populations, suggesting that their resistance to an introduced disease is especially low and once one island population is infected there is a good chance that it will spread to other populations due to individual movements (Nims et al. 2007).

As of yet little data exist on marine invasive species and they are not a problem on the islands. However the threat does exist for the arrival and establishment of some aggressive marine species such as the North Pacific Sea Star (*Asterias amurensi*) ("Galapagos.org : Invasive Species" 2008). With the continual increase of tourism and shipping, which in the past have introduced invasive species such as rats and mosquitoes, it may only be a matter of time before marine invasive species become a problem. The offloading of untreated ballast water and throwing organic waste into the water has caused many problems in other areas, such as the San Francisco Bay. While regulations

do exist to prevent such occurrences, if some ignore such regulations we could soon begin to see reports of marine invasives in the waters of the Galápagos.

4.2 Population and economic growth

People have been using the islands as early as the 1600s. Miguel Caballo de Balboa in 1586 wrote that the Galápagos islands had first been discovered by the Incas during the 15th century. They were christened *Las Islas Encantadas* (The Enchanted Isles) by the Bishop of Panama in 1535 (UNEP/WCMC 1981, Larson 2002). Pirates and buccaneers used the islands as a base to attack mainland ports and ships traveling along the coast. Whalers used the islands throughout the 1700 and 1800s as a base for hunting and fishing the plentiful waters ("Galapagos.org : Human Presence" 2008). In 1832, Charles Darwin, during his famous voyage on the Beagle, stopped on the islands that gave him his revolutionary ideas about evolution and speciation. The first alien species were also introduced during this time, namely goats and rats, and likely some insects and plants as well (Gonzalez et al. 2008).

Ecuador annexed the Galápagos in 1832 (UNEP/WCMC 1981). The Galápagos were first colonized that year, and for more than 100 years after the labor force still consisted of conscripted vagrants, political dissidents, and prisoners (Epler 2007). The original colonists of the Galápagos had hard lives, lacking potable water, sewers, and many other public services. Their economy was based on fishing and agriculture (Bremner and Perez 2001). In 1949 the population of the Galápagos was only 800 inhabitants (UNEP/WCMC 1981). By the early 1970s the population had grown to 4000 (Epler 2007, "Galapagos.org : Human Presence" 2008). In 1990 it had increased to 9,785

and by 2004 it had increased again to 25,000. In 2008 the population had reached 24,000 legal residents, 1,800 temporary residents, and up to 5,000 "irregular" residents (“Galapagos.org : Invasive Species” 2008), and it has been estimated that the populations of the islands could increase to 40,000 by 2015 (UNEP/WCMC 1981).

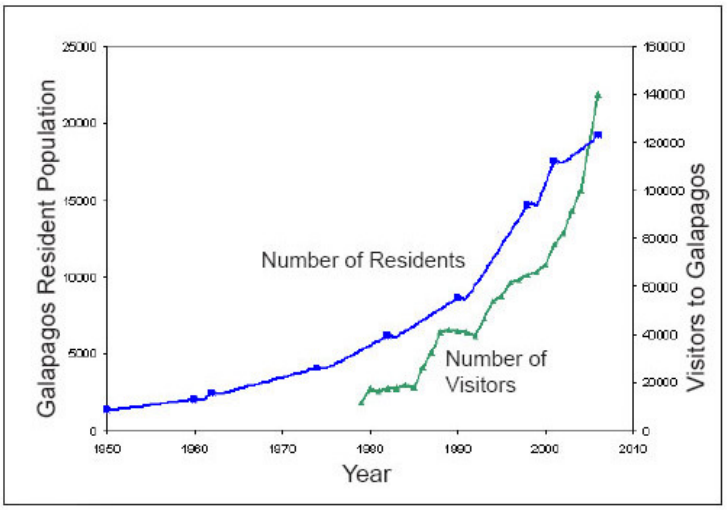

Figure 2: Comparison of yearly population growth on the Galápagos Islands with yearly visitors to the islands. Retrieved from http://www.galapagos.org/2008/index.php?id=107.

The human populations inhabit about 3% of the islands, with the rest designated as the GNP. Much of the population growth is due to immigration, with 6.1% of the increase from 1990 to 1995 due to immigration and only 1.7% due to natural increase (UNEP/WCMC 1981, Bremner and Perez 2001). Many workers migrated after the mainland fisheries collapsed from overfishing in 1989 (UNEP/WCMC 1981). Declining oil prices in the 1980s and 90s and border problems with Peru and Colombia also contributed to the problem. The Sucre, the national currency, lost 98% of its value over this time period, inflation was out of control, and by 2000, 70% of the population of Ecuador lived below the poverty level, and a large exodus of inhabitants from the

mainland occurred, many of them choosing to come to the Galápagos (Epler 2007, "Galapagos.org : Human Presence" 2008).

It is not surprising that migrants choose to come to the islands from the mainland when you compare the quality of life between them. In 1998 mortality (deaths per 1000) was 1.2 and the illiteracy rate was 1% and 2% for males and females over age 9, respectively, on the Galápagos (Baine et al. 2007). Compare this to a mortality of 15 and an illiteracy rate of 8% and 12% for males and females over age 16, respectively, on the mainland (Baine et al. 2007). Unfortunately, this large influx of people wanting a better life has had a negative impact on the well-being of the islands. A 1994 survey showed that 73% of immigrants since 1986 were transient businessmen or low-skilled economic refugees, populations that have little concern for the natural environment, agitate for the terrestrial and marine environments to be opened for development, and are strongly against protected area regulation (UNEP/WCMC 1981).

The significant growth in population has led to increasing strain on both terrestrial and marine resources. The infrastructure of the islands is increasingly inadequate to deal with the high numbers of visitors. The groundwater supplies on the islands are struggling to cope with high populations; the underground aquifer that supplies water to Isla Santa Cruz is becoming more and more brackish with each passing year, and is contaminated. Sewage treatment is also inadequate. Education is also a problem on the islands. Families who can afford it send their children to private school while those who can't send their children to the overcrowded and underfunded public schools. Graduates of these schools are thus ill-equipped to compete with better educated foreigners in local

business industries, and there is a lack of skilled labor on the islands, leading tourism operators to look to the mainland for employees (Epler 2007).

The intense population growth has led to a number of problems in the GNPMR, as it is putting increasing strain on the Park Service to keep track of illegal migrants and increasing the chances of illegal fisheries and other activities. Population growth and tourism also combine to create a cycle of growth, feeding each other.

4.3 Tourism

As the local populations increased, various economic activities grew and expanded. Much immigration occurred due to the draw of the fishing industry after the collapse of the mainland fisheries in 1989. However much of the economic growth was due to ever-increasing tourism. Commercial tourism increased by 8% annually from 1967 to the 1990s (UNEP/WCMC 1981), and over the past 15 years the gross income that tourism generates has increased by an average of 14% with each successive year ("Galapagos.org : Human Presence" 2008). The number of tourists visiting the islands has increased dramatically over the years (see figure 2) reaching almost 100,000 in 2006 (UNEP/WCMC 1981), and 122,000 the previous year (Epler 2007). Figure 3 shows a breakdown of the revenues from tourism (not including park entrance fees). All told the tourism industry contributes an estimated US $150 million to the income of the islands (Epler 2007), although most of the money generated by tourism goes to large tour companies based on the mainland rather than local communities (UNEP/WCMC 1981). The tourism industry also accounts for 40% of the employment (Gonzalez et al. 2008).

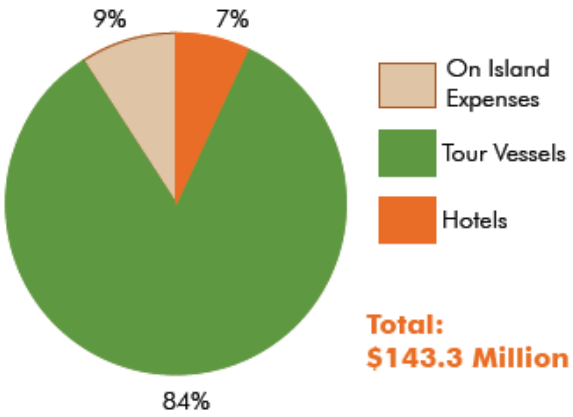

Figure 3: Galápagos Tourism Revenues by Source,
June 2005 to May 2006 (Epler 2007).

$6 million of the income from tourism is solely from park fees and equal to the value of the local fishery. The park entrance fees were set in 1993, and although how they are distributed was altered with the 1998 Special Law, rates have not increased since 1993 (Epler 2007). A majority of the funding for the GNPMR comes from park entrance fees, funding which is used for patrolling the National Park and the Reserve, and education, among other activities. They are distributed to various organizations on the islands in the following percentages: 10% to INGALA, 5% to the Navy, 10% to the Provincial Council of Galápagos, 5% to the Quarantine and Inspection System (SICGAL), 40% to the Galápagos National Park, 25% to the Galápagos municipalities, and 5% to the GMR (see fig. 4) ("Entry tax to protected areas" 2009). The marine reserve is steadily becoming a major attraction for tourists, with the increase in aquatic activities such as diving, snorkeling, and pesca vivencial, but only 5% of the funding received by the park goes to managing the reserve, which includes mitigating impacts from tourists.

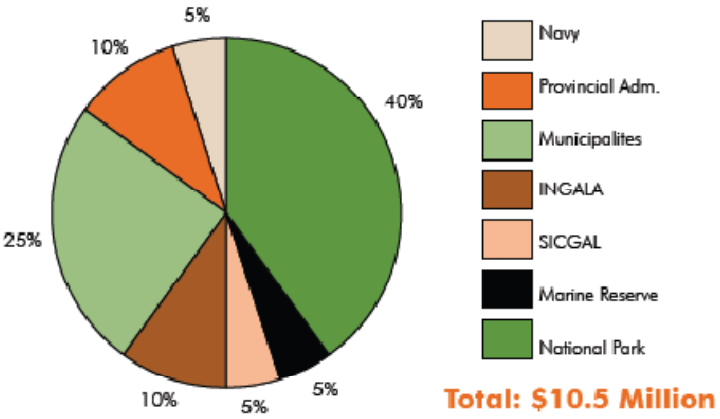

Figure 4: Galápagos distribution of park entrance fees (Epler 2007)

The late 1960s saw the beginning of organized tourism to the Galápagos, with 12 passenger schooners and the 66 passenger Lina A (Epler 2007). By 1981 the fleet had grown to 40 vessels, 90 in 1996, then decreasing to 80 by 2006. Passenger capacity over the same period grew from 600 to 1,805 (Epler 2007). Today cruise ships carrying as many as 500 passengers often stop at the Galápagos, and tourists also travel by air or six-12 passenger tour boats. Tourists are only allowed to visit certain places among the islands, and the number of tourists allowed simultaneously is limited by the Park Service ("PART II: Acceptable load of visitors" 2009). Unfortunately, while infrastructure such as hotels, lodges, and restaurants is in place to deal with these tourists, many problems are also present, such as a lack of adequate water, sewage disposal, and medical facilities (UNEP/WCMC 1981). Also, from 1991 to 2006 there was a distinct decline in visitor satisfaction with the nature and wildlife of the islands (Epler 2007).

The tourism industry also brings many other challenges, including shipping, fuel, and provisions. With increasing numbers of tourists there is an increasing need to

provision those tourists. Shipping both food and fuel can cause significant problems as invasive insects and other animals are transported from the mainland, as well as being inherently risky. An estimated 850,000 gallons of fuel are shipped to the islands each month to power cruise ships and electric generators (Nash 2009), whose presence is a direct result of increased tourism activity. Along with the transport of invasive species there is an inherent danger in fuel transport of a spill, which is exactly what occurred when the Jessica grounded off the coast of Isla San Cristóbal in 2001, releasing 1080 cubic meters of diesel fuel and oil into the waters of the reserve. Few measures are in place to prevent a recurrence (Nash 2009), which represents a lack of foresight on the part of the GMR.

4.4 Fishing

Another result of increased population was the increase in fishing. As mentioned previously, artisanal fishing and agriculture formed the economic basis of early Galápagos settlers. As the number of migrants and residents on the islands increased, so did the fisheries. In 2000, 682 fishing boats were registered with the National Park registry, while 1014 were recorded in the four island co-operatives (Baine et al. 2007), although other numbers suggest approximately 1000 fishermen currently fish in the islands (Viteri and Chavez 2007). Currently fishing is the most important economic activity on the islands, next to tourism, generating approximately $4-$6 million annually (Viteri and Chavez 2007). Ruttenberg (2001) noted that target species of artisanal fisheries decreased, although the effect may be limited due to the use in the Galápagos of hand-lines and spear-guns, which have limited selectivity. Signs were also noted that the

removal of higher trophic species had a cascading effect on community structure, with variability decreasing in heavily fished populations (Ruttenberg 2001), and heavy fishing led to trophic cascades in which herbivore populations increased as predators decreased, leading to decreasing amounts of non-coralline algae and an increase of crustose algae (Sonnenholzner et al. 2007).

In the 1960s the lobster fishery began to develop, using boats from the mainland, and by the mid 1980s a local fishery had arisen (Baine et al. 2007, Sonnenholzner et al. 2007). In 1999 54.4 metric tons (Mt) of lobster were recorded caught, increasing to 85.3 Mt in 2000. 76.3% of this catch was spiny red lobster, followed by green lobster and slipper lobster (Baine et al. 2007). The island populations also consume large quantities of fish, up to 12.7 Mt per week, according to some estimates (Baine et al. 2007). About half the consumption is due to tour boats. In 2007 the total value of exported fish products was around US $4.5 million (Baine et al. 2007).

In 1991 a sea cucumber fishery, targeting a single species, *Isostichopus fuscus*, began illegally around the islands. Previously the fishery had been present on mainland Ecuador, but due to a lack of stock assessment surveys and poor management practices it was quickly depleted (Toral-Granda 2008). As a result those fishermen moved to the islands, and in 1994 an experimental, legal, fishery was attempted. It was opened for three months with a catch quota of 500,000 individuals, but a forcible closure had to be implemented after two months because an estimated 6-12 million sea cucumbers had been caught (Hearn et al. 2005). A five-year ban was then imposed, but from 1993-2003 the fishery was opened in the Galápagos. The fishery is now considered one of the most important income sources for the fishing sector of the Galápagos (Hearn et al. 2005), and

is one of the oldest of its kind in South America (Toral-Granda 2008). In 2002 the sea cucumber fishery generated almost US $1.7 million in gross income, and 8.3 million individuals were caught (Viteri and Chavez 2007).

Clearly there is a great deal of potential for the GMR to mitigate impacts and pressures from fishing through strong fisheries management. However, often regulations and moratoriums are imposed but not complied with or effectively enforced.

4.5 Local conflict and dysfunctional government

The Galápagos can be described as a social-ecological system in which the ecological system is intrinsically linked with one or more social systems (Gonzalez et al. 2008). The economic activities of the islands, including tourism, fisheries, and agriculture, are completely dependent on the integrity of the native ecosystems and services, and in turn the future of the islands' biodiversity and ecosystems is the responsibility of the local populations (Gonzalez et al. 2008). Unfortunately, those responsible for protecting the future of the islands are also the ones putting them in danger.

The Galápagos archipelago is such a small and isolated area that human interference must be carefully managed to ensure the survival of the biodiversity and ecosystems that live there. Currently the success of the marine reserve is hampered by a lack of local cooperation in maintaining the reserve and enforcing regulations. A number of conflicts have arisen in the past between the local stakeholder groups: fishermen, tourist groups, and local and international conservationist groups, as well as between these three and mainland industrial fishing groups (Heylings and Cruz 1998). It was

these conflicts that the Special Law endeavored to reduce by promoting and fostering local participation in reserve management and compliance with regulations (Heylings and Cruz 1998, Viteri and Chavez 2007). However the situation on the islands remains dysfunctional. There is also a lack of complete understanding about the participatory management process at a grassroots level: most locals involved with each sector are aware that the participatory management board exists, but there is not complete knowledge about who the representatives are or how decisions are reached (Heylings and Bravo 2007).

Although the Special Law grants exclusive fishing rights to local artisanal fishermen, these rights are being threatened by national and international industrial demands, while conflicts of use are arising between the artisanal fishing sector and the tourism sector, and demand for products lucrative on the Asian markets are swamping local traditional lobster and cod fisheries (Heylings and Bravo 2007). Jurisdictional authority and responsibility over the reserve is a source of competition for the GNPMR and the Navy, while conservationist and developmental policies clash, the Minister of the Environment changed 5 times in a six year period (Heylings and Bravo 2007), and between 2003-2006 12 different individuals served as the Park Director, the person responsible for overseeing the management of both the National Park and the Marine Reserve ("Galapagos.org : Political Context" 2008, "A park director on the wheel of ill fortune" 2009). After those 12 Raquel Molina became park director for two years and took a rigid stance on how to run the park, trying to enforce the law without giving into political pressure and being fair to all parties, including the ecosystem. The target of threats, bullying and attacks, she never gave in to fear tactics. She was fired in 2008 by

the national environmental minister, after she denied entry into the park to a cruise ship with questionable papers, a move some say was caused or influenced by her "lack of political skill (“A park director on the wheel of ill fortune” 2009)."

4.6 Non-compliance with reserve regulations

There have been a number of examples of non-compliance with reserve regulations in recent years both before and after the enactment of the Special Law, particularly in response to new fishing restrictions or moratoriums. The fishermen on the islands have a history of reacting, often violently, when conservationist groups attempt to institute new policies or reduce illegal fishing efforts. When the sea cucumber fishery was closed for the year in 1995 fishermen armed with machetes and clubs took Charles Darwin Station researchers and their families hostage to protest (Ferber 2000). In 1997 fishermen opened fire on park rangers, seriously wounding one, when the men stumbled upon their illegal fishing camp (Abbott 1997). Other incidents have occurred numerous times in which park officials and politicians have received death threats or been attacked with instruments such as cudgels (Abbott 1997). When the spiny lobster quota was reached barely halfway through the 2000 fishing season fishers reacted with a "strike," laying siege to the CDS, destroying research records and offices, making death threats to Station employees, and hijacking the boat of the acting director of the CDS while he was on his way to work (Ferber 2000).

Even the endemic species aren't safe as fishermen have sometimes taken the charismatic Giant Galápagos Tortoises hostage in protest against fishing restrictions (Ferber 2000, Finchum 2002). The Station was occupied again in 2004 by 100 fishermen

from Isla Santa Cruz, while about 70 more from Islas Isabela and San Cristóbal arrived on the National Park Dock. Their demands included some activities that would have serious negative environmental impacts, including a completely unregulated artisanal long-line fishery, reopening the collapsing sea cucumber fishery, and dropping the charges against Isabela fishermen caught with illegal shark fins (Banks 2004).

4.7 Illegal fisheries and poor fisheries management

The over-exploited sea cucumber fishery is driven by demand from Asian markets, as they are willing to pay high prices for the imported delicacy, and the fishermen often riot and hold protests, sometimes violent, when attempts are made to close the fishery. Not only is *I. fuscus* fished, but a number of other species are fished illegally, including *Stichopus horrens*, *Holothuria kefersteini,* and *H. atra*, on a semi-industrial scale, even though fishing within reserve waters is limited to artisanal vessels (Toral-Granda 2008). No baseline ecological or biological data exists for the species. As a result of strong overexploitation many spots where previously high densities of sea cucumbers were reported now are almost abandoned, with no sea cucumbers present.

There is also a thriving illegal shark fishery on the islands (Hearn 2008). Shark fins are a delicacy in Asia, especially in shark fin soup, and about 400,000 sharks per year are claimed from the marine reserve to support this industry, which may be significantly larger than estimated (Handwerk 2003, Hile 2004, Nash 2009). Although shark fishing as an industry is banned, in 2007 Ecuadorian President Rafael Correa repealed Decree 2130, which had prohibited the fishing and trading of shark fins and meat. As a result, fishermen on the mainland are allowed to sell fins and meat if they can

show the shark in question was caught as a result of accidental bycatch, without using gear that would increase bycatch rates ("Galapagos.org : Invasive Species" 2008). However with under-staffed and under-trained monitoring agencies fear rose that the illegal fishery would experience a boom, as it is difficult to prove one way or another if a species came from bycatch. Although it shark fishing and sale is still completely illegal in the Galápagos, many of the bycatch sharks caught in Ecuador are actually caught in the Galápagos, adding a further burden to park officials, and the Ecuadorian government does little to prevent the activities (Hile 2004, "Galapagos.org : Invasive Species" 2008).

Dysfunctional management is not the only serious threat towards proper management of the reserve. There is simply too much space and too little marine patrol support (Hearn 2008). The National Park currently has 11 vessels and one floating base for monitoring the reserve, a terrestrial base, three terrestrial vehicles, a plane, and a recently added satellite tracking system to patrol 70,000 km^2, or 27,000 $miles^2$ of ocean. Of their sea-going vessels, seven are short range, high speed patrol boats which are expensive to operate and do not last as long if frequently used at high speeds ("Control and Monitoring of the Galapagos Marine Reserve" 2009). Three ocean going ships are available that can remain at sea for many days, hold a large crew, and can reach the outer limits of the reserve. These are equipped with radar and communications equipment and could be the most important ships involved in keeping industrial mainland fishing boats out of the GMR ("Control and Monitoring of the Galapagos Marine Reserve" 2009).

5. SUCCESSES

The park and reserve have had a number of successes over the years in combating both the natural and anthropogenic issues faced by the islands. Efforts to combat several invasive species have been successful, so much so that certain species have been eradicated from some islands. Some progress has also been made in the fishing sector to reduce illegal fishing operations and earn the cooperation of the local populations.

5.1 Invasive species

In the 1990s the Charles Darwin Foundation helped to establish the Galápagos Inspection and Quarantine System, SICGAL ("Galapagos.org : Invasive Species" 2008). The Ecuadorian service for agricultural health (SESA), under the Special Law, is responsible for SICGAL and programs for the eradication of invasive species, funded by INGALA (Special Law). Efforts to control invasive species have been on-going since 1959 with the establishment of the CDF, and many terrestrial programs have been successful ("Galapagos.org : Invasive Species" 2008, "Control and eradication of donkeys (Asnus asinus)" 2009, "Control and eradication of feral cats (Felis catus)" 2009, "Control and eradication of goats (Capra hircus)" 2009, "Control and eradication of pigs (Sus scrofa)" 2009, "Eradication, monitoring, and control of introduced rats (Rattus rattus and Rattus norvegicus)" 2009), but the increase in tourism and migration to the islands beginning in the 1980s has made stopping any new invasive species a matter of importance ("Galapagos.org : Invasive Species" 2008). These successes need continual

monitoring and the processes are ongoing as invasive species remain a significant terrestrial issue on the islands, and hopefully one that can be avoided in the marine realm.

As has been stated previously, there are no reported instances of marine invasive species as of yet, and we can only hope it will remain so. Further efforts are in place in an attempt to prevent and slow the spread of invasive mosquitoes and other organisms. Every aircraft that lands on the islands is fumigated to kill any onboard insects from the mainland. Efforts are also in place to prevent the spread of organisms between islands so more pristine islands remain so. INGALA has a series of strict regulations on what may or may not be transported between islands, and every tourist and vessel is inspected before departing for another island to ensure no prohibited materials are being transported. There are three categories of products: permitted, which are allowed, restricted, which are allowed under certain conditions and provisions, and not-permitted. Galápagos ("The Galapagos Inspection and Quarantine System" n.d.).

5.2 Population and economic growth

Several attempts have been made over the years to mitigate the impacts of the human populations on the islands. Large populations inevitably have significant impacts due to waste and resource use. The islands currently use a color coded system to separate recyclable, organic, and regular waste. In 2006 the municipal authorities in Puerto Ayora provided each household with these bins, and volunteers went door to door and gave community talks on the importance of recycling (Barraclough 2010). Clean up programs involving islanders have taken place both on land and in the water, using divers, to clean

up and remove litter and trash. The author participated in both activities, along with many others.

There are also controls in place to restrict visitor access to the islands based on the zoning scheme and island sensitivity. Some areas permit almost no visitors, while others allow as many as 10 tourist groups at once ("PART II: Acceptable load of visitors" 2009).

Efforts have also been made to improve the education provided on the islands. In 2002 the Universidad San Francisco de Quito established GAIAS, the Galápagos Academic Institute for the Arts and Sciences in an effort to promote conservation and sustainable development on the islands. Together with foreign universities they have established a number of courses in the biological and social science for international students (Universidad San Francisco de Quito n.d.), as well as offering several courses to local populations in business management and conservation.

5.3 Local conflict, fisheries, and governance

Many problems are evident in the fisheries on the islands, as a result of poor management and lack of local cooperation. However changes have begun to be made to improve the situation. In 2008 the Special Regulation of Fishing Activity in the Galápagos was passed, detailing a number of rules and regulations for Galápagos fisheries (La Ministra del Ambiente 2008). For example, only permanent local residents are allowed to fish in the reserve and a number of identification methods and proofs or residence are needed to obtain a fishing license (La Ministra del Ambiente 2008). The types of fishing and fishing gear allowed in the reserve are also tightly regulated

(Comisión Técnica Pesquera de la Junta de Manejo Participativo 2009). As of 2009 the Galápagos National Park has a new satellite monitoring system to improve their ability to monitor the reserve. It is the first MPA in the world to use 100% satellite monitoring technology to monitor ships within the area ("Resources for marine control and monitoring" 2009). Currently all Ecuadorian vessels over 20 tons are outfitted with transmitters and they can be monitored within a 60 mile radius of the islands ("Galapagos.org : Invasive Species" 2008). Various new policies are also being attempted within the fishing sector to improve and maintain sustainable practices while still allowing the fishermen to have a livelihood. Two such practices are the use of fish aggregating devices (FADs) and the promotion of artisanal fishing combined with tourism, known as pesca artisanal vivencial ("Monitoring and evaluation of Experiential Artisanal Fisheries" 2009, "Supporting sustainable fisheries with Fish Aggregating Devices (FAD)" 2009).

Sport fishing is prohibited in the Galápagos Marine Reserve by Executive Decree No. 014, however experiential artisanal fishing has been developed in its place (Comisión Técnica Pesquera de la Junta de Manejo Participativo 2009, "Monitoring and evaluation of Experiential Artisanal Fisheries" 2009). The practice is really another tourist draw, where a tourist pays to accompany a local fisherman on a trip to observe traditional fishing practices. This was designed in an effort to reduce fishing efforts in the reserve, as the catch is limited to what is caught during the fishing trip, instead of fishermen participating in larger, semi commercial fishing activities. Artisanal fishing currently supports over 50 families on the Galápagos, and fishermen are required to attend a number of training sessions that discuss everything from species identification to

passenger quality service (“Monitoring and evaluation of Experiential Artisanal Fisheries” 2009).

Experimental fishing with Fish aggregating devices (FADs) may allow local fishermen to fish further out to sea, reducing the impact on coastal fish populations. Fish aggregate around large floating objects in the sea, and while many theories abound it is still unclear the exact reason why. However the fishermen of the Galápagos are attempting to exploit this behavior for sustainable fishing practices. The main idea is that fishermen can use these devices to attract and catch larger fish migrating through the reserve out at sea, thus lessening the pressure on near shore coastal water populations. The activity would be carefully managed to ensure the use of proper gear and low bycatch rates, and all fishermen are trained in the correct use and maintenance of FADs (“Supporting sustainable fisheries with Fish Aggregating Devices (FAD)” 2009).

5.4 Marine and biodiversity conservation and protection

Although placed on the World Heritage Sites in Danger list in 2007, in July of 2010 the Galápagos Islands were removed from the list because the World Heritage Committee has determined that "significant progress had been made by Ecuador in addressing" problems with invasive species, tourism, and overfishing (UNESCO 2010). Several programs are in place to eradicate and reduce the invasive species on the islands. As was stated previously, the recent addition of a satellite monitoring system has made it easier to monitor activity within the park by larger ships. The system can monitor all ships registered in Ecuador greater than 20 tons by their electricity generation within a 60 mile radius of the islands (Galapagos Conservancy 2009).

6. EVALUATION

The current situation demonstrates that the Galápagos Marine Reserve is not fully effective as a reserve that must respond not only to the needs of the environment but also to the needs of the local population. The GNPMR is a unique situation in which locals actually live within and use the resources of the protected area. As such stronger considerations need to be given to the social aspect of the marine reserve than may be needed in other situations. Although the GMR is a single large MPA, and not an MPA network, due to the zoning scheme that determines what areas can be used for certain activities, there is in essence a network within the GMR, of areas with differing levels of use. This, the IUCN criteria for an effective MPA can be applied to the GMR and I will use these criteria to demonstrate the main areas in which the GMR needs improvement.

6.1 Ecological criteria

As far as ecological criteria are concerned, the GMR is functioning well in principle, due to its large size. Table 1 displays the status of each of the ecological criteria in the GMR.

Table 1: The status of the eight ecological design criteria for MPA networks within the Galápagos Marine Reserve.

Criteria	**Status in GMR**
Representativeness	Large size (27,000 mi^2) ensures majority, if not all, habitats and biodiversity are represented.
Replication	Within the large area many replicates of habitats exist around the shorelines of different islands and in the deeper waters.
Viability	Large size allows for geographic dispersal of habitats and species. Allows for potential areas of renewal if some sites suffer a disaster. Sedentary species have almost complete protection.
Precautionary design	Little baseline data exists for many species. Most regulations are based on best current available data, however poor political commitment leads to a lack of enforcement of those regulations. Often moratoriums and fishing limits will be lifted or altered because of protests from locals.
Permanence	Thus far no plans are in place to remove the reserve. Protection should continue.
Maximum connectivity	The reserve protects all the water between the islands as it is a single large protected area, not a series of networks. Theoretically this allows for maximum protected connectivity between species within the reserve boundaries.
Resilience	The large size ensures replication and representativeness of habitats and ecosystems within the reserve to provide resilience in the event of a significant stressor.
Size and shape	The large size of the reserve allows greater potential for recovery from stressors since a great deal of area is theoretically protected from intense pressure and can renew and support impacted areas.

6.1.1 Recommendations

While the ecological criteria seem to be well supported, that is due mostly to chance, because the GMR encompasses such a huge area. Precautionary design of the GMR is lacking. Although the GNP does perform baseline surveys, for many commercial species little historical data exists. When regulations are established, such as the decision to close the sea cucumber fishery for five years in 1994, protests from fishermen usually result in these moratoriums, regulations, and restrictions being lifted or altered. The attempts at precautionary design must be reinforced and supported by political commitment and determination, not altered because of pressure from local fishermen.

6.2 Best practices

The six best practices outlined by the IUCN should be used so "planners can create networks that achieve maximum environmental, economic, and social benefits (WCPA/IUCN 2007, p. 6)." It is among these criteria that we begin to see strong deficiencies in the effectiveness of the marine reserve, as explained in Table 2.

Table 2. The status of the six best practices for MPA network design within the Galápagos Marine Reserve.

Criteria	Status in GMR
Clearly define network objectives	The network objectives of the GMR are well-defined. The GMR states that its purpose is to "Protect and conserve the marine-coastal ecosystems and biological diversity of the archipelago for the benefit of humanity, local populations, science, and education (Parque Nacional Galapagos 2004, p. 2). Since the creation of the special law several amendments, regulations, and management schemes have been introduced that clearly define the rules for fishing, zoning, tourist visitation to the islands, etc. (Witt 2000, La Ministra del Ambiente 2008, Comisión Técnica Pesquera de la Junta de Manejo Participativo 2009)
Establish long term political commitment and will	The establishment of long-term political commitment and will has been half-hearted at best. The Special Law was enacted in 1998, and it was not until 2003 that the government produced regulations to define territorial boundaries and enact rules (Heylings and Bravo 2007). The Minister of the Environment and the President of the Republic changed four times during a 5 year period and the Director of the National Park, changed 12 times in the span of 4 years, from 2003-2006 (“Galapagos.org : Political Context” 2008, “A park director on the wheel of ill fortune” 2009). The 13th director, Raquel Molina, was fired after 2 years because she denied entry to a cruise ship with controversial papers, and people considered her a strong fighter but politically naive (“A park director on the wheel of ill fortune” 2009). In other words, she was fired for not playing the political game. There has been a great deal of political instability in on the mainland in recent years as well. The two parliamentary seats held by the Galápagos are contested by "door-to-door politics" (Hearn 2008), and uprisings and strikes in response to regulations have achieved success at the local and national level (Heylings and Bravo 2007), demonstrating the lack of political will to fully endorse and enforce the goals of the GMR.
Encourage stakeholder participation	One of the main aspects of the creation of the marine reserve was to implement the participatory management scheme and encourage stakeholder participation. Yet as resources and support declined this scheme began to break down after the first few years (Hearn 2008). Heylings and Bravo (2007) found that at the grassroots level local understanding of the participatory management scheme is incomplete. There is also unequal influence of different sectors on the participatory management board, as fisheries resources are still seen as belonging to the state and the fishing sector focuses on maximum value that can be exploited rather than conservation (Hearn 2008). There is low consistency and stability of elected representatives within the fishing sector and the Ministry of Environment as well (Heylings and Bravo 2007).
Make best use of available information	The regulations of the GMR are based on the best available data - unfortunately, little baseline data exists for many species, but that cannot be changed at this point. However, non-compliance and political pressure can often lead the government to overlook the data and establish a quota or regulation due to pressure. Thus the available information is not being used in the most effective way within the GMR.
Develop integrated management frameworks	The Special Law established a hierarchical management structure for the Galápagos Marine Reserve at its creation. There are multiple levels of organization, local, regional, and national, to establish cohesive management schemes. However there is competition between the GNP and the Navy over who has jurisdictional responsibility for the GMR, undermining the hierarchical structure. There is also confusion and a weakening of the process of nesting different levels of institutions within the co-management regime.
Employ adaptive management techniques	Many regulations are based on the best available information, at least at the beginning. There is also monitoring in place for species like the spiny lobster and sea cucumbers. (“State of the sea cucumber and lobster in the Galapagos Marine Reserve” 2009). The promotion of experiential artisanal fishing is an example of adaptive management: although sport fishing is illegal the activity has been altered and regulated in an effort to reduce the impact on local fisheries.

6.2.1 Recommendations

Lack of political will and frequent arguments between the GNP and the Navy over who has responsibility of the GMR has undermined the hierarchical structure called for in the Special Law. This also has negative implications for the reserve, as the Special Law, which was designed to be adaptive, is undermined by political and social instability. Much stronger political commitment is critical for an effective MPA network, and the Galápagos is no exception. The position of Director of the GNP needs to be given to more people like Raquel Molina, and those people need to relate to and foster relations with local populations, to ensure that political pressure cannot oust them if they are "politically naive."

Far more effort needs to be given to promoting understanding of the Special Law at the grassroots level, through education and community outreach. While there is high attendance at management board meetings from all sectors, there is little satisfaction at the grassroots level that their interests are being represented reliably, and no mechanisms are in place to gather information on grassroots interests and opinions (Heylings and Bravo 2007). Also, equal weight must be given to all stakeholders: right now there is unequal representation and only the fishing sector receives support for building social and political capacity in decision-making (Heylings and Bravo 2007).

6.3 Broader considerations

These four broader considerations must be taken into account when designing an MPA network, to set the MPA network in context in the social and political arena and

ensure its success. Table 3 elaborates on the status of these considerations within the GMR.

Table 3. The status of the four broad considerations to ensure MPA networks are set in context within the Galápagos Marine Reserve.

Criteria	**Status in the GMR**
Economic and social	The economic and social aspect is being considered and discussed at the expense of the environmental considerations. Violent protests by fishermen in objection to fisheries closures are driven by a desire for financial gain. Often these protests result in their demands being met, providing riches in the short term but will eventually lead to the complete collapse of the sea cucumber and other fisheries.
Spatial and temporal	This is also evidence of the lack of attention and enforcement to spatial and temporal issues: the eventual consequences of continuous overexploitation far outweigh the benefits of short term profit, but that is not being considered in practice
Scientific and information management	Monitoring an assessment schemes exist within the reserve but there is a lack of coordination between the participatory management board and scientific institutions such as the Charles Darwin Research Station, who gather and present the data. There is also little scientific education and information sharing with the local public.
Institutional and governance	There is a distinct lack of effective coordination among sectors and jurisdictions, such as competition between the GNP and the Navy for control of the reserve. The Special Law has established guidelines for creating regulations at the local, regional, and national level, but conflicts still exist and there is a great deal of non-compliance with reserve regulations.

6.3.1 Recommendations

The economic and social considerations must not take over all others when trying to create regulations for the reserve. Allowing regulations to be altered and dictated by the fishing cooperatives instead of scientific information and stakeholder consensus demonstrates a significant lack of attention to temporal considerations. Long-term consequences of present actions must be considered when deciding to alter regulations and political determination must be present to resist pressures to change from local stakeholders, when the changes do not have long-term viability.

6.4 Key elements

Perhaps the most important criteria are the ones that the IUCN deems the Key elements needed to make MPAs happen and achieve their goals. It is these areas that most strongly demonstrate the ineffective aspects of the GMR.

Table 4. The status of the four key elements needed to make MPA networks happen within the Galápagos Marine Reserve.

Criteria	Status in the GMR
Political will and leadership	Political will and leadership is lacking within the reserve. The position of Director of the National Park changed hands 12 times in a four year period. The 13th director, Raquel Molina, demonstrated the necessary qualities for an effective leader, but she was fired for not playing the political game, demonstrating the necessity for a strong director who can also appease persons at many political levels. Political leaders also need to relate well to local populations to have their support, and many people on the islands feel that most of the leaders of the GNP are corrupt and do not have local interests at heart.
Public education, communication, and awareness	Schools on the islands are underfunded, policies and practices are not being implemented the same way on the islands, teacher preparation and student proactivity and leadership are both lacking, the knowledge and skill development level of students on the islands is below the national average, and there is no incorporation of environmental education into the curriculum, among other problems ("Galapagos.org : Education System" 2008). Although the Galápagos Academic Institute does exist, education on the islands, there are no universities and students must go to the mainland to study higher education ("Galapagos.org : Education System" 2008).
Monitoring and assessment	There are monitoring and assessment plans in place within the reserve, to keep track of sea cucumber and lobster populations, to monitor ocean conditions, and to monitor pelagic fish species in an effort to • "Understand the importance of marine protected areas and specific locations therein for sharks and other migratory species. • Understanding the migration patterns of coastal-pelagic sharks. • Assess the state of shark populations in the South-East Pacific Ocean. • Ensure that research results are communicated transparently and on time to stakeholders and decision makers. • Provide local and national authorities with technical recommendations for the management and conservation of sharks and other pelagic migratory species. ("Research of abundance and distribution of pelagic fish in the South-Eastern Pacific Ocean" 2009)."
Sustainable financing	A set method of sustainable financing is needed to ensure that the reserve can maintain and improve its activities. While tourism brings in a great deal of money to the island economy, a majority of that ultimately goes to mainland companies (UNEP/WCMC 1981) and the rest remains among local island businesses. A majority of the funds received by the park from tourism and in general come from park entrance fees, followed by the central government (fig. 5).
Compliance and enforcement	A concern that must be addressed is the non-compliance and poor enforcement on the islands. There is disconnectedness between the local Galápagos populations and the islands themselves, and the conservation efforts aimed at the islands. There is a distinct lack of a desire to comply with fishing regulations among a majority of local fishermen on the Galápagos. The self-declared rate of regulation violations among Galápagos boat-owners is almost 30% (Viteri and Chavez 2007). The premise and goals of the Special Law are good ones, yet they require far more support to be effective. Elicier Cruz, director of the Galápagos office for the World Wildlife Fund, says that the Special law has several weak points that require improvement, namely that clear penalties need to be in place and enforced for illegal migrants and employers who don't follow the law, changes to the concessions made for tourism, and changing the inspection and quarantine system so it was focused specifically and institutionalized on the Galápagos ("WWF's Cruz says Galapagos' Special Law need work" 2009). Enforcement is an extremely important aspect in the proper functioning of an effective marine reserve. Both the Galápagos National Park and the Ecuadorian Navy jointly patrol and enforce the regulations of the marine reserve. Unfortunately, there is simply not enough support and funding for these patrolling efforts.

6.4.1 Recommendations

The reasons behind this non-compliance and lack of ecological awareness may be a result of a lack of feelings of legitimacy and justification among fishermen about the GMR, leading to low incentive to promote its success. Viteri and Chavez (2007) found that among boat owners on the Galápagos the level of legitimacy of regulations, the legitimacy of local organizations, the levels of individual participation within fishing cooperatives and the individual's sense of belonging all positively affected compliance/violation decisions of fishermen within the GMR. Stern (2008) also found that voluntary compliance with regulations in protected areas was a key aspect to the protection of those areas, in accordance with the IUCN. Voluntary compliance in following protected area regulations was strongly related to the perceptions of trustworthiness of the managers of the area to be fair and honest with local groups, while fear of reprisals for violations was only a small deterrent. Positive perceptions of protected area managers was enhanced by perceptions of consistency in enforcement of regulations, and meaningful exchanges and interactions between managers and locals were possibly the most important drivers behind developing trust (Stern 2008).

This feeling of legitimacy appears to be missing in the minds of many local Galápagos fishermen, at the least. Anecdotal reports from Finchum (2002) indicated many of the fishermen felt they were being left out of the decision making process, that the conservationist sector was limiting their activities unjustly and taking away their livelihoods, and that the National Park was corrupt and carrying out actions specifically to impede the fishermen's way of life. Many of the fisherman and tourism individuals share similar feelings about the corruption among the park officials and local

governments (Personal observation). They feel that the government and the organizations that create and enforce park and reserve regulations continue to put increasing restrictions and pressures on local residents, while doing little to nothing about illegal industrial fishing on the edges of the reserve and similar activities. Whether these feelings are warranted does not necessarily matter; they exist and must be addressed before feelings of legitimacy and cooperation can be fostered.

It is important that feelings of legitimacy are fostered about the national park and the marine reserve in order to stimulate and encourage local cooperation with the regulations. With local cooperation and invested interest in protecting the islands, there will be increased support for management actions to limit tourism, immigration, and development on the islands, as well as more support and understanding for fishing and fishery restrictions. However this will also require a firm commitment by the governing authorities to increase stability in the area, to support local populations financially and culturally, and to do more to limit corruption and illegal activities outside of the reserve, rather than focusing on within only.

To patrol the 27,000 mi^2 of reserve waters the GNP has 11 vessels and one floating base for monitoring the reserve, a terrestrial base, three terrestrial vehicles, a plane, and a recently added satellite tracking system ("Control and Monitoring of the Galapagos Marine Reserve" 2009). Because of a lack of resources, the uninhabited and far flung islands like Darwin and Wolf are difficult to access and patrol. Thus, there is a low probability of being caught fishing illegally and a low probability of sanctions, increasing non-compliance among fishermen (Hearn 2008). The Navy and the GMR combined only receive 10% of the funds from entrance fees (fig. 4). Increasing revenue

is necessary to provide the necessary financial support for effective patrolling and management of the reserve.

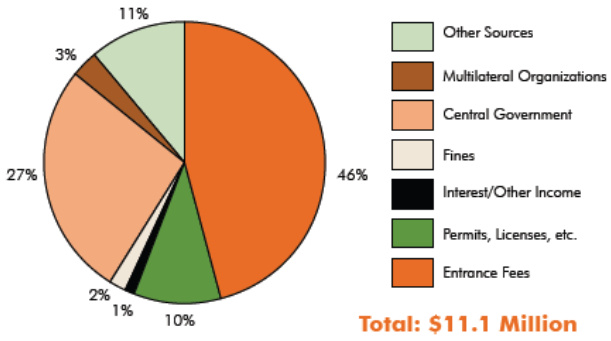

Figure 5: Galápagos National Park budget sources, 2006. (Epler 2007)

7. POTENTIAL SOLUTIONS

User fees and vessel fees paid by incoming tourists and tour companies on the islands have not increased since 1993, despite the fact that tourism has been steadily increasing and continues to do so and revenues for said vessels have increased by 725% (Epler 2007). In light of the fact that these fees are divided among institutions on the islands and are used for park and reserve management and conservation, it is reasonable that a re-evaluation of user fees should be performed, potentially leading to an increase. Increasing fees could lead to the islands becoming an "elitist destination," where only the wealthier are able to visit, thus leading to a decrease in mainlanders and lower income visitors. However, we must consider 1) travel to other countries is already fairly elitist, with the cost of airline or ship travel, lodging, and food, which many cannot afford; 2) even a moderate increase from a $100 entrance fee to $200 could generate significantly more income overall without unduly raising the cost for individual travelers; and 3) higher fees could indeed potentially reduce the number of visitors per year, thus reducing the impact on the ecosystems.

Epler (2007) notes that there is ample justification to raise entrance, permit, vessel license, and patent fees. He also commented on the fact that higher fees could lead to lower visitation rates, and thus indirectly slow population growth. Although a fee of $100 seems high, in relation to other parks and protected areas in the world the rate is actually fairly low (Epler 2007). Other park fees range from $5/day in the Red Sea Marine Park, in Egypt, to $60/day at Mt. Kilimanjaro in Tanzania. Since visitors generally leave the park every day they pay this fee each time they enter, while the

Galápagos entrance fee is a one-time charge (Epler 2007), and tourists may stay on the islands up to 90 consecutive days ("Tarjeta de Control de Transito (TCT)" n.d.). It has also been shown that people are willing to pay higher fees for marine protected areas (Peters and Hawkins 2009) and higher income tourists on high-end tours are more willing and able to pay higher entrance fees (Epler 2007).

Increasing tourist entrance fees would also increase funding available for another critical institution: education. Education is arguably one of the best ways to improve both the environmental and the economic situation in struggling areas. It was thought that keeping most of the money from tourism on the islands would enhance the wellbeing of the local inhabitants, but increasing population due to illegal immigration has hindered and negated any increases in GDP per capita (Epler 2007). Because the standard of living on the Galápagos is significantly better than on the mainland, with a shortage of labor instead of high unemployment, illegal immigration is high and efforts to stem the tide are largely unsuccessful (Epler 2007). As a result, local employers hire illegal migrants, who aside from being willing to work for less, are generally more educated than locals and end up taking higher paying jobs on cruise ships or as guides (Epler 2007). Although IGNALA began an 18 month project to remove "irregular residents" other actions can be taken to influence population growth and welfare. One method is improving the "quality" of the local population. Providing legal residents with increased access to higher quality long-term education and short-term training and internships (Epler 2007) will create a well-trained and skilled local worker pool for employers to draw on.

Aside from providing a skilled worker pool, educating the local populations could be one of the surest ways to improve relations between the government and locals and significantly reduce incidences of non-compliance and illegal activity on the islands. Not only do those with higher education generally have more opportunities, they often better understand the importance of conservation of natural resources and similar situations, especially when those subjects are incorporated into the curriculum from an early age. While efforts have been made, continued violations of park regulations and feelings of illegitimacy persist. Although Viteri and Chavez (2007) noted those with higher education were more likely to be critical of policies, more educated people tend to be more able to think critically and arrive at well thought out and informed conclusions. This is not to say those who are less educated are stupid or incapable of understanding the importance of concepts like conservation, but a higher level of education generally leads to more skill in critical thinking and analysis. It is likely that improving the education of the islands will go a long way to alleviate many of the conflicts as parties are better able to communicate their thoughts, opinions, and concerns and arrive at mutually beneficial decisions. A greater understanding of the islands and the management system will also likely lead to feelings of legitimacy and ownership among the locals regarding the islands, leading to an increase in voluntary compliance with the regulations of the reserve.

8. CONCLUSION

The Galápagos Archipelago is one of the most unique ecosystems in the world. Its rich biodiversity is being threatened by relatively recent and severe anthropogenic factors. Rapid population growth and increasing tourism are stressing the inadequate infrastructure on the islands and having an adverse impact on local ecosystems. Disconnectedness between local populations and the islands and government has led to feelings of illegitimacy about the GMR. This is turn has led to a great deal of non-compliance with reserve regulations, illegal fisheries, and violent protests.

Although the problems faced are potentially grave, in the past several years significant improvements have been made to mitigate the effects of the human populations living on the islands and protect and conserve local ecosystems. However, far more political commitment must be established and maintained to ensure success. The National Park must receive more funding to adequately support patrolling and enforcement efforts. Increasing user fees is potentially a good way of receiving extra funds.

Furthermore, more funding from increased user fees or other resources can be put to significantly improve the educational opportunities on the islands. Improving education is a must if the marine reserve hopes to become an efficient and successful conservation tool. An educated populace is more able to understand the reasoning and consequences behind various policies and actions, and is far more likely to participate in the participatory management scheme of the islands. A well-educated, more involved population is also better equipped to have thorough and effective discussions with

government agencies to arrive at a mutually beneficial solution. Increasing participation in the governing process will also help foster feelings of ownership and legitimacy among locals, helping to significantly alleviate problems with non-compliance and illegal activities within the reserve.

The Galápagos remain one of the world's most unique and treasured sites. With effort, support, commitment, and vigilance, we can keep it that way.

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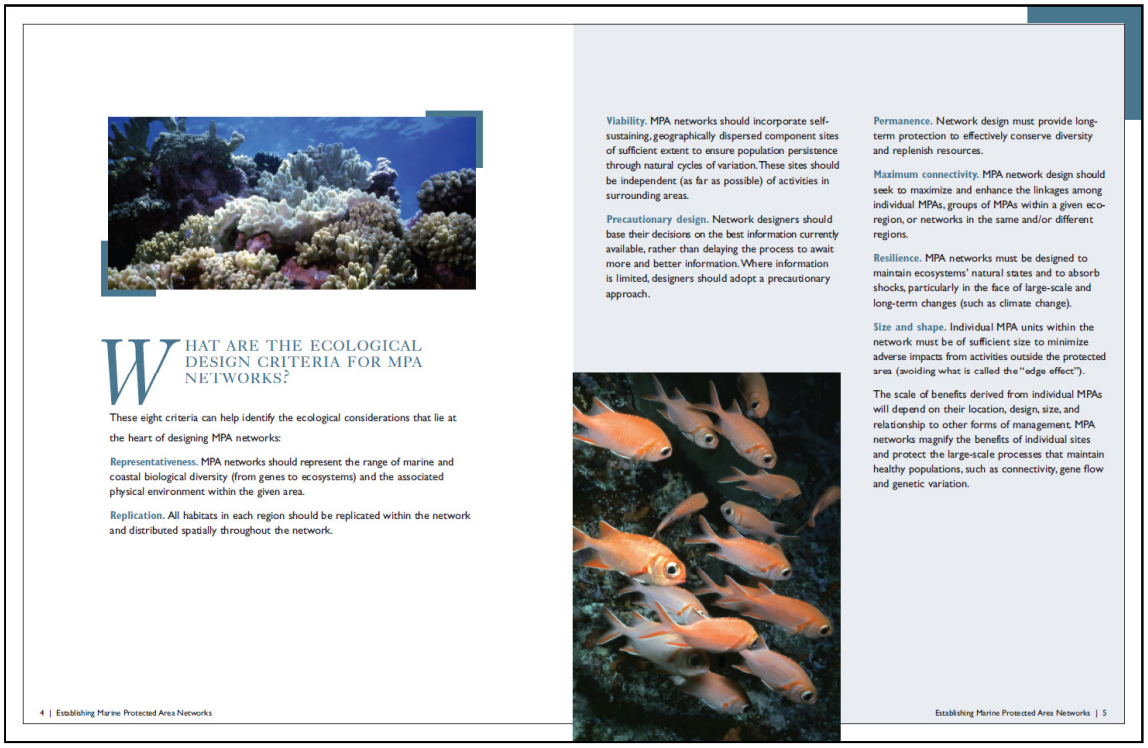
APPENDIX A



WHAT ARE THE ECOLOGICAL DESIGN CRITERIA FOR MPA NETWORKS?

These eight criteria can help identify the ecological considerations that lie at the heart of designing MPA networks:

Representativeness. MPA networks should represent the range of marine and coastal biological diversity (from genes to ecosystems) and the associated physical environment within the given area.

Replication. All habitats in each region should be replicated within the network and distributed spatially throughout the network.

Viability. MPA networks should incorporate self-sustaining, geographically dispersed component sites of sufficient extent to ensure population persistence through natural cycles of variation. These sites should be independent (as far as possible) of activities in surrounding areas.

Precautionary design. Network designers should base their decisions on the best information currently available, rather than delaying the process to await more and better information. Where information is limited, designers should adopt a precautionary approach.

Permanence. Network design must provide long-term protection to effectively conserve diversity and replenish resources.

Maximum connectivity. MPA network design should seek to maximize and enhance the linkages among individual MPAs, groups of MPAs within a given eco-region, or networks in the same and/or different regions.

Resilience. MPA networks must be designed to maintain ecosystems' natural states and to absorb shocks, particularly in the face of large-scale and long-term changes (such as climate change).

Size and shape. Individual MPA units within the network must be of sufficient size to minimize adverse impacts from activities outside the protected area (avoiding what is called the "edge effect").

The scale of benefits derived from individual MPAs will depend on their location, design, size, and relationship to other forms of management. MPA networks magnify the benefits of individual sites and protect the large-scale processes that maintain healthy populations, such as connectivity, gene flow and genetic variation.

Figure 6. Ecological criteria for MPA networks, by the IUCN (WCPA/IUCN 2007).

WHAT ARE THE BEST PRACTICES FOR PLANNING AND IMPLEMENTING MPA NETWORKS?

By following the key best practices below during network design and development, planners can create networks that achieve maximum environmental, economic, and social benefits.

Clearly define network objectives.

At the very outset, designers must clearly define objectives in three broad areas:

- ❑ Ecological objectives seek to protect, manage and/or restore marine ecosystems and their components;
- ❑ Economic objectives determine how the region will benefit from the network, and who may suffer negative economic impacts;
- ❑ Socio-cultural objectives include the full range of benefits that biodiversity provides, especially those that directly affect human health and well-being. The lead organization should work to ensure that all MPA network objectives are determined through an open, transparent and balanced process involving users, industry, government representatives, and other groups with an interest in the area. Timetables for achieving targets and milestones should be appropriate, realistic and err on the side of caution.

Establish long-term political commitment and will.

Political commitment and will must be established early in the process and maintained throughout. In some regions, the political will and resources needed to implement all components of a network may already exist. But in most cases, implementing an MPA network will take time, as political will and commitment for the network and component sites build. The more aware elected officials are of the planning process and of community support, the more they will support the network during planning, implementation and beyond.

In some parts of the world, legal frameworks are often the only way to ensure consistency or to avoid the concept of a "paper park"-that is, a park that has been announced or designated, but not truly implemented. Voluntary support can be susceptible to changes in political priorities; these changes can force governments to focus on short-term gains at the expense of longer-term and wider benefits for society as a whole.

Encourage stakeholder participation.

Developing effective MPA networks requires involving relevant stakeholders from the very beginning. Engaging stakeholders enhances information exchange, fosters the accountability of experts and authorities, reduces mistrust in the decision-making process, and enables stakeholder groups to collaborate and find mutually acceptable solutions. An open, participatory process also fosters a sense of ownership and accomplishment among the groups involved, thereby strengthening support and political will for the MPA network. Timely, planned consultation processes operating at meaningful spatial scales are critical to success. These include indigenous community meetings led by traditional leaders, government-sponsored opportunities for information sharing and comment, or inter-governmental planning meetings.

Make best use of available information.

Rather than waiting for perfect data, involved parties must use the best information available for gap analysis, planning and decision making. This information should not only consist of scientific and socio-economic data, it should include traditional and local ecological knowledge-the knowledge that indigenous and local groups have gained about an area's ecology, accumulated by experience and passed through generations. New data that emerges during or after the planning process can be applied through adaptive management. Delaying design and implementation rarely, if ever, benefits marine conservation.

Develop integrated management frameworks.

It is important to establish a hierarchy of planning and management scales, ranging from national planning frameworks to regional and local coordination, to local planning and site planning. A spatially based planning system will help coordinate and improve management; separate conflicting uses; and ensure appropriate spatial allowances for industry, wildlife and healthy ecosystems. When ecological boundaries are not consistent with jurisdictional or political boundaries, planners can help ensure consistency across jurisdictions by creating management strategies that mirror each other in most aspects, such as rules and regulations, but still retain unique jurisdictional aspects.

Employ adaptive management techniques.

"Adaptive management" means using the best available information to develop the MPA network and creating monitoring and evaluation systems to test the effectiveness of management methods and refine them over time. Adaptive management empowers managers to assess the success of their efforts and to adapt their methods as conditions and knowledge change.

Adaptive management can be used to improve management capacity and effectiveness, particularly through professional development programs for network managers and staff. Capacity building also leverages opportunities to attract and provide additional expertise, resources and technology to the MPA.

Figure 7. Best practices for MPA networks, by the IUCN (WCPA/IUCN 2007)

WHAT ARE THE BROADER CONSIDERATIONS NEEDED TO ENSURE THAT MPA NETWORKS ARE SET IN CONTEXT?

To help ensure the success of MPA networks, designers must also reflect on:

Economic and social considerations:

❑ **Integrate the network into the economic and socio-cultural setting and promote activities that maximize positive benefits.** Planners need to identify the broad costs and benefits provided by effectively managed MPA networks, as well as the indirect and opportunity costs incurred by people living in and around protected areas. One tool for making these calculations is economic valuation of consumptive and non-consumptive activities and non-use values, such as those provided by ecosystem services. Current social relationships and aspirations, cultural traditions and values, and political processes that influence attitudes and decisions about coastal and marine resource use and protection are also important considerations.

❑ **Evaluate the economies of scale provided by networks, as well as the costs of inaction.** Network planners should consider the increased benefits and economies of scale when moving from an individual MPA to a network of MPAs, as well as the costs of inaction – that is, of not creating a network. For example, MPA networks may provide value-added benefits over individual MPAs, such as increased ecosystem services and reduced management costs per unit area.

Spatial and temporal considerations reflect the fact that ecosystems function at different scales and change over time due to factors such as human activities or climate change. Planners should:

❑ **Take actions to address ecological processes, resources and impacts that extend beyond network boundaries or influence MPA networks.** Network design must account for connectivity within and between networks, as well as the impacts of activities outside network boundaries, including upstream areas such as catchments. Given the fluid nature of the ocean environment, network planners must apply all available information on biological, chemical, and physical linkages within the network and beyond.

❑ **Address the concept of "shifting baselines" in network design.** The "shifting baseline syndrome" is the failure of managers and decision makers to fully grasp the enormous changes that have occurred in ocean ecosystems because they have occurred gradually over many years. Managers often fail to see that their baseline already represents a disturbed state. Therefore, it is especially important that planners set historically appropriate objectives for the MPA network.

Scientific and information management considerations. Science and information play fundamental roles in planning and implementing MPA networks. Yet managers must do more than apply available information; they must seek new information that is pertinent to management and create mechanisms for gathering such information. Network planners and managers should:

❑ **Develop and employ appropriate scientific skills, tools, training and partnerships to design and systematically monitor MPA networks.** Planners can address this in a number of ways: by setting research priorities and training requirements based on management needs; by creating auditing science programs that seek to assess and optimize results; and/or by incorporating end-user and manager input into multi-annual scientific work programs.

❑ **Ensure standardization, synthesis, storage and access to information across and among MPA networks.** Information on individual MPAs may be scattered across institutions and /or individuals. Planners should foster coordination among institutions, develop information archives and create mechanisms for ensuring broad access to information. Such systems should be actively managed and should provide relevant historical data as well as current scientific knowledge.

Institutional and governance considerations.

Institutional and governance arrangements can have a significant effect on network design and management. In some cases, these institutional arrangements have taken shape over many years and were devised to meet the demands of the time, rather than the need for developing representative and effectively managed MPA networks or meeting sustainability objectives. Network planners and managers should, therefore:

❑ **Develop and maintain effective coordination and linkages across sectors and jurisdictions.** Government agencies often fail to coordinate their marine-based activities, resulting in a divided and insular management approach aligned with sector-based laws. This can mean duplication of effort, failure to address cumulative impacts and a poor outcome

Figure 8. Broader considerations for MPA networks, by the IUCN (WCPA/IUCN 2007)

for the environment. This complexity is often exacerbated by the fact that government agencies may have different-and even opposing–mandates.

❑ **Develop the legal authorities and institutional frameworks needed to deliver MPA networks.** Where agency responsibilities and authorities overlap, participants will need to clarify responsibilities or elect one of the parties to play a leadership role. Effective coordination across agencies requires sustained leadership, either by one agency or a specially formed committee or council that can coordinate overlapping and complex jurisdictional arrangements. Complementary and/or consistent legal and institutional frameworks can help resolve inconsistencies where jurisdictions or institutional responsibilities overlap.

❑ **Clarify the legal framework for developing MPA networks.** Many countries have special or single-purpose legislation enabling individual MPAs, and often a variety of agencies share responsibilities for these areas. Only a few have legislative or institutional arrangements that provide a comprehensive basis for an MPA network. A poorly integrated array of legal and institutional responsibilities can lead to problems such as competing mandates, overlaps, gaps and inefficiencies.

❑ **Recognize that the diversity and capacity of the institutions and other groups involved in developing MPA networks can influence the network's efficacy.** It is rare for a single agency to have complete authority over a comprehensive MPA network. To develop effective arrangements for MPA governance, planners must consider the environmental and ecological circumstances, the cultural and socio-political context, and the economic and logistical aspects of management.

Creating an MPA network can proceed only as quickly as the institutions and individuals responsible for key functions develop the skills and attributes needed to manage the network and its component MPAs well. Frequently, existing organizations will need to take on new and different roles; sometimes, entirely new institutions will need to be created to oversee or coordinate activities at the network level.

❑ **Promote trans-boundary MPA networks as instruments for shared management, conservation and cooperation.** Ecosystems, habitats and species rarely correspond to political or jurisdictional boundaries. Therefore, they require cooperative management among states, regions, nations, and jurisdictions. Trans-boundary protected areas, those that straddle the boundaries of jurisdiction and sovereignty and often involve high-level political initiatives, represent one strategy for cooperative management.

Figure 9. Broader considerations continued

WHAT ARE THE KEY ELEMENTS NEEDED TO MAKE MPA NETWORKS HAPPEN AND ACHIEVE THEIR GOALS?

Political will and leadership

Political support is fundamentally important throughout the process of developing an MPA network. Public participation and political support are inter-related and are critical to achieving significant and lasting marine conservation outcomes. To successfully implement a network, designers must remain aware of the political environment at every step.

Many scientists and marine managers may not have an adequate level of political savvy, nor do they have the appropriate political contacts. In such instances, planners and managers will need to be creative in finding contacts to ensure the participation of political leaders. Moreover, some conservation objectives may be politically untenable, so planners must be prepared to forge compromises in order to make progress.

Public education, communication and awareness

Education and outreach can enhance people's attitudes, behaviors, understanding of, and appreciation for, MPA networks. Education programs can address specific resource management issues, help achieve management objectives and promote other essential services such as research, monitoring and enforcement.

In developing a communication plan, designers and managers must first identify key audiences, including managing agencies, as well as local stakeholders and even traditional site users or owners.

Education and outreach efforts may focus on the unique natural and cultural resources of each component MPA. But they must also be part of a larger strategy for the network, ensuring that the objectives of component MPAs are consistent with the network as a whole. A communication plan should also strengthen communication between and among networks, promoting global cooperation and understanding.

Monitoring and assessment

Monitoring and assessment allows managers to determine whether progress is being made towards network objectives and goals. It is also crucial to a successful adaptive management approach (see Best Practice 4.6, above). Systematic monitoring builds a base of knowledge to improve decision making, and positive results can increase the support of target groups, whether they be stakeholders or other relevant parties.

To be truly beneficial monitoring and assessment structures must built into MPA networks from the very outset. They should include sites outside the network, creating a system of controls against which overall performance can be assessed.

Information derived from ongoing monitoring can help MPA managers to secure political support, justify requests for additional staff or funding, and build stakeholder support. Moreover, successful evaluation strategies in one area can also serve as effective models for other areas in the network and beyond.

Sustainable financing

Creating and maintaining representative, effectively managed networks of MPAs requires substantial funding from local, national, regional and even international entities (e.g. Global Environment Facility and other donors). A financially sustainable MPA network should be able to meet, on a continuing basis, the minimum level of recurrent and investment costs needed to achieve its conservation objectives.

Individual MPAs are frequently supported by ad hoc, short-term or piecemeal funding. MPA networks introduce a new level of complexity and a need to share resources among protected areas and institutions, some of which may depend on other areas in the network-and indeed on areas not formally protected-to sustain critical functions, habitats, and resources. Even with major initiatives to mobilize financing for MPA networks, resources will be limited relative to the challenge. Network designers and managers must therefore ensure that funds are used cost-effectively.

What are the key elements of a successful financing strategy?

Sound financing strategies consist of four main elements.

Figure 10. Key elements for MPA networks, by the IUCN (WCPA/IUCN 2007)

❑ **Sharing costs and management responsibilities.** Many of the investments and recurrent expenditures needed to sustain MPA networks can be shared by building local support for network objectives. Alternatively, they may be assumed by communities, NGOs, private businesses, or others with a relevant interest, or funding leveraged from local governments for activities that benefit communities in or near protected areas.

❑ **Building diverse portfolios.** Resilient financing strategies comprise diverse portfolios of complementary revenue sources and cost-effective management approaches. Sources may include government funds, grants from private foundations and non-governmental organizations, and endowment funds.

❑ **Administrative and governance systems.** Funding for MPA networks must be channeled effectively to activities on the ground; this is vital in building local confidence in, and support for, individual networks. To help secure long-term funding, network designers must create mechanisms to track and report spending with a high degree of accountability.

❑ **Political support for implementation.** Generating broad-based political support – among government agencies and key stakeholders – is as essential for securing revenue sources as it is for ensuring the governance systems and policies needed to build MPA networks. Wherever possible, planning and budgeting for MPA networks should be incorporated into regular government processes and sustainable development strategies.

How do you create sustainable financing strategies for MPA networks?

As a country begins to scale up from individual MPAs to MPA networks, it may not be sufficient to simply expand or replicate mechanisms that have worked for specific MPAs. Financing strategies at the network level will involve trade-offs, such as retaining income at specific sites versus pooling resources for the network overall.

Here are some steps that governments, communities, NGOs, businesses, donors, and others should take to help determine their own strategies for achieving financial sustainability:

❑ Conduct cost-benefit analyses of the MPA network, set within the broader land and ocean area.

❑ Include the potential for generating resources or for creating partnerships as an explicit criterion for selecting which MPAs or areas should make up a network.

❑ Clearly identify MPA network objectives and the activities essential to meeting them, and seek funding sources and partnerships that are compatible with those ends.

❑ Identify existing and potential funding sources and ways to reduce or share management costs.

❑ Develop a strategy that includes diverse finance mechanisms and management approaches.

❑ Identify management (including collaborative management), accountability, and oversight arrangements needed to generate and allocate resources efficiently.

Compliance and enforcement

"Compliance" is when people voluntarily accept and act in accord with the rules and regulations of the MPA network. "Enforcement" is the action taken against those people who fail to abide by the rules. Network planners must make it more profitable and preferable for the public to comply with the MPA network regulations than not to comply. Enforcement across an MPA network allows for economies of scale. Aerial surveys, for example, are more cost effective when employed across an MPA network as opposed to a single MPA.

Education and compliance should be the first option, and enforcement, the last resort. Both depend on the legal and judicial support of the national government. However, compliance strategies must match the economic and socio-cultural context of the MPA network. The following actions will help ensure effective compliance and enforcement.

❑ **Build in compliance and enforcement considerations at the MPA network planning stage.** Primary considerations include feasibility, affordability, public understanding and protecting areas most vulnerable to impact from human activities.

❑ **Educate to build compliance.** To ensure compliance, managers must educate policy makers and government leaders, as well as citizens, about the MPA network and why regulations are needed. Gaining public support for laws can contribute to "cooperative enforcement," whereby citizens themselves willingly help to enforce rules.

❑ **Develop surveillance programs to support compliance and enforcement.** "Surveillance" entails monitoring people's activities within the MPA network to ensure that they follow the rules. Some new technologies can increase the efficiency of enforcement while requiring less manpower. Agreements among nations, government agencies, local communities and resource users can help to mobilize resources that are already available.

❑ **Enforcement should be supported by appropriate penalties.** In order to foster compliance and ease enforcement, regulations and penalties must be clear, understandable, and appropriate to the socio-cultural context of the network. Penalties can range from a public verbal reprimand to confiscating property, suspending a license, or prosecution.

Figure 11. Key elements continued