ACHIEVING A SCIENTIFICALLY-BASED REGIONAL SYSTEM OF MARINE PROTECTED AREAS IN THE NORTHWEST STRAITS: A NEARSHORE PERSPECTIVE

PREPARED FOR THE NORTHWEST STRAITS COMMISSION
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PREFACE

A significant portion of this report also helped to fulfill the requirements of a Master's thesis in the School of Marine Affairs at the University of Washington in December 2001. Since then, portions of the data have been updated and minor changes have resulted.

EXECUTIVE SUMMARY

Marine Protected Areas (MPAs) have increasingly been recognized as a tool to manage and help protect fragile marine ecosystems. As defined by the World Conservation Union (IUCN), an MPA is:

Any area of intertidal or subtidal terrain, together with its overlying water and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment (1988).

Systems or networks of MPAs may provide more effective protection for the diversity of species and their life history stages than single, isolated MPAs.

The Northwest Straits Marine Conservation Initiative, established by Congress in 1999, has a mandate to "Achieve a Scientifically-Based, Regional System of Marine Protected Areas in the Northwest Straits." This is to be achieved through local marine resources committees (MRCs) in each of the seven counties along the Northwest Straits through the Northwest Straits Commission, a regional organization. Located in the northwest corner of Washington State, these estuarine waters experience large tidal fluctuations and significant freshwater inputs. To date, 107 MPAs have been established in this region by federal and state agencies, local governments, and private organizations. These MPAs offer varying levels of protection. Most were established independently, and were not intended or designed to function as a network.

Using the ShoreZone Inventory developed by the Washington Department of Natural Resources (WDNR), habitat characteristics along the shoreline of each MPA were mapped using Geographic Information Systems (GIS). The ShoreZone Inventory examines shoreline habitats throughout the entire state, which provides a comprehensive view of the region, but the data is limited to the nearshore. Therefore, this analysis is limited to the nearshore marine environment.

After investigating the habitat types within the existing MPAs along the Northwest Straits, these MPAs were evaluated together for functionality as a "de facto" MPA network based on five criteria of MPA network design from primary literature. These criteria include representativeness, replication, oceanographic linkage, size, and level of protection. For representativeness, the proportions of each habitat type within MPAs should be equal to the proportions of each habitat type that exists regionally. For example, if 49% of the Northwest Straits shoreline is sand/gravel then 49% of the shorelines within existing MPAs should be sand/gravel to be representative of the region. Replication refers to protecting multiple areas of similar habitat to guard against natural or human disturbance, offset the chance of poor site selection, and help facilitate scientific research and monitoring. Potential oceanographic linkages between sites would allow species at different life history stages to utilize multiple MPAs, thereby providing greater protection. Size and level of protection can also affect the success of the network if MPAs are not large enough or provide enough protection to the species within.

Approximately 19% of the shoreline within the Northwest Straits is contained within these documented 107 MPAs. However, most of these confer only partial protection to the species within them, so sites were divided into "fully protected" and "partially protected". Within the Northwest Straits, 3% of the shoreline lies within fully protected MPAs, while partially protected MPAs represent 16% of the entire Northwest Straits shoreline.

Based on MPA network design criteria, fully protected MPAs exhibit a minimal degree of representativeness along the shoreline. Although some habitat types have significant protection, the majority of habitat types are underrepresented in fully protected MPA shorelines of the Northwest Straits. Replication is insufficient for fully protected MPA shorelines, except within San Juan County. Therefore, the potential for oceanographic linkage between fully protected MPAs is small within the Northwest Straits. In addition, because the size of these fully protected MPAs is very small, relatively few individual organisms may be protected by these MPAs.

Within partially protected MPAs, most of the species within these shorelines are not protected by existing regulations. Representatives of most habitat types are protected, although some are still underrepresented. Replication is limited in certain parts of the region, so potential oceanographic linkages could exist for species whose harvest is restricted.

Substantially greater protection for species could be achieved by expanding existing MPAs. Additional MPAs could also be established to help guard against natural and human disturbances and provide connected refugia for species at all life history stages. To achieve this, a partnership between county MRCs and the state is necessary to gain maximum support for additional regulatory designations. Additional coordination between management authorities would also improve the “de facto” network as a whole. As the Northwest Straits Marine Conservation Initiative works to protect and restore marine resources on a regional scale, an ecosystem-based approach must guide decisions at every level. It is therefore necessary to streamline and coordinate current activities at all levels.

MPA networks represent an emerging tool for reversing the declines of marine resources worldwide. Achieving a network or system of marine protected areas in the Northwest Straits will require additional research on topics presented in this report. However, this process will depend greatly on socioeconomic and political factors. Educating the public and decision-makers about the MPAs that now exist and how they can be more effectively used as a tool to protect resources is essential to achieving the Northwest Straits Marine Conservation Initiative benchmark.

CHAPTER ONE: THE NORTHWEST STRAITS MARINE CONSERVATION INITIATIVE

BACKGROUND

The Northwest Straits Marine Conservation Initiative is a community-based regional approach to protecting and restoring marine resources in northwestern Washington State. With the involvement of seven counties, the Initiative seeks to bring together federal, state, tribal and local community representatives for marine conservation. This first-of-its-kind approach has been successful at bringing people together and taking definitive steps towards improving the state of the marine environment in the Northwest Straits (NWSMCI, 2000; NWSMCI, 2001).

The Northwest Straits area includes the marine waters in the northwest corner of Washington State. The Northwest Straits area extends north to the Canadian border, surrounds the San Juan Archipelago, continues south to the tip of Whidbey Island, and west to Cape Flattery (Figure 1) (NOAA, 1997). With freshwater influences from many rivers and streams, the Northwest Straits is part of the Puget Sound/ Georgia Basin/Juan de Fuca region, comprising the second largest estuary in the lower 48 states. This estuarine character, combined with a 12-foot tidal range, gives rise to an area rich in biological and habitat diversity. Representative habitats include kelp forests, eelgrass beds, soft bottom, gravel/cobble, mudflats, sand flats, rocky shores, and emergent saltmarshes (NOAA, 1997). Such habitats are extremely important because they serve many different functions. These include erosion and flood control, water quality protection, shoreline anchoring, and social and economic benefits such as recreation and tourism.

Humans also play a significant role in the Northwest Straits ecosystem. They live along the shoreline, utilize marine waters for transportation, gather marine resources for commercial, recreational, and subsistence purposes, and pursue other types of life activities that affect coastal and marine habitats and the resources within them (NOAA, 1997). Many of these activities directly support Washington State's economy, such as water-dependent businesses (Battelle, 1996). Nevertheless, all of these activities have contributed to steady declines in habitat and species beginning before 1980 (West, 1997; WSG, 1994).

Seven counties are adjacent to the Northwest Straits waters, including (from north to south) Whatcom, San Juan, Skagit, Island, Snohomish, Clallam, and Jefferson. Within these counties, 48.8% of the total population in 1990 lived within three miles of the shoreline. This shoreline density is higher in certain counties, e.g. up to 75.4% in Jefferson and 100.0% in both San Juan and Island counties (Battelle, 1996). Continued population growth in the region will contribute to further habitat loss and degradation even with implementation of protective management strategies. While there is existing governmental authority to regulate harmful activities or implement protective measures, little has been done to reverse the negative trends in marine species and habitat loss (Murray-Metcalf Commission, 1998).

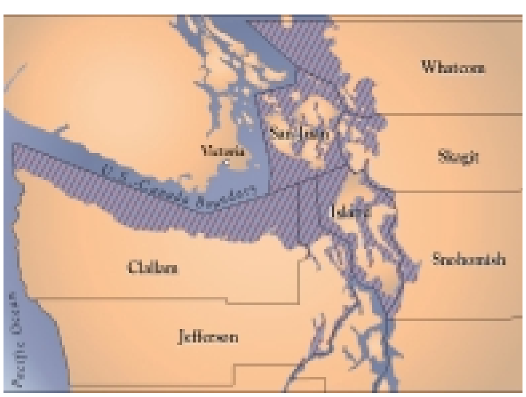

Figure 1: Northwest Straits Region, Washington State

THE NORTHWEST STRAITS INITIATIVE

The thirteen-member Northwest Straits Commission includes seven members which represent each of the county Marine Resources Committees (MRCs). The other members include a tribal appointment made by the Secretary of the Interior, and five appointments by the Governor of the State of Washington, one of whom represents the Puget Sound Action Team. Many responsibilities were bestowed upon the Commission through by an act of Congress, which put recommendations developed by a bipartisan Murray-Metcalf Northwest Straits Citizen's Advisory Commission (CAC) into law (P.L. 105-384). These recommendations included taking an ecosystem-wide approach to direct scientific, technical, and financial support of the MRCs while coordinating efforts and actions to help regulatory authorities make more informed decisions about the Northwest Straits (Murray-Metcalf Commission, 1998).

Each county MRC must represent the significant marine interests within the county in order to place decision-making at the local level. The MRCs include representatives from the Native American tribes, the scientific community, local government, affected economic interests, affected recreational interests, conservation and environmental interests, and other community members. Using the Commission as a coordinating mechanism, each MRC is challenged with assessing marine resources in cooperation with government agencies, tribes, and other entities, while working closely with county leadership to implement local marine conservation and restoration initiatives (Murray-Metcalf Commission, 1998).

The activities of the Commission and MRCs are guided by a set of Performance Benchmarks, also recommended by the Murray-Metcalf CAC and required by Congress (1998; P.L. 105-384). These benchmarks are as follows:

1) Broad county participation in MRCs.
2) Achieve a scientifically-based, regional system of Marine Protected Areas (MPAs).
3) A net gain of highly ecologically productive nearshore, intertidal and estuarine habitat in the Northwest Straits, and no significant loss of existing, high-value habitat; improve state, tribal, and local tools to map, assess, and protect nearshore habitat and prevent harm from upland activities.
4) Net reduction in shellfish harvest areas closed due to contamination.
5) Measurable increases in factors that support recovery of bottom fish (such as rockfish) – including numbers of fish of broodstock size and age, average fish size, and abundance of prey species – as well as sufficient amounts and quality of protected habitat.
6) Increases in other key marine indicator species (including those identified in the 1997 West report on Puget Sound marine resources).
7) Coordination of scientific data (for example, through the Puget Sound Ambient Monitoring Program), including a scientific baseline, common protocols, unified GIS, and sharing of ecosystem assessments and research.
8) Coordinate with the Puget Sound Action Team and other entities on an effective outreach and education effort with measurements of the numbers of people contacted as well as changes in behavior.

The benchmarks were established to guide the activities of the Initiative and provide standards by which 'success' could be measured (Murray-Metcalf Commission, 1998). The Northwest Straits Marine Conservation Initiative is scheduled to be evaluated after five years (in 2004) based on these Performance Benchmarks (Cowan, pers. comm.).

Many people within the Northwest Straits region have been educated about the issues that each of these benchmarks addresses (NWSMCI, 2000; NWSMCI, 2001). Progress has been made toward several of the benchmarks, and each of the MRCs continues to set priorities for actions most relevant to its local marine areas. The Northwest Straits Commission has contributed to and coordinated these efforts through monthly meetings, staff support, financial support in the form of Action Grants distributed to each MRC, and region-wide projects initiated through the Commission itself (NWSMCI, 2000; NWSMCI, 2001).

MPA BENCHMARK

Two of these benchmarks mention “protected habitat”, and the second benchmark specifically identifies the establishment of a system of marine protected areas (MPAs) as a goal. Congress included the Murray-Metcalf CAC recommendation for MPA establishment as a priority for both the Northwest Straits Commission and the MRCs (Murray-Metcalf Commission, 1998). Even before the Northwest Straits Commission was established, the San Juan County MRC led the effort to establish MPAs by designating eight voluntary MPAs for the recovery of bottomfish in 1998 (Klinger, 2001; San Juan County, 2001). Many of the counties, including Skagit and Jefferson, have begun to discuss a process for designating MPAs within their counties (NWSMCI, 2001). To date, the Commission has had lengthy discussions concerning this benchmark, but limited regional coordinated action has been initiated.

This report represents one of the initial efforts by the Commission to specifically address the benchmark to ‘achieve a scientifically-based, regional system of marine protected areas (MPAs)’ within the Northwest Straits as a region. To do this, the analysis is restricted to linear shoreline segments, because these are the only areas for which appropriate data exist. This interpretation differs from conventional interpretation of MPAs, which are commonly thought of as polygons, which may extend offshore.

Marine protected areas are the focus of Chapter Two, expanding on the criteria that help to define a “scientifically-based system of MPAs”. To be consistent with terminology used in scientific literature, the term “network” is used synonymously with “system” (which appears in the Northwest Straits Commission language). The potential “de facto” MPA network already in place is evaluated in Chapter Three, based on design criteria presented in Chapter Two. In Chapter Four, recommendations are made on how to improve this “de facto” network and achieve this benchmark.

CHAPTER TWO: MARINE PROTECTED AREA NETWORKS

MARINE PROTECTED AREAS

The concept of setting aside part of the ocean for conservation or restoration purposes by establishing marine protected area (MPA) is not new. The use of MPAs as a management tool has increased dramatically in the past 25 years due to concerns about the rapid loss of habitat, species, and genetic diversity all of which are potentially attributable to human actions (Agardy, 1997; Bohnsack, 1993; Kelleher an Kenchington, 1992; Murray et al., 1999; NRC, 2001). Even so, less than 0.5% of the oceans presentl lie within MPAs, even though the vast majority of the world population lives near the coasts (Kelleher e al., 1995)

The majority of MPAs were established before the term "marine protected area" was widely used. Mos people know MPAs as parks, preserves, reserves, sanctuaries, and refuges that have a marine componen (McArdle, 1997). Part of the difficulty in defining MPAs is that no common language for discussin marine protected areas has been agreed upon, and because of this, confusion abounds (Agardy, 2000 Ballantine, 1999; NRC, 2001). The most commonly used definition was adopted by the World Conservation Union (IUCN) in 1988 (IUCN, 1988; Kelleher et al, 1995)

Any area of intertidal or subtidal terrain, together with its overlying water and associated flora, fauna historical and cultural features, which has been reserved by law or other effective means to protect par or all of the enclosed environment

On May 26, 2000 President Clinton issued Executive Order 13158 to develop a national system o marine protected areas and defined an MPA as

Any area of the marine environment that has been reserved by Federal, State, territorial, tribal, or loca laws or regulations to provide lasting protection for part or all of the natural and cultural resource therein

These broad definitions are indicative of the diverse types of MPAs that exist internationally (Carr an Raimondi, 1999; NRC, 2001). The term MPA has been applied to areas set aside for biodiversity conservation, fisheries management, scientific research, education, recreation, and/or cultural preservation Traditionally, fisheries management and scientific research focus on increasing numbers and size o single species. Biodiversity conservation considers multiple species, with increasing numbers, size distribution, and richness as the primary goals. MPAs established for purposes other than conservatio can contribute to conservation of marine habitats and species (Agardy, 2000; Allison et al., 1998 Ballantine, 1999; Ellingsen, 2001; NRC, 2001). This report focuses primarily on MPAs in the context o biodiversity conservation, with the recognition that multiple goals can be fulfilled within one MPA

In the last decade, the amount of scientific research devoted to the establishment and management o MPAs has increased dramatically. Research clearly indicates the success that MPAs worldwide have ha in increasing species abundance within their boundaries (Agardy, 2000; Halpern, in press; Roberts an Hawkins, 2000; Russ and Alcala, 1996, 1997). A recent study of more than 100 fully protected marin reserves (primarily in the tropics) showed a 91% increase in population densities, 192% increase i biomass, 31% increase in average organism size, and a 23% increase in species diversity inside reserve (Halpern, in press). Active management of MPAs helps to improve the likelihood of attaining the goal laid out in designation. Even so, it is estimated that 71% of MPAs worldwide have no active management (Kelleher, 1996). At the same time, it is important to point out that the success of MPAs ca depend greatly on the degree of monitoring and enforcement invested (Ballantine, 1999). Monitoring and enforcement will not be evaluated in this report, but both are important for the management of current and future marine protected areas.

DESIGNING A NETWORK OF MARINE PROTECTED AREAS

Increasingly, scientists theorize that a system or "network" of interconnected MPAs will be more effective for the conservation of species and habitats than individual MPAs established in isolation (Agardy, 2000; Ballantine, 1999; Murray et al., 1999; NRC, 2001; Roberts, 1997; Roberts, 1998a; Roberts et al., 2001). When discussing the concept of MPA networks, it is important to recognize that most of the scientific literature addresses the idea in terms of no-take MPAs or fully protected marine "reserves" (NCEAS, 2001; NRC, 2001). Although full protection for species within a reserve would likely achieve a greater conservation result, the basic criteria can be applied to the design of any MPA network: representation, replication, oceanographic linkages, size, and level of protection (Airame et al., in press; Murray et al., 1999; Roberts et al., 2001). Designing networks also depends greatly on social and economic factors, or "opportunity" (Agardy, 2000; Dayton et al., 2000; Roberts, 1998b). This report focuses solely on the natural scientific basis of MPA network design and does not discuss social and economic factors.

In theory, marine reserve networks are more effective than isolated reserves because they have the potential to guard against catastrophic events such as oil spills and other natural or human impacts, provide refuge for different life stages of various species, and protect against poor site selection and management (Agardy, 2000; Allison et al., in press; Ballantine, 1999; Murray et al., 1999; NRC, 2001; Roberts et al., 2001; Sullivan Sealy and Bustamante, 1999). At the February 2001 meeting of the American Association for the Advancement of Science (AAAS), a scientific consensus statement was presented, signed by more than 150 scientists on the success of (fully protected) marine reserves and the importance of establishing marine reserve networks. Leading scientists agreed that networks of reserves can act as buffers against environmental variability and catastrophes, while providing greater protection for marine communities than a single reserve (NCEAS, 2001).

Although the support for this concept is increasing, few marine reserve networks have been established to date. Many groups worldwide are actively implementing the most recent scientific theories of marine reserve network design, and these initiatives are in various stages. Some of these groups consist of individual nations and groups of nations that have begun to discuss the establishment of marine protected area networks, and in some cases, marine reserve networks (MCBI, 2001). Australia has been an international leader in marine protected areas, with the federal government now working to establish a National Representative System of MPAs. Lessons from the Great Barrier Reef Marine Park (GBRMP) indicate potential success of fully protected zones within a large protected area, which was created through the Great Barrier Reef Marine Park Act (Kelleher and Kenchington, 1992). Within the Channel Islands National Marine Sanctuary in California, network design principles are currently being used to zone no-take reserves (Airame et al., in press; MPA News 2001). This effort is part of a coordinated California state effort to improve the current network of marine protected areas through the California Marine Life Protection Act (McArdle, 1997; State of California, 1999). These efforts, as well as the Northwest Straits Marine Conservation Initiative fall within the Baja to Bering Sea (B2B) geographic area. A North American initiative under the auspices of the Commission of Environmental Cooperation (CEC), this B2B initiative was launched by the Canadian Parks and Wilderness Society (CPAWS). The goal of B2B is to establish a coordinated marine protected area network from Baja, California, Mexico, to the Bering Sea, Alaska (CPAWS, 2001; Lerch, 2001).

For some of these initiatives and other efforts around the world, mathematical modeling has become an important tool for guiding marine reserve network design. Originally used in fisheries management, modeling approaches have been adapted to incorporate expected ecological and economic benefits that these networks can provide (Airame et al., in press; Walters et al., 1998; Walters, 2000). Models are used to identify potentially valuable sites within a network, and do not always take already established areas into account. However, many of the factors that models incorporate can also be examined independently, including MPA network design criteria such as representation, replication, oceanographic linkage, and size of reserves (Airame et al., in press; NRC, 2001; Walters et al., 1998; Walters, 2000). These factors theoretically play an important role in the success of marine reserve and MPA networks both regionally and worldwide.

Within the Great Barrier Reef Marine Park, these criteria have been applied by protecting the diversity of habitats in representative no-take zones. Using the Great Barrier Reef Marine Park as an example, the World Conservation Union (IUCN), World Bank, and Great Barrier Reef Marine Park Authority (GBRMPA) called for a "global representative system of marine protected areas" in 1992 (Kelleher and Kenchington). The GBRMPA, IUCN, and World Bank then published a series of volumes in 1995 inventorying the MPAs throughout the world which could contribute to a Global Representative System of Marine Protected Areas (Kelleher et al., 1995). Since then, many other scientists have also noted the importance of protecting habitats representative of those within each region. For maximum representativeness, the amount of protected area of each habitat type should be proportional to the actual quantities of each habitat in that biogeographic region, although other proportions are sometimes desirable depending on the goals of the network (Agardy, 2000; Airame et al., in press; Ballantine, 1999; Kelleher and Kenchington, 1992; Murray et al., 1999; NRC, 2001; Roberts, in review; Roberts et al., 2001; Sullivan Sealy and Bustamante, 1999). Rare habitats and species are also important to protect and may be overlooked when focusing on representativeness (NRC, 2001; Roberts and Hawkins, 2000). This report does not take rarity into account due to data limitations, but acknowledge that, where possible, protecting rare species and habitats within a representative network is important to help maintain biodiversity.

According to network design criteria, several replicates of each habitat type should be protected for a variety of reasons. First, setting aside multiple areas of similar habitats helps to insure against natural or human disturbances, which are sometimes catastrophic. Second, replication offsets the possibility of poor site selection and insufficient management. Third, MPAs must be replicated to facilitate scientific research and monitoring to provide accurate data on their success (Agardy, 2000; Allison et al., in press; Ballantine, 1999; Murray et al., 1999; NRC, 2001; Roberts et al., 2001; Sullivan Sealy and Bustamante, 1999).

Potential oceanographic linkages between individual sites are very important to MPA network design because they help protect the different life history stages of species, some or all of which may be motile. By protecting the diversity of habitats utilized by species at larval, juvenile, and adult stages, vulnerable species are likely to have a greater chance of recovery. In this regard, the importance of larval dispersal has recently been the focus of substantial research. Depending on the distance between sites and on local ocean circulation, MPAs have the potential to exchange larvae. However, larval dispersal and recruitment vary between species, regions, and years, making generalizations difficult or impossible. Some research has focused on selecting marine reserves based on "source" and "sink" dynamics, although these connections have so far only been demonstrated in tropical regions. (Agardy, 2000; Roberts, 1998b; Ballantine, 1999; Crowder et al., 2001; Murray et al., 1999; NRC, 2001; Palumbi, 2001;

Roberts et al., 2001; Sullivan Sealy and Bustamante, 1999).

The size of individual MPAs and the amount of area that comprises the network of MPAs also partially determine the effectiveness of the network. Both individual size and network size have proven controversial in the design of marine reserve networks. Overall, a variety of individual MPA sizes within a network is recommended to achieve success (Agardy, 2000; Ballantine, 1999; Dahlgren and Sobel, 2001; NRC, 2001; Walters, 2000). For individual MPA sizes, Halpern (in press) found that abundance, biomass, size, and diversity of organisms increased in almost every fully protected MPA (n>100), regardless of size. Other research has demonstrated that smaller protected areas may be more vulnerable to disturbances than larger areas, and may not significantly protect mobile fish species. In addition, wide-ranging and migratory species may require larger protected areas (NRC, 2001; Roberts, in review). Small MPAs may be satisfactory, but do not provide as great an overall benefit as larger MPAs, unless many small MPAs are closely spaced because the larger the area the more habitat and species are protected (Roberts and Hawkins, 2000). Scientists continue to debate the optimum network size for a given set of goals or the percentage of the region that should be included in MPAs. After examining several studies with estimations, the National Academy of Sciences (2001) concluded that between 10% and 35% of an area should be protected within MPAs, if protection and restoration are to be effective.

As discussed earlier, the level of protection afforded to each MPA is an important criterion for biodiversity conservation. However, the level of protection afforded to species and habitats within MPAs is usually variable due to the diversified goals of each site. Marine reserves or fully protected MPAs guard against all extractive activities, and will confer the most protection to both species and habitats within the MPA. However, the effectiveness of all of these criteria is greatly dependent on political and socioeconomic factors. These will be briefly discussed within the context of the "de facto" MPA network in the Northwest Straits in Chapter Three.

MPAs IN THE NORTHWEST STRAIT

Within the Northwest Straits region, 107 marine protected areas (MPAs) have been documented to dat (Appendix A). Most of these were documented by Murray and Ferguson (1998), and additional MPA were included in this report when information was available. The majority of these sites were established independent of one another, or without consideration of a regional network. Most are small an vary greatly in the level of protection they provide. The majority of these areas are marine extensions o terrestrial protected areas, such as the state parks, and do not extend beyond the intertidal zone. Examples of designations in the region include underwater parks, special fishery management areas preserves established by private non-governmental organizations (NGOs), state parks, national histori preserves and reserves, national wildlife refuges, and voluntary bottomfish recovery reserves. Thes examples span federal, state, local, and tribal levels of management. They were established with divers objectives, and most exist without a management plan. To date, the coordination between and amon the various managing authorities has been minimal in the Northwest Straits. In addition, there is n formal process for designating MPAs in the Northwest Straits, which is entirely within Washington Stat waters (Murray and Ferguson, 1998). These management and regulatory issues will be examined minimally in Chapter Three. Further examination and recommendations of these issues are discussed i Murray and Ferguson (1998)

The Northwest Straits Marine Conservation Initiative is challenged to integrate and transform this fragmented "de facto" network of MPAs to "achieve a scientifically-based, regional system of MPAs".

This report is intended to synthesize the scientific information on the shorelines of existing MPAs and identify potential gaps to achieving a scientifically-based network of MPAs in the Northwest Straits. In Chapter Three, the potential "de facto" MPA network along the shoreline will be evaluated based on the identified MPA network design criteria: representativeness, replication, oceanographic linkages, size, and level of protection.

CHAPTER THREE:
SCIENTIFIC ASSESSMENT OF THE CURRENT "DE FACTO" NETWORK OF MPAs IN THE NEARSHORE

INTRODUCTION

To date, 107 MPAs exist along the shorelines of the Northwest Straits. Although most of these were all designated independent of one another, this chapter examines the potential for them to function as a de facto MPA network. In the following section, the methods are explained, followed by the maps produced for this analysis (Figures 2-9). The management of MPAs in the Northwest Straits is then briefly discussed. Management is important to the success of the network but not a specific focus of this report. Finally, the MPAs along the shorelines of the Northwest Straits are evaluated based on MPA network design criteria discussed in Chapter Two.

METHOD

Most recent scientific literature discusses MPA networks in the context of fully protected MPAs. However, few existing MPAs within the Northwest Straits are fully protected. Network characteristics (e.g. representation, replication, oceanographic linkages, size, and level of protection) are evaluated here i the context of fully protected MPAs, partially protected MPAs, and the entire potential "de facto" network along the shoreline as a whole. The level of protection afforded to each MPA was determined b considering the management goals and restrictions for each site. For the purposes of this report, full protected was defined as a total ban on the take of marine species, whether for commercial, recreational or personal use, or as a total ban on human access to the site (e.g., Protection Island National Wildlif Refuge (NWR)). Partially protected MPAs afford varying levels of protection to some species. Mos MPAs in the Northwest Straits provide protection from commercial or residential development tha would result in the loss of habitat (Murray and Ferguson, 1998). Enforcement and compliance were no taken into account for this exercise, although both are very important for achieving the goals of eac MPA or MPA network

The locations of marine protected areas in the Northwest Straits were systematically identified i Murray and Ferguson (1998). Since the publication of that report, a regional environmental organization, People for Puget Sound (PPS) mapped most of these MPAs in Geographic Information System (GIS), and added sites that have been established since 1998 such as a Nature Conservancy Preserve a Port Susan Bay (PPS, unpublished). GIS is becoming an important tool in the establishment of MPA and evaluation of MPA networks (Bushing, 1997). PPS also performed the GIS mapping for this repor (Figures 2-9)

Nearshore habitat characteristics were overlaid using GIS to examine the shoreline habitats within MPAs in the Northwest Straits. The ShoreZone Inventory, compiled by the Washington State Department of Natural Resources (WDNR), has the most recent comprehensive habitat data for the entire region, but it only includes shoreline characteristics (WDNR Nearshore Habitat Program, 2001). Therefore, this analysis is limited to shoreline segments only. Despite this limitation, some intertidal habitats, such as geomorphology, often extend subtidally. Consequently, the available information can be a predictor of the likely composition of adjacent subtidal communities within MPAs that extend past the intertidal. It should also be noted that many of the MPAs examined in this analysis do not extend past the shoreline or intertidal area (Appendix A).

The ShoreZone Inventory was accumulated over a six-year period during low tides in the months of June and July from low elevation helicopter surveys. Fifteen hundred miles (2490 km) of the Northwest Straits marine shorelines were inventoried. The crew included a marine ecologist, a geologist, and a navigator. Continuous narratives were recorded describing physical and biological characteristics, 35mm photographs were taken of the shore zone, and the shoreline was videotaped continuously during each flight. “The ShoreZone Inventory is a conservative representation of the actual extent of the resources” (Berry et al., 2001). Again, the analysis presented here is limited to shoreline segments of exiting MPAs only, because these are the areas for which data currently exist. The analysis therefore is a 2-dimensional linear analysis, instead of a more conventional 3-dimensional analysis of a polygon.

Both geomorphology and vegetation types are included in the ShoreZone Inventory. For clarity, this report uses the term “geomorphology” instead of “habitat” to refer to the physical characteristics of the shoreline. To describe these physical characteristics, WDNR used the British Columbia (BC) Classification System (Howes et al., 1997; Searing and Frith, 1995), the Washington State Marine and Estuarine Classification System (Dethier, 1990) and the Natural Resource Damage Assessment (NRDA) Classification System (Berry et al., 2001). For simplicity, a modified version of the BC Classification System is used, based on conversations with Megan Dethier and John Harper who were involved in the ShoreZone Inventory (Dethier, pers. comm.; Harper, pers. comm.). Each simplified geomorphology classification (e.g., rock, rock with sand/gravel, sand/gravel, mud, organics/fines, man-made) includes one or several BC Codes or Classes (Table 1).

Table 1: Geomorphology type simplified from BC Classification System (WDNR Nearshore Habitat Program, 2001)

BC CODE	**BC CLASS**	**Geomorphology Type** (as defined for the purposes of this report)
1	Rock ramp, wide	rock
2	Rock platform, wide	rock
3	Rock cliff	rock
4	Rock ramp, narrow	rock
5	Ramp with gravel beach, wide	rock with sand/gravel
6	Platform with gravel beach, wide	rock with sand/gravel
7	Platform with gravel beach, wide	rock with sand/gravel
8	Cliff with gravel beach	rock with sand/gravel
9	Ramp with gravel beach	rock with sand/gravel
10	Platform with gravel beach	rock with sand/gravel
11	Ramp with gravel and sand beach, wide	rock with sand/gravel
12	Platform with gravel and sand beach, wide	rock with sand/gravel
13	Cliff with gravel and sand beach	rock with sand/gravel
14	Ramp with gravel and sand beach	rock with sand/gravel
15	Platform with gravel and sand beach	rock with sand/gravel
16	Ramp with sand beach, wide	rock with sand/gravel
17	Platform with sand beach, wide	rock with sand/gravel
18	Cliff with sand beach	rock with sand/gravel
19	Ramp with sand beach, narrow	rock with sand/gravel
20	Platform with sand beach, narrow	rock with sand/gravel
21	Gravel flat, wide	sand/gravel
22	Gravel beach, narrow	sand/gravel
23	Gravel flat or fan	sand/gravel
24	Sand and gravel flat or fan	sand/gravel
25	Sand and gravel beach, narrow	sand/gravel
26	Sand and gravel flat or fan	sand/gravel
27	Sand beach	sand/gravel
28	Sand flat	sand/gravel
29	Mud flat	mud
30	Sand beach	sand/gravel
31	Organics/fines	organics/fines
32	Man-made, permeable	man-made
33	Man-made, impermeable	man-made
34	Channel	*

*= 'Channel' Classification was left out of the analysis due to the lack of coverage within the study area

To document vegetation, WDNR recorded 'bio-bands' for dominant species types, specifying null or absent, patchy, and continuous (WDNR Nearshore Habitat Program, 2001). Presence (including both patchy and continuous) or absence of each vegetation type is recorded here for simplicity. Only some bio-bands were relevant to this report. Those that were relevant were combined as kelp/Fucus, saltmarsh, seagrass, and "unvegetated." "Unvegetated" does not necessarily indicate that no vegetation exists, but that none of the other vegetation types (e.g., kelp/Fucus, saltmarsh, and seagrass) is found on that section of shoreline. The comparability of the ShoreZone Inventory data with these vegetation types is summarized in Table 2.

Table 2: Vegetation Type simplified from ShoreZone Inventory (WDNR Nearshore Habitat Program, 2001)

Bio-band	**Species Included**	**Vegetation Type** (as defined for the purposes of this report)
chocolate browns	*Laminaria setchellii*, *Eisenia* and/or *Pterygophora, Hedophyllum, Egregia*, *Lessoniopsis*	Kelp/*Fucus*
Fucus	*Fucus spp.*, *Pelvetiopsis*	Kelp/*Fucus*
Macrocystis	*Macrocystis integrifolia*	Kelp/*Fucus*
Nereocystis	*Nereocystis leutkeana*	Kelp/*Fucus*
soft browns	*Laminaria spp.*	Kelp/*Fucus*
sedges	brackish/freshwater assemblages	Saltmarsh
native high saltmarsh	*Triglochin, Salicornia, Deschampsia, Distichylus*	Saltmarsh
Salicornia	*Salicornia*	Saltmarsh
introduced saltmarsh	*Spartina*	Saltmarsh
surfgrass	*Phyllospadix*	Seagrass
Zostera	*Zostera marina, Zostera japonica*	Seagrass
Not within any other classification		Unvegetated

For the analysis, the shoreline segment measurements from the WDNR ShoreZone Inventory were utilized. Several calculations were made with respect to management and MPA network design criteria for MPAs in the Northwest Straits. These included the proportion of each habitat type within fully and partially protected MPAs (Tables 3a-4b) and the percentage of shoreline within full and partially protected MPAs in each county (Table 5). For geomorphology and vegetation types, the expected amount of fully and partially protected MPA shoreline was calculated, based on the actual existing amount of shoreline in the Northwest Straits. These numbers will change as the amount of protected shoreline changes. They are not targets for protection, but are meant to indicate whether representation is roughly proportional or not (Tables 3a-4b).

This research represents only a preliminary characterization of the shoreline of MPAs in the Northwest Straits. Relying exclusively on the ShoreZone Inventory raises some concerns regarding the limitations of the data, which were gathered to gain a region-wide perspective on habitats and concentrated primarily on intertidal characteristics (Berry et al., 2001). In addition, the fact that the habitat characteristics documented in the ShoreZone Inventory are grouped in larger category types simplifies classification and the level of detail. Faunal species were not included in this analysis because it was beyond the scope of this project. Therefore, this research can be used as a building block for a more detailed investigation of habitat characteristics (including flora and faunal species) beyond the intertidal that can later be used to help guide decision-making in the region.

Table 3a: Proportion of each geomorphology type within the Northwest Straits in fully protected MPAs. The degree of representation is noted as underrepresented (u), overrepresented (o), or proportional (p). Values are rounded to the nearest whole mile.

Geomorphology Type	Representation as Percent of Total Shoreline	Expected Amount of Fully Protected Shoreline, if Proportional	Actual Amount of Fully Protected Shoreline
Man-made	7% (98 miles)	3 miles	1 mile (u)
Mud	6% (88 miles)	3 miles	9 miles (o)
Organics/Fines	12% (186 miles)	5 miles	0 miles (u)
Rock	13% (198 miles)	6 miles	13 miles (o)
Rock with Sand/Gravel	13% (198 miles)	6 miles	6 miles (p)
Sand/Gravel	49% (731 miles)	22 miles	14 miles (u)
TOTALS	***100% (1499 miles)***	***45 miles***	***43 miles***

Table 3b: Proportion of each geomorphology type within the Northwest Straits in partially protected MPAs. The degree of representation is noted as underrepresented (u), overrepresented (o), or proportional (p). Values are rounded to the nearest whole mile.

Geomorphology Type	Representation as Percent of Total Shoreline	Expected Amount of Partially Protected Shoreline, if Proportional	Actual Amount of Partially Protected Shoreline
Man-made	7% (98 miles)	16 miles	3 miles (u)
Mud	6% (88 miles)	15 miles	20 miles (o)
Organics/Fines	12% (186 miles)	31 miles	21 miles (u)
Rock	13% (198 miles)	33 miles	51 miles (o)
Rock with Sand/Gravel	13% (198 miles)	33 miles	29 miles (u)
Sand/Gravel	49% (731 miles)	121 miles	123 miles (o)
TOTALS	***100% (1499 miles)***	***249 miles***	***247 miles***

Table 4a: Proportion of vegetation type within the Northwest Straits in fully protected MPAs. The degree of representation is noted as underrepresented (u), overrepresented (o), or proportional (p). Values are rounded to the nearest whole mile.

Vegetation Type	Representation as Percent of Total Shoreline	Expected Amount of Fully Protected Shoreline, if Proportional	Actual Amount of Fully Protected Shoreline
Kelp/Fucus	41% (612 miles)	18 miles	24 miles (o)
Salt Marsh	15% (231 miles)	7 miles	8 miles (o)
Seagrass	39% (579 miles)	17 miles	11 miles (u)
Unvegetated	5% (78 miles)	2 miles	1 mile (u)
TOTALS	***100% (1500 miles)***	***44 miles***	***44 miles***

Table 4b: Proportion of vegetation type within the Northwest Straits in partially protected MPAs. The degree of representation is noted as underrepresented (u), overrepresented (o), or proportional (p). Values are rounded to the nearest whole mile.

Vegetation Type	Representation as Percent of Total Shoreline	Expected Amount of Partially Protected Shoreline, if Proportional	Actual Amount of Partially Protected Shoreline
Kelp/Fucus	41% (612 miles)	96 miles	110 miles (o)
Salt Marsh	15% (231 miles)	39 miles	38 miles (u)
Seagrass	39% (579 miles)	99 miles	93 miles (u)
Unvegetated	5% (78 miles)	13 miles	7 mile (u)
TOTALS	***100% (1500 miles)***	***247 miles***	***248 miles***

MAPS

The shorelines of established marine protected areas within the Northwest Straits region are shown in Figure 2. It is important to note that even though each MPA is a discrete site, the boundaries may appear connected along the shoreline due to the scale of the maps. The MPAs are further classified according to level of protection and habitat characteristics for analysis (Figures 3-9).

Again, "fully protected" was defined as either no access (except through permit, e.g., Protection Island NWR) or no collecting or harvesting of any marine life at least within the intertidal portions of the MPA (Figures 3-5). Authorities managing fully protected MPAs (Figure 3) and partially protected MPAs (Figure 4) are indicated in different colors. The six geomorphology types are identified by various colors within fully protected MPAs (Figure 5) and partially protected MPAs (Figure 6). Vegetation types are shown for fully protected MPAs (Figure 7) and partially protected MPAs (Figure 8). Finally, certain MPAs have been established for the protection of particular species groups, such as bottomfish, unclassified marine invertebrates, or commercially harvested sea urchins and cucumbers (Figure 9).

MANAGEMENT OF MPAs

Overall, 19% of the Northwest Straits shoreline lies within some level of protection. The protected areas are spread throughout the region, although many are concentrated in the San Juan Islands and no MPAs exist west of Tongue Point on the Olympic Peninsula (Figure 2). Few MPAs confer full protection for all species- full protection is limited to approximately 3% of the region's shoreline. Multiple federal, state, local, and tribal agencies have management authority over the boundaries and resources within MPAs in the Northwest Straits (Figures 3 and 4). Private organizations such as The Nature Conservancy (TNC) and San Juan Preservation Trust (SJPT) also manage small portions of shoreline within MPAs. However, even though restrictions on collecting species exist in the intertidal and uplands at private sites, no protection is conferred to marine species subtidally if the ownership does not include subtidal bedlands (Murray and Ferguson, 1998).

In many partially protected areas, which make up approximately 16% of the Northwest Straits shoreline, most of the protection is only afforded intertidally, not subtidally. A significant portion of the partially protected shoreline lies within State Parks and Special Management Fishery Areas (SMFA). Within

SMFAs, the Washington Department of Fish and Wildlife (WDFW) restricts commercial harvest of sea urchins and sea cucumbers. The Washington State Parks and Recreation Commission (WSP&RC) holds more than 3% of the shorelines in the Northwest Straits within State Parks, Marine State Parks, and Undeveloped State Park Areas (Appendix A). Restrictions are imposed on the taking of unclassified marine invertebrates (UMI). The Washington Administrative Code (WAC) 352-32-150 prohibits the removal of fish from any state park except for food fish, shellfish, and game fish, which leaves restrictions only on the taking of UMI (Murray and Ferguson, 1998).

Within larger partially protected MPAs managed by federal agencies such as the United States Fish and Wildlife Service (USFWS), the National Park Service (NPS), and the National Oceanic and Atmospheric Administration (NOAA), protection is only afforded to habitats and not to most of the species living within them (Murray and Ferguson, 1998). While some of these agencies have purchased or leased the tidelands from WDNR, few specific restrictions exist against harvesting or other impacts to the areas. In the San Juan National Wildlife Refuge (NWR), buffer zones extend beyond the intertidal legally restrict offshore access, which could function to prevent the taking of species even though the tidelands are not owned by the USFWS. Two state agencies involved in MPA designation are WDFW and WDNR, both of which manage MPAs in the Northwest Straits. WDNR holds the bedlands as trustees for the citizens of Washington State and manages the vegetation throughout the state. WDFW is the only state agency that can legally enforce harvest regulations pertaining to marine animal species. Therefore, designation of fully protected MPAs usually involves both agencies.

Tribal rights are fundamental to the management of marine species in Washington State. Sixteen Native American tribes have usual and accustomed (U&A) treaty rights in various parts of the Northwest Straits. Since the Boldt Decision in 1974, these treaty tribes are co-managers of the marine resources in Washington with WDFW (U.S. vs. Washington, 1974). Due to difficulties in reaching agreements during MPA designation, no U&A tribal fishing rights are restricted in any MPAs within the Northwest Straits. It should also be noted that in some cases, the tribes have voluntarily restricted fishing in some areas in the region, although these have not been documented systematically (Williams, pers. comm.).

Certain counties and municipalities within the Northwest Straits have established voluntary no-take areas, as well as fully protected MPAs in partnership with WDFW. To gain fully protected status, the local entities must work with WDFW because they lack the regulatory authority to protect species from harvest. Critical areas within each local Shoreline Management Plan (SMP), which can protect the habitat from development, have been designated along portions of the shoreline (Murray and Ferguson, 1998). However, the number of municipalities in the Northwest Straits prevented a thorough investigation of all existing MPAs at the local level. All currently identified MPAs and their management authorities, date of establishment, level of protection (including any restrictions), and size are listed in Appendix A.

SCIENTIFIC ASSESSMENT OF “DE FACTO” NETWORK

This section discusses elements of the existing network that can be incorporated into a natural science-based network of MPAs. As discussed in Chapter Two, several criteria are involved in the design of MPA networks. These include representativeness, replication, oceanographic linkage, size, and level of protection. Even though most MPAs in the region have been established without regard to nearby MPAs, some of these criteria are fulfilled , which may create a de facto network.

Representativeness

For representativeness, the quantity of each geomorphology type within a network of MPAs should be proportional to the absolute quantity of that habitat type found within the region to accomplish biodiversity conservation goals (Agardy, 2000; Airame et al., in press; Ballantine, 1999; Kelleher and Kenchington, 1992; Murray et al., 1999; NRC, 2001; Roberts, in review; Roberts et al., 2001; Sullivan Sealy and Bustamante, 1999). Geomorphology and vegetation types within the shorelines of existing Northwest Straits MPAs were compared to geomorphology and vegetation in the shorelines throughout the region (Figures 5-8). The proportion of each geomorphology and vegetation type within the entire Northwest Straits shoreline was calculated for the shorelines of both fully protected MPAs and partially protected MPAs using the WDNR ShoreZone Inventory (Tables 3a-4b). Some geomorphology and vegetation types are underrepresented within MPAs as compared with the entire Northwest Straits shorelines. Underrepresentation has the potential for negative conservation consequences, because the species that are supported by the underrepresented habitats are afforded less protection. Other geomorphology and vegetation types are overrepresented in comparison to their frequency throughout the Northwest Straits shorelines. Overrepresentation has fewer potential negative consequences for conservation than underrepresentation, and may provide additional protection to species utilizing overrepresented habitats.

Representativeness of each geomorphology type of fully protected MPAs is extremely variable in the nearshore (Table 3a). As expected, man-made shoreline is underrepresented in fully protected MPAs compared with its overall occurrence within the entire Northwest Straits. This may reflect purposeful exclusion of hardened shorelines from protected areas. Mud and rock are both overrepresented in fully protected MPA shorelines as compared to the natural occurrence along Northwest Straits' shorelines, and therefore provide additional protection to species that utilize these geomorphology types. Yet, rock with sand/gravel, organics/fines and sand/gravel types are underrepresented in fully protected MPAs in the nearshore waters of the Northwest Straits.

Representativeness of vegetation types was also variable within fully protected MPA shorelines (Table 3b). Kelp/Fucus habitats were overrepresented within the shorelines of fully protected MPA as compared with the entire Northwest Straits. Seagrass, saltmarsh, and unvegetated areas were all underrepresented in fully protected MPA shorelines. Both the geomorphology and vegetation analyses are highly sensitive to the amount of shoreline protected, however. For example, only 3% of the Northwest Straits shoreline is fully protected. Thus, small additions or subtractions of habitat within fully protected MPAs could have a large effect on the degree of representation.

For partially protected MPAs, geomorphology types are moderately represented along the Northwest Straits shoreline (Table 4a). Again, man-made shoreline is underrepresented when compared with the entire Northwest Straits. Rock and mud are overrepresented within partially protected MPA shorelines. Organics/fines and sand/gravel are both well represented, with the proportions of these habitat types slightly overrepresented in partially protected MPAs as compared with their natural occurrence along the entire Northwest Straits shoreline. Rock with sand/gravel shorelines are slightly underrepresented in partially protected MPAs when compared with the Northwest Straits.
Saltmarsh, seagrass, and unvegetated vegetation types within partially protected MPA shorelines are nearly representative of their occurrence along the entire Northwest Straits shoreline, but are still underrepresented. However, as with fully protected MPAs, kelp/Fucus is overrepresented within partially protected MPA shorelines. (Table 4b).

Overall, all MPAs along the shoreline show a surprising amount of representativeness of some habitats along the Northwest Straits shoreline, considering they were established independently (Tables 3a-4b). Rock and kelp/Fucus are best represented within MPA shorelines in the Northwest Straits. Because they are overrepresented, species associated with these habitats could have more extensive protection. Mud shorelines, which are slightly overrepresented in MPAs, also potentially provide more widespread protection than other habitats. MPA shorelines with organics/fines, sand/gravel, seagrass, and unvegetated areas are slightly underrepresented as compared with their natural occurrence in the Northwest Straits. Additional protection for these habitat types could be achieved by expanding the size of an existing area, increasing the level of protection, or designating new areas. These strategies would improve representativeness within MPAs in the Northwest Straits.

Replication

As discussed in Chapter Two, MPAs comprising representatives of the diverse habitats of the Northwest Straits should be replicated throughout the region to guard against natural and human disturbances, some of which can be catastrophic (Allison et al., in press). Replication hedges against the effects of poor site selection (Murray et al., 1999, Roberts et al., 2001), and can also be used in scientific research to monitor the success of individual MPAs and the network (Murray et al., 1998). For the purposes of this report, adequate replication is defined as three or more sites or habitats of the same type. This definition is applied here to geomorphology and vegetation characteristics within fully and partially protected MPA shorelines.

When examining geomorphology along fully protected MPA shorelines, only rock is replicated, and this is limited to a small region of the Northwest Straits (Figure 5). Rock with sand/gravel is minimally replicated, and mud is not replicated. Other than San Juan County where most of the fully protected MPAs are located, there is little replication in geomorphology within fully protected MPA shorelines in the Northwest Straits.

Geomorphology is better replicated in partially protected MPAs along the Northwest Straits shoreline (Figure 6). Sand/gravel shorelines are well replicated within partially protected MPAs in the region, and both rock and rock with sand/gravel shorelines are replicated to a lesser degree. Organics/fines and man-made shorelines are minimally replicated within partially protected MPAs.
Vegetation types are minimally replicated within fully protected MPA shorelines (Figure 7). Replication of kelp/Fucus is limited to San Juan County, and saltmarsh and unvegetated shorelines are not replicated at all.

Within partially protected MPA shorelines, saltmarsh, seagrass, and kelp/Fucus are all replicated to varying degrees, but this is concentrated in certain areas of the Northwest Straits (Figure 8). Once again, unvegetated shorelines show little replication. Overall, all MPA shorelines, both fully and partially protected, exhibit minimal replication. Certain geomorphology and vegetation types show some replication, but this is primarily along partially protected MPA shorelines within the Northwest Straits region.

Oceanographic Linkages

Replication of habitat characteristics throughout the region is also important for potential oceanographic linkages that could exist between sites (Agardy, 2000; Roberts, 1998b; Ballantine, 1999; Crowder et al., 2001; Murray et al., 1999; NRC, 2001; Palumbi, 2001; Roberts et al., 2001; Sullivan Sealy and Bustamante, 1999). Local and regional ocean circulation patterns in the Northwest Straits are highly complex (Thompson, 1981) and are strongly influenced by tidal forcing. Due to this complexity, ocean circulation patterns are not considered in the analysis of connectivity. Instead, distance between replicate sites is used as a proxy for the likelihood of oceanographic linkage. Examining tides and currents in conjunction with this habitat information would provide a more accurate indication of potential linkages, or the ability for species at different life history stages to travel between MPAs within the potential "de facto" network. However, the lack of widespread replication of all habitats means less potential for linkage among current sites, regardless of oceanography. Because it is difficult to protect all habitats utilized by both sessile and mobile marine organisms at every life history stage, MPAs that encompass the diversity of habitats throughout the Northwest Straits could be essential for an optimally functioning network.

Among existing fully protected MPAs, most are concentrated in one area of the region, implying the existence of potential linkages within that area (Figures 5,7). Organisms whose larvae or other life history stages utilize rock and rock with sand/gravel and rock geomorphology shoreline types may be able to utilize linkages between fully protected MPAs within a small part of the region (Figure 5). Potential linkages also exist for those species utilizing kelp or Fucus vegetation, because they dominate the small number of existing fully protected MPA shorelines (Figure 7). Organisms utilizing other geomorphology types such as sand/gravel, mud, or organics/fines have few or no potential linkages between their few fully protected MPA refuges in the Northwest Straits because they are not well replicated throughout the region (Figure 5). Likewise, saltmarsh and seagrass vegetation types are not well replicated throughout the region's fully protected MPA shorelines, and organisms utilizing these habitats at any life stage likely do not currently have linked shoreline refugia (Figure 7). This may be problematic for vulnerable species that are not protected from harvest by partially protected MPAs.

Within partially protected MPAs, potential linkages exist for species utilizing sand/gravel habitats throughout part of the region (Figure 6). Rock, rock with sand/gravel, and mud habitats have less potential for linkage because they are less replicated and in some cases widely spaced. For vegetation, organisms utilizing seagrass shorelines have potential for linked refugia, although sometimes large distances separate MPAs. Otherwise, saltmarsh, kelp/Fucus and unvegetated shorelines within partially protected MPAs are widely spaced, so linkages between them would be unlikely for many species (Figure 8). In addition, few MPAs exist along the Strait of Juan de Fuca shorelines and none exist west of Tongue Point, so organisms would have to travel long distances to reach other MPAs (Figure 2).

Size

The size of individual MPAs is also a factor of potential importance in achieving a functional system of MPAs. The size of individual MPAs will determine in part their success. The success of individual MPAs will contribute to the success (or failure) of a functional network. Since many of the seaward boundaries of MPAs in the Northwest Straits are undefined (Murray and Ferguson, 1998) and this report focuses primarily on the intertidal, size of MPAs is extrapolated from miles of shoreline. Among fully protected sites, the size of existing MPAs in the Northwest Straits is very small, with an average size of less than three miles of shoreline (Figures 3,5,7). This is also true for many of the partially protected sites, although some, such as the Special Fishery Management Areas, make up more than sixty miles of shoreline (Figures 4,6,8). Many socioeconomic and management trade-offs exist between the size and amount of protection conferred by individual MPAs. Overall, a diversity of sizes exists among the MPAs in the Northwest Straits, with the exception that all fully protected MPAs are all small. The percentage of area protected within the Northwest Straits could not be evaluated due to the linear limitation of the data beyond the nearshore.

Levels of Protection

Factors contributing to a functional network of MPAs all are dependent on the level of protection afforded to the species within them, and the level of threat experienced by the organism, which is often unknown. It is evident that partially protected MPAs outnumber fully protected MPAs within the Northwest Straits (Figures 3-8), and the relative proportions of fully protected versus partially protected MPAs varies between counties (Table 5). Few of the partially protected MPAs provide protection to many species within them. The scientific theory for MPA network design is based on fully protected MPAs. Partially protected MPAs may be incapable of achieving the same goals as fully protected MPAs because some elements of the ecosystem may be lost to exploitation or other forms of human use.

Table 5: Proportion of county shoreline within the Northwest Straits in fully protected and partially protected MPAs. Values rounded to nearest whole mile.

County	Total Shoreline	% of County Shoreline in Fully Protected MPAs	% of County Shoreline in Partially Protected MPAs
Clallam	(168 miles)	1% (2 miles)	13% (22 miles)
Island	(214 miles)	2% (5 miles)	23% (50 miles)
Jefferson	(201 miles)	3% (7 miles)	0% (0 miles)
San Juan	(408 miles)	5% (20 miles)	26% (106 miles)
Skagit	(233 miles)	<1% (1 mile)	27% (64 miles)
Snohomish	(129 miles)	7% (9 miles)	1% (1 mile)
Whatcom	(145 miles)	<1% (<1 mile)	4% (5 miles)
TOTALS	***(1500 miles)***	***3% (44 miles)***	***16% (247 miles)***

OTHER CONSIDERATIONS

In addition to the MPA network design criteria, other factors are important to better understand the existing MPAs in the region. Even though this particular analysis is limited to the shoreline, intertidal versus subtidal protection is valuable to discuss. Voluntary versus regulatory protection is also important since both exist within the region. Lastly, it is useful to examine MPAs that have been established for individual or groups of species and how they might contribute to species-specific networks.

Intertidal vs. Subtidal Protection

Although this report examines primarily intertidal habitats within MPAs, subtidal habitats and the species they support are also significant considerations within MPA network design. Many species such as rockfish rely on subtidal habitats throughout much of their lives (WDFW, 2001). Other mobile species may utilize intertidal areas as juveniles but are pelagic (swimming through the water column) as adults. For this reason, it is necessary for MPAs within the network to extend into the subtidal in order to protect the diversity of species at all life history stages within the region. Again, habitat types in the intertidal region are often indicators of subtidal terrain, so some generalizations can be made for MPAs that extend into subtidal habitats.

Voluntary vs. Regulatory Protection

It is also important to consider the regulations behind the protection afforded to species and habitats. Most MPAs within the Northwest Straits have regulatory authority afforded to the species and habitats they protect (Appendix A) (Murray and Ferguson, 1998). However, some MPAs are voluntary, affording only voluntary protection to species within them. Voluntary protection is one of the few options available at the county level for establishing MPAs, and relies mainly on education and community support for compliance with restrictions (Murray and Ferguson, 1998). Because managing authorities of voluntary MPAs cannot “enforce” these restrictions, anyone can choose to disregard these restrictions. In some cases however, voluntary protection may be more effective than regulatory enforcement, if compliance is high. This may be more likely to occur in island communities and other locales where the level of stakeholder investment in protection is high.

Species-Specific MPA Networks

Voluntary and regulatory MPAs have been established for the protection of bottomfish, commercially harvested cucumbers and urchins, and unclassified marine invertebrates (UMI) (Figure 9). WDFW is considering the establishment of an MPA network primarily for bottomfish by protecting a number of sites with appropriate rocky habitat for recovery of these vulnerable populations (WDFW, 2001). Because the voluntary MPAs established by San Juan County do not have regulatory protection, WDFW does not consider them part of the network. This report considers all MPAs established for bottomfish recovery to contribute to a potential functional MPA network for bottomfish. When examined together, these bottomfish sites established by WDFW and San Juan County are very small and are concentrated within San Juan County. Although San Juan County has more bottomfish habitat than other counties (WDFW, 2001), efforts are currently underway in Skagit County to set aside Voluntary Bottomfish Recovery Areas (NWSMCI, 2001). Only two large Special Fishery Management Areas in San Juan County protect commercially harvested sea urchin and cucumber species in the Northwest Straits (Murray and Ferguson, 1998). Even though they encompass a large area, these two sites alone do not likely comprise a network to adequately protect these benthic organisms, which possess pelagic mobile larvae. Other urchin and cucumber species are included in state park restrictions against the take of unclassified marine invertebrates (UMI) (Murray and Ferguson, 1998). Although these MPAs were set aside for other purposes, they have the potential to protect populations of UMI and potential linkages between sites could exist because of the number and position of state parks within the region.

CHAPTER FOUR: CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

Overall, the existence of 107 MPAs, affording some level of protection to approximately 19% of the Northwest Straits region's shoreline is notable. The majority of these sites were established independently. Nonetheless, the existing MPAs in the region have some characteristics of a de facto MPA network along the shoreline.

Fully protected MPAs, which make up 3% of the Northwest Straits shoreline, exhibit minimal representativeness of the habitats in the region. While rock, mud, and kelp/Fucus shorelines have significant protection, organics/fines, sand/gravel, saltmarsh, seagrass, and unvegetated shorelines are all underrepresented within fully protected MPAs (Figures 5,7). Replication is poor for fully protected MPA shorelines, except within San Juan County, where most are located. Therefore, the potential for oceanographic linkage between fully protected MPAs is highest within San Juan County. Relatively few individual organisms may be protected by these fully protected MPAs because their size is very small.

Partially protected MPAs make up approximately 16% of the Northwest Straits shoreline, which protects a significant amount of geomorphology and vegetation (Figures 6,8). Being partially protected indicates that most of the species within these shorelines are not protected by existing regulations. Representatives of most habitat types are partially protected within these shorelines, although rock with sand/gravel, saltmarsh, seagrass, and unvegetated shorelines are all underrepresented as compared with the entire Northwest Straits. Replication is limited in certain parts of the region, so potential oceanographic linkages could exist for species whose harvest is restricted.

RECOMMENDATIONS

Improvements to the potential de facto network of MPAs could enhance its effectiveness. First, additional protection is required for underrepresented habitats. This can be achieved by enlarging existing MPAs or designating new sites. If the existing MPAs are to be linked through a network, additional sites must be interspersed with existing sites to help facilitate linkage between sites. Replication would also help guard against natural and human disturbances affecting part of the region. To better protect species within particular habitats, the level of protection should be increased within partially protected MPAs through state regulation.

The county Marine Resources Committees in the Northwest Straits have already begun discussing the establishment of MPAs. This report can be used as tool to guide the placement of MPAs by focusing on underrepresented habitat types or areas that lack other existing MPAs. Although local outreach can help build support for new designations, there is no regulatory framework for establishing MPAs at the county level outside of Shoreline Management Plans (SMPs). Therefore, a partnership between local MRCs and state agencies (WDFW, WDNR, WSP&RC) is necessary to gain maximum support for additional regulatory designations. Additional coordination between management authorities would also improve the de facto network as a whole. Enforcement and compliance could be made simpler with increased coordination and outreach because the public might be less confused by the multitude of MPAs with diverse goals. To this end, a small group of people primarily from NGOs and state and federal agencies have been meeting quarterly in the last year. However, no managers of existing MPAs in the Northwest Straits have attended these meetings. As the Northwest Straits Marine Conservation Initiative works to protect and restore marine resources at a regional scale, an ecosystem-based approach must guide decisions at every level. It is therefore necessary to streamline and coordinate current activities at all levels, and encourage the involvement of stakeholders, especially MPA managers.

Achieving a network or system of marine protected areas in the Northwest Straits will require additional research on topics presented in this report, but it will also depend greatly on socioeconomic and political factors. In addition, because this report only focuses on shorelines, a more detailed investigation of subtidal habitats is recommended to examine the level of protection afforded to species and habitats beyond the shoreline. Local ocean circulation patterns could also be examined in conjunction with this analysis to provide a more complete assessment of existing potential linkages.

MPA networks represent an emerging tool for reversing the decline of marine resources worldwide. Educating the public and decision-makers on the range of MPAs and their associated benefits and how they can be expanded to more effectively protect resources is essential to achieving the Northwest Straits Marine Conservation Initiative benchmark.

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APPENDIX B: SITES MISSING FROM FIGURES 2 THROUGH 9 THAT ARE INCLUDED IN APPENDIX A

All Counties: Some State Park sites, which particular sites are undeterminable due to the limitations of the data provided by the agency: Washington State Parks and Recreation Commission

San Juan: 1) Kimball Preserve, Decatur Island: San Juan Preservation Trust

2) Parts of the San Juan Islands National Wildlife Refuge: USFWS