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The Potential for Marine Protected Areas in the San Francisco Bay

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THE POTENTIAL FOR MARINE PROTECTED AREAS IN THE SAN FRANCISCO BAY

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The Potential for Marine Protected Areas in the San Francisco Bay

Abstract

The San Francisco Bay (the Bay) is the largest estuary on the Pacific Coast. This makes it one of country's greatest natural resources. Historical and current impacts from mining, pollution, and dredging have reduced the size of the Bay's shallow, productive environment, which provides vital habitat for many important species. The seven and a half million people that inhabit the shores and hills surrounding the Bay, and economic activities such as commercial fishing and development continue to degrade ecosystems. Although conservation efforts have led to improvement of water quality and some habitat restoration over the past few decades, very little has been done establishing marine protected areas in the San Francisco Bay. In 2009, with the Marine Life Protection Act (MLPA), California adopted a regional network of Marine Protected Areas (MPAs) to effectively protect its coastal waters. All designated regions of the MLPA have been completed, except for the fifth and final region, San Francisco Bay, for which no planning has yet occurred. Efforts toward conservation and sustainable use of the Bay, by means of MPAs would provide a potential solution to counteract increasing pressure on natural resources due to extractive activities, and may help mitigate other impacts. In this literature review, thirty five ecologically and economically important plant, fish, bird, and marine mammal species were identified, within eight unique ecosystems. However, only small fragments of disconnected area in the Bay are currently protected, and no area offers complete protection from extraction or disturbance. Based on personal interviews, an extensive literature review, analyzed data, and lessons learned from the four coastal regions of the MLPA, I make recommendations for MPAs in San Francisco Bay in the matters of: funding, current protection efforts, future protection efforts, and the complex governance structure.

1. Introduction

1.1 Definition of Marine Protected Areas (MPAs)

Marine ecosystems across the world are facing an increasing number of threats from human impacts including: over-fishing, degradation of coral reefs, increases in ocean temperature, ocean acidification, and loss of habitat (Edgar 2007). These effects have the

potential to cause a number of biological and ecological changes, such as a reduction in the number of plant and animal species and in their body size and biomass, a lower biodiversity, and changes in the life history and genetics of many species (Fenberg et al. 2011). Such changes shift the food web, which can distress entire ecosystems, prompting the need for conservation approaches that can control and possibly reverse some of these effects.

The United States is no exception to the global pattern of threatened marine ecosystems with its coastal, marine, and Great Lakes waters and the world's largest exclusive economic zone (Mayr 2010). These waters have a long history of human use, which has resulted in loss of species and habitat degradation (National Marine Protected Areas Center 2008). As human populations continue to grow, so does the need for resources, resulting in more threatened ecosystems. Declining yields in fisheries and the rapid decay of precious ocean habitat has heightened interest in establishing a comprehensive system of marine protection (Allison et al. 1998). Management is required to ensure the preservation and sustainability of these ecosystems.

The most significant management option, in the United States and around the world, is the establishment of Marine Protected Areas (MPAs) (Weible and Sabatier 2005). MPAs are named, discrete geographic marine or estuarine areas that vary in size and have been designated by law administrative action, or voter initiative to protect, conserve, or enhance ocean life and habitat (Edgar et al. 2010). In these areas, human activity has been limited to safeguard the natural environment, the water surrounding it, the species inhabiting it, and any cultural or historical resources that necessitate preservation or management (Vann 2010). Within the boundaries of an MPA, resources may be protected by national, regional, native, state, or local authorities and differ greatly from nation to nation (National Academy Press 2001).

1.2 Benefits and costs of an MPA system

The benefits and costs associated with MPAs can be thoroughly identified and described. However, an exact measurement of the expected net benefits gained by expressing all benefits and costs in monetary terms is not always possible. As with many other society

based investments, the potential benefits of an MPA are often not fully recognized until some future date. Conversely, many of the costs are immediate, such as the economic cost to commercial fishers. This implies that marine protection can result in inter-temporal tradeoffs, maybe even across generations (Sanchirico et al. 2002). The many ecological benefits associated with MPAs, such as increased biodiversity and connectivity, have the potential to create positive socio-political impacts as well, including enhanced research opportunities, greater fish catches and the recovery of degraded fisheries (Charles and Wilson 2009).

While an understanding of the benefits of MPAs is simple, measuring the efficacy of them is not. The marine environment is a difficult ecosystem to conduct experimental work in. This is partially due to imprecise sampling methods, which are used to determine abundance and biodiversity, such as visual monitoring. The research challenges associated with marine data collection limit our knowledge of the extent of the effect of MPAs. This lack of comprehensive data can create some measure of difficulty in quantifying the benefits and costs. However, there are some easily observable ecological benefits to MPAs, perhaps one of the most significant being ecological connectivity.

a. Connectivity

An ecological network of MPAs is a group of distinct MPAs within a region that are operatively connected through the dispersal of reproductive stages or the movement of juveniles and adults. When designed correctly these networks can improve connections between sources and sinks for marine species, which may be essential for the persistence of some populations (Mayr 2010).

Ecological connectivity is also effective in providing stock for neighboring areas (Stevens 2002). When fishing is ceased in an area, resident fish populations begin to recover. Once they recover abundance of fish rises, as does the number of older and more sizeable fish, who would have likely been caught without protection. The quantity of larvae in the entire area may increase after protection as well because older and larger fish are more fecund (Sanchirico 2002). MPAs provide direct protection to total fish stock residing within their boundaries. As fish stocks increase, they will spillover to adjacent areas. However, the volume and scale of the

spillover depends on the mobility and dispersal characteristics of the species within the MPA. For example, the relatively sedentary black abalone (*Haliotis cracherodii*), found in the South La Jolla Marine Conservation Area, will have a limited spillover, regardless of the population size. Conversely, in a very mobile species such as the white seabass (*Atractoscion nobilis*), found in the same area, a high amount of spillover would be expected with an increase in population.

b. Increased protection of marine ecosystems

One of the most comprehensive reviews of 89 MPAs concluded that on average, density, biomass, size of organisms, and diversity were higher inside no-take MPAs compared to outside or after reserve establishment versus before, for all species. The study examined each of the following functional groups separately; carnivorous fishes, herbivorous fishes, invertebrate eaters, and invertebrates (Halpern 2003).

A meta-analysis of 124 MPAs, with varying levels of protection, in 29 countries found that in nearly every case, the area inside the MPA had more organisms, larger organisms, and more species than the unprotected area immediately adjacent to the MPA. The study also showed that these ecological effects can occur within a few years of MPA establishment and they appear to last as long as the MPA exists (Lester et al. 2009). Similar results were found in California, after it established its state wide MPA system in 1999. Data showed that California's network of MPAs significantly increased the number of MPAs and areas protected in state waters, larger MPAs that capture a broader range of habitats, and more area of state waters protected in no-take areas (Gleason et al. 2013).

c. Human oriented

Sustainable Fisheries

Marine protection can be a controversial issue with stakeholders, who may have apprehension about the economic impacts of reducing and even eradicating fishing opportunities within proposed MPAs. However, some data indicates that successful MPA's can aid in fisheries output (Lester et al. 2009). Fisheries oftentimes experience both the benefit of and costs from the MPAs (Table 1).

Table 1. Fisheries: the Potential Benefits and Costs associated with MPAs (Sanchirico et al. 2002).

Categories	Benefits	Costs
Extractive Users (e.g., commercial and recreational fishermen)	increase in catch reduced variation in catch improved catch mix (i.e., greater frequency of older/larger fish)	decrease in catch congestion on the fishing grounds user conflicts higher costs associated with choice of fishing location increase in safety risks

When designing an MPA, one of the goals of any managerial entity is to support the sustainable production of marine resources. A successful MPA network has the long-term potential to improve fishing opportunities for both commercial and recreational fishers as a result of spillover, species recovery, and genetic diversity. However, some parties and individuals can incur immediate financial and social costs from the establishment of an MPA such as local fishermen and fishery dependent businesses (Helvey 2004). For example, in California's statewide network of MPAs some of the state's recreational and commercial fishermen, fishing organizations, and fishing-related business interests were and still oppose the statewide marine protection system. Due to already declining fish populations and more strict regulations, many fishermen have already experienced economic downfalls and view existing and proposed MPAs as unnecessary, in addition to the perceived increasingly heavy regulations on fishing (Gleason et al. 2013).

Public awareness, understanding, and education

The creation of MPAs could help improve marine conservation by raising the public profile of MPAs as a management option and by raising public awareness of the need to protect marine resources. It could also build support for investment in existing and future MPA sites. The recognition of protected areas in other, terrestrial systems such as the National Trail and the National Estuarine Research Reserve has experienced similar results (Vann 2010).

MPAs provide an enhanced opportunity for education in nature and as a tool for the public to understand not just a species but the entire marine ecosystem. Students and visitors, at many sites, have access to valuable information concerning the marine and coastal ecosystems supported there. The potential educational resources supported by MPAs include onsite visits, in addition to classroom and virtual tools, in MPAs that are accessible for recreational use (Mayr 2010). MPAs that allow for research or research permits will provide scientists with more opportunity to understand the dynamics of individual marine ecosystems and the anthropogenic forcing that affect them under various levels of protection and management strategies (Vann 2010).

Resources and time required

Design, implementation, and monitoring costs of an MPA are dependent on factors such as size, location, and use restrictions of the MPA, fisheries regulations, and available technology (Sanchirico et al. 2002). In the case of California's statewide network of MPAs, the completion of a draft master plan took almost seven years and substantial financial investment and included support from private donors and state and federal governmental agencies (Gleason et al. 2013).

1.3 Statement of purpose

It is crucial to understand how humans will interact with the potential MPAs and how they might respond to closures (Gleason et al. 2013). Designing, implementing, and managing MPAs requires that attention be paid not only to the biological and oceanographic issues that influence the performance of the MPA, but also to the human dimensions (Charles and Wilson 2009). This is especially true within United States marine ecosystems, where the stakeholders include commercial and recreational fishers, scientists, non-governmental organizations, and local, state, and national government agencies.

In this paper I examine MPA networks under different levels of management and on varying spatial scales: the United States, California, and the San Francisco Bay. Based on those management efforts, personal interviews, an extensive literature review, and analyzed data I

make recommendations for MPAs in San Francisco Bay in the matters of: funding, current protection efforts, future protection efforts, and the complex governance structure.

2. Methods

I obtained relevant research concerning MPAs by searching biological and environmental science databases for primary research material. I utilized a total of 16 research databases from 1994 to the present (2014), with key articles obtained mostly from Scopus, ScienceDirect, BioOne, and the Gleeson Library. In order to ensure that relevant studies were not missed, I initially used broad search terms. These were "MPAs", plus "California", plus "San Francisco" anywhere in the title or abstract. I considered a study eligible for my review if the focus of the study was: (a) MPAs in California (b) federal marine protection in the United States or (c) marine protection in the San Francisco Bay.

The next step I took was a detailed examination of the papers. At this point, studies were excluded if they did not contribute to a better understanding of the benefits and costs of MPAs in the United States, California, and/or the San Francisco Bay. I categorized the chosen articles into three categories; the Unites States MPAs, California's MPAs, and the San Francisco Bay. For the United States, the breadth of my research focused on the federal management system of MPAs post 2009. When examining MPAs in California, I concentrated my research on what marine resources the state possesses and what measures have been taken, historically, to protect them. For the San Francisco Bay, my search criterion differed; I looked for papers that showed species and resources of importance.

To increase my knowledge on the subject of the California MPA system, I conducted and interview with the Stephen Wertz, Senior Environmental Scientist Supervisor on the MPA project for the state of California, on April 22, 2014. For information on areas in the Bay that should be prioritized for protection, and to take me through the process that would lead to more MPAs, I interviewed Brian Baird, Director of the Ocean and Coastal Program at The Bay Institute and Aquarium of the Bay, on May 2, 2014. Finally, to get some insight on the history of the MLPA and future of protection in the Bay, in general, I spoke with Mike Sutton, who serves

on California's Fish and Game Commission and is also the executive director of Audubon, California, on May 5, 2014.

3. Marine Protection in the United States and California

3.1. Levels of protection

The label MPA has become a very broad term and provides little information about what is being protected, at what level, or why protection is necessary (Al-Abdulrazzak and Trombulak 2011). MPAs offer varying levels of protection and these levels can range from prohibiting all extractive activities, to merely restricting commercial fishing. To further complicate matters, different agencies give different names to MPAs. These names may explain the conservation goals (e.g., reserve, sanctuary, and preserve), but they do not give specific information about their actual contribution to ecological protection (Al-Abdulrazzak and Trombulak 2011). However, this non-specific form of categorizing varying levels of protection in MPAs can be useful in providing general reference information.

The most widely used categorization method for MPAs in the world was developed by the International Union for the Conservation of Nature (IUCN). Internationally, these categories apply to areas that are a minimum of 1,000 hectares and reflect a wide range of management objectives. The IUCN categories of protection are:

1. Strict Nature Reserve/Wilderness Area: primarily for science and/or wilderness protection.

Ia: primarily for science.

Ib: primarily for wilderness protection.

2. National Park: primarily for ecosystem protection and recreational use.

3. National Monument: primarily for the conservation of natural features.

4: Habitat Species Management Area: primarily for conservation through management.

5: Protected Landscape/Seascape: primarily for landscape and seascape conservation and recreation.

6: Managed Resource Protected Area: primarily for the sustainable use of natural ecosystems.

The IUCN categories were originally developed for the conservation of terrestrial ecosystems. Terrestrial ecosystems differ greatly from marine ecosystems In terms of physical, biological, and social characteristics. Therefore, it is critical to avoid the misapplication of these categorizations to the marine realm (Al-Abdulrazzak and Trombulak 2012) (ICUN 2010).

Some experts recommend that MPAs continue to be based on broad definitions, to include names where protection is a limited to only a few resources or uses. Other authorities suggest that the term MPA should apply only to areas that human use is strictly protected. Between these two possibilities there are many intermediate approaches to categorizing MPAs, which are generally handled differently by each MPA system manager (Vann 2010).

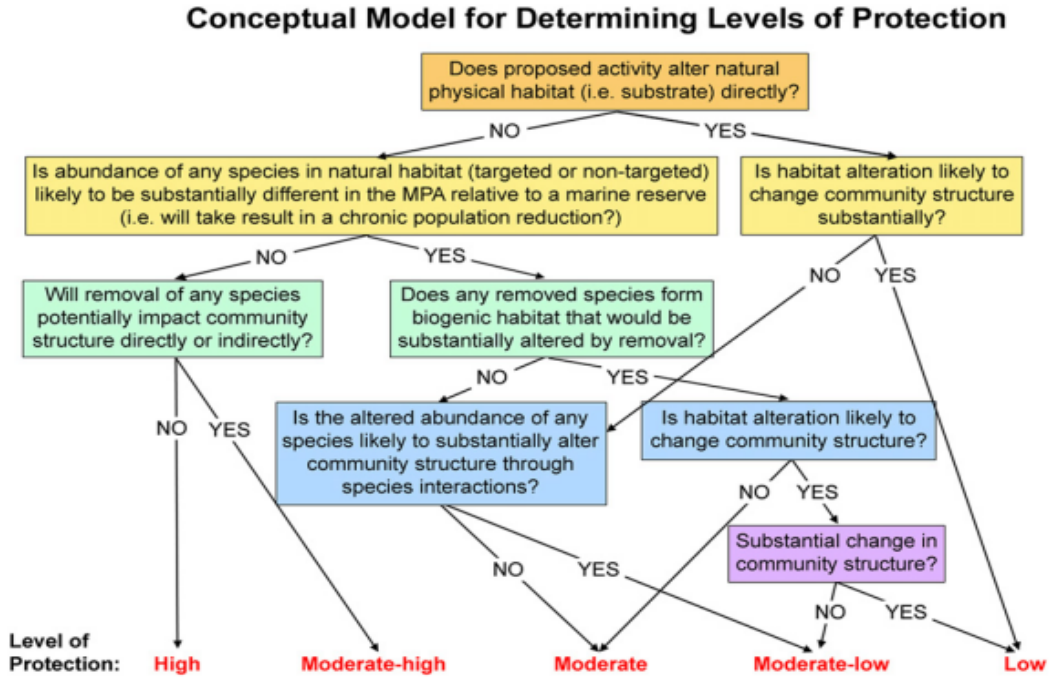


Figure 1. The decision tree used for assigning levels of protection to specific extractive activities within proposed MPAs allowed participants in the MPA planning process to clearly identify decision points and contribute concrete and relevant information to support or refute specific conclusions drawn in assigning levels of protection (Saalman et al. 2013).

For example, in California, a team of scientists created a conceptual model to determine what level of protection would restrict enough human activity for the MPA to contribute

towards California's conservation goals for each individual MPA in the state's marine protection system. A decision tree was developed for assigning levels of protection that improved transparency of MPA design and gave stakeholders more involvement (Figure 1) (Saalman et al. 2013).

To achieve clear planning, implementation, and management of a MPA, it is important that each managing entity create a very specific classification system that outlines the level of protection allotted to each particular area under its jurisdiction. For example, in its framework for a national system of MPAs, the Unites States created a unique set of MPA categories. The federal government works with the managing entities of existing MPAs to decide the most suitable category for the MPA as it becomes part of the national system (Vann 2010).

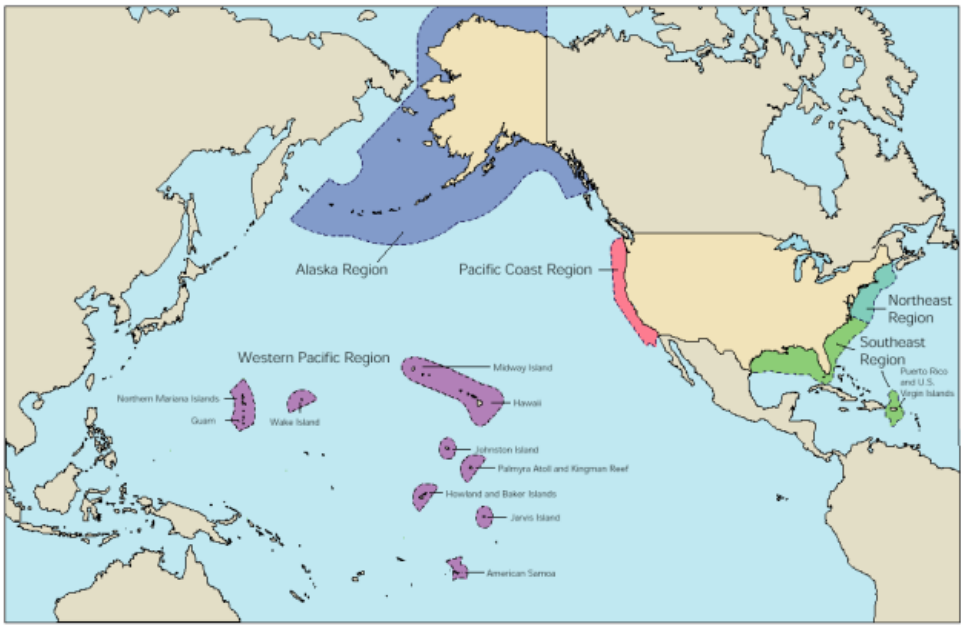


Figure 2. The United States Exclusive Economic Zone

3.2 Marine protection in the United States

The United States is exceptional in its considerable and diverse collection of marine resources: sea grass beds, salt marshes, coral reefs, mangrove forests, and kelp beds, and ocean and coastal expanses. The country boasts 95,000 miles of coastline and over 3.40 million square miles of ocean (Figure 2) (Sanchirico et al. 2002). To aid in protecting these vast

resources, there are more than 1,600 MPAs, which are founded and regulated by multiple levels of government (Fox et al. 2013).

Over the past century MPAs have been established by a combination of federal, state, and local legislation, each created for its own specific purpose. Because of this, the nation's collections of MPAs are fragmented, complex, confusing, and potentially missing opportunities for broader conservation through coordinated planning and management (Vann 2010).

In April 2009, the United States System of Marine Protected Areas was launched to strengthen protection efforts. 225 sites, managed by various agencies, were required to work together toward common goals and priorities. The national system does not require a change in the management of any MPA when it incorporates existing MPAs into its system (National Marine Protected Areas Center 2008). This affords individual states federal marine protection, while simultaneously allowing them to govern their existing MPAs. An existing MPA must have preexisting protection to qualify for the United States System of MPAs. The criteria that must be met by an MPA for it to qualify for the national system include (Figure 3):

1. Meet the criteria of a MPA, as federally defined – has clear geographical boundaries, qualifies as a marine environment, is established and currently regulated by some branch of government, and has permanent protection.

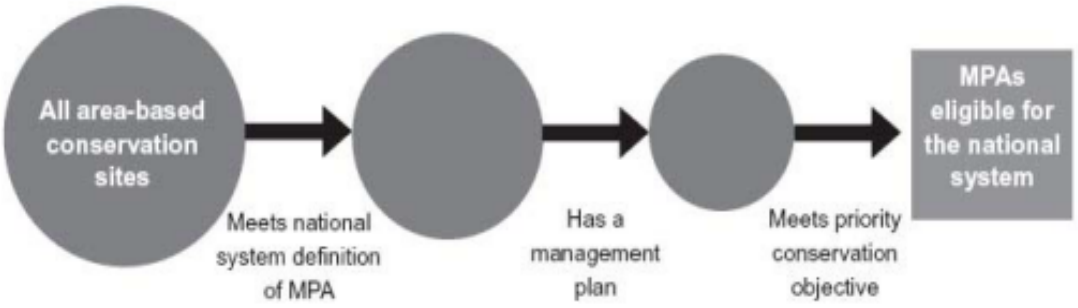


Figure 3. Eligibility Criteria for the National System of MPAs (Mayr 2010).

2. Have pre-existing management plan.
3. Support the priority conservation goal the national system (Mayr 2010).

The most well-known MPAs in the United States are the areas in the National Marine Sanctuary System. These are administered under the National Oceanic and Atmospheric

Administration (NOAA), and consist of 14 marine protected areas that encompass more than 170,000 square miles along the coasts of the United States (Figure 4) (Vann 2008). The system was created to protect marine ecosystems from oil and gas spills, and they have significantly limited oil traffic, but other potentially harmful activities such as commercial and recreational boating and fishing are still allowed in many of the sanctuaries (Poppick 2014).

One example of an MPA under this type of federal protection is the Channel Islands, which were originally granted protection by the state of California. The Channel Islands provide an example of how federal and state management of MPAs can overlap.

The entire MPA network consists of 11 marine reserves, in which, all take and harvest is prohibited, and two marine conservation areas, in which a controlled amount of take of spiny lobster and pelagic fish is allowed. This MPA network is comprised of 318 square miles, making it the largest off of the mainland United States. The overarching conservation goal for the Channel Islands MPA network is congruent with that of the National System of MPAs, whose purpose is to:

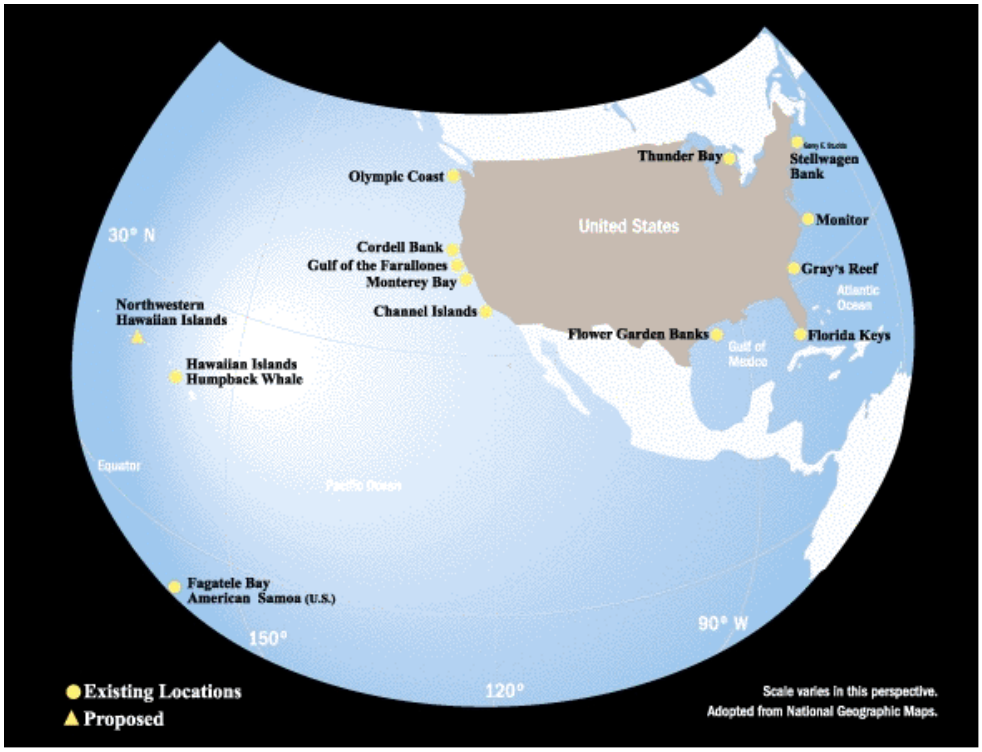


Figure 4. National Marine Sanctuaries (Vann 2008).

"…support the effective stewardship, conservation, restoration, sustainable use, and public understanding and appreciation of the nation's significant natural and cultural marine heritage and sustainable production marine resources, with due consideration of the interests of and implications for all who use, benefit from, and care about our marine environment (Mayr 2010)."

In 2002 California founded a network of MPAs, within three miles offshore of the coast of Santa Barbara. In 2006 and 2007 NOAA increased the MPA network into deeper waters, further offshore (NOAA 2014). When the federal government acquired the islands as part of the National Marine Sanctuary System, California had already protected it (Hamilton et al. 2010). However, United States MPA programs were not designed to overrule the jurisdiction of existing MPAs. Managing entities can achieve more effective conservation by working together rather than separately. While under federal jurisdiction, the United States System of MPAs outlines a clear and collaborative process for MPA systems in every level of government; state, local, territorial, or tribal, must work in conjunction with the public to accomplish mutual ecological and economic objectives (Mayr 2010). While ideal, this framework is not always fully realized. In some cases, relationships between the federal and lower levels of government are based on uncertainty and distrust, which can result in a prolonged planning process.

To foster strong relationships and understanding, the National System of MPAs works with the current managers of MPAs that qualify for federal protection to determine the appropriate classification level for the MPAs as they become part of the federal system. While the IUCN categories' are used by the federal government to categorize MPAs, they also use narrower terms to describe MPAs that have a higher levels of protection. These terms include (NOAA 2014):

1. ***Marine reserve*** *- where uses that remove resources are generally prohibited.*
2. ***Ocean wilderness*** *- like the terrestrial concept for wilderness areas on federal lands, these are areas where no alterations or activities that leave lasting impacts are permitted, but low impact recreational activities may be permitted.*
3. ***Fully protected marine area*** *- generally a "no-take" area where a wide variety of extractive and consumptive uses/activities are prohibited.*

4. ***National marine sanctuary*** *- a specific designation created in federal legislation more than 30 years ago to ensure conservation and management for areas of special national significance.*
5. ***Marine managed area (MMA)*** *- managing for multiple objectives, where protection is not the only, and may not even be the main objective.*
6. ***Marine park*** *- similar to the terrestrial concept for a park where recreational activities are allowed and resource conservation is also a goal of the designation.*

In addition to the federal system for marine protection, individual states have been developing their own MPA systems and categories for specific areas within each system. California has been the most active in this this task by reaching an agreement on a comprehensive program of MPAs in its coastal waters (Mayr 2010).

3.3 History of marine protection in California

California has some of the most productive marine regions in the world (Gleason et al. 2006). The California coastal zone is one of only four large upwelling systems in the world (CDFW 2004). Seasonal winds allow colder, denser, more nutrient rich water from deep in the ocean to rise to the surface, which sustains a complex food web. California's coast includes hundreds of miles of beaches, rocky intertidal zones, and estuaries, one of which is the San Francisco Bay, the largest estuary on the West Coast (Gleason et al. 2006). Estuaries consist primarily of open water surrounded by salt marshes and eelgrass beds which support the many species throughout various life stages and sustain high levels of productivity (Blake and Duffy 2012). Rich and productive kelp forests are also found close to shore. Hard and soft seafloor ecosystems house many communities of invertebrates and fish, from the shoreline to the bottom of the continental slope (Gleason et al. 2006).

The Continental shelf-slope break is a hotspot for biodiversity in the pelagic waters off the coast of California, this area is important for migratory and resident marine mammals and seabirds (Gleason et al. 2006). There are many large submarine canyons along the continental shelf, such as the Monterey Canyon, with depths comparable to that of the Grand Canyon.

Despite the importance and breadth of California's marine environments, prior to 1999, there were few measures being taken to protect them (CDFW 2004). Before recent measures were taken to increase marine protection less than 3% of state waters were listed as MPAs in the state. The areas that were being protected were mostly small and had little restriction on activity and were not considered under any comprehensive network or planning process (Figure 5a) (Gleason et al. 2013).

a. The Marine Life Protection Act (MLPA)

In 1999, California approved the Marine Life Protection Act (MLPA) as part of the California Fish and Game Code. The act reevaluated all current MPAs in California and allowed for the potential to designate new MPAs that would contribute to the statewide system. Once implemented, the MLPA establish a network of 124 coastal and estuarine MPAs, each with

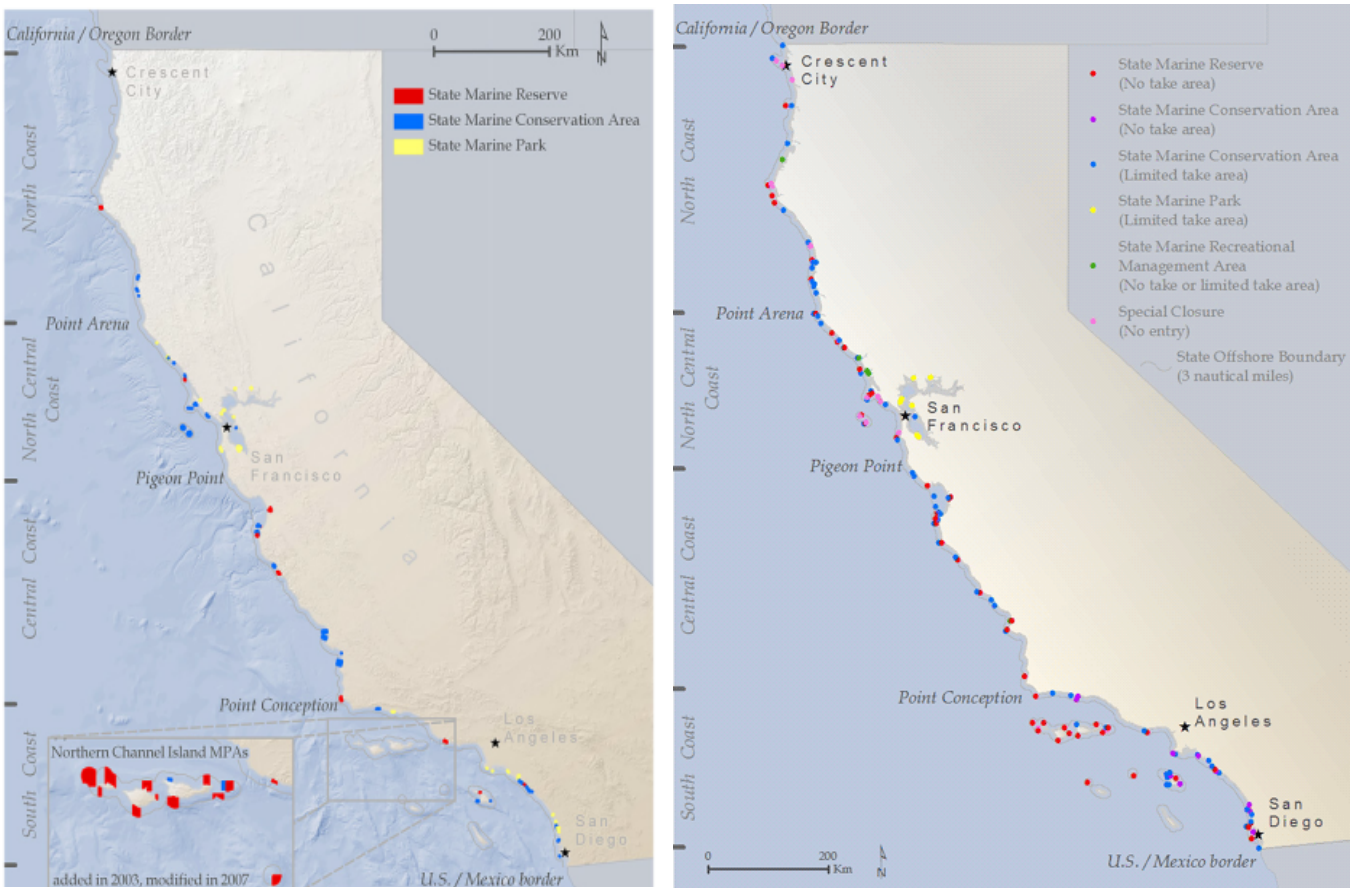


Figure 5. (a) Prior to enactment of the MLPA in 1999, California's had 63 MPAs covering less than 3% of state waters; in 2003, 13 MPAs were implemented in the Channel Islands following a separate MPA planning process. (b) The newly redesigned statewide network of MPAs includes 124 MPAs protecting 16% of state waters, including 61 no-take areas that cover 9.4% of state waters (Gleason et al 2013).

unique boundaries, coordinates, and regulations (Owens and Pope 2012). Currently, California is managing a network of 124 MPAs that cover 16.0% of state waters, including 9.4% of state waters in no-take MPAs (Figure 5b) (Gleason et al. 2013). The MLPA is the United States' first state regulation that requires a comprehensive, science-based network of MPAs. It mandates the redesign of California's existing MPAs to create a statewide network that achieves six ecosystem based goals. The goals of the MLPA are to (CDFW 2011):

1. *Protect the diversity and abundance of marine life, and the structure, function, and integrity of marine ecosystems.*
2. *Help sustain, conserve and protect marine life populations, including those of economic value, and to rebuild those that are depleted.*
3. *Improve the recreational, educational, and study opportunities provided by marine ecosystems that are subject to minimal human disturbance, and to manage these uses in a manner consistent with protecting biodiversity.*
4. *Protect marine natural heritage, including protection of representative and unique marine life habitats in California for their intrinsic value.*
5. *Ensure that California's MPAs have clearly defined objectives, effective management measures, and adequate enforcement, and are based on sound scientific guidelines.*
6. *Ensure that the state's MPAs are designed and managed, to the extent possible, as a network (Weible 2008).*

In addition to the above ecological goals of the act, the MLPA strives to improve recreation and educational and scientific opportunities to study marine ecosystems (Weible and Sabatier 2005).

To implement the law, the state formed the Marine Life Protection Act Initiative to work in conjunction with the California Department of Fish and Wildlife (CDFW). The initiative consisted of: policy advisors, stakeholder and scientific advisory groups, and the public (Owens and Pope 2012).

b. MPA classifications as defined by California

While assessing existing MPAs to be included under the new state network, a team of scientists from the MLPA Initiative assigned 17 MPAs with a protection level that would allow the take of some marine resources, but still provide them enough protection to contribute to the ecological goals set forth by the MLPA. The remaining 46 MPAs in the network were given a much lower level of protection and are not expected to contribute to the ecological goals of the MLPA. However, these MPAs do contribute toward other goals such as recreation and research (Gleason et al. 2013). There are six MMA classifications used in California's MPA network, which were established by the Marine Managed Areas Improvement Act (MMAIA). The MMAIA is complementary to MLPA; it identified six classifications of MMAs, by reorganizing California's previous scheme of eighteen MMAs and their sub-classifications. It also names allowed and disallowed uses within different classifications. The current system is a follows (NOAA 2013):

1. ***State marine reserve*** *– Against the law to injure, damage, or take, live, geological, or cultural resource, except with a permit or authorization from the managing entity. While, to the extent feasible, the area shall be open to the public for managed enjoyment and study. Research, restoration, and monitoring may be permitted by the managing agency.*
2. ***State marine park (SMP)*** *- it is unlawful to injure, damage, take, or possess any living or nonliving marine resource for commercial exploitation purposes. Any human use that would compromise protection of the species of interest, natural community or habitat, or geological, cultural, or recreational features, may be restricted. All other uses are allowed, including scientific collection with a permit, research, monitoring, and public recreation, including recreational harvest.*
3. ***State marine conservation area*** *- it is unlawful to injure, damage, take, or possess any living, geological, or cultural marine resource for commercial or recreational purposes, or a combination of commercial and recreational purposes, that the managing agency determines would compromise protection. The designating entity or managing agency may permit research, education, and recreational activities, and certain commercial and recreational harvest of marine resources.*

4. ***State marine recreational management area*** *- it is unlawful to perform any activity that, as determined by the designating entity or managing agency, would compromise the recreational values for which the area may be designated. Recreational opportunities may be protected, enhanced, or restricted, while preserving basic resource values of the area. No other use is restricted.*
5. ***Special closure*** *- an area designated by the Fish and Game Commission that prohibits access or restricts boating activities in waters adjacent to sea bird rookeries or marine mammal haul-out sites (CDFW 2013).*

Figure 6. Four study regions were established for planning purposes in the Marine Life Protection Act Initiative; actual planning activities of roughly two years in each over lapped somewhat (San Francisco Bay not pictured) (Kirlin et al. 2013).

c. Interconnectivity between regions

A regional planning approach was used to effectively implement the MLPA, resulting in five management regions, the Central Coast, North Central Coast, South Coast, North Coast, and the San Francisco Bay (not indicated in Figure 6) (Figure 6) (Fox et al. 2013). The regions were designed to function as one complete system in order to achieve network effects across the entire coast of California and were implemented in a series of phases (CDFW 2011):

•**Phase I** – Central Coast, implemented September, 2007 (Pigeon Point in San Mateo County to Point Conception in Santa

Barbara County).

•**Phase II** – North Central Coast, implemented May, 2010 (Alder Creek near Point Arena in Mendocino County to Pigeon Point in San Mateo County, including the Farallon Islands).

•**Phase III** – South Coast, implemented January, 2012 (Point Conception to the California/Mexico border).

•**Phase IV** – North Coast, implemented December, 2012 (the California-Oregon border to Alder Creek, adjacent to Point Arena).

•**Phase V** – San Francisco Bay, under consideration (waters in San Francisco Bay, from the Golden Gate Bridge to the Carquinez Bridge)

One of the objectives of the MLPA was to have greater ecological connectivity between protected areas. Connectivity, the movement of plant and animal species, including dispersal and movement of adults, is a primary mechanism in the persistence and re-colonization of may marine species, and therefore, is important to MPA design. While it is clear that connectivity is crucial to the efficacy of most conservation measures, it has not been incorporated into most MPA network designs (Magris et al. 2014). In an attempt to achieve efficient connectivity in the MLPA, habitats were replicated many times within each planning region and MPAs were spatially designed to enhance population connectivity for important species (Gleason et al. 2013).

The process for all regions if the MLPA: Central Coast, North Central Coast, South Coast, and North Coast are complete, with the exception of the San Francisco Bay, for which planning and design have not yet occurred, nor has a framework for such a processes been established (Owens and Pope 2012). The San Francisco Bay is the final study region in which MPAs might be instated by the MLPA (CDFW 2011).

4. Ecology of San Francisco Bay

In the remaining portion of this paper I examine current protection in the San Francisco Bay. Using literature, data, interviews, and lessons learned from marine protection systems in

the United States and California, I offer recommendations on how marine protection can be enhanced in the San Francisco Bay.

4.1 A brief look at natural history

San Francisco Bay is a large and productive estuary that provides vital habitat for many plants and animals. In the Bay, rivers drain 40 percent of California's landscape that meet and mix with the Pacific Ocean and create marine and fresh water fluxes (Okamoto and Wong 2011). Many resident species depend on the Bay, as well as seasonal species that migrate in and out of it throughout the year. It supports more than 500 species of indigenous and introduced species, including 105 threatened and 23 endangered species (Save the Bay 2011).

San Francisco Bay encompasses 470 square miles of open water. From end to end, the Bay is approximately 42 miles in long and ranges from 5-13 miles in width. The deepest portion of the Bay is under the Golden Gate Bridge, where the Bay bottom is 330 feet below sea level, but the majority is less than 12 feet deep. However, the Bay is not static environment and has been constantly changing since the arrival of people (Okamoto and Wong 2011) (Table 2).

Table 2. Changes in the San Francisco Bay through history (Okamoto and Wong 2011).

	1700	**2014**
Bay surface area	~800	~580 square miles
Bay area human population	10,000	8 million
Tidal marsh	190,000	45,000 acres
Freshwater flows through the Bay	~30	~20 million acre-feet/year
Salmon returning to spawn	>2 million	<150,000 (1/5 wild origin)
Spring shorebird count	millions	hundreds of thousands

Today, 7.5 million people live on the shores and hills surrounding San Francisco Bay. Over the past 150 years, engineers and architects have constructed 46 cities, 6 ports, 4 airports, and 275 marinas (CDFW 2011). They have also drained marshes, built on coastlines and straightened rivers. To survive this type of large scale change, ecosystems must be very resilient. However, more recently local fish and wildlife have had difficulty adapting to constant disturbance (Okamoto and Wong 2011).

4.2 Key ecosystems

San Francisco Bay has many unique and important habitats that support its marine populations (Table 3).

Table 3. Important habitats in San Francisco Bay

Important habitats in San Francisco Bay	Habitat description
Sandy beach	Relatively rare in the Bay, occurring primarily in high-energy areas, including narrow straits and areas near the mouth of the Bay. Sandy beaches within the Bay likely support aquatic communities that differ from those on sandy beaches of the open coast and vary across salinity gradients (Subtidal Goals 2010).
Rocky shore	Relatively rare in the Bay, occurring primarily in high-energy areas, including islands, narrow straits, and areas near the mouth of the Bay. Rocky shores within the Bay likely support aquatic communities that differ from those on the open coast and vary across salinity gradients (Subtidal Goals 2010).
Soft bottom subtidal	The most abundant habitat in the San Francisco Bay ecosystem, occurring throughout the Bay and ranging from fine-grained mud or silt to coarse-grained pebbles and shell hash. Soft bottom habitats in the Bay support aquatic communities that differ from those on the open coast and vary across salinity, energy, and depth gradients. These variations in soft bottom habitats and communities should be considered in designing MPAs. Further division of this habitat category based on depth, salinity, or grain size may be necessary to accurately reflect the diversity of soft bottom associated communities in the Bay (Subtidal Goals 2010).
Rock subtidal	Relatively rare in the Bay, occurring primarily in high-energy areas including narrow straits and areas near the mouth of the Bay. Rocky subtidal habitats are likely to support marine communities that differ from those on the nearby open coast. It may be necessary to further divide this habitat into several depth or salinity categories to accurately reflect the diversity of rock associated communities in the Bay (Subtidal Goals 2010).
Shellfish beds	The native oyster (*Ostrea lurida*) and native mussel (*Mytilus trossulus*) beds play important roles in the San Francisco Bay ecosystem, filtering water and providing habitat structure for other species. Shellfish beds formed by these two species do not typically occur on the open coast, but occur in smaller estuaries elsewhere in the state. Although shellfish beds tend to occur in areas of rocky substrate, they should be considered a separate habitat category due to the unique communities they support. Shellfish beds composed primarily of non-native species also exist within the Bay but these may not be desirable targets for protection by MPAs (Subtidal Goals 2010).
Seagrass beds	Eelgrass (*Zostera marina*), and widgeongrass (*Ruppia maritima*) play important roles in the Bay ecosystem, providing food and habitat structure for a variety of other species. Other types of submerged aquatic vegetation that occur within the Bay and may be appropriate target for protection include two surfgrass species (*Phyllospadix torreyi* and *P. scouleri*), and sago pondweed (*Stuckenia pectinatus*). The two surfgrass species also occur along the open coast, but eelgrass is typically confined to estuarine environments, including smaller estuaries elsewhere in the

	state. Widgeongrass and sago pondweed occur in brackish to fresh water and thus are unlikely to occur on the open coast, but may occur in streams and estuaries elsewhere in the state (Subtidal Goals 2010).
Tidal marsh	Relatively abundant in the Bay although human activities have drastically reduced their extent as compared to historical levels. The category 'tidal marsh' encompasses a range of communities that vary across salinity and energy gradients, from salt marsh communities dominated by pickleweed (*Sarcocornia pacifica*) and native cordgrass (*Spartina foliosa*), to low-salinity communities dominated by tule (*Schoenoplectus spp*.). Tidal marshes act as nurseries and foraging habitat for fish and other organisms, and typically occur in estuarine embayments including smaller estuaries elsewhere in the state, but are rare on the open coast. It may be necessary to further divide this habitat into several salinity categories to accurately reflect the diversity of tidal marsh communities in the Bay (Subtidal Goals 2010).
Tidal flat	Relatively abundant in the more saline portions of the Bay and often occur near tidal marshes. These areas of intertidal, fine-grained sediments without emergent vegetation support unique marine communities, including shorebirds and their invertebrate prey (Goals Project 1999). Tidal flats typically occur in estuarine embayments including smaller estuaries elsewhere in the state, but are rare on the open coast. Tidal flat communities may vary across salinity and other environmental gradients, such as the prominent mud flats, thus it may be desirable to divide this habitat into several categories to accurately reflect the diversity of tidal flat communities in the Bay (Subtidal Goals 2010).

4.3 Plants and wildlife

Species in San Francisco Bay may benefit from MPAs in a number of ways, dependent on their life cycles and movement patterns. Estuarine species that spend their life in the Bay will benefit from MPAs that restrict of prohibit fishing and other activities such as recreation, dredging, and building. Species that spend only a portion of their life in bay, such as juvenile Dungeness crabs (Metacarcinus magister), would benefit MPAs indirectly. The indirect benefits to these species come from the ecosystem based protection that MPAs would provide by enhancing habitat or food availability. To measure how a species would benefit from potential MPAs, it is important to look at the human impacts they experience and their movement patterns (Bay Options Report 2011).

In the following sections the plants and animals described listed are not the only species that would benefit from MPAs in San Francisco Bay, but they are some of the most important and visible.

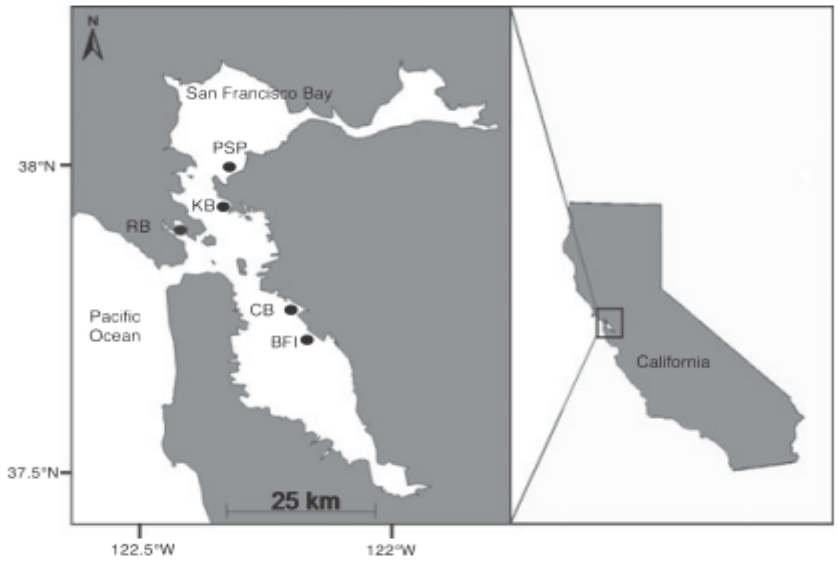


Figure 7. Key eelgrass populations in San Francisco Bay: Point San Pablo, Keller Beach, Richardson Bay, Crown Beach, and Bayfarm Island (Carr et al. 2010).

a. Seagrass

Eelgrass (*Zostera marina*) is the only seagrass species in San Francisco Bay. Its beds are sporadically dispersed throughout Southern San Pablo Bay, Central San Francisco Bay and the most northern portion of South San Francisco Bay in 23 separate locations, with a total area in the Bay estimated at 1,166 hectares (Figure 8) (Carr et al. 2010). Most of the beds grow vegatatively, but some beds are annual and rely on seeds produced each summer (to fall) to recolonize in spring (Carr et al. 2010). Eelgrass has been the subject of a number of scientific investigations in the San Francisco Bay and was determined to be an extremely important element in the spawning of Pacific Herring (*Clupea pallasii*), who use eelgrass blades as their primary spawning substrate.

Figure 8. Eelgrass bed in San Francisco Bay (SF Bay Wildlife 2014).

Current biophysical modeling efforts indicate that nearly 9,490 hectares of bottom area in the San Francisco Bay may now be suitable habitat for eelgrass. Zimmerman et al. (1995) examined eelgrass transplant success within Paradise Cove, a region of the San Francisco Bay, and found that transplants were depth dependent and succeeded in depths of up to one meter. The same study also showed that given appropriate environmental conditions, eelgrass could be reestablished in areas of suitable habitat within the San Francisco Bay such as Paradise Cove.

The San Francisco Bay has experienced varied levels of eelgrass growth throughout history. While their abundance fluctuates, the most prevalent stressors of eelgrass are: lowered light availability through diminished water quality, direct loss of habitat related to dredge and fill activities, and the impact of boating (Boyer and Wylie-Echeverria 2010). Eelgrass surveys within seven selected locations in the San Francisco Bay recommend protecting resident eelgrass due to the benefits the eelgrass offers the surrounding ecosystems and species, including the commercially important Pacific Herring (Boyer and Wylie-Echeverria 2010).

b. Fish

The San Francisco Bay is the largest known spawning grounds of Pacific herring in California. In 2006, it produced up to 90-100% of the state's annual herring catch (Smith and Horeczko 2008). Herring in the San Francisco Bay are found offshore during the spring and summer, but from October through April schools of adult herring move inshore to bays and estuaries to spawn in areas of reduced salinity and calmer water (Smith and Horeczko 2008, Smith and Kato 1979). Eelgrass is the preferred spawning-substrate of the fish, but man-made structures such as pier pilings and riprap are also frequently used. With both hard and soft substrate, the San Francisco Bay offers ideal reproductive condition for the Pacific Herring (Smith and Horeczko 2008, Bailey 2011).

Figure 9. Pacific herring swim in a large ball (SF Bay Wildlife 2014).

The Pacific herring is a species of commercial and ecological importance. Ecologically, they serve as a robust food source for Flyaway birds and many other species. Commercially, the herring roe is in great demand in Japan. Egg coated kelp and eelgrass blades are harvested in the San Francisco Bay, at state-managed herring fisheries and exported to Japan (CDFW 2011). Other important and key fish species in San Francisco Bay are listed in the table below along with the human impacts they face, their movement patterns, status, and other relevant information (Table 5).

Table 4. Important fish species in San Francisco Bay, their human impacts, movement patterns, status, and other relevant information (Okamoto and Wong 2011).

Common Name (Scientific name)	Human impacts	Movement patterns	Status and relevant information
delta smelt (*Hypomesus transpacificus*)	Currently threatened, mainly affected by major habitat alteration and water diversions.	Adults live exclusively in brackish and fresh water areas of the Bay, including Suisun Bay.	Currently listed as threatened under federal and endangered under state Endangered Species Acts. Larvae are planktonic.
jacksmelt (*Atherinopsis californiensis*)	Recreational fishery in the Bay, **the most commonly caught species**	Spawn and rear in the Bay. Adults are mobile schooling fish, spending time on the open coast.	Larvae are planktonic
leopard shark (*Triakis semifasciata*)	Recreational fishery in the Bay	Bays serve as nursery habitat. Adult movement studies suggest they return to the same areas of bays year after year.	Live-bearing with low reproductive rate.
longfin smelt (*Spirinchus thaleichthys*)	Historical commercial fishery, now primarily caught as bycatch of the shrimp fishery.	Adult spawn in fresh and low salinity water, juveniles rear in brackish areas, and move to higher salinity as adults, with limited movements along the open coast.	Currently listed as threatened under the state Endangered Species Act. Larvae are planktonic
Pacific herring (*Clupea pallasii*)	The herring roe fishery is one of the few remaining commercial fisheries in the Bay.	Adults are highly mobile, but aggregate in the Bay to spawn. The Bay is the only major spawning ground south of Puget sound.	Larvae are planktonic
Pacific sanddab (*Citharichthys sordidus*)	Recreational fishery in the Bay (among top 10 species caught)	Moderately mobile, not estuarine dependent	Larvae are planktonic
Pacific staghorn sculpin (*Leptocottus armatus armatus*)	Common in the recreational catch in the Bay, but not often targeted	Both adults and juveniles inhabit the Bay and have limited home ranges	Larvae are planktonic
Sacramento splittail (*Pogonichthys macrolepidotus*)	Historical recreational fishery	Although primarily a fresh water species, adults use the brackish waters of Suisun Bay	Federally listed as a threatened species from 1999-2003. Larvae are planktonic.

salmonids (*Oncorhynchus tshawytscha, O. kisutch, and O. mykiss*)	Recreational fishery for Chinook (king) salmon in the Bay, but coho salmon and steelhead trout are protected from take.	Adults migrate through the Bay en route to freshwater spawning habitats. Juveniles rear in the Bay during their transition from riverine to open coast habitats.	Coho salmon and winter run Chinook are currently listed as endangered under the federal Endangered Species Act.
starry flounder (*Platichthys stellatus*)	Recreational fishery in the Bay and both recreational and commercial fisheries on the open coast.	Little is known about adult movements, but adults spawn near estuarine mouths and juveniles use low salinity estuarine habitats as nurseries	Larvae are planktonic
white croaker (*Genyonemus lineatus*)	Recreational fishery in the Bay and on the open coast	Juveniles use the Bay as nursery habitat, adults exhibit movements outside the Bay.	Larvae are planktonic
white sturgeon (*Acipenser transmontanus*)	Recreational fishery in the Bay	Juveniles use the Bay as nursery habitat, adults exhibit movements outside the Bay.	Larvae are planktonic

c. Marine mammals

The Pacific harbor seal (*Phoca viulina*) is the last resident marine mammal species in San Francisco Bay, breeding and feeding year-round in its waters. Despite their high mobility, the Bay supports a local population of about 400-500. Pacific harbor seals are easily disturbed by humans, especially during their

Figure 10. Sites where bottlenose dolphins and harbor porpoises are found. Porpoises now live in the Bay throughout the year, but their daily locations shift with the tides. Dolphins are seen primarily in summer through fall (Keener 2011).

breeding season and at haul-out sites, many of which are artificial structures (Bay Options Report 2011).

Harbor porpoises (*Phocoena phocoena*) have returned to San Francisco Bay after an absence of approximately 65 years. Since at least 2008, harbor porpoises have aggregated daily in the water around the Golden Gate Bridge, entering and leaving the San Francisco Bay with the tide. The porpoises are vulnerable to human disturbance and become bycatch in the gillnet fishery, which is currently closed in the central region of California. Like the harbor seal, harbor porpoises are a very mobile species, and reproduce at a low rate (Bay Options Report 2011). Golden Gate Cetacean Research, a group that researches primarily cetaceans, has created a photo identification database that allows scientists to recognize specific porpoise individuals and, in doing so, is attempting to determine whether healthier ecosystems in the Bay is the cause of their return (Figure 8) (Lecky 2011).

California Sea-Lions (*Zalophus californicus*), can easily be seen at the waterfront of the San Francisco, but do not permanently reside in San Francisco Bay. Other marine mammals that make occasional appearances in the San Francisco Bay but do not hold a permanent or seasonal residence are: the gray whale (*Eschrichtius robustus*), the humpback whale (*Megaptera noveangliae*), and the sea otter (*Enhydra lutris*) (Cotter et al. 2012).

Figure 11. Pacific harbor seals resting at a haulout site (SF Bay Wildlife 2014).

Figure 12. Fisherman offloading Dungeness crab from their fishing boat on November 17, 2010 (SF Bay Wildlife 2014).

d. Invertebrates

Table 5. Important and key invertebrate species in San Francisco Bay, the human impacts they face, their movement patterns, and other relevant information (Okamoto and Wong 2011).

Common Name (Scientific name)	Human impacts	Movement patterns	Relevant information
Dungeness crab (Cancer magister)	No commercial or recreational fishing for Dungeness currently allowed in the Bay, but intensive fishing on the open coast.	Juveniles use the Bay as nursery habitat	Larvae are planktonic
rock crabs (*Cancer antennarius*, and *C. productus*)	Recreational fishery in the Bay	Limited adult movement	Larvae are planktonic
shore crabs (*Hemigrapsus oregonensis, H. nudus,* and *Pachygrapsus crassipes*)	Can be harvested for bait, populations reduced by introduced species	Limited adult movement	Larvae are planktonic
Olympia oyster (*Ostrea lurida*)	Historically important fishery, now rare due to exploitation, habitat loss, and invasive species.	Very limited adult movement	Larvae are planktonic
California mud snail (*Cerithidea californica*)	Historically abundant, now rare and declining due to competition from an introduced species.	Low adult movement	Non-planktonic larvae
Limpets (*Collisella* spp. and *Tectura* spp.)	Recently abundant but now rare, likely as a result of subsistence harvest.	Low adult movement	Larvae are planktonic
turban snails (*Chlorostoma funebralis*)	Commonly harvested for food/ subsistence	Low adult movement	Long lived, large individuals may be 20 or 30 years old. Larvae are planktonic with short larval duration.
mussels (*Mytilus* spp.)	Commonly harvested for food/ subsistence	Very limited adult movement	Larvae are planktonic

e. Birds

With its tidal flats, managed ponds, tidal marsh, subtidal habitat, and human-created habitat, the San Francisco Bay is an important area for seabird species to breed, feed, forage, rear chicks, and for migratory species to spend the winter (Kelly and Evans 2013). These diverse habitats hold the highest proportion of total wintering and migrating shorebirds on the United States Pacific coast and are used by more than 900,000 shorebirds annually.

The San Francisco Bay's location is a key link along the Pacific Flyaway. The Pacific Flyaway is a major north-south flyway for migratory birds in America, extending from Alaska to Patagonia. Every year, migratory birds travel some or all of this distance both in spring and in fall, following food sources, heading to breeding grounds, or travelling to overwintering sites. Annually, millions of waterfowl annually use the shallow water of the Bay as a refuge, including two federally listed endangered species: the California least tern (*Sterna antillarum br owni)* and the California clapper rail (*Rallus longirostris obsoletus*). The California least tern prefers to breed on hard surfaces, using indentations to form their nests. Abandoned salt flats in the San Francisco Bay provide the perfect substrate for the birds, and their breeding colonies can usually be found there, and along estuarine shores with relatively low disturbance. The California clapper rail has a relatively small home range. It lives in tidal salt and brackish marshes (Bay Options Report 2011).

Figure 13. California least tern (SF Bay Wildlife 2014).

The ponds of the South San Francisco Bay are the breeding ground to about 10% of the United States Pacific coast population of the Western Snowy Plover (*Charadrius nivosus*), a migratory wader, that has been designated as threatened under the Endangered Species Act (WHSRN 2009).

The highly productive central San Francisco Bay provides an abundant resource of alternative prey fish for many sea birds, which may explain their success in a highly disturbed environment (SF Bay Joint Venture 2004). For example, regardless of the heavy human disruptions they meet, productivity and population growth for Pelagic Cormorants

(*Phalacrocorax pelagicus*), and Western Gulls (*Larus occidentalis*) breeding on Alcatraz Island are higher than productivity of the same species nesting on South East Farallon Island, a undisturbed island off the coast of San Francisco Bay (Gardner et al. 2004). Other important and key bird species in San Francisco Bay are listed below (Table 7).

Table 6 Important and key bird species in San Francisco Bay the human impacts they face, their movement patterns, and other relevant information (Okamoto and Wong 2011).

Common Name (Scientific name)	Human impacts	Movement patterns	Status and relevant information
California clapper rail (*Rallus longirostris obsoletus*)	Vulnerable to human disturbance, human-associated predators, and habitat modification.	Small adult home ranges, inhabit tidal salt and brackish marshes with the entire state's population occurring within the Bay.	Federally listed endangered species.
California Black Rail (*Laterallus jamaicensis*)	Vulnerable to human disturbance, human-associated predators, and habitat modification.	Small adult home ranges, inhabit tidal salt and brackish marshes with the entire state's population occurring within the Bay.	State listed threatened species
California least tern (*Sterna antillarum browni*)	Vulnerable to human disturbance, introduced terrestrial predators, and reduction in forage base.	Small breeding populations in the Bay and important rearing sites where juveniles learn to forage	Federally listed endangered species. Occurs in the Bay April-August.
canvasback (*Aythya valisineria*)	Vulnerable to habitat modification and loss of forage base due to habitat degradation and invasive species.	Migratory species that uses shallow open water areas, salt ponds, and mudflats in the Bay during the winter months. No local breeding population.	The Bay is among the top 10 wintering sites for canvasbacks in North America.
double-crested cormorant (*Phalacrocorax auritus*)	Vulnerable to human disturbance and loss of prey base.	Several breeding colonies within the Bay. Forage primarily on schooling and	Year-round resident in the Bay, breeding March-August.

		benthic fishes within the Bay and more estuarine than other cormorant species.	
northern pintail (*Anas acuta*)	Vulnerable to habitat modification, recent decline in numbers in the Bay area.	Migratory species that uses mudflat, marsh, and salt pond habitats in the Bay during the winter months. Small numbers breed in the Bay area.	California is the most important overwintering area in North America.
red knot (*Calidris canutus*)	Vulnerable to human disturbance and habitat modification.	Migratory species uses mudflats within the Bay during winter months, but does not breed in the Bay area.	San Francisco bay is one of just 3 major overwintering areas on the Pacific coast.
ruddy duck (*Oxyura jamaicensis*)	Vulnerable to habitat modification and loss of forage base.	Migratory species that uses shallow open water areas and salt ponds in the Bay during winter months. No local breeding population.	The Bay is a critical wintering habitat the roughly 40% of the North American population that winters in California.
tule greater white-fronted goose (*Anser albifrons gambelli*)	Vulnerable to habitat modification and loss of forage which is primarily made up of aquatic plants.	Migratory species uses brackish tule marshes in Suisun Bay.	Federally listed threatened species.
western snowy plover (*Charadrius alexandrinus nivosus*)	Vulnerable to human disturbance, predation, and habitat modification.	Both migratory and resident populations use salt ponds and tidal flats as overwintering grounds. Eggs are laid on the ground usually in dry salt ponds.	Federally listed threatened species.

Despite the presence of these species, the key ecosystems they inhabit (Table 3), and the opportunity to enhance species diversity and persistence, San Francisco Bay has no MPAs that exist as marine reserves. Further, the small areas that are protected, lack proper

enforcement, which has the potential to render them as inefficient. Although a great amount of attention and government and private resources have been allocated to protect federal waters outside the Bay, under the National Marine Sanctuary System, and along the northern and southern coastline adjacent to the Bay, under the MLPA, San Francisco Bay remains, for the most part, unprotected.

5. Marine Protection in San Francisco Bay

5.1 Existing MPAs and their regulatory entities

There are a number of existing MPAs in San Francisco Bay, labeled as SMPs, but they do not conform to guidelines set by the MMAIA (See section 3.3.b). The California Park and Recreation Commission has proposed two state marine reserves, but has not received approval from the California Fish and Game Commission (Bay Options Report 2011). As with most regions, the MPAs in San Francisco Bay were established and are managed by different levels of government. The MPAs within the boundaries of San Francisco Bay are regulated by CDFW, United States Fish and Wildlife Service, and the California Department of Parks and Recreation (California State Parks). These MPAs, in general, are small in area and protect mostly shallow waters (CDFW 2011).

There are a number of other organizations that deal with protecting Bay such as the San Francisco Bay Conservation and Development Commission (BCDC). The BCDC is a California State Commission that is *dedicated to the protection, enhancement, and responsible use of San Francisco Bay*. Two of the most significant existing projects in the Bay, the deal in part with its conservation and restoration, are led by the BCDC: the San Francisco Bay Subtidal Habitat Goals Project and the San Francisco Bay Plan.

The federal government protects two large areas adjacent to San Francisco Bay under the National Marine Sanctuary System, the Gulf of the Farallones and Monterey Bay. While neither is located within the Bay, its ecological connectivity to them is important for many wildlife species. The Gulf of the Farallones National Marine Sanctuary consists of an area of 1,282 square miles just outside of the Golden Gate Bridge and is one of the most bountiful marine environments on earth (NOAA 2011). The Monterey Bay National Marine Sanctuary

encompasses 6,094 square miles, making it the largest MPA in the National Marine Sanctuary System. It ranges from Marin County, just north of the Golden Gate Bridge to Cambria in San Luis Obisbo.

United States Fish and Wildlife Service have seven National Wildlife Refuges called the San Francisco Bay National Wildlife Refuge Complex (Table 4) (Bay Options Report 2011).

Table 7. Important habitats in San Francisco Bay (Bay Options Report)

National Wildlife Refuge	Location and habitat	Wildlife
The San Pablo Bay National Wildlife Refuge	North shore of San Pablo Bay in Sonoma, Solano, and Napa counties. Open bay/tidal marsh, mud flats, and seasonal and managed wetland habitats.	Created in 1974 to protect migratory birds, wetland habitat, and endangered species such as the salt marsh harvest mouse and California clapper rail. These are critical habitats for migratory and wintering shorebirds and waterfowl. It also provides habitat for 11 fish species as they move toward their fresh water spawning grounds
The Marin Islands National Wildlife Refuge and State Ecological Reserve .	San Pablo Bay off the coast of San Rafael in Marin County. East Marin and West Marin islands form the core of the refuge. Tidelands, tidal mud flats, and submerged tidelands.	The islands are both important bird rookeries, especially for several species of heron and egrets. The tidelands are important habitat for resident and migratory water birds. The refuge's main objectives are to protect migratory species, the tidal mud flats and the unique island ecosystem. The area is closed to visitors to reduce disturbances to the wildlife and habitats
Don Edwards San Francisco Bay National Wildlife Refuge .	30,000 acres of bay, salt ponds, salt marshes, and mudflats, located throughout South San Francisco Bay.	It has the dual goals of conservation (protecting species and preserving wildlife habitat) and access. Millions of shorebirds and waterfowl pass through the Refuge, which is located along the Pacific Flyway, during the

		spring and fall migration. The endangered California clapper rail can also be found here.

There are currently eight state MPAs in San Francisco Bay, that are managed by CDFW They are classified as SMPs, or in the case of Robert W. Crown, a State Marine Conservation Area (Table 5) (Figure 7) (CDFW 2011)

Table 8. California San Francisco Bay MPAs (CDFW 2011)

San Francisco Bay MPAs	**Boundary and habitat**	**Permitted/prohibited uses**
Marin Islands SMP	Waters below the average high tide line that also lie within the Marin Islands Ecological Reserve.	*Take of all living marine resources is prohibited except the recreational hook and line take of species other than marine aquatic plants from shore only. Boating, swimming, wading, and diving are prohibited within the park.*
Fagan Marsh SMP	Along the Napa River. Waters below the mean high tide line within the ecological reserve.	*Take of all living marine resources is prohibited except the recreational hook and line take of species other than marine aquatic plants. Only lightweight, hand-carried boats may be launched or operated within the park.*
Albany Mudflats SMP	Defined by the Albany Mudflats Ecological Reserve boundaries and the underwater unit between these areas. Tidelands and upland property along 8.5 miles of shoreline of the San Francisco Bay. The tidelands comprise rich tidal marshes, subtidal areas, and mudflats that extend bayward from the shoreline.	*Take of all living marine resources is prohibited except the recreational hook and line take of species other than marine aquatic plants from shore only. Boating, swimming, wading, and diving are prohibited within the park.*
Corte Madera Marsh SMP	Water below the average high tide line within the boundries of the Corte Madera Marsh Ecological Reserve.	*Take of all living marine resources is prohibited except the recreational hook and line take of species other than marine aquatic plants from shore only. Only lightweight, hand-carried boats may be launched or*

		operated within the park. Swimming, wading, and diving are prohibited within the park.
Peytonia Slough SMP	Water below the average high tide line within the Peytonia Slough Ecological Reserve.	*Take of all living marine resources is prohibited except the recreational hook and line take of species other than marine aquatic plants. Only lightweight, hand-carried boats may be launched or operated within the park.*
Robert W. Crown State Marine Conservation Area	This area is bounded by the average high tide line and a distance of 150 feet offshore.	*Take of all living marine resources is prohibited except:* *1.Finfish may be taken recreationally by hook and line only.* *2.Finfish and kelp may be taken commercially.*
Redwood Shores SMP	Water below the average high tide line within the boundaries of the Redwood Shores Ecological Reserve.	*Take of all living marine resources is prohibited except the recreational hook and line take of species other than marine aquatic plants. Only lightweight, hand-carried boats may be launched or operated within the park.*
Bair Island SMP (No person, except officers, may enter this park during February 15 through May 20.)	Composed of three islands: Inner, Middle and Outer islands, located between Steinberger Slough and Redwood Creek in the southwestern portion of the Bay.	*Take of all living marine resources is prohibited except the recreational hook and line take of species other than kelp from shore only. Boating, swimming, wading, and diving are prohibited within the park.*

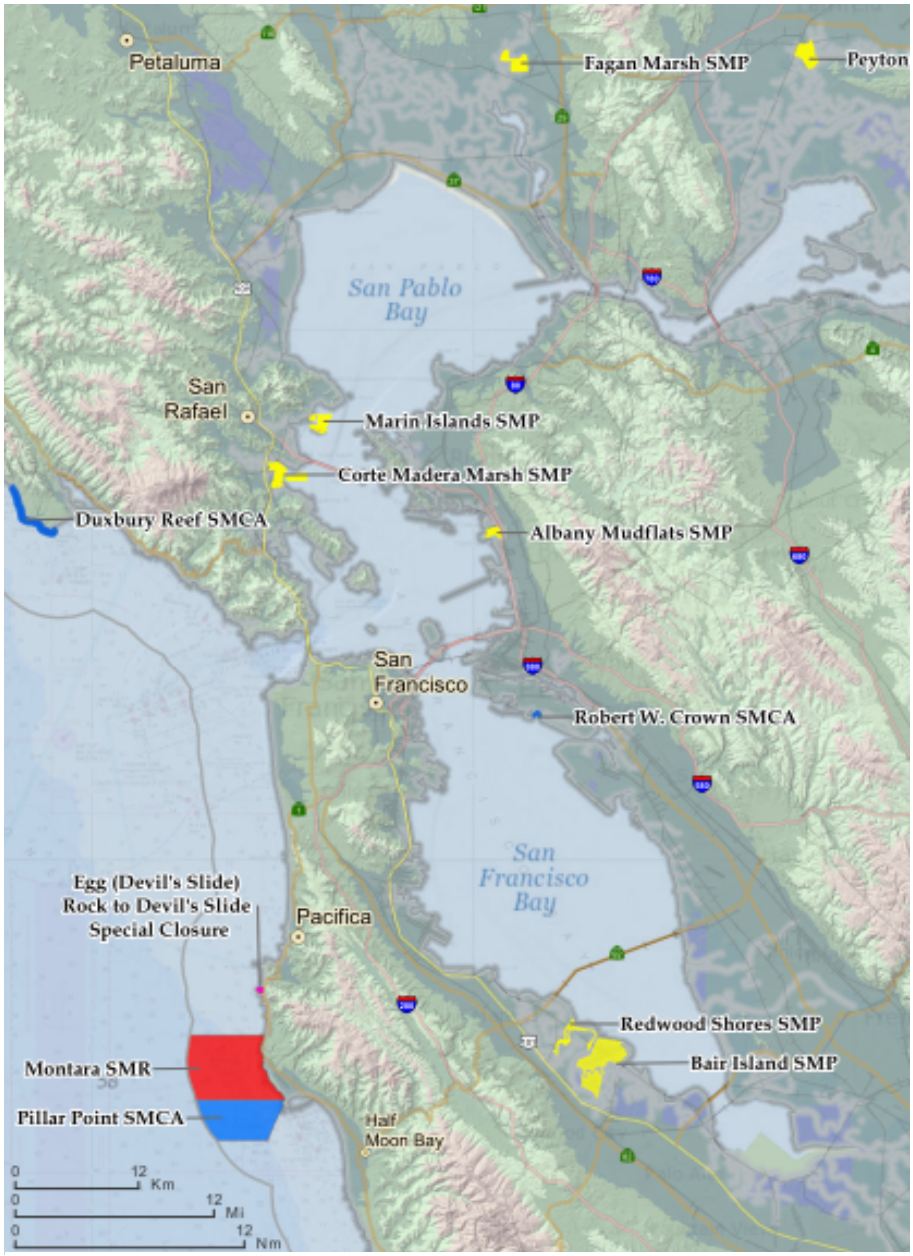


Figure 14. California San Francisco Bay MPAs (CDFW 2011).

The regulatory bodies of MPAs in San Francisco Bay are: CDFW, CDF, and the California Department of Parks and Recreation. In relation to the human population surrounding the Bay, there is little enforcement for the restrictions imposed by the MPAs. The United States government does not assist in enforcing state MPA regulations, but it does enforce federal laws that effect many species in the Bay such as: the Marine Mammal Protection Act, the Migratory Bird Treaty Act, and the Endangered Species Act.

5.2 The need for a network of MPAs in San Francisco Bay

San Francisco Bay is a busy center of commerce and supports over seven million people. Residents commute across the Bay in ferries, or utilize it for recreational boating, fishing, and swimming. Cargo ships and tankers from around the world use the ports. Annually, three to six million cubic yards of sediment are dredged from the Bay to keep navigation channels open and about two million tons of sand is mined from the bay floor, for use in construction. Oyster shell deposits are mined for human and animal consumption (Subtidal Habitat Goal Report 2010). These ongoing impacts have the potential to degrade San Francisco Bay's unique estuarine and marine habitats and a network of MPAs may be a useful mitigation tool.

Although the important habitats described in this paper (Table 3) are present in other regions of the MLPA, the size, complexity, and diversity of the Bay's ecosystems are unique to California. Accordingly, the Bay harbors many species and communities not found in smaller estuaries in the state. These species and communities should be represented in the MLPA. Without a network of MPAs to protect them, California will be at a greater risk of losing key species and may lose the opportunity to enhance ecological connectivity within the Bay and its adjacent open coast habitats.

For the Central Coast region of the MLPA, baseline data for a number of species was recently collected. In a person interview, Stephen Wertz, Senior Environmental Scientist Supervisor on the MPA Project for CDFW said, the [baseline data] results look good, although it has only been two years since implementation and it is still difficult to gauge success. There are more black abalone than there were before protection. Point Lobos and Lover's Point are the oldest SMRs in California, and at those sites we know that species are bigger and diversity is greater. San Francisco Bay has many threatened, endangered, and commercially important species with similar life-cycles to species found in the Central Coast region (Personal communication, Wertz 2014).

a. Threatened, endangered, and commercially important species

As the largest estuary on the Pacific Ocean, San Francisco Bay is teaming with natural resources and provides habitat to many species that are federally listed as endangered or

threatened by the United States Fish and Wildlife Service (FWS) (Table 9). The Bay is also home to a number of species that have had commercial importance in the past, including a variety of sharks, skates, and rays, sturgeon, flatfishes, native oysters, and mussels. Current commercially important species are Pacific herring, several species of bay shrimp, and Dungeness crab (Table 10). If a network of MPAs in San Francisco Bay is not created, California would lose a valuable opportunity to target these at-risk and commercially important species for protection.

Table 9. Species listed as endangered or threatened by the FWS in San Francisco Bay

Common name	Federal status
Salmonids	Endangered
delta smelt	Threatened
longfin smelt	Species of concern
Sacramento splittail	Species of concern
green sturgeon	Species of concern
Western snowy plover	Threatened
California clapper rail	Endangered
tule greater white-fronted goose	Threatened
California least tern (seasonal in the Bay)	Endangered
California Black Rail	Listed by the State of California but not federally

Table 10. Species of commercial importance in San Francisco Bay

Common name	Importance
Pacific herring	Commercially fished in the Bay, at the Pacific Roe Fishery
Bay Shrimp	Commercially harvested in the Bay for bait
Dungeness crab	Commercially fished (seasonally), and only on the open coast. Juveniles use the Bay as a nursery

b. Connectivity

In regard to statewide connectivity, the Bay estuary provides nursing and breeding habitat for many important open coast species, that occupy the two adjacent National Marine Sanctuaries and beyond. A network of MPAs in the Bay could enhance ecological connectivity between protected populations in the Bay and the open ocean (Figure 16).For example, in the Channel Islands National Marine Sanctuary, data show that species with longer larval duration, such as the Cabezon (*Scorpaenichthys marmoratus*), have a strong genetic connection from mainland to islands (NOAA 2014).

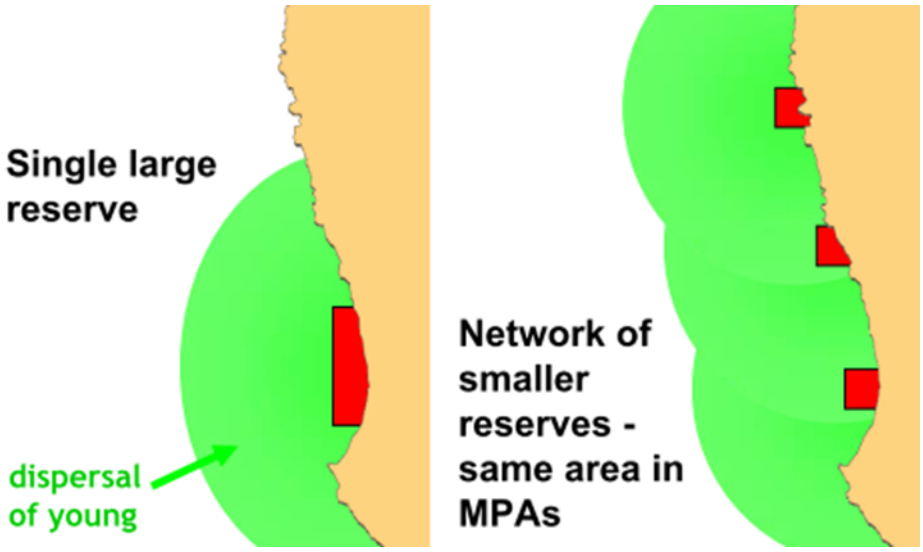


Figure 15. A network of MPAs have greater ecological connectivity potential than single or fragmented ones.

Current data indicate a relatively large amount of larval ecological connectivity across the San Francisco Bay, due partially to complex oceanographic currents and variable freshwater flows from the Delta. Therefore, a network of MPAs in the Bay, rather than the existing small and fragmented ones, when designed correctly, have the potential to improve connections between sources and sinks for marine species within the Bay (Figure 15). These connections may be essential for the persistence of populations and the expansion of range to new areas that have been impacted and are being restored. However, connectivity of some marine and anadromous fish (born in fresh water and spends most of their life in the ocean, returning to fresh water to spawn) between the North and South portions of the Bay could be reduced during years with low freshwater influx (Okamoto and Wong 2011).

Many government and private resources have been allocated to protect federal waters outside the Bay, under the National Marine Sanctuary System, and along the northern and

southern coastline adjacent to the Bay, under the MLPA. Despite the great potential for connectivity, San Francisco Bay remains, for the most part, unprotected.

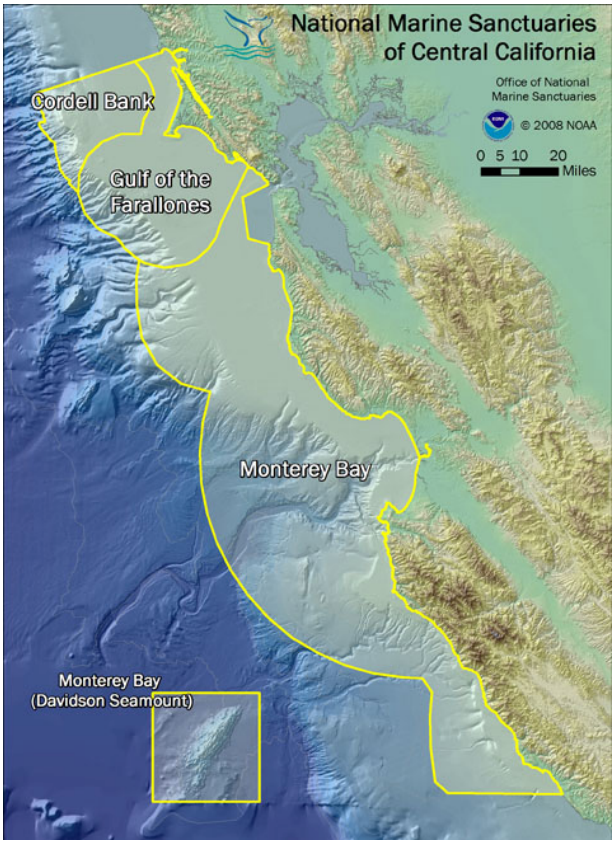


Figure 16. National Marine Sanctuaries of Central Californa (NOAA 2014).

5.3 Why has the MLPA not protected San Francisco Bay?

The San Francisco Bay was classified by the MLPA as its own unique region because it had many ecological and multi-agency jurisdictional issues that were not associated with either of its adjacent regions, North Central Coast and Central Coast. There has been no official statement from the CDFW as to why the MLPA has taken not taken any initiative to plan for protecting its fifth and final region, the Bay. There are many feasible possibilities for the delay, including: Bay specific factors that may impair the efficacy of MPAs in the Bay, the Bay Delta Conservation Plan (BDCP), and multi-governance issues, and limited funding.

a. Bay specific threats that may impair the efficacy of MPAs

The San Francisco Bay is a complex environment ecologically and politically, which affects any planning and implementation for MPAs in the Bay. There are many aspects of the very developed San Francisco Bay area, which may impact the eventual success of an MPA network. MPAs typically regulate activities that result in take or harm to species within their area, including activities that would modify existing habitat. However, there are few MPAs in the MLPA that consider factors that would result in the indirect take of species or degradation of habitat. Examples of these types of indirect threats include: low water quality, invasive

species, dredging, and other habitat modifications associated with the shipping industry. Regarding this issue Stephen Wertz said that establishing protected areas is a good idea but that there is so much degradation, dredging, and pollutants that are already in the Bay, if a network of MPAs was created, it may not function properly. There are only four to five indicator species in the bay, because of the poor and constantly fluctuating conditions, whereas the other four regions have many more (Personal communication, Wertz 2014)

Although MPAs are not a comprehensive solution to all of the threats to San Francisco Bay's ecosystems, they are an important tool in supplementing current management efforts. If a network of MPAs was coordinated correctly with current management and restoration projects in the Bay, it would most likely contribute valuably to the statewide network (MLPA) and increase resilience of entire ecosystems in the Bay (Bay Options Report 2011).

b. The Bay Delta Conservation Plan (BDCP)

In May 2012, the CDFW announced that the implementation of a network of MPAs in San Francisco Bay would be delayed until the completion of the planning process for the Sacramento-San Joaquin River Delta under the BDCP. In general, the BDCP plans to construct a peripheral tunnel to export a greater quantity of Delta water to southern California and agriculture businesses in San Joaquin Valley (CDFW 2014). In a personal interview, Stephen Wertz said, the BDCP is the main reason that there has been no recent movement in protecting the Bay. This initiative has such an effect on the whole Bay that California wants to wait until it's finished. It wouldn't be good to have two such projects [MLPA and BDCP] happening at the same time (Personal communication, Wertz 2014).

The CDFW website claims that successful planning and implementation of MPAs in San Francisco Bay must complement the ecosystem restoration efforts of the BDCP. They also state that they are dedicated to protecting San Francisco Bay subsequent to the completion of planning efforts in the Sacramento-San Joaquin River Delta (CDFW 2014). However, according to Stephen Wertz, there is no idea as to when the BDCP will be complete, not in the near future, because of the drought and dredging and all the other issues. The Bay area is a huge can of worms (Personal Communication, Wertz 2014). If the MLPA intends to wait for the BDCP to

begin planning for a network of MPAs in the Bay, it is reasonable to assume that it may not occur in the foreseeable future. Brian Baird, director of the Ocean and Coastal Program at The Bay Institute and Aquarium of the Bay, said that in his opinion, CDFW has no immediate or future desire to take-on planning to protect the Bay at this time, which they make apparent by pinning the delay on a process [BDCP] that has been in limbo for twenty years (Personal Communication, Baird 2014).

c. Limited funding and a complex governance structure

Both political will from DFW and State Parks, and adequate funding were essential components in completing the MLPA for the four coastal regions of the MLPA. The MLPA Initiative also had the benefit of support from a public-private partnership. To plan for a network of MPAs in San Francisco Bay, in a meaningful way, similar jurisdictional commitment and financial support will be necessary. But the MLPA has few monetary resources left, as suggested by Stephen Wertz (Personal Communication, Wertz 2014). Everyone was so excited to get the entire coast protected and we did. Now, there's no money left for the Bay. In each individual coastal region, all of the money was used, and any money left over is being used for enforcement, things like equipment for wardens. Limited funding could be a major obstacle that exists for a potential planning process for a network of MPAs in San Francisco Bay.

Additionally, the large overlap of jurisdictions and overlying regulations make implementation a political challenge. In a personal interview, Mike Sutton, who serves on California's Fish and Game Commission and is also the executive director of Audubon, California said there are already many entities that deal with the Bay, especially the San Francisco Bay Conservation and Development Commission (BCDC). You'd have to incorporate them and their processes in the MLPA when planning for the San Francisco region. It's an issue of governance; agencies are saying it's too complex, so let's not deal with it (Personal Communication, Sutton 2014). There are ongoing conservation and restoration efforts that exist in the Bay, and many of these efforts address the ecology of the Bay habitat from different planning and regulatory perspectives, depending on the managing entities involved and their separate directives and authorities (Table 11).

Table 11. Existing planning efforts in the San Francisco Bay

Project or organization	Website
Bay Delta Conservation Plan	(http://baydeltaconservationplan.com/default.aspx)
Baylands Ecosystem Habitat Goals Project	(http://www.sfei.org/)
Comprehensive Conservation and Management Plan	(www.sfestuary.org)
North Richmond Shoreline: A Community Vision	(http://www.restorationdesigngroup.com/ docs/NorthRichmondShorelineVision.pdf)
Regional Boards Basin Plan	(http://www.waterboards.ca.gov/sanfranciscobay/basin_planning.shtml#2004basinplan)
Regional Monitoring Plan	(http://www.sfei.org/rmp/)
Richardson Bay Plan	(http://www.tiburonaudubon.org/conserve_planning.html)
Richardson Bay Special Area Plan	(http://www.bcdc.ca.gov/laws_plans/plans/plans.shtm
San Francisco Bay Plan	(http://www.bcdc.ca.gov/laws_plans/plans/sfbay_plan.shtml)
Uplands Habitat Goals Project	(http://www.uplandhabitatgoals.org/)
Long Term Management for Disposal of Dredged Material in San Francisco Bay	(http://www. bcdc.ca.gov/dredging/ltms/ltms_program.shtml)
Dredged Materials Management Office	(http://www.spn.usace.army.mil/conops/dmmo.htm)

6. Recommendations

A network of MPAs may not provide a comprehensive solution for the threats to San Francisco Bay's ecosystems. However, if coordinated correctly with existing management and protection efforts and if adequately funded, a network of MPAs would most likely contribute valuably to the health and resilience of species in the Bay and their habitats. However, the process leading to protection is complex and requires: collection and analysis of data, development of science guidelines, MPA planning, capacity to respond to developing issues, habitat mapping, and the recommendation for implementation of MPAs. As previously discussed, there are challenges in creating a system of protection in such a developed and populace region.

Based on personal interviews, an extensive literature review, analyzed data, and lessons learned from the four coastal regions of the MLPA, I make recommendations for the future of protection in San Francisco Bay in the matters of: funding, building upon existing MPAs, using alternate methods to establish MPAs, and dealing with the complex governance structure.

6.1 Funding

Adequate funding was one of the critical elements that made the four coastal regions of the MLPA so successful. It was an expensive venture, and was privately funded. According to Stephen Wertz, doing it the right way is expensive, but it was only possible through private funding, lots of private funding (Personal Communication, Wertz 2014). Those resources have since been spent, and financially the MLPA cannot currently afford to begin planning for the San Francisco Bay region. Without funding, a successful, science based MPA network in the Bay is impossible. The process leading to protection requires: collection and analysis of data, development of science guidelines, MPA planning, capacity to respond to developing issues, habitat mapping, an recommendation for implementation of MPAs. These tasks are very costly and require a full-time team as well as outside contractors (Bay Options Report 2011).

In Mike Sutton's opinion, it may be possible to get the amount of funding necessary to plan for protecting the Bay, but the great need for a network of MPAs would have to be made very apparent to donors. The private funders are still involved with the MLPA, still contributing to monitoring and implementation efforts (Personal Communication, Sutton 2014). Mike also discussed what he referred to as MPA fatigue. MPA fatigue means that there was such excitement [privately and publicly] to protect the coast, that when the process was finished, there was not enough energy to begin protecting the Bay. He went on to suggest that in a few years, when interest levels have increased again, another attempt should be made.

Funding recommendations:

1. There is already a wealth of necessary data and information to begin planning for protection in the San Francisco Bay. I recommend using existing data collection efforts, from government studies and non-governmental agencies such as Save the Bay, to help minimize the initial expenses (outlined above).
2. Although information exists, it takes navigating through a myriad of websites, reports, and academic journals to compile a comprehensive look of the data available on the San Francisco Bay. The public has access to a long history of biological, ecological, special, socioeconomic, recreational, and commercial data. Although, this information is not always easily accessible, nor is it available in one location. Many organizations have

publications, reports, mapping data, and management plans that can be accessed on their websites. However, the information is usually categorized in topic-specific collections, and can be difficult to locate while doing a general search. Planning for an effective MPA requires a balance between social, economic, and ecological needs of the Bay, as mentioned above; this can be a very costly process. To help alleviate the initial expenses by using existing data, I recommend creating a comprehensive website that is easily navigable and can hold all media necessary for the kind of inclusive, interdisciplinary planning that would be required to create a network of MPAs in San Francisco Bay. I also recommend creating a mapping tool, similar to MarineMap or Wetland Tracker, which can display all ecological data, jurisdictions, and economic trends relevant to the Bay. This tool would support cross interest planning and decision making.

3. My final recommendation for funding is to prioritize the needs of San Francisco Bay. In the Bay there are many indirect impacts to potential MPAs, such as water quality, which is constantly fluctuating. These threats can bring an unknown requirement of time and money, as they have the potential to draw out the planning process. In past regions, it was discovered that some issues consume more time and money than others (CDFW 2011). Having a process to prioritize issues can not only reduce costs, but it can also save time and avoid distraction from the end goal.

6.2 Existing protection and Bay specific threats

The six current SMPs in San Francisco Bay do not conform to the MMAIA. The MMAIA is complementary to MLPA; it identified six classifications of MPAs, by reorganizing California's previous scheme of eighteen MPAs and their sub-classifications. It also names allowed and disallowed uses within different classifications (See section 3.3.b for more information). The California Fish and Game Commission has the legal authority to establish SMRs and SMCAs, while only the State Parks and Recreation Commission may create, modify or delete SMPs. Therefore, the existing MPAs are not consistent with the MMAIA. Additionally, San Francisco Bay is much different in terms of ecology and urbanization than the four coastal regions of the

MLPA. Planning for a network of MPAs must involve consideration of certain Bay-specific impacts.

Recommendations for building on existing SMPs:

1. Currently the MPAs in San Francisco Bay are small in area and are terrestrially managed as ecological reserves. All six SMPs (see section 5.1) are defined as ecological reserves and bound as such. This means that within them, the take of wildlife species by hook and line and (in most cases) recreational boating is allowed. Consistent with other regions of the MLPA, I recommend that the California Fish and Game Commission modify the existing SMPs to become SMCAs or SMRs. This would bring them into compliance with the standards of the MLPA/MMAIA. During the planning process and redesign, the existing boundaries of the MPAs would need to be defined in a manner consistent with redefined boundaries in the other regions of the MLPA. For example, the Goleta Slough SMP in the South Coast region of the MLPA was adopted and then redesigned as a SMCA, which increased its area and restricted more activity.

   Building upon the existing MPAs by raising the standards up to those as defined by the MLPA/MMAIA would enhance the protection of key species in San Francisco Bay (threatened, endangered, and commercially important). It would improve ecological connectivity within the boundaries of the Bay and also between the Bay and its open ocean waters. These connections may be essential for the persistence of populations and the expansion of range to new areas that have been impacted and are being restored.

2. Due to the extent of development in the region, it is important that the design for a network of MPAs in San Francisco Bay consider external threats to the marine and estuarine habitats. Threats I recommend considering in MPA planning include: water quality, shipping, petroleum industry, power plants, non-native species, habitat modification, and human disturbance. In addition, I recommend that scientists identify and map areas in the Bay that have been severely degraded by these threats. That information should then be considered when choosing MPA locations, as those particular areas may not be ideal candidates for potential MPAs.

6.3 Establish MPAs using the MMAIA

The MLPA calls for a comprehensive approach to protection, as it demonstrated in the competed coastal regions. If the MLPA does eventually plan for the San Francisco Bay region it will not be any time in the near future. This is primarily because establishing MPAs in the Bay has been tied to completing California fresh water planning (e.g. the Bay Delta Initiative), which had no completion date. Therefore, other avenues for marine protection should be pursued. In Mike Sutton's opinion it is not realistic to believe that we are going to see an MPA initiative in the Bay anytime soon (Personal communication, Sutton 2014). Similarly, Brian Baird suggested that the likelihood of the MLPA planning for the San Francisco region is remote (Personal communication, Baird 2014). To achieve more protection in San Francisco Bay, in the relatively near future, I recommend using the process described by the MMAIA. The MMAIA process is a relatively unknown method outlined in the MMAIA. An individual or organization can identify a site-specific marine or estuarine area or network of areas, in the state of California, which exhibits a justifiable need for protection. The individual or organization may then submit a proposal for that area or areas, requesting with valid cause, that it be granted protection by the California Fish and Game Commission.

MMAIA recommendations:

Because the MLPA planning for the San Francisco Bay region is unlikely, I recommend using the MMAIA process. This process allows individuals and organizations to submit proposals to the California Fish and Game Commission for designating specific sites or a network of sites at any time. In order to adequately demonstrate the need for an MPA, substantial research may be necessary. To draft an initial proposal, I recommend that a team of scientists, stakeholders, and groups such as the Blue Ribbon Task Force collaborate using the best science possible to identify areas in the Bay that have the most immediate need for protection. There are many principal areas of concern (see section 4.2), like eelgrass nurseries, that act as critical habitat for bringing back and maintaining species of concern. The easy part is determining where to protect; the hard part is making that protection happen (Personal communication, Sutton 2014). Following demarcation of the proposed MPAs, the team should employ federal laws

such as the Endangered Species Act and the Marine Mammal Protection Act to provide a justification for protection. If sufficient evidence is shown, under the statute of the MMAIA, the Commission will grant the appropriate amount of protection to each proposed MPA or the network of MPAs.

Section **36870** of the MMAIA establishes a standard set of instructions that helps guide individuals and organizations through the requirements for submitting a proposal for a MPA or network of MPAs. The requirements for the initial proposal include, at the very minimum, the following elements:

1. Name of individual or organization proposing the designation.
2. Contact information for the individual or organization, including contact person.
3. Proposed classification.
4. Proposed site name.
5. Site location.
6. Need, purpose, and goals for the site.
7. Justification for the manner in which the proposed site meets the designation criteria for the proposed classification.
8. A general description of the proposed site's pertinent biological, geological, and cultural resources.
9. A general description of the proposed site's existing recreational uses, including fishing, diving, boating, and waterfowl hunting.

Additional information is required by the Commission prior to a final decision regarding designation:

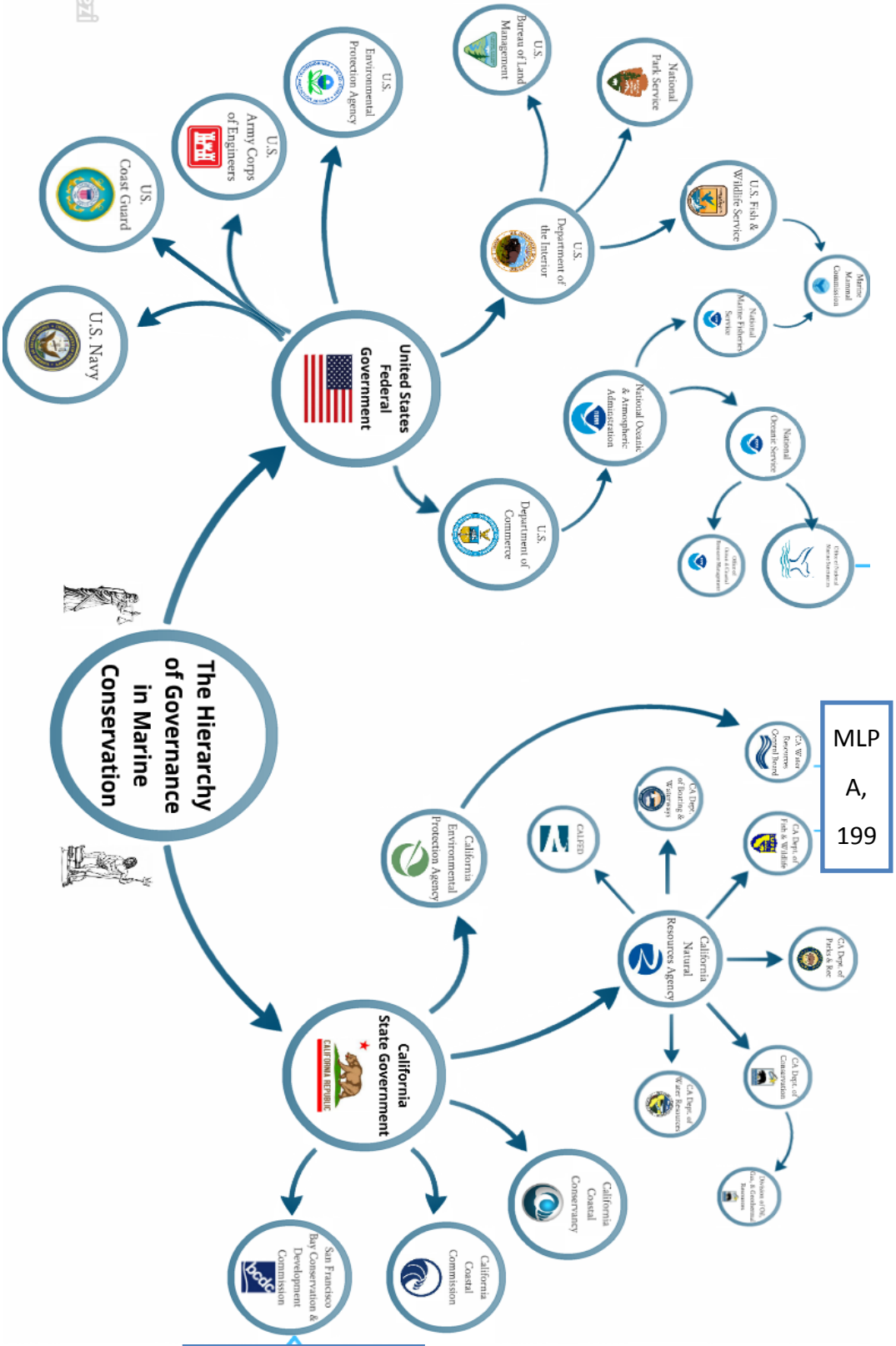
1. A legal description of the site boundaries and a boundary map.
2. A more detailed description of the proposed site's pertinent biological, geological, cultural, and recreational resources.
3. Estimated funding needs and proposed source of funds.
4. A plan for meeting enforcement needs, including on-site staffing and equipment.
5. A plan for evaluating the effectiveness of the site in achieving stated goals.
6. Intended educational and research programs.
7. Estimated economic impacts of the site, both positive and negative.
8. Proposed mechanisms for coordinating existing regulatory and management authority, if any exists, within the area.
9. An evaluation of the opportunities for cooperative state, federal, and local management, where the opportunities may exist.

Section **36900** of the MMAIA discusses the review process that each proposal goes through under the California Fish and Game Commission. In general, the Commission will annually consider and promptly act on proposals until a MPA master plan is adopted. A master plan for California has been adopted (the MLPA) since the MMAIA was created. However, San Francisco Bay has not yet been included in the statewide network and is therefore, still eligible for the MMAIA consideration. After review by the Commission, the Secretary of the Resources Agency establishes a scientific review panel to further evaluate proposals for technical and scientific validity. Subsequent to passing a review by the scientific panel, the committee forwards the proposal, and any recommendations, to an appropriate entity for a public review process. If the proposal is accepted by the California Fish and Game Commission, it would be a more immediate route to creating a network of MPAs in San Francisco Bay then waiting for the MLPA.

6.4 The complex governance

There are ongoing conservation and restoration planning efforts that exist in the Bay. Many of these plans address Bay habitat from different regulatory perspectives, depending on the entities involved and their separate directives and authorities (Figure 17) (see Table 11). There are already many entities that deal with the Bay, especially the San Francisco Bay Conservation and Development Commission (BCDC). Existing managing entities and their processes would have to be incorporated into the MLPA when planning for the San Francisco region (Personal communication, Sutton 2014).

Figure 17. The hierarchy of governance in marine conservation



Recommendations for governance:

1. To address the issue of multigovernance in planning for a network of MPAs in San Francisco Bay, I recommend integrating the plans set forth by the BCDC (see section 5.1) (drawing from both the San Francisco Bay Subtidal Habitat Goals Project and the San Francisco Bay Plan) into the statewide plan (MLPA) for the San Francisco region. While the designs would be primarily those of the BCDC, the potential network of MPAs should adhere to the stringent standards of the MLPA/MMAIA. Giving the BCDC implementation power for the MLPA in the Bay, would maintain and expand local control, while still ensuring that the San Francisco Bay region goes through the same rigorous planning and implementation process as the coastal regions. Combining the MLPA and the BCDC assures that both entities would benefit from interagency cooperation.
2. I further recommend that the lead agencies establish a forum to engage a large community of agencies and partners who will be included in the design and implementation of a network of MPAs in the Bay. The forum should include all levels of government, academic institutions, non-profit organizations, and businesses. Incorporating such a diverse group of participants will increase regional coordination, collaborative planning, and enhance public awareness of the need for enhanced marine protection in San Francisco Bay.

Appendix A Transcript of interview with Stephen Wertz

April 22, 2014
Interview Transcript
Steve Wertz, Senior Environmental Scientist Supervisor on the MPA Project for CDFW
Stephen.Wertz@wildlife.ca.gov

Why is the San Francisco Bay its own unique region in the MLPA?
The bay was made into its own unique region in the MLPA because it is so unique. The state was initially split into only 2 regions for the MLPA, but it was too much to take on the state as halves, so it was split up in 4 regions on the coast.

Sf had too many of its own issues to be grouped with either the North Central or Central regions, so the decision was made to create a 5th region as the SF Bay. There are also lots of multi-agency jurisdiction issues to work through in SF, so another reason it was separated was to work on those.

There is really no difference between North Coast and North Central Coast in terms of species but oh well. Southern CA is the closest in infrastructure to the bay of all 4 regions, but biologically it is so very different.

Why has the MLPA made no advancements in protecting or planning to measures to protect the San Francisco Bay since the MLPA initiative presented the Bay Options Report in 2011?
The Bay Delta Initiative is the reason that there has been no recent movement in protecting the bay.

This initiative has such an effect on the whole bay that we want to wait till that's finished. It wouldn't be good to have two such projects happening at the same time. Bay Delta first, then we'll go into MPA planning in the bay.

When will the Bay-Delta Initiative be completed?
No idea when the bay delta initiative will be complete, not in the near future, because of the drought and dredging and all the other issues. The bay area is a huge can of worms.

Is there any plan to move forward with any of the options presented in the Bay Options Report?
Not at this time. The most costly option is option 5, it is a proven process, stakeholder driven, costly, and calls for an identification of all biological and jurisdictional issues. Once all that information was compiled, it was given to the blue ribbon task force. We did a year of fact finding, made sure all MLPA guidelines were being followed under the MLPA, went through that process 3 times, then passed it through CDFW.

But the best option is also option 5, cause that's what we did for the other regions. It took a lot of money and was only possible through private funding, lots of private funding.

Everyone was so excited to get the entire coast protected, but now… We're just letting the Bay Delta Initiative work its way through before we look anymore into protecting the bay. Besides, now, there's not any money left for option 5 in the bay (option 5 has the most protection).

There's no money left for the bay in general. In each individual coastal region, the money was used up, and any money left over is being used for enforcement, things like equipment for wardens.

4 million dollars was given to each region to collect baseline data to measure performance for the future, right after completion of the MLPA. The money was to collect baseline info, an inventory of species, right after the process, maybe 2 yrs. of baseline data collection, This data provides a foundation for us, in 5 years, to come back and look at same species from the baseline data and measure performance of the MPAs

Monitoring Unified is the company we use to collect data. For the Central coast, the data is out. Southern coast has just finished and will be coming out in the next year. Results look good, but its only two years out and it is hard to tell. There are more black abalone. Point Lobos and Lover's Point oldest in CA, species bigger, diversity larger.

** The problem with planning for the bay is that there are currently no marine reserves in place there, to form a backbone, to offer ecological connectivity to adjacent areas, there are just state parks. They only have a hash work of protection areas that were created to protect a single species or because they are adjacent to a state park. When we go back to planning for protection in the bay, we need to get some marine reserves in there. However, some people say it would be impossible to achieve a good marine reserve in the bay because of the water flow ect. This must be studied further, in the future, when we get there.

Why are there no marine reserves in San Francisco Bay, despite the many important, threatened, and endangered species?

There are no reserves in the bay because of the multijurisdictional issues. Species that are listed as threatened or endangered species have protection on their own, and that's not enough to justify setting up a marine reserve.

In the Marine Managed Areas Improvement Act (MMAIA) all stakeholders need to get together and work out the overlapping jurisdiction issues, but that it very complicated. A good example is found in the Southern California region. The goal was to create a network, because they couldn't create a reserve, due to too many conflicting interests with owners of artificial structures in the area. So they came up with a MPA called a no-take marine conservation area. This type of area prohibited fishing, but allowed for some take during maintenance on artificial structures, like sewer pipes.

In San Pedro and Low Angeles Harbor, there is a break wall, not a natural reef, but certain stakeholders tried to get credit for the habitat, but we didn't grant them that.

There has to be a certain amout of habitat replication in a reserve, and if stakeholders don't accomplish it to the extent that we require, then we have to say it didn't meet the guidelines according to the MLPA and the Blue Ribbon task force tells them they have to do better, do more. In San Pedro the break wall didn't qualify, they weren't happy about it though.

Is there ever jurisdictional overlap with the National System of Marine Sanctuaries and areas protected by the MLPA?

Not really, the High Seas Territorial Act ensures that the bay and Monterey Bay are state waters. Usually waters only go out to three miles from out coast, so we are only responsible for the species there.
Federal marine protection systems are mainly to protect from oil spills, but more recently, especially in the Gulf of the Farallons, they have tried to use their authority to protect species, which has rubbed some agencies there the wrong way.

In the Channel Islands, the National System added three more miles of protection on top of our protected areas, they piggybacked on Californa's MPA. We have a joint authority now, with Coast Guard, National Parks, ect.

What would you recommend in terms of enhancing marine protection in the San Francisco Bay?
Establishing protected areas is a good idea, but to tell you the truth, there is so much degradation and dredging, and pollutants in the bay, I don't even know that if we created protected areas, they would function properly, based on the current regulations that are in place. There are only 4-5 key indicator species in the bay, because of the poor and constantly fluctuating conditions, whereas the other four regions have many more indicator species.

What type of legislation would be necessary to get more protection in the bay?
The legislation to protect the bay is already put into place by the MLPA. We need to address the bay, but what's slowing it down is the Bay Delta Initiative. To find out more about the initiative contact the Water Branch in Cal Fed., Water Rights, Water Diversion, ect. They need to work through the Bay Delta Initiative first, before we can think about planning for protection.

Appendix B Transcript of interview with Brian Baird

April 22, 2014
Interview Transcript
Brian Baird, Director of the Ocean and Coastal Program at The Bay Institute and Aquarium of the Bay.

In general terms, what are the most important types of areas to protect?

In my opinion, there is no desire to take on planning for protecting the Bay at this time, which is made apparent by CDFW pinning the delay on a process [BDI] that has been in limbo for twenty years.

There are principle areas, such as nurseries, that are critical habitat for bringing back and maintaining species of concern. But the question isn't, what specific areas should we protect. What you're asking me is a process question, the Bay needs to be evaluated by stakeholders and scientists, and the Blue Ribbon Task Force, as the other regions in the MLPA were. The Bay needs to go through the same process.

MLPA calls for a comprehensive approach, which has happened in all of its completed regions. If it is to ever occur for the San Francisco Bay Region, it's a long ways off. Because of the MMAIA it is possible for groups to come together to identify areas to make a site specific proposal to the Fish and Game Commission. So if there was a special area, that someone was able to justify needing protection, under federal laws such as the Endangered Species Act or the Marine Mammal Protection Act, the area could be granted protection by the United Stated, before the MLPA gets around to protecting the Bay. For this to happen there, again, there would have to be a strong rationale. Also Fish and Game Commission wouldn't be happy about it, but it is an option.

In my opinion, the likelihood of the MLPA planning for the San Francisco region is pretty remote. If someone really wanted to see any kind of MPA in San Francisco Bay in the near future, they should consider using process described by the MMAIA.

Appendix C Transcript of interview with Mike Sutton

May 5, 2014
Interview Transcript
Mike Sutton, Director of Audubon California, serves on California's Fish and Game Commission and heads the Monterey Bay Aquarium's Center for the Future of the Oceans

6 elements are critical to the success of MLPA. If you apply those elements to the SF bay, there may be one or more missing, which is why it may not be possible, with such an elaborate process.
1. Funding, where will the money come from? The MLPA was privately funded.
2. MPA fatigue there was such excitement to protect the coast, that there wasn't enough energy to do the sf bay. Maybe in a few years we can come back to protecting the bay. After all the coastal resources were used up, we were fatigued and had no money

There are already many entities that deal with the Bay especially the BCDC, you'd have to incorporate them and their process in the MLPA. It's under the category of governance. Agencies are saying it's too complex, so lets not deal with it.

Audubon owns 900 acres of the bay in Richardson's Bay. A group of citizens purchased the bay and now own it, but are trying to purchase more and expand protection in the Bay

SMCs areas are easier to establish so fishing can be used there during part of the year.

The Bay is a complex space, with a complex governance structure. The further you go up the delta the more complex issues come into water. The question you want to ask is, how far up the delta you want to go with protection? Maybe not further that San Pedro Bay.

Essential elements to the MLPA
1. A robust legal mandate – gave us a legal hook to hang our hats on, the MLPA mentions the bay, so we have the beginning.
2. An elaborate public-private partnership- doing it right means bottom up.
3. The best possible science- there is a lot of science on what the Bay needs, it doesn't mean that it's going to happen, but we have it. In the coastal regions, scientists had veto power over the law, public process is where science played such a big role.
4. Political support at the highest level- the governor is necessary. The MLPA was able to secure political support at the highest level. It didn't happen automatically, we built it. Science can be defeated politically.

Lack of any one of these, would not make it possible. We would need to think about these. The easy part is where to protect; the hard part is making it happen! It might be possible to get funding, but you'd need to really show the need. Realistically I'm not sure we are going to see an MPA initiative in the Bay anytime soon. Contact Kaitlin Gaffey of R**esources Legacy Fund**, talk to her. The private funders are still in the game contributing to monitoring and implementation. kgaffney@resourceslegacyfund.org

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