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Effectiveness of Marine Protected Areas Across a Latitudinal Gradient

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Abstract:

Use of marine protected areas (MPA) as a tool for conservation and sustainable use of marine biological diversity is increasing worldwide. However, the geographic extent of MPA designation varies, as does a full understanding of the ecological utility of such designations. Progress towards marine conservation goals needs to be evaluated in order to determine areas lacking effective MPA designation. The goal of this study is to evaluate the representation (in terms of communities and habitats) and performance of marine protected areas in the Northwestern Atlantic and Northeastern Pacific across a latitudinal gradient. Presence or absence of MPAs in specific ecological settings was used to examine the completeness of representative networks of sites across the study region. Specific post-designation studies were then examined to determine what effects designation and management had on community structure across habitats. Results suggest that despite widespread use of MPAs as a management tool and the desire to utilize MPAs to sustain multiple functions while conserving diversity, much work still needs to be done to establish MPAs in poorly represented habitats, and to assess the outcomes of designation, both immediately following closure, as well as over time. Lack of funding to first designate MPAs and then conduct adequate assessments pre and post-designation impedes meeting regional and global MPA representation goals. The ultimate goal of MPA studies should be to develop a capability to predict with a high degree of certainty the outcome of management measures in various ecological settings within the context of achieving global conservation goals.

Introduction:

Marine Protected Areas (MPAs) are areas of the ocean designated for a specific purpose based on the widely accepted notion that it is beneficial to conserve an area of ocean from human disturbance by restricting use. Such areas have been established all over the world by different management agencies and for a variety of purposes, including recovering fish stocks, increasing biodiversity, and protecting unique habitats (Sobel & Dalgren 2004). MPAs restrict users from conducting specific activities such as various types of fishing, mineral extraction, or even speed of vessel traffic, depending on the type of protected area and goal of designation.

MPAs have become an increasingly popular way to manage ocean areas around North America. Half of all marine protected areas in United States waters were designated between 1983 and present, following an increase in state and federal legislation to justify use of protected area strategies for conservation (National Marine Protected Areas Center: The Marine Protected Areas Inventory 2012). For example, there are currently over 1,700 MPAs in United States waters, encompassing 41% of waters within national boundaries (National Marine Protected Areas Center: Federal MPA Legislation 2012). In Latin America and the Caribbean, there are over 700 MPAs which encompass over 300,000 km^2 (Guarderas et. al 2008). As of International Oceans Day, June 8, 2011, there were 809 MPAs designated within Canadian waters (Canada's National Network of Marine Protected Areas 2011). The majority of protected areas allow some form of exploitation, as opposed to being designated as strictly no-take reserves (Guarderas et. al 2008).

The International Union for the Conservation of Nature has been advocating for designation of a global representative system of MPAs since 1986 (Kelleher et. al 1995). The term “representation” here means that examples of all habitats and communities (i.e. biological diversity) should be found within a global system of protected areas. The 5th World Parks Congress recommended 20-30% of coastal and marine areas out to the limit of national jurisdiction to be incorporated into highly restrictive types of MPAs by 2003 (Wood et. al 2008). Given the conflicting uses of the ocean, and the tradeoffs involved in conservation versus exploitation in particular areas, an understanding of the conservation benefits of protected areas in various regions remains unclear. While there are a large number of MPAs designated around North America, from the tropics to the arctic, their role in regional conservation is poorly understood as is their role in meeting global objectives. The Commission for Environmental Cooperation (CEC), a trinational organization formed under the North American Free Trade Agreement (i.e. between the United States, Canada and Mexico), has a mission to “foster conservation, protection and enhancement of the North American environment” that includes marine ecosystems (Mission 2012). Assessing the role of MPAs in a region essentially encompassing marine ecosystems around North America can be of value for aiding international conservation planning and management. In this study, I examine MPA effectiveness, based on ecological representation and management outcomes in the greater CEC region (i.e. Eastern Pacific, Western Atlantic and Caribbean).

Methods:

I collected information on marine protected areas in the latitudinal range of 9 degrees North to 57 degrees North in the Western Atlantic (n=49 MPAs) and Eastern Pacific (n=38 MPAs) (Figure 1). These include MPAs in the national waters of Canada, the United States, and

Mexico, as well as Belize, Venezuela and multiple Caribbean Island nations. I included the greater Caribbean region since both the United States and Mexico have protected areas within the region, and any analysis of representation needs to be inclusive of this larger biogeographic province. From a total of 3,247 MPAs within the study region, only 86 were found to have adequate ecological data after designation. Data related to MPA designation and status were incorporated from two global synthesis papers (n=35 studies) (Lester et. al 2009, Halpern 2003). Additional protected areas were evaluated based on internet and literature searches for the term "MPA" and included the WorldCat search engine. Only subtidal MPAs were included (i.e. intertidal and marsh MPAs were excluded).

To provide a broad perspective on the distribution of MPAs based on representation in the range of ecological settings across the region, data were collected for each site including location, habitats, depth range and area. Sites were classified by ecoregion as defined by the CEC (Figure 2; Wilkenson et. al 2009), with all MPAs in the Caribbean, nominally outside the CEC region, classified as Caribbean Sea. Further, the most northern CEC regions were not included in the study (i.e. regions 2-5 in Figure 2) due to the difficulty in finding information for these regions. Rather than improperly assessing their status, they were excluded.

In order to identify cause and effect relationships related to ecological responses and MPA designation goals, additional data were collected on year of designation, agency with management responsibility, rationale for designation, and post designation ecological studies. The primary indicators used to determine effects of designation were diversity, species abundance, organism size, density, and biomass. Comparisons were either based on ecological conditions inside versus outside each MPA or pre and post designation. Diversity is a measure of total species richness, or the number of species represented per habitat. Species abundance is the number of a single species per unit area. Organism size is the average size of each organism. Density is a measure of the number of individuals per unit area. Biomass is the weight of all species per unit area (Stirling & Wilsey 2001). The post-designation data across sites are not always comparable, due to different species in communities serving as the focus of designation.

MPA effectiveness was determined by a qualitative evaluation of designation goals and post designation studies. An MPA was classified as “effective” if post-designation outcomes met performance goals. An area was classified as “ineffective” if post-designation data suggest there was no progress towards the intended goal, if no difference was actually observed, or if there was a reverse trend in metrics related to the intended goal (e.g. if increased fish size was the goal and fish were smaller post-designation). An MPA was classified as “inconclusive” if studies had been done post-designation but the relation between results and intended goals appeared unclear (e.g. if the goal was to increase fish size but in fact fish density increased). It is not possible to evaluate *de facto* MPAs. While a *de facto* MPA functions as an MPA in practice, there was no official designation, hence no defined set of goals to evaluate change against. Many MPAs had no post-designation data available to conduct an evaluation and were classified as "no data."

Results:

The representation of MPAs across ecoregions is highly uneven (Table 1). The Carolinean Atlantic, Caribbean Sea, Southern Californian Pacific, Montereyan Pacific Transition, and Columbian Pacific have MPAs designated across depth ranges (0-30m, >30-200m, >200m). Here I infer depth is a useful but coarse proxy for habitats and communities based on significant changes in both due to multiple factors such as vertical zonation in light, productivity, and food availability. The remaining twelve ecoregions fully lack representation in particular depth ranges. Approximately half the MPAs included are less than 50 km^2 and only 29% of MPAs are greater than 200 km^2. Two ecoregions have no MPAs that were amenable for assessment in this study, the Southwestern Coast of Mexico and Southern Gulf of Mexico.

At a finer spatial scale, the representation of habitats in MPAs around North America is also uneven (Table 2, Figure 3, Appendix 1). Coral reefs are the most common habitat designated in MPAs, with rocky reefs and mixed habitat areas second and third in number, respectively. Coral reefs are most common in the Western Atlantic/Caribbean region, while rocky reefs are the dominant type of MPA in the Eastern Pacific.

There are larger and deeper MPAs designated at higher latitudes and a general lack of deep, large MPAs in the tropics (Figures 4-11). The area of MPAs assessed ranges from 0.026 to 13,799 km^2 (Appendix 2). Eighty-one percent of MPAs assessed are less than 1,000 km^2 in area. Small MPAs exist across the study region, but are especially numerous on the coast of California and in the tropics. Most MPAs were in shallow, near shore areas. Seventy percent are less than 100 m deep and eighty-five percent are less than 500 m deep (Appendix 3).

The deepest MPAs in the Eastern Pacific are located at approximately 22 degrees latitude, including the Bowie Seamount Marine Protected Area, the Gwaii Haanas National Marine Conservation Area Reserve, and the Endeavor Hydrothermal Vents MPA. These areas have a maximum depth between 2.25 and 3 kilometers (Appendix 2). MPAs with maximum depths of greater than 1000 m (Figure 4) and depth ranges (maximum depth minus minimum depth) greater than 1000 m (Figure 5) were only found north of 35 degrees latitude. Only Oceanographer and Lydonia Canyons in the Western Atlantic have maximum depths greater than 1000 m, located between 38 and 40 degrees latitude (Figures 9-11) and only Oceanographer Canyon had a depth range in excess of 500 m. Both canyons were designated gear restricted areas by the Mid-Atlantic Fishery Management Council in the Tilefish Fishery Management Plan in 2009 in order to protect to protect deep water corals, sponges, and biogenic structures in clay outcroppings (Snapper Grouper Amendment 2012).

Large MPAs in the East Pacific occur primarily above 30 degrees North, while large MPAs occur above approximately 18 degrees North in the Western Atlantic. Southern sites in the Western Atlantic are primarily small MPAs comprised of shallow coral reefs.

Of the 86 sites evaluated in this study, only 39 were found to be effective, mainly in small, nearshore MPAs. Ten sites were found to be ineffective, where results of designation do not support designation goals. Twenty four sites were inconclusive, where shifts in community structure were not comparable to designation goals. Thirteen sites had no post designation data, either because they were *de facto* MPAs, which are impossible to evaluate on the basis of effectiveness, or because the sites were offshore, which are more difficult to measure effectiveness than smaller, nearshore sites. In the Atlantic, the majority of effective MPAs were shallow, rocky reef (Table 3a & 3b). In the Pacific, the majority of effective MPAs were shallow coral reef. Effective MPAs in the Pacific exist across a greater range of habitats than effective sites in the Atlantic.

Designation objectives differ in the Western Atlantic and Eastern Pacific (Table 4). In the Western Atlantic, the main objectives for MPA designation are recovering fisheries and protecting biological diversity, whereas protecting the natural heritage of a site (such as protecting an area before it is disturbed by humans or maintaining non-use value in an area of the ocean) and protecting biological diversity are the main reasons for designation in the Eastern Pacific. Designation objectives also differ across latitudes. The greatest number of MPAs designated were in the >30 to 40 degrees latitudinal range (Table 5). This latitudinal range has MPAs designated for multiple reasons. Further north, MPAs were designated more to protect the natural heritage of a site and to recover fisheries, whereas lower latitudes had the primary designation objective of protecting biodiversity and recovering fisheries.

Discussion:

The uneven level of representation and effectiveness of MPAs across a range of ecological settings makes clear the need for more focused conservation efforts in order to comply with global conservation goals. As the IUCN and the 5th World Parks Congress have both highlighted the need for MPA representation in all habitats, this study has demonstrated habitats which are underrepresented (e.g. deep habitats in the Caribbean, offshore habitats in the Pacific). Incorporating every ecological setting into highly restrictive MPAs not only makes progress towards global conservation goals, but ensures that diversity is conserved and creates areas that may be more resilient to ecological change. Underrepresented areas should be priority locations for MPA representation moving forward.

The study area was chosen as it incorporates a large number of MPAs and diverse ecological settings. The majority of ecoregions did not have MPA representation across depths. MPAs need to be designated in all depth ranges to be inclusive of all biological communities, because what we gain from MPA designation is different in various ecological settings. Protecting a specific habitat or significant features can be one strategy for designation, as evidenced in Waquoit Bay National Estuarine Research Reserve, or in protecting a range of habitats, such as the Olympic Coast National Marine Sanctuary. MPAs should be designated in all ecoregions to encompass the full range of communities and habitats that are unique for that specific setting. For example, MPAs in temperate systems may fundamentally need to be larger as a result of higher rates of movement of adult fishes and other megafauna as well as greater larval export ranges (Laurel & Bradbury 2006). Further, the Southwestern Coast of Mexico and Southern Gulf of Mexico ecoregions lack representation altogether, which constitutes a large area of coastal ocean and associated diversity that does not contribute to global conservation goals.

Two very different oceanographic and geologic settings are included in the CEC region, namely the Eastern Pacific and Western Atlantic. The Eastern Pacific coast incorporates a narrow continental shelf formed by processes related to subduction, influenced by colder water upwelling as a driver of biological productivity as well as the cyclical effects of El Nino (Knauss 2005). One example of an MPA designated to conserve an area affected by nutrient rich upwelling is the Cordell Bank National Marine Sanctuary. The large size and range of depths which encompass a large diversity of species, both resident and migratory, contributes to its effectiveness (Condition Reports- Cordell Bank 2009). In contrast, the Western Atlantic is characterized by a broad continental shelf and is influenced by the Gulf Stream, which carries warm water north from the tropics, and colder shelf waters flowing south from Canada (Knauss 2005). Many offshore banks were designated MPAs in the Western Atlantic. One example is the Red Hind Closed Area off of the coast of the United States Virgin Islands. This MPA is effective because it has clear designation goals of protecting a single species and was delineated in an area where red hind commonly spawn to provide the maximum conservation benefit (Nemeth 2005). The Caribbean, however, is not characterized by the wide continental shelf present in much of the Western Atlantic but instead, offshore islands surrounded by a range of depths, from shallow banks (such as the aforementioned Red Hind Closed Area) to thousands of meters deep along the Southern Coast of Cuba (International Bathymetric Chart of the Caribbean Sea and the Gulf of Mexico 2010).

The east and west coasts differ in geologic features, biological communities, and water currents. There are similarities in that they both have areas comprised of rocky reef and sandy bottom, but the level of representation of habitats is very different. The Cabo Pulmo MPA contains the only extensive coral habitat in the Eastern Pacific, but coral reefs are numerous in the Caribbean and included in many of the local MPAs. There are many examples of effective coral reef MPAs in the Western Atlantic, including the Hol Chan Marine Reserve, the Saba Marine Park and the Southwest Pedro Bank. One primary reason for their effectiveness is that these nearshore areas are managed by community members, as it is in the community interest to protect these areas for ecotourism and the economic benefits that are derived, such as from diving and glass bottom boat tours (Hol Chan Marine Reserve 2012, Polunin & Roberts 1993, Sustainable Management of the Shared Living Marine Resources of the Caribbean Large Marine Ecosystem 2012).

There is a general lack of deep, large MPAs, especially at lower latitudes and in the Pacific. Excluding this ecological setting from proper MPA representation neglects the habitat where the most new species are being discovered (Wealth of New Species Discovered from the Abyssal Plains of the Atlantic Ocean 2001). These areas are underexplored and would benefit from MPA representation, but have yet to be internationally recognized as areas that should be protected (Armas-Pfirter 2009). Areas past the continental shelf or outside of a country's exclusive economic zone are controlled by the International Seabed Authority- managed by all nations but without legal authority (Armas-Pfirter 2009). Furthermore, as fishing turns away from coastal, shallow fish assemblages (due in part to stricter regulations and reduced catch rates from overexploitation), deeper water areas are being targeted to satisfy global seafood consumption (Is Time Running Out For Deepsea Fish? 2012). Research needs to occur to determine if deeper MPAs are effective in protecting essential fish habitats and deepwater species. Areas in the Western Atlantic already being recognized as essential fish habitat, such as the Snowy Grouper Wreck MPA and Georgia MPA, designated to protect the snowy grouper and other long lived, slow growing species (Deepwater MPAs 2009). Other areas are protected as a precautionary measure to protect sensitive habitats in the deep ocean, such as slow growing coral, which can be destroyed by fishing gear, as exemplified in Oceanographer Canyon and Lydonia Canyon (Cunningham et. al 2012).

Larger MPAs have a greater capacity for conservation (Kelleher 1999). Larger MPAs can encompass a greater habitat and depth gradient, which may be the key to conserving organisms with a high geographic range (Kelleher 1999). Larger MPAs are more impactful on the basis that they can incorporate more habitats and networks of MPAs can help buffer habitats from ecological variability and promote transport of adults and larvae between MPAs (Consensus Statement on Marine Reserves and Marine Protected Areas 2003). Large MPAs were not found at lower latitudes on either coast, indicating the need for representation to ensure a more resilient marine system in the face of changing climate conditions.

Though MPAs are represented across latitudes and ecological settings, effective examples cannot be found in all habitats. Since less than half of MPAS included in this study were effective in achieving designation goals, this study highlights the need for effective post-designation management and representation across habitats. A lead-by-example knowledge base should be utilized, because there is much to be learned from each new MPA designation. Furthermore, there were many MPAs across habitats that were inconclusive or ineffective, such as the Emerald/Western Bank Juvenile Haddock Closed Area. This MPA was designated to protect haddock off of the Scotian Shelf, but demonstrated increased American plaice and winter flounder and decreased haddock post-designation (Frank. et al 2000). Thus, this MPA was not effective in meeting designation goals. While an MPA manages human activity, the ecosystem response cannot be predicted. MPAs utilized as a precautionary approach rather than a recovery measure may minimize unwanted impacts to community structure.

Designation objectives also differ across latitudes, which may be linked to how closely an economy relies on the ocean, and for what purpose. The countries represented agree that MPAs are an effective way to limit human activity in the marine environment, but differ in their use of designation. In the North, places such as Newfoundland rely on an active fishing community for revenue (Costs and Earnings Survey, Atlantic Region 2011). This area may be difficult to designate MPAs, where the majority of community members may oppose restricting fishing. In the United States, MPAs are usually set up at the State level for a specific purpose, such as to protect a single species or local population. Further south, a thriving tourism industry is the main driver of MPA designation, where MPAs may be fully supported by local communities who would benefit from protection of reef areas for activities such as scuba diving and glass bottom boat tours (Lloret et. al 2006). In many cases, when determining where to designate an MPA, socioeconomic factors are weighted heavier than ecological considerations, which may mean that MPAs are designated in areas with little biological significance (Roberts et. al 2003). Community members are influential in MPA designation, and can be evidenced in the primary designation objectives over latitudes.

To conclude, there are several examples of highly effective MPAs across latitudes, but these examples are only the first step toward using MPAs as a global conservation tool. Since what we gain from designation is different in various ecological settings, there is currently little confidence in predicting the effects of designation. MPAs should be represented in every ecological setting based on the best available knowledge of similar sites within each ecoregion. Once designated, comprehensive post-designation studies should be done to document changes in the community and contribute to adaptive management of a global MPA network. Ecoregions, habitats, and depths sans effective MPA designation should become priority sites to meet global conservation goals. Though there is still progress to be made in both representation and management, with the knowledge that this is largely an adaptive management tool, MPAs can be an effective conservation strategy across latitudes.

Figures:

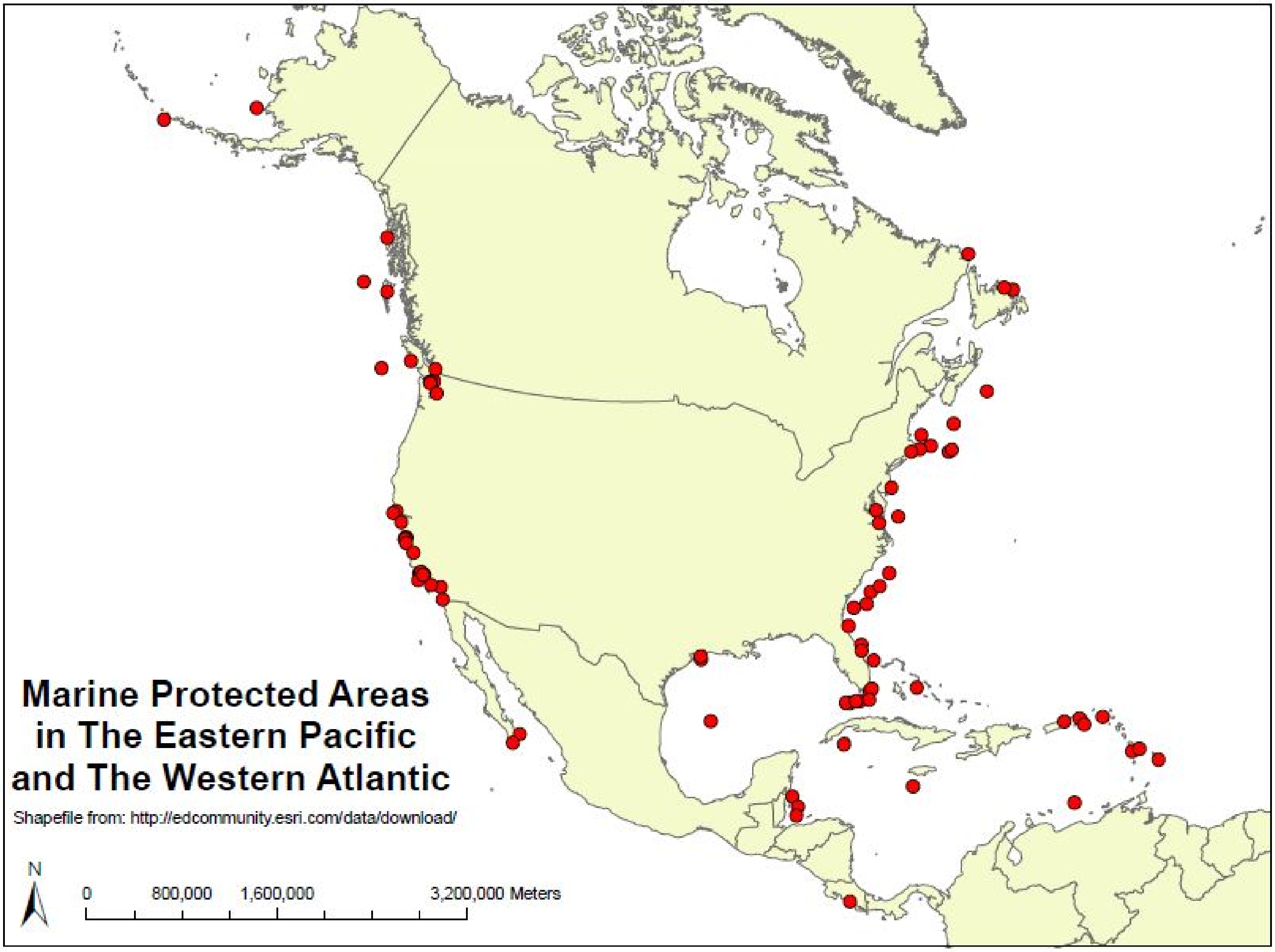

Figure 1: MPAs included in this study were along the Eastern Pacific and Western Atlantic coasts of North America and Central America. (North America 2012)

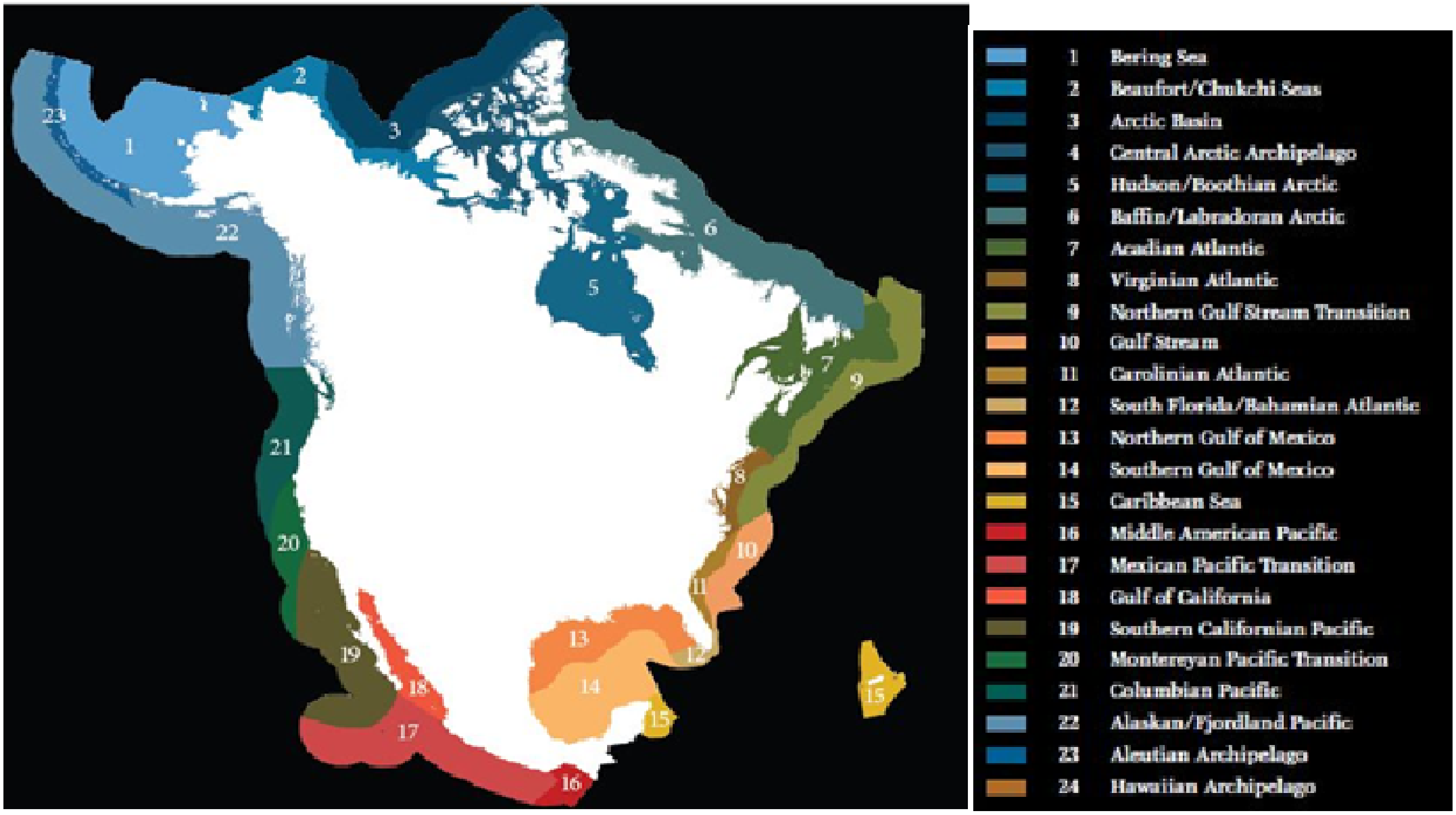

Figure 2: Marine ecoregions of North America based on the CEC classification system (No MPAs were evaluated in regions 2-5, and no MPAs were amenable for assessment in this study from regions 14 and 17) (Wilkinson et. al 2009).

Table 1: Representation of sites within ecoregions (n=80)

Ecoregion		MPA Area Max depth (m)	Total number of sites	0-50 km^2	50-200 km^2	>200 km^2
1	Bering Sea	0-30	0			
		>30-200	0			
		>200	1			1
6	Baffin/Labradorean Arctic	0-30	2			
		>30-200	1		1	
		>200	0			
7	Acadian Atlantic	0-30	0			
		>30-200	4			4
		>200	0			
8	Virginian Atlantic	0-30	4	3	1	
		>30-200	0			
		>200	1	1		
9	Northern Gulf Stream Transition	0-30	0			
		>30-200	0			
		>200	2	2		
10	Gulf Stream	0-30	0			
		>30-200	1			1
		>200	0			
11	Carolinean Atlantic	0-30	2	1	1	
		>30-200	4	1	3	
		>200	3			3
12	South Florida/Bahamiam Atlantic	0-30	5	4	1	
		>30-200	1			1
		>200	0			
13	Northern Gulf of Mexico	0-30	1			1
		>30-200	2	1	1	
		>200	0			
14	Southern Gulf of Mexico	0-30	0			
		>30-200	0			
		>200	0			
15	Caribbean Sea	0-30	2	1	1	
		>30-200	11	6	4	1
		>200	1			1
16	Middle American Pacific	0-30	1			1
		>30-200	0			
		>200	0			
17	Mexican Pacific Transition	0-30	0			
		>30-200	0			
		>200	0			
18	Gulf of California	0-30	2		2	
		>30-200	0			
		>200	0			

19	Southern Californian Pacific	0-30	8	5	2	1
		>30-200	1			1
		>200	3			3
20	Montereyan Pacific Transition	0-30	4	3	1	
		>30-200	1	1		
		>200	3	2	1	
21	Columbian Pacific	0-30	3	3		
		>30-200	1	1		
		>200	1			1
22	Alaskan/Fjordland Pacific	0-30	0			
		>30-200	2	2		
		>200	3		1	2
23	Aleutian Archipelago	0-30	0			
		>30-200	0			
		>200	1			1

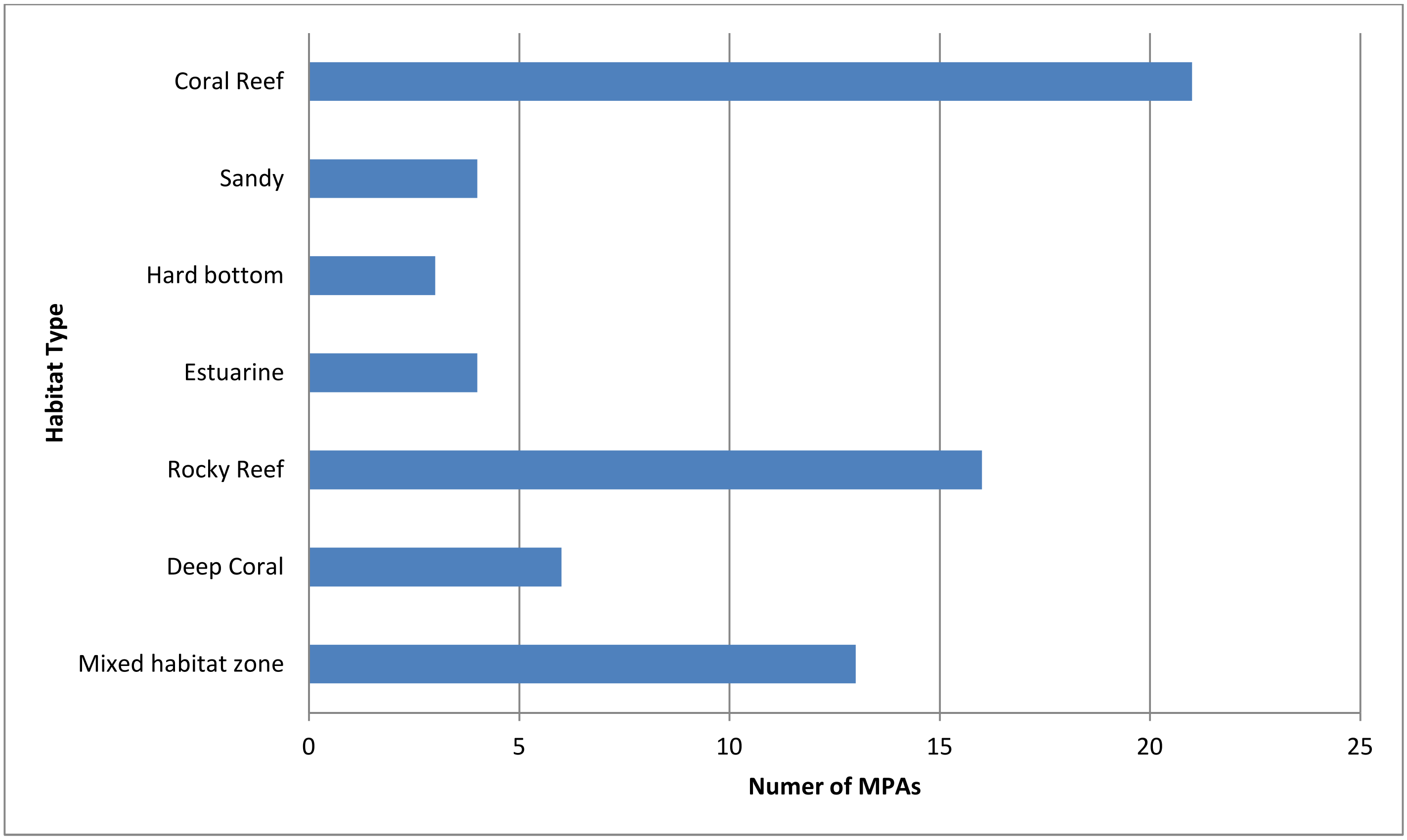

Figure 3: Habitat types represented on both coasts (Eastern Pacific and Western Atlantic combined) (n=79).

Table 2: MPA representation across the Eastern Pacific and Western Atlantic (n=79)

	Eastern Pacific	Western Atlantic/ Caribbean
Unique	4	1
Shipwreck	1	5
Mixed habitat zone	10	3
Deep Coral	1	5
Rocky Reef	13	3
Estuarine	1	3
Hard bottom	1	2
Sandy	0	4
Coral Reef	3	19

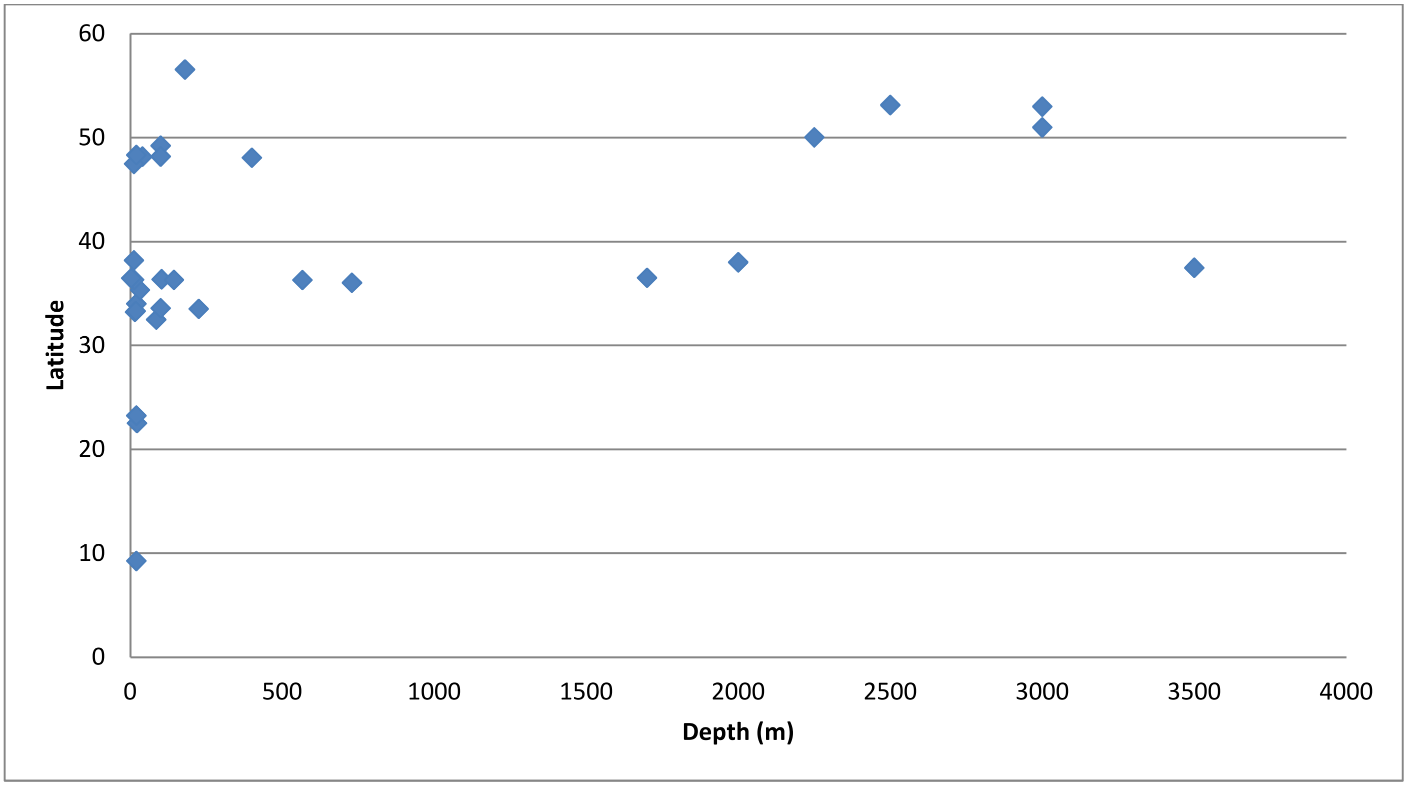

Figure 4: Maximum depth of MPAs in the Eastern Pacific across a latitudinal range.

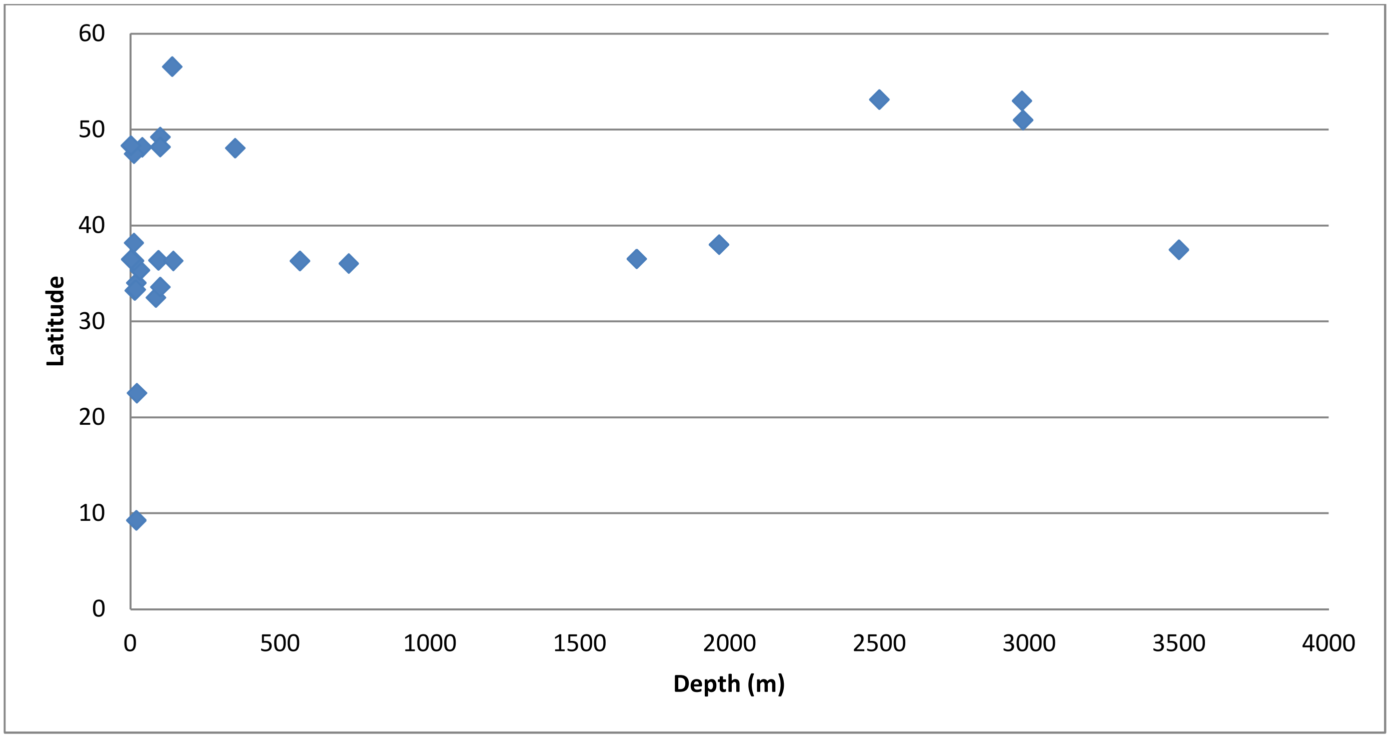

Figure 5: Depth range of MPAs in the Eastern Pacific across a latitudinal range.

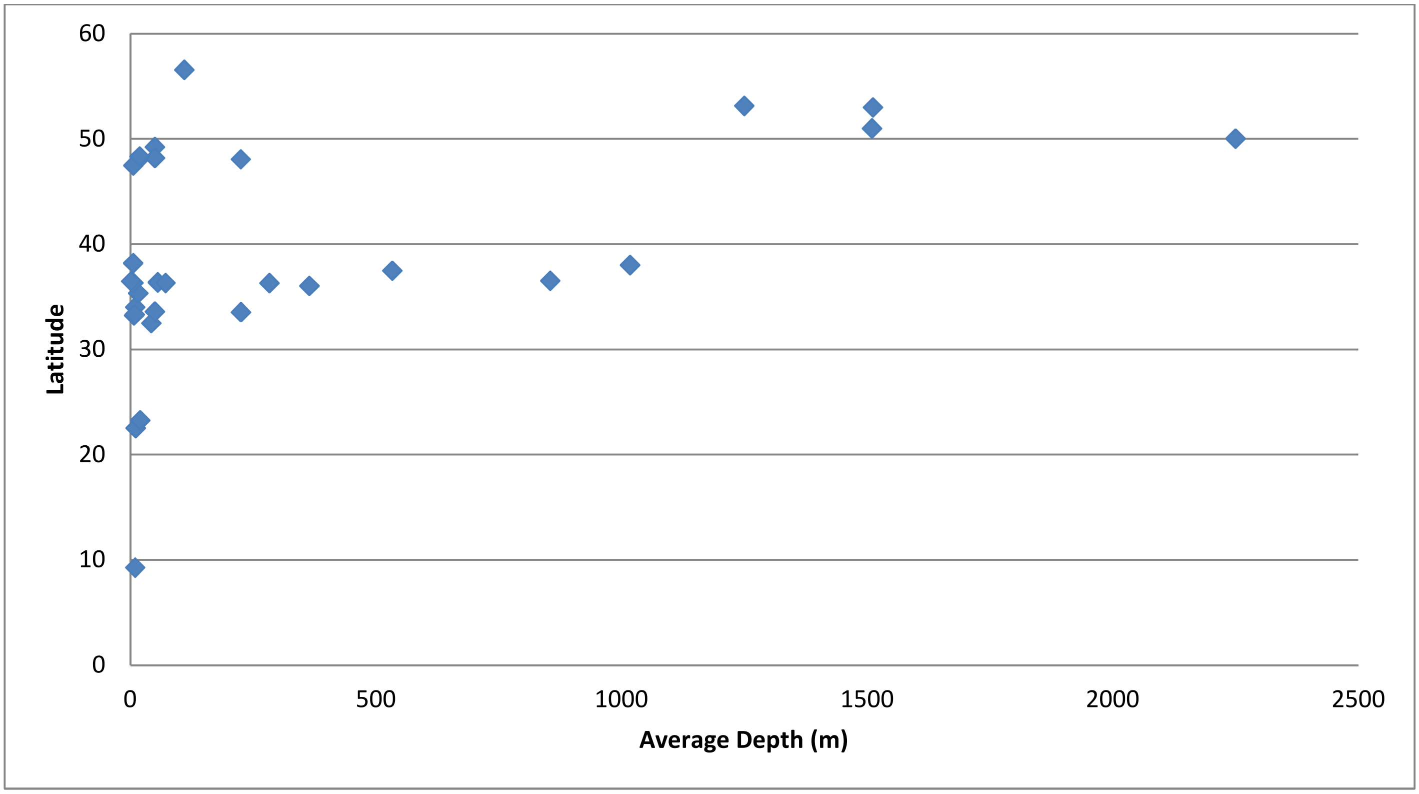

Figure 6: Average depth of MPAs in the Eastern Pacific across a latitudinal range.

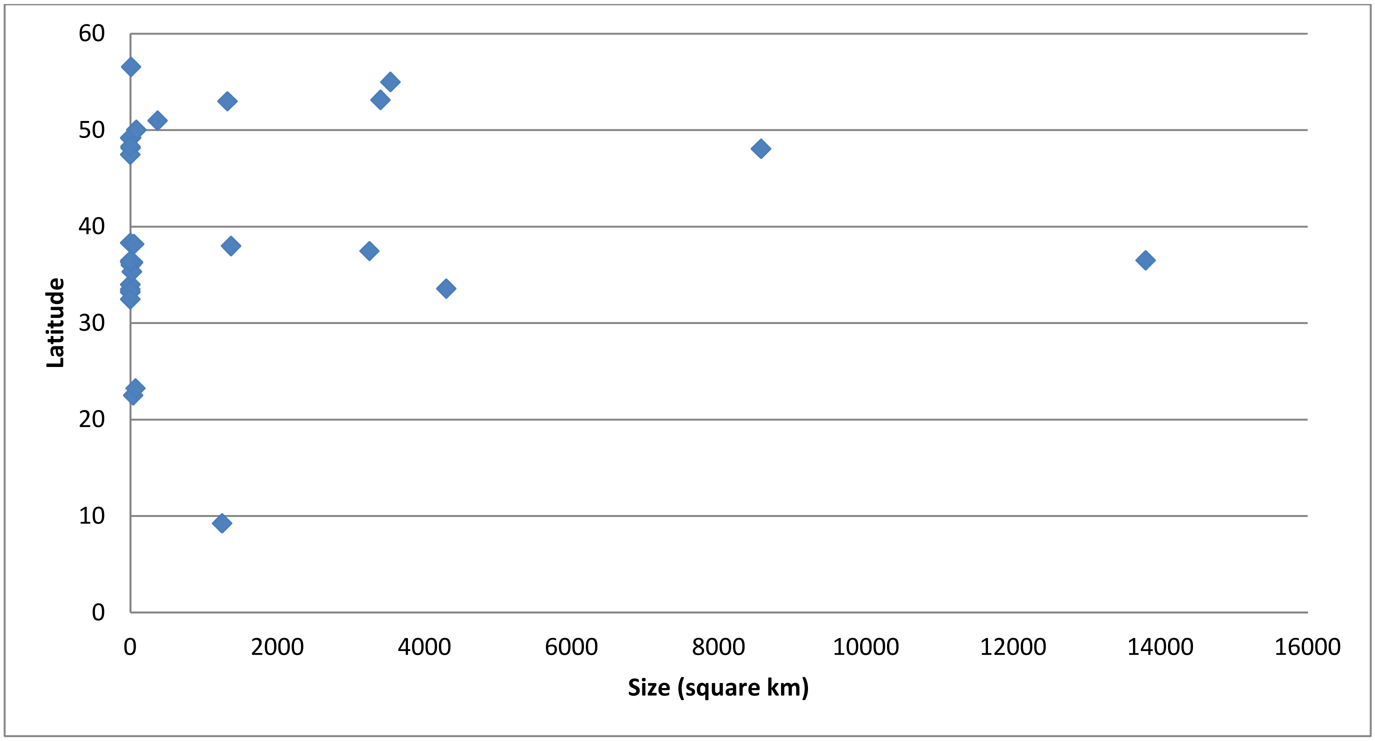

Figure 7: Size of MPAs in the Eastern Pacific across a latitudinal gradient.

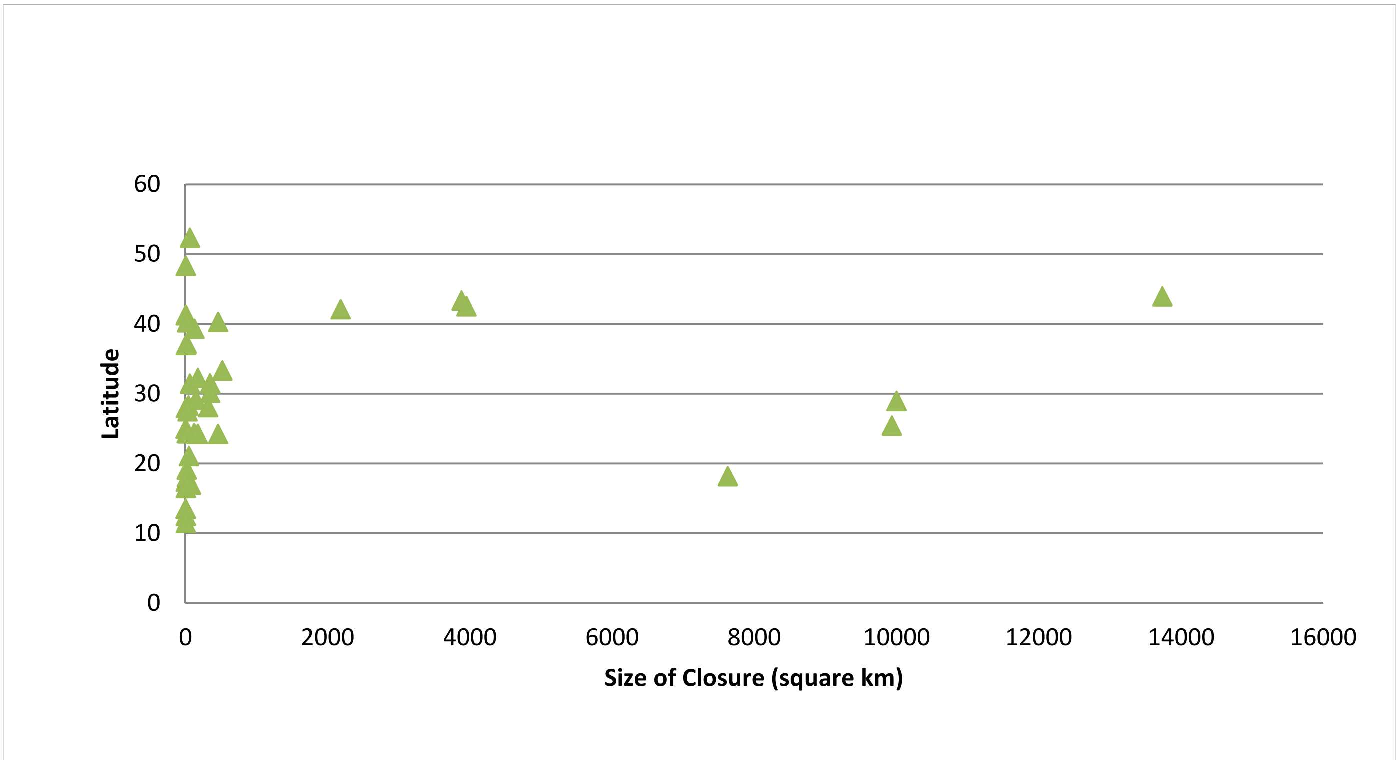

Figure 8: Sizes of MPAs in the Western Atlantic across a latitudinal range.

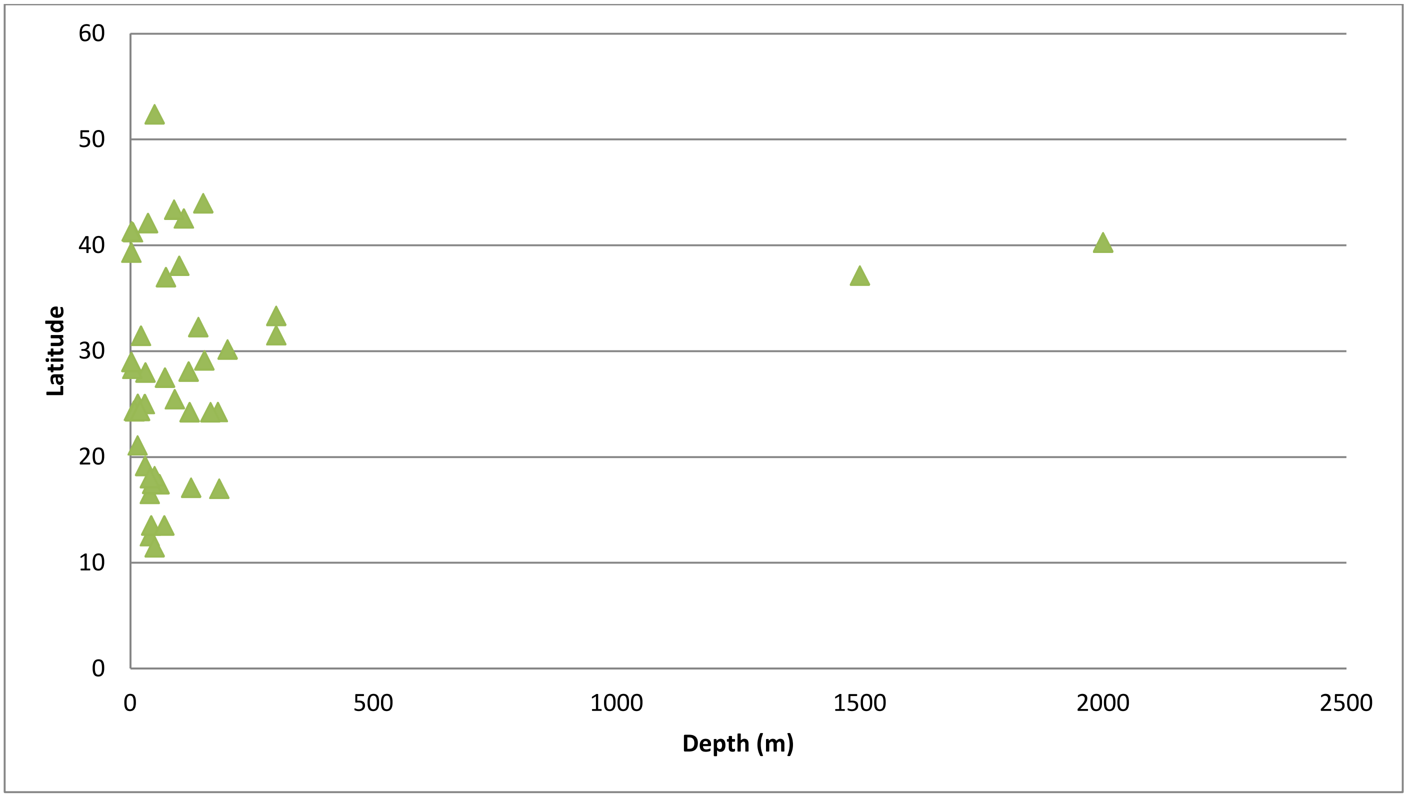

Figure 9: Maximum depth of MPAs in the Western Atlantic across a latitudinal gradient.

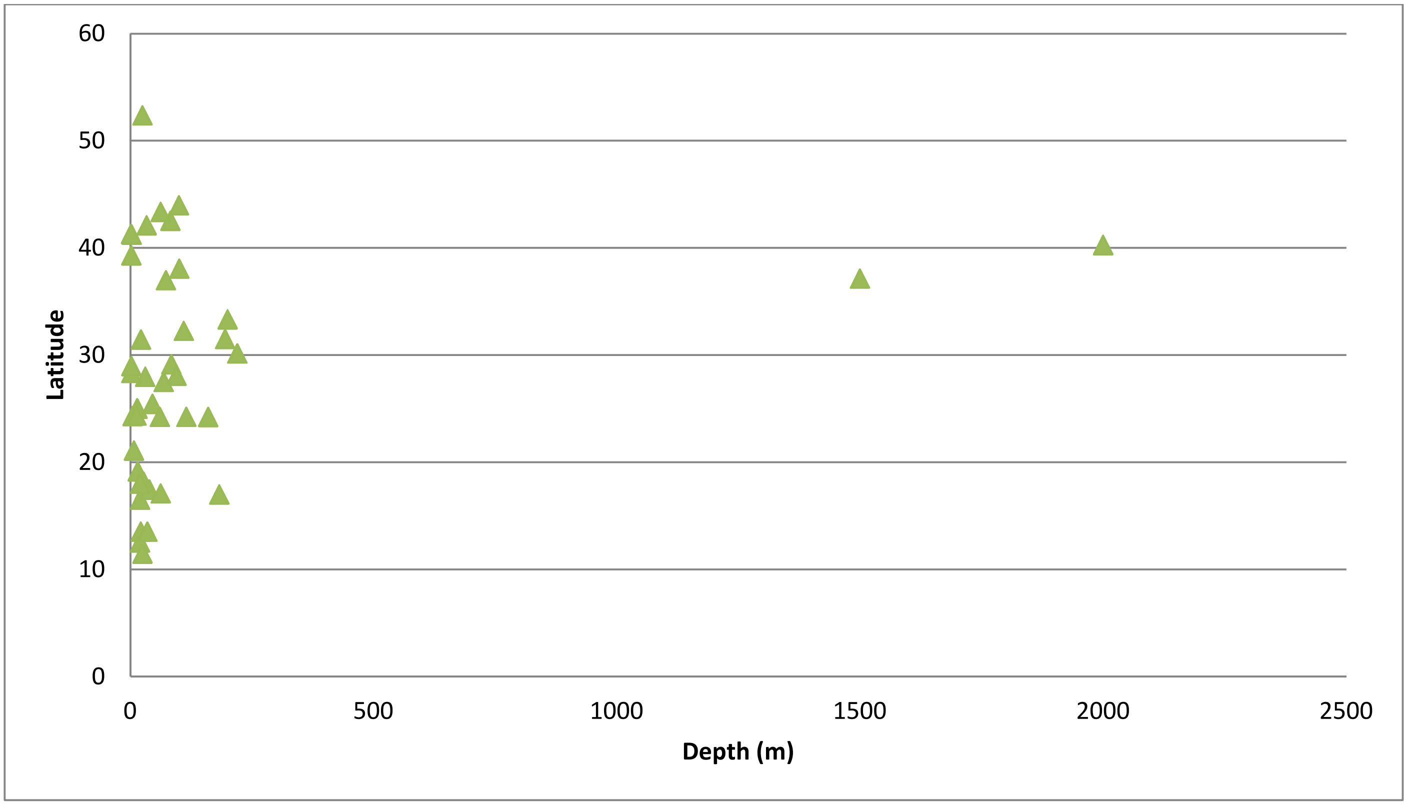

Figure 10: Average depth of protected areas in the Western Atlantic across a latitudinal range.

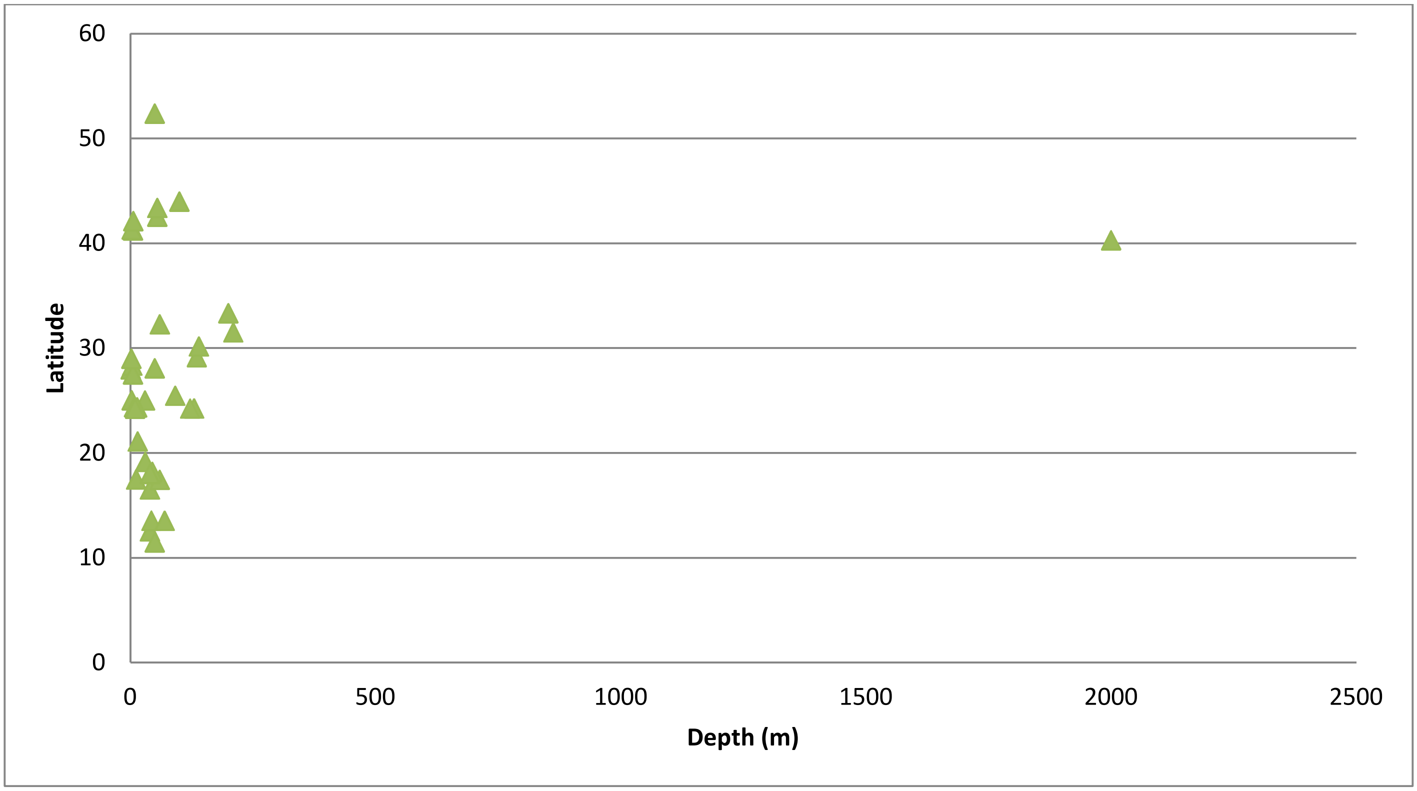

Figure 11: Depth range of MPAs in the Western Atlantic across a latitudinal range.

Table 3a: Effective MPA representation across habitats and depth zones in the Eastern Pacific (n=37)

			Average Depth			
Effectiveness		**Total Number of MPAs**	**0-30 m deep**	**>30-200m deep**	**>200m deep**	**Unknown depth**
Effective	Rocky Reef	7	5	2		
	Shipwreck	1	1			
	Hardbottom	1				1
	Mixed habitat zone	2			2	
	Unique habitat	1			1	
	Coral reef	2	2			
Ineffective	Estuarine habitat	1	1			
	Unknown habitat	1				1
Inconclusive	Mixed habitat zone	8	1	2	5	
	Deepwater Coral	1			1	
	Unique habitat	3			1	2
	Rocky Reef	3	1		1	1
	Coral reef	1	1			
	Unknown habitat	2	1	1		
No data	Rocky Reef	3	1	2		

Table 3b: Effective MPA representation across habitats and depth zones in the Western Atlantic (n=49)

			Average Depth			
Effectiveness		**Total Number of MPAs**	**0-30 m deep**	**>30-200m deep**	**>200m deep**	**Unknown depth**
Effective	Estuarine	3	3			
	Coral Reef	12	9	3		
	Deepwater Coral	1		1		
	Shipwreck	3	1	2		
	Unique habitat	1		1		
	Mixed habitat zone	1		1		
	Sandy	2	1	1		
	Unknown habitat	2				2
Ineffective	Coral Reef	4	3	1		
	Mixed habitat zone	2	1	1		
	Unknown habitat	1		1		
	Rocky Reef	1	1			
Inconclusive	Coral Reef	2	1			1
	Shipwreck	1		1		
	Rocky Reef	1	1			
	Sandy	2		2		
No data	Deepwater Coral	4		1	3	
	Hardbottom	2		1	1	
	Unknown habitat	2		2		
	Shipwreck	1		1		
	Rocky Reef	1		1		

Table 4: Designation Objectives of MPAs in the Western Atlantic and Eastern Pacific

Designation objective	Western Atlantic	Eastern Pacific
Protect biological diversity	16	14
Recovering Fisheries	17	2
Protect sensitive habitat	5	2
Protect a natural heritage	6	15
Protect a Shipwreck	3	0
Conservation of a spawning site	2	0
Tourism benefits	0	1
De facto MPA	0	3

Table 5: Designation objective across latitudinal ranges in entire study region

Latitude	Protect biological diversity	Protecting Natural heritage	Recovering Fisheries	Protect Sensitive habitat	de facto MPA	Tourism benefits	Conservation of a Spawning site	Protect a Shipwreck	Total
>50-57	2	2	1	1					6
>40-50	1	5	7	1	2	1			17
>30-40	10	10	3	3	1		1	2	30
>20-30	7	3	7	2					19
>10-20	9	1	1				1	1	13
9-10	1								1

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Appendices:

Appendix 1: MPAs with habitat classification and full descriptions across latitudes

Latitude	Protected Area	Standardized Habitat	Habitats
57	Sitka Pinnacles Marine Reserve, U.S.A.	unique	
55	Alaska Maritime National Wildlife Refuge, U.S.A.	transition zone	more than 2,500 islands, islets, spires, rocks, reefs, waters and headlands
53	Gwaii Haanas National Marine Conservation Area Reserve and Haida Heritage Site, Canada	transition zone	transitions between ocean abyss, continental slope, shallow shelf, and the islands
53	Bowie Seamount Marine Protected Area, Canada	unique	three underwater submarine volcanoes
52	Gilbert Bay, Labrador, Canada	rocky reef	rocky, cobble, and sandy areas, brings sub-arctic conditions to the area,
51	Aleutian Islands Coral Habitat Protection Area, U.S.A.	deep coral	high density coral gardens
50	Endeavour Hydrothermal Vents Marine Protected Area Canada	unique	hydrothermal vents
49	Maquinna Marine Provincial Park, Canada		
49	Whytecliff Marine Park, Canada		
48	Round Island, Canada		
48	Duck Islands, Canada		
48	Shady Cove, WA, San Juan Islands, U.S.A.	rocky reef	temperate rocky reef
48	"Prison Reserve," B.C., Canada	rocky reef	sloping bedrock, kelp covered
48	"Ecological Reserve," B.C., Canada	rocky reef	sloping bedrock, kelp covered
48	Race Rocks Ecological Reserve, Canada		
48	Olympic Coast National Marine Sanctuary, U.S.A.	transition zone	rocky and sandy shores, kelp forests, seastacks and islands, continental shelf, open ocean, deepwater canyons
47	Edmonds Underwater Park, WA, U.S.A.	shipwreck	man made structure, submerged vessels
44	Emerald/Western Bank juvenile haddock closed area, Canada		
43	Georges bank closed area 2, U.S.A.	sandy	sand, small muddy outcrops in nothwest corner, rippled sand bedforms 20-30 cm high, absent below 65m
43	Georges bank closed area 1, U.S.A.	sandy	fine grained sand in deep water to gravel pavements and boulder piles associated with sand dunes at intermediate depths, shallow depths characterized by coarse-

			grained sand
42	Gerry E. Studds/Stellwagen Bank National Marine Sanctuary, U.S.A.	sandy	underwater sandy plateau,
41	Waquoit Bay National Estuarine Research Reserve, U.S.A.	estuarine	open water, marshlands
41	Narragansett Bay National Estuarine Research Reserve, U.S.A.	estuarine	sandy and rocky shorelines
40	Oceanographer Canyon, U.S.A.	deep coral	deep-sea corals, sponges, and clay outcroppings
40	Lydonia Canyon Gear Restricted Area, U.S.A.	deep coral	Fine sediment predominates on walls and along thalweg; rock outcrops, cobbles and pebbles with some hash, 100-120 feet deep populations of corals
39	Jacques Cousteau National Estuarine Research Reserve, U.S.A.	estuarine	estuarine
38	Gerstle Cove, CA, U.S.A.	hardbottom	caverns and sandstone
38	Bodega Head State Marine Reserve, U.S.A.	rocky reef	kelp forests
38	U-1105 Black Panther Historic Shipwreck Preserve (Maryland Archaeological Survey #18ST636) , U.S.A.	shipwreck	underwater structure
38	Cordell Bank National Marine Sanctuary, U.S.A.	transition zone	rocky subtidal areas, open ocean, soft sediment continental slope and shelf, pinnacles
37	Gulf of the Farallones National Marine Sanctuary, U.S.A.	transition zone	coastal beaches, rocky shores, salt marsh, estuaries, mud and tidal flats, pelagic, open ocean, deep benthos, continental slope and shelf
37	Norfolk Canyon Gear Restricted Area, U.S.A.	deep coral	diversity of species, corals
37	NOAA's Monitor National Marine Sanctuary, U.S.A.	shipwreck	wreck of a boat
37	Monterey Bay National Marine Sanctuary, U.S.A.	transition zone	sandy beaches, rocky shores, kelp forests, subtidal rocky reefs, soft-bottom benthic submarine canyons, cold seeps, wetlands and pelagic, open ocean
36	Elkhorn Slough State Marine Conservation Area, U.S.A.	estuarine	Mudflats, tidal creeks and channels, and eelgrass beds
36	Hopkins Marine Life Refuge, U.S.A.	rocky reef	rocky reef, kelp
36	Del Mar Landing State Marine Reserve, U.S.A.	rocky reef	rocky subtidal habitat
36	Carmel Bay State marine Conservation Area, U.S.A.	transition zone	kelp forest, sandy beach, submarine canyon head, and surfgrass
36	Point Lobos State Marine Reserve and Marine Conservation Area, U.S.A.	transition zone	intertidal, soft and hard
36	Big Creek State Marine Park and Marine Conservation Area, U.S.A.	rocky reef	bottom

35	Cambria State Marine Conservation Area, U.S.A.	transition zone	steelhead streams, kelp forests, rocky intertidal, sandy and cobble beach, reef and sandy bottom, pinnacles and offshore rocks
34	"Pelican Closure," Anacapa Island, U.S.A.	rocky reef	rocky reef
34	"Natural Area" Anacapa Island, U.S.A.	rocky reef	rocky reef
34	Anacapa Island, U.S.A.	rocky reef	rocky reef
34	Channel Islands National Park/National Marine Sanctuary, U.S.A.	transition zone	kelp forests, rocky shores, sandy beaches, seagrass meadows, deep rocky reefs, and pelagic open oceans
34	Platform Gail de facto reserve, U.S.A.	unique	oil platform
33	Snowy Grouper Wreck MPA, U.S.A.	shipwreck	wreck site that supported spawning aggregations of snowy grouper
33	Laguna Beach State Marine Reserve, U.S.A.	rocky reef	rocky reef
33	Catalina Marine Science Center Marine Life Refuge, U.S.A.	rocky reef	rocky reef
32	San Diego- La Jolla, U.S.A.	rocky reef	rocky reef
32	Edisto MPA and Charleston Deep Reef MPA, U.S.A.	rocky reef	shelf-edge habitat, steep scarps with rocky cliffs and overhangs
32	Georgia MPA, U.S.A.		deepwater habitat
31	Gray's Reef National Marine Sanctuary, U.S.A.	rocky reef	calcareous sandstone reefs, sand bottom, moderate relief ledges, tropical/temperate reef
30	North Florida MPA, U.S.A.	hardbottom	some mud bottom habitat and shelf-edge reef and slab pavement, blocked boulders, and buried block boulders
29	Flower Garden Banks National Marine Sanctuary, U.S.A.	transition zone	coral reefs, algal-sponge communities, brine seep, sand flats, artificial reef and pelagic open ocean
29	Galveston Bay National Estuary Program, U.S.A.	transition zone	coastal wetlands, seagrass meadows, barrier islands and oyster reefs
28	Merritt Island National Wildlife Refuge, U.S.A.	sandy	eelgrass, sandy
28	Oculina Research Reserve, U.S.A.	unique	thirty miles from shore set of pinnacles and ridges that rise 10 to 29 m off the bottom, support habitat structured by Oculina
28	Freeport Liberty Ship Reef Complex, U.S.A.	shipwreck	hard bottom artificial reef structure
28	St. Lucie Hump MPA, U.S.A.		
25	Florida Keys National Marine Sanctuary, U.S.A.	Coral reef	coral reefs, patch and bank reefs, mangrove-fringed shorelines and islands, sand flats, seagrass meadows, hardbottom communities
25	Molasses Reef, FL, U.S.A.	Coral reef	tropical corals
25	French Reef, FL, U.S.A.	Coral reef	tropical corals
24	Looe Key Reef, FL, U.S.A.	Coral reef	“groove and spur” reef
24	Dry Tortugas National Park, U.S.A.	Coral reef	coral reef, sandy shores

24	Western Sambo Ecological Reserve, FL, U.S.A.	Coral reef	Tropical coral reef habitat
24	Northern South Carolina MPA, U.S.A.	hardbottom	hard bottom habitat including eroding rock in shelf edge
24	Exuma Cays Land and Sea Park, Bahamas	transition zone	Includes shallow water sea grass, flats, mangrove, patch reef, offshore reefs and deepwater habitats
24	East Hump MPA, U.S.A.	deep coral	pinnacle formations primarily made up of hardened layers of sandy carbonate sediments (also home to deep water corals)
23	Cabo Pulmo, Mexico	Coral reef	Coral reef
23	Cabo San Lucas Flora and Fauna Area Protection, Mexico	Coral reef	Coral reef
21	Parque Nacional Punta Frances, Cuba	Coral reef	tropical, reefs
19	Cayman Islands marine park zones, Cayman Islands	Coral reef	Coral reef habitats
18	Buck Island Reef National Monument, U.S. Virgin Islands	Coral reef	nearshore patch reefs out to spur and groove reefs
18	Hol Chan Marine Reserve, Belize	Coral reef	Coral reef habitats
18	Jobos Bay National Estuarine Research Reserve, U.S.A.	Coral reef	extensive networks of mangrove forests, upland dry forests, lagoons, seagrass beds and coral reefs.
17	Red Hind Closed Area, U.S.V.I.	deep coral	deep coral reefs
17	Saba Marine Park, Netherland Antilles	Coral reef	Tropical coral reef habitats
17	Half Moon Caye, Belize	Coral reef	tropical fringing reefs, reef atolls
17	Glover's Reef, Belize	Coral reef	Sand and mangrove, cayes, coral, littoral thicket, seagrass beds and reef
17	SW Pedro Bank, Jamaica	Coral reef	sand, coral reefs, deep reefs, sea grass beds, and three coral cays known as the Pedro Cays
14	Anse Chastanet, St. Lucia	Coral reef	Tropical coral reef habitats
14	Soufriere Marine Management Area (SMMA), St. Lucia	Coral reef	tropical, coral reefs
13	Barbados Marine Reserve (Folkestone Marine Reserve), Barbados	shipwreck	sunken freighter for diving
11	Los Roques Archipelago National Park, Venezuela	Coral reef	Coral reef habitats
9	Manuel Antonio, Costa Rica	Coral reef	Tropical coral reef habitats

Appendix 2: Marine Protected Areas at each latitude, with ecoregion classification and area

Latitude	Ecoregion	Protected Area	size of closure (km^2)
57	22	Sitka Pinnacles Marine Reserve, U.S.A.	10.30287004
55	1	Alaska Maritime National Wildlife Refuge, U.S.A.	3536.00
53	22	Gwaii Haanas National Marine Conservation Area Reserve and Haida Heritage Site, Canada	3400
53	22	Bowie Seamount Marine Protected Area, Canada	1320.00
52	6	Gilbert Bay, Labrador, Canada	60
51	23	Aleutian Islands Coral Habitat Protection Area, U.S.A.	371.00
50	22	Endeavour Hydrothermal Vents Marine Protected Area Canada	82
49	21	Maquinna Marine Provincial Park, Canada	13.98
49	21	Whytecliff Marine Park, Canada	0.11
48	6	Round Island, Canada	0.5
48	6	Duck Islands, Canada	3.8
48	21	Shady Cove, WA, San Juan Islands, U.S.A.	1.71
48	22	"Prison Reserve," B.C., Canada	
48	22	"Ecological Reserve," B.C., Canada	
48	22	Race Rocks Ecological Reserve, Canada	2.2
48	21	Olympic Coast National Marine Sanctuary, U.S.A.	8573
47	21	Edmonds Underwater Park, WA, U.S.A.	0.133505794
44	7	Emerald/Western Bank juvenile haddock closed area, Canada	13737
43	7	Georges bank closed area 2, U.S.A.	3880
43	7	Georges bank closed area 1, U.S.A.	3950
42	7	Gerry E. Studds/Stellwagen Bank National Marine Sanctuary, U.S.A.	2181
41	8	Waquoit Bay National Estuarine Research Reserve, U.S.A.	3.34
41	8	Narragansett Bay National Estuarine Research Reserve, U.S.A.	3.38
40	9	Oceanographer Canyon, U.S.A.	
40	9	Lydonia Canyon Gear Restricted Area, U.S.A.	20
39	8	Jacques Cousteau National Estuarine Research Reserve, U.S.A.	125
38	20	Gerstle Cove, CA, U.S.A.	0.20
38	20	Bodega Head State Marine Reserve, U.S.A.	50
38	8	U-1105 Black Panther Historic Shipwreck Preserve (Maryland Archaeological Survey #18ST636), U.S.A.	
38	19	Cordell Bank National Marine Sanctuary, U.S.A.	1369
37	19	Gulf of the Farallones National Marine Sanctuary, U.S.A.	3250

37	8	Norfolk Canyon Gear Restricted Area, U.S.A.	14.5
37	8	NOAA's Monitor National Marine Sanctuary, U.S.A.	
37	19	Monterey Bay National Marine Sanctuary, U.S.A.	13799
36	19	Elkhorn Slough State Marine Conservation Area, U.S.A.	0.23
36	20	Hopkins Marine Life Refuge, U.S.A.	2.75
36	19	Del Mar Landing State Marine Reserve, U.S.A.	0.206057401
36	19	Carmel Bay State marine Conservation Area, U.S.A.	6.9
36	20	Point Lobos State Marine Reserve and Marine Conservation Area, U.S.A.	36.80
36	20	Big Creek State Marine Park and Marine Conservation Area, U.S.A.	8
35	19	Cambria State Marine Conservation Area, U.S.A.	22.2
34	19	"Pelican Closure," Anacapa Island, U.S.A.	1
34	19	"Natural Area" Anacapa Island, U.S.A.	1.86
34	19	Anacapa Island, U.S.A.	0.14
34	19	Channel Islands National Park/National Marine Sanctuary, U.S.A.	4294
34	20	Platform Gail de facto reserve, U.S.A.	0.13
33	11	Snowy Grouper Wreck MPA, U.S.A.	515
33	20	Laguna Beach State Marine Reserve, U.S.A.	0.13
33	20	Catalina Marine Science Center Marine Life Refuge, U.S.A.	0.18
32	19	San Diego- La Jolla, U.S.A.	0.000
32	11	Edisto MPA and Charleston Deep Reef MPA, U.S.A.	172
32	11	Georgia MPA, U.S.A.	343
31	11	Gray's Reef National Marine Sanctuary, U.S.A.	60
30	11	North Florida MPA, U.S.A.	343
29	13	Flower Garden Banks National Marine Sanctuary, U.S.A.	145
29	13	Galveston Bay National Estuary Program, U.S.A.	10000
28	11	Merritt Island National Wildlife Refuge, U.S.A.	39.6
28	10	Oculina Research Reserve, U.S.A.	316
28	13	Freeport Liberty Ship Reef Complex, U.S.A.	1.29
28	11	St. Lucie Hump MPA, U.S.A.	27
25	12	Florida Keys National Marine Sanctuary, U.S.A.	9933
25	12	Molasses Reef, FL, U.S.A.	0.9
25	12	French Reef, FL, U.S.A.	0.37
24	12	Looe Key Reef, FL, U.S.A.	15.54

24	12	Dry Tortugas National Park, U.S.A.	119
24	12	Western Sambo Ecological Reserve, FL, U.S.A.	30
24	11	Northern South Carolina MPA, U.S.A.	172
24	15	Exuma Cays Land and Sea Park, Bahamas	456
24	11	East Hump MPA, U.S.A.	172
23	18	Cabo Pulmo, Mexico	71
23	18	Cabo San Lucas Flora and Fauna Area Protection, Mexico	37.88
21	15	Parque Nacional Punta Frances, Cuba	46
19	15	Cayman Islands marine park zones, Cayman Islands	15
18	15	Buck Island Reef National Monument, U.S. Virgin Islands	7625
18	15	Hol Chan Marine Reserve, Belize	18
18	15	Jobos Bay National Estuarine Research Reserve, U.S.A.	
17	15	Red Hind Closed Area, U.S.V.I.	41
17	15	Saba Marine Park, Netherland Antilles	0.9
17	15	Half Moon Caye, Belize	39.25
17	15	Glover's Reef, Belize	74
17	15	SW Pedro Bank, Jamaica	3
14	15	Anse Chastanet, St. Lucia	0.026
14	15	Soufriere Marine Management Area (SMMA), St. Lucia	1.1
13	15	Barbados Marine Reserve (Folkestone Marine Reserve), Barbados	2.3
11	15	Los Roques Archipelago National Park, Venezuela	2.21
9	16	Manuel Antonio, Costa Rica	1247.7

Appendix 3: Depth Data for MPAs across latitudes

Latitude	Protected Area	Country	Averaged depth (m)	Max depth (m)	Delta depth
57	Sitka Pinnacles Marine Reserve	U.S.A.	110	180	140
55	Alaska Maritime National Wildlife Refuge	U.S.A.			
53	Gwaii Haanas National Marine Conservation Area Reserve and Haida Heritage Site	Canada	1250	2500	2500
53	Bowie Seamount Marine Protected Area	Canada	1512	3000	2976
52	Gilbert Bay, Labrador	Canada	25	50	50
51	Aleutian Islands Coral Habitat Protection Area	U.S.A.	1510	3000	2980
50	Endeavour Hydrothermal Vents Marine Protected Area (MPA)	Canada	2250	2250	
49	Maquinna Marine Provincial Park	Canada	50	100	100
49	Whytecliff Marine Park	Canada			
48	Round Island	Canada			
48	Duck Islands	Canada			
48	Shady Cove, WA, San Juan Islands	U.S.A.	19	20	2
48	"Prison Reserve," B.C.	Canada	50	100	100
48	"Ecological Reserve," B.C.	Canada	50	100	100
48	Race Rocks Ecological Reserve	Canada	20	40	40
48	Olympic Coast National Marine Sanctuary	U.S.A.	225	400	350
47	Edmonds Underwater Park, WA	U.S.A.	6.096	12.192	12.192
44	Emerald/Western Bank juvenile haddock closed area	Canada	100	150	100
43	Georges bank closed area 2	U.S.A.	62.5	90	55
43	Georges bank closed area 1	U.S.A.	82.5	110	55
42	Gerry E. Studds/Stellwagen Bank National Marine Sanctuary	U.S.A.	33.528	36.576	6.096
41	Waquoit Bay National Estuarine Research Reserve	U.S.A.	1.3716	2.7432	2.7432
41	Narragansett Bay National Estuarine Research Reserve	U.S.A.	2.7432	5.4864	5.4864
40	Oceanographer Canyon	U.S.A.	2000	2000	2000
40	Lydonia Canyon Gear Restricted Area	U.S.A.	2000	2000	
39	Jacques Cousteau National Estuarine Research Reserve	U.S.A.	2	2	
38	Gerstle Cove, CA	U.S.A.			
38	Bodega Head State Marine Reserve	U.S.A.	6	12	12
38	U-1105 Black Panther Historic Shipwreck Preserve (Maryland Archaeological Survey #18ST636)	U.S.A.	100.584	100.584	

38	Cordell Bank National Marine Sanctuary	U.S.A.	1017.5	2000	1965
37	Gulf of the Farallones National Marine Sanctuary	U.S.A.	533.4	3500	3500
37	Norfolk Canyon Gear Restricted Area	U.S.A.	1500	1500	
37	NOAA's Monitor National Marine Sanctuary	U.S.A.	73.152	73.152	
37	Monterey Bay National Marine Sanctuary	U.S.A.	855	1700	1690
36	Elkhorn Slough State Marine Conservation Area	U.S.A.	1.524	3.048	3.048
36	Hopkins Marine Life Refuge	U.S.A.	56	103	94
36	Del Mar Landing State Marine Reserve	U.S.A.	6.4008	12.8016	12.8016
36	Carmel Bay State marine Conservation Area	U.S.A.	71.7804	143.5608	143.5608
36	Point Lobos State Marine Reserve and Marine Conservation Area	U.S.A.	283.1592	566.3184	566.3184
36	Big Creek State Marine Park and Marine Conservation Area	U.S.A.	364.5408	729.0816	729.0816
35	Cambria State Marine Conservation Area	U.S.A.	16.002	32.004	32.004
34	"Pelican Closure," Anacapa Island	U.S.A.	10	20	20
34	"Natural Area" Anacapa Island	U.S.A.	10	20	20
34	Anacapa Island	U.S.A.			
34	Channel Islands National Park/National Marine Sanctuary	U.S.A.	50	100	100
34	Platform Gail de facto reserve	U.S.A.	225.2472	225.2472	
33	Snowy Grouper Wreck MPA	U.S.A.	199.9488	299.9232	199.9488
33	Laguna Beach State Marine Reserve	U.S.A.	9.144	18.288	18.288
33	Catalina Marine Science Center Marine Life Refuge	U.S.A.	7.5	15	15
32	San Diego- La Jolla	U.S.A.	42.672	85.344	85.344
32	Edisto MPA and Charleston Deep Reef MPA	U.S.A.	109.8804	139.9032	60.0456
32	Georgia MPA	U.S.A.	194.9196	299.9232	210.0072
31	Gray's Reef National Marine Sanctuary	U.S.A.	22	22	
30	North Florida MPA	U.S.A.	220.0656	199.9488	139.9032
29	Flower Garden Banks National Marine Sanctuary	U.S.A.	84.582	152.4	135.636
29	**Galveston Bay National Estuary Program**	U.S.A.	2	2	2
28	Merritt Island National Wildlife Refuge	U.S.A.	2	4	4
28	Oculina Research Reserve	U.S.A.	95	120	50
28	**Freeport Liberty Ship Reef Complex**	U.S.A.	30.7848	31.0896	0.6096
28	St. Lucie Hump MPA	U.S.A.	68.58	71.3232	5.4864
25	Florida Keys National Marine Sanctuary	U.S.A.	45.72	91.44	91.44
25	Molasses Reef, FL	U.S.A.	13.8684	15.24	2.7432
25	French Reef, FL	U.S.A.	15	30	30

24	Looe Key Reef, FL	U.S.A.	7.62	7.62	7.62
24	Dry Tortugas National Park	U.S.A.	13.048	20	13.904
24	Western Sambo Ecological Reserve, FL	U.S.A.	4.572	9.144	9.144
24	Northern South Carolina MPA	U.S.A.	115.062	180.1368	130.1496
24	Exuma Cays Land and Sea Park	Bahamas	60.96	121.92	121.92
24	East Hump MPA	U.S.A.	160.02	164.8968	9.7536
23	Cabo Pulmo	Mexico	20	20	
23	Cabo San Lucas Flora and Fauna Area Protection	Mexico	11	22	22
21	Parque Nacional Punta Frances	Cuba	7.5	15	15
19	Cayman Islands marine park zones	Cayman Islands	15.24	30.48	30.48
18	Buck Island Reef National Monument	U.S. Virgin Islands	27.5	50	45
18	Hol Chan Marine Reserve	Belize	20	40	40
18	Jobos Bay National Estuarine Research Reserve	U.S.A.			
17	Red Hind Closed Area, USVI	U.S. Virgin Islands	39	45	12
17	Saba Marine Park	Netherland Antilles	30	60	60
17	Half Moon Caye, Belize	Belize	62.5	125	
17	Glover's Reef	Belize	182.88	182.88	
17	SW Pedro Bank, Jamaica	Jamaica	20	40	40
14	Anse Chastanet, St. Lucia	St. Lucia	21.5	43	43
14	Soufriere Marine Management Area (SMMA)	St. Lucia	35	70	70
13	Barbados Marine Reserve (Folkestone Marine Reserve)	Barbados	20	40	40
11	Los Roques Archipelago National Park	Venezuela	25	50	50
9	Manuel Antonio, Costa Rica	Costa Rica	10	20	20

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MPA	References			
Sitka Pinnacles Marine Reserve	1			
Alaska Maritime National Wildlife Refuge	2	3		
Gwaii Haanas National Marine Conservation Area Reserve and Haida Heritage Site	4			
Bowie Seamount Marine Protected Area	5			
Gilbert Bay, Labrador	6	7		
Aleutian Islands Coral Habitat Protection Area	8	9		
Endeavour Hydrothermal Vents Marine Protected Area (MPA)	10	11	12	
Maquinna Marine Provincial Park	13			
Whytecliff Marine Park	14	15		
Round Island	14	16	17	18
Duck Islands	14	16	17	18
Shady Cove, WA, San Juan Islands	19	20		
"Prison Reserve," B.C.	14	21	22	
"Ecological Reserve," B.C.	14	22		
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Edmonds Underwater Park, WA	19	26	27	
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Georges bank closed area 2	30	31		
Georges bank closed area 1	30	31	32	
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Northern South Carolina MPA	70	71	77	
Exuma Cays Land and Sea Park	14	96	97	98
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Cabo Pulmo	99	100	101	
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