

**Final Report for Marine Managed Areas Cost Effectiveness**  
**Principal Investigator**  
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The Marine Managed Areas (MMA) Cost Effectiveness project set out to determine which management investment components (e.g. education, staff, enforcement boats, alternative livelihood training workshops) make the most cost efficient contributions to marine managed area effectiveness depending on data availability. We sought to generate information on which management components (e.g., education, enforcement, alternative livelihoods) are most closely associated with effectiveness, and, if data permit, determine the relative contribution of the different components to achieving effectiveness.

The motivation for the work is that available funding for MMAs or marine protected areas (MPAs) is inadequate to cover all activities necessary to ensure effective management of the world's MPA systems. In the context of this budget constraint, ensuring that scarce funds are spent on the most cost effective activities is a vital priority. Further, improved knowledge about costs and efficiency in spending also has a role in helping to increase the confidence of potential MPA management supporters, and hopefully, overall funding available to MPAs. Conservation groups, governments, communities and individuals around the world are already working on a range of issues aimed at increasing PA finance and improving efficiency of spending. This research is aimed to build on these efforts and provide a valuable technical input.

**The expected deliverables include:**

- 1) article published on cost effectiveness in MPA management, including analysis of what management strategies are most closely associated with effectiveness, what effective “basic” management costs and what it would achieve, and implications of this cost structure for both site selection and adequate management funding;
- 2) presentation of findings in at least 1 major symposium;
- 3) in countries/regions where significant information was provided, data collectors will directly present findings to collaborators and ensure they are understood and available. We will jointly develop briefs/presentations/CDs with materials as needed to support this.;
- 4) depending on results of discussions with the AC and CI staff with “science to action” field experience (e.g., Sebastian Troeng), the research methodology itself may also be made an independent product.

**Project outputs:**

Dale Marsden and Rashid Sumaila, U. (2010). Investments in Marine Managed Areas: a preliminary analysis. (to be submitted to Coastal Management).

Contributed to "The People and Oceans Booklet" produced by Conservation International.

McCrea-Strub, A., Zeller, D., Rashid Sumaila, U., Nelson, J., Balmford, A., & Pauly, D. (2010). Understanding the cost of establishing marine protected areas. Marine Policy DOI: 10.1016/j.marpol.2010.07.001.

**Presentation** by Rashid Sumaila on “Global valuation and socio-economics of the international trade of coral reef species” at the IMCC (International Marine Conservation Conference), May 18, 2009.

**Presentation** by Rashid Sumaila on the “Costs and Benefits of Marine Protected Areas”, International Symposium on Marine Protected Areas, Tokyo, Japan, March 15, 2009.

# **Investments in Marine Managed Areas: a preliminary analysis**

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## **1. Introduction**

Management of any kind always faces funding constraints. Perhaps this is even more so in the case of marine management areas (MMAs)<sup>1</sup>, which faces scarce conservation funds; many diverse demands for those funds, and which is often in a developing country context. Given this, the initial objectives of the analysis were to assess how expenditures on different aspects of marine managed areas (MMAs) will contribute to the effectiveness of the MMA at attaining the objectives for establishing them. The goal was to identify which management investment components (e.g., education, enforcement, alternative livelihood training workshops) are most closely associated with marine managed areas (MMAs) effectiveness. Our ultimate goal was to come up with suggestions on the relative amounts of a budget for a MMA project that should be allocated to each of the above. The ideal would have been to obtain a large data set on many MMAs worldwide so as to be able to detect changing marginal returns of these investments.

Unfortunately, after trying hard to obtain the relevant data without success, we have come to the conclusion that the initial objective for the project was both too ambitious and premature given lack of appropriate data to examine these questions at the moment. While many MMA managers and scientists have been very helpful in providing data on expenditure allocations to various aspects of their MMA, we have not obtained enough data to conduct a substantial quantitative cross-site analysis.

We have therefore scaled back our ambition level. In lieu of the initial objectives, we have opted to take a more ad hoc and qualitative approach. After reviewing some background information, we compile and describe the data that we were able to collect on eight MMA sites in South and Central America. We then examine patterns in these data in how money is allocated among uses, and examine differences among sites and how these differences related to characteristics of the MMA. Finally, we use current knowledge of the effectiveness of MMAs in the literature together with the budgetary information reported herein to present a qualitative analysis of current MMAs budgets are allocated to management components considered to be effective in terms of meeting the objectives of establishing MMAs.

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<sup>1</sup> Even though there is a subtle difference between Marine Managed Areas (MMAs) and Marine Protected Areas (MPAs), they are used in this paper interchangeably.

We conclude the paper by providing recommendations for the way forward with respect to pursuing the initial objective of the study.

## **2. Background**

### **2.1. Why study cost-effectiveness?**

Available funding for MMAs is inadequate to cover all activities that might be seen as contributing to effective management of those MMAs. In the context of this budget constraint, ensuring that these funds are spent on the most cost-effective activities is a vital priority. Furthermore, understanding, demonstrating and/or improving the cost-effectiveness of MMAs might help to increase the confidence of potential MMA supporters and funders, and affirm and/or increase their willingness to fund these and other marine management and conservation activities.

### **2.2. Previous work**

We know of no similar efforts to what we originally set out to do. Much previous work has, however, looked at issues around cost and effectiveness of MMAs, factors contributing to success and how to prioritize expenditures.

#### **2.2.1. *Costs***

Balmford et al. (2004) examined the operation/management costs of running marine protected areas (MPAs) and found that the annual running cost per unit area were higher in MPAs that were smaller, closer to coasts, and in high-cost, developed countries. Balmford and collaborators (Balmford et al. 2003) conducted similar work on terrestrial protected areas, where they found a similar relationship between cost and the above variables. They also found that conservation benefits of protected areas tended to be higher in the developing world than in developed countries, suggesting that benefit-to-cost ratios of protected areas were much higher in developing countries. Gravestock et al. (2008) examined 'income requirements' of MPAs and found that MPA size and visitor numbers explained almost half of the variation in these requirements, and that most MPA managers perceived a significant gap between the amount of funding they would need to fulfill ideal or even minimum requirements, and the amount that they actually received.

#### **2.2.2. *Effectiveness***

There is a great deal of literature looking at what determines MMA effectiveness. For example, Alder et al. (1994) found that in three MMAs in Indonesia, proximity to urban areas, the protected area's economic potential, current uses and the resolution of jurisdictional disputes all helped to influence MMA management. Christie et al. (2009) examined MMA networks in the central Philippines and found that MMA design must be

context appropriate, capacity development is a good investment, that conflict and controversy are a predictable part of MPA design and implementation and need to be planned for, and that, while scaling up management interventions can be useful, there is a point at which institutional capacity is exceeded. White et al. (2002) found that one salient characteristic of successful MMAs is the strong involvement of communities and the local government in the planning and enforcement process. Finally, Armada et al. (2009) suggested that fisheries management interventions should always consider a defined ecosystem boundary as a resource management unit, and that a governance system that can limit fisheries resource exploitation activities is critical.

### ***2.2.3. Prioritization and Cost-effectiveness***

We found few studies looking at prioritization or cost-effectiveness of different activities in MMAs. Wilson et al. (2006) presented two simple heuristics (maximize short-term gain and minimize short-term loss) for allocating limited resources spatially. Naidoo et al. (2006) examined a variety of costs associated with MMAs, including those for acquisition of property, management of the MMA, damages to other existing activities, and opportunity costs associated with setting aside areas. They suggested that examining spatial heterogeneity of costs and incorporating this into site selection can significantly improve cost-effectiveness of conservation efforts.

## **3. Data**

We obtained data from eight MMA sites (Figure 1 and Table 1). All sites are in Central and South America and all but one are associated with islands or archipelagos, from only a few to almost 1000 km from the mainland. As outlined in Table 1, for five of the sites we have detailed planning reports on the nature of the MMA and expectations for management, including budget data. For the other four sites, we have only budget or expenditure data.

Below we describe each site, as well as the data set available for each. The first three sites described are those for which we have only budgetary data, while the next five are those with more detailed information available. For each site we categorized expenditures according to the type of activity with which they were associated. These categorizations are described briefly in Table 2.



**Figure 1. Map of MMA sites included in this study.**

**Table 1. Information on MMA sites included in the study. Note that GSSC and LBC are considered jointly.**

Site	Country	Size (km <sup>2</sup> )	Data available
Abrolhos Marine National Park	Brazil	2,808	Budget
Cocos Island National Park	Costa Rica	1,970	Detailed plan
Coiba National Park	Panama	2,160	Detailed plan
Galapagos Marine Reserve	Ecuador	133,000	Detailed plan
Gorgona National Natural Reservation Park	Colombia	461	Detailed plan
Great Blue Hole and Half Moon Caye (GBHHMC)	Belize	45	Expenditures for 2008
Gladden Spit and Silk Cayes Marine Reserve (GSSC)	Belize	105	Expenditures for 2006-08
Laughing Bird Caye National Park (LBC)	Belize	40	Expenditures for 2006-08
Malpelo Island	Colombia	8,575	Detailed plan

**Table 2. Categorization of MMA expenditures.**

Expenditure category	Description
Admin & Overhead	Administration costs such as offices, supplies, or other non-field expenses not associated with specific activities.
Planning	Costs related to planning the MMA.
Research & Monitoring	Biological and socio-economic research, as well as monitoring of any aspect of the MMA.
Enforcement	Enforcement activities.
Outreach	Any activities oriented toward communication and/or collaboration with, and education of local communities, visitors, and other stakeholders.
Tourism	Funding specifically to support or deal with tourism.
Field operations	Similar to Admin & Overhead, but field expenses such as fuel, maintenance of vehicles, etc.
Staff (role unspecified)	In the case of one MMA, staff costs were not allocated to activities.

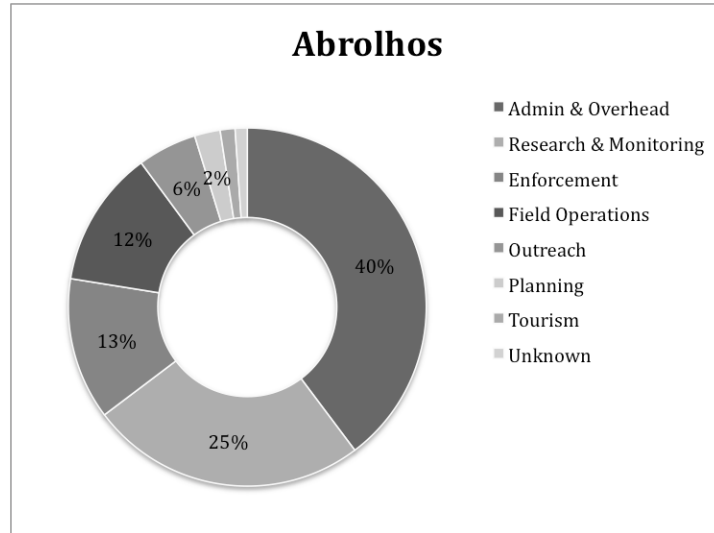
### 3.1. Abrolhos Marine National Park, Brazil

Abrolhos Marine National Park is a group of five islands about 65 km off the coast of Bahia state in Brazil. The park is part of the Abrolhos Bank, the Southern Atlantic Ocean's largest and richest reef system, encompassing most of the southern coast of Bahia. Communities of artisanal fishermen depend on marine resources to make a sustainable living, overfishing by commercial fleets, coastal development and large scale land conversion to agriculture pose challenges to these ecosystems and, by extension, the people who rely on them.

Spatial management in the area has three components: the Park itself, the Corumbau Marine Extractive Reserve, established in 2000, and the Cassurubá Extractive Reserve, established in June 2009. The first two are based around islands, while the last is mostly land- and estuary-based, on the mainland shoreline immediately west of the park.

For this site we have detailed information on estimated annual costs for running the MMA network. Some of these data are available for each component of the network, but some costs are shared by the whole network. We therefore consider this network as a single site. Proportions of expenditures allocated to each aspect of MMA management are shown in the figure<sup>2</sup> below.

<sup>2</sup> While the colours in the pie charts are difficult to distinguish, the items in the chart are in clockwise order



### 3.2. Great Blue Hole and Half Moon Caye, Belize

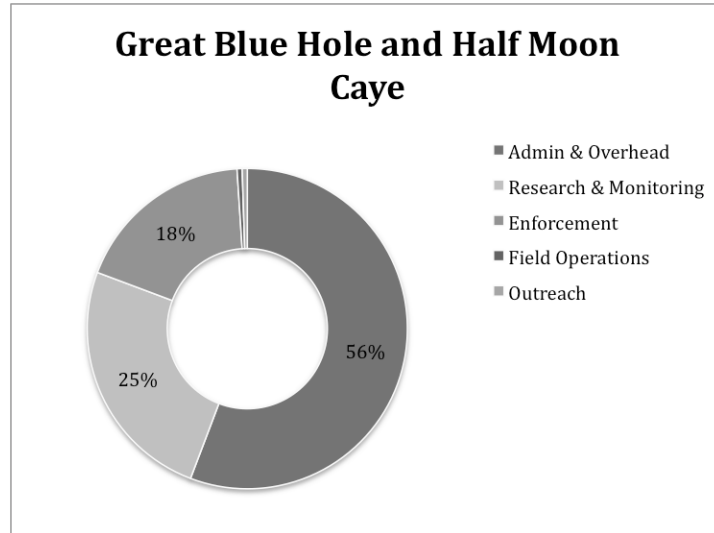
The Great Blue Hole (GBH) is an almost circular sinkhole with a diameter of approximately 318 m and a maximum depth of 125 m, and is a major attraction for scuba divers. The Blue Hole, along with seven other MPAs on the Belize Barrier Reef, was inscribed by UNESCO on the World Heritage Sites List in 1996 and declared a Natural Monument in February 1999. Blue Hole Natural Monument covers an area of approximately 3,000 acres and consists of the GBH, surrounding coral patch reef and shallow seagrass lagoon.

Half Moon Caye (HMC) is located at the southeast corner of Lighthouse Reef Atoll, the outermost of Belize’s three coral atolls and some 50 miles southeast of Belize City. The 45 acres are divided into two areas, the Ziricote forest and the coconut palm beach. HMC was the first protected area in Belize and first marine protected area in Central America. It was designated a Natural Monument in 1982 along with 10,000 acres of surrounding waters, and was also declared a World Heritage Site by UNESCO.

GBH and HMC are both managed by the Belize Audubon Society, in association with the national government and The Nature Conservancy, an international NGO. The expenditure data that we have are estimates of expenditures in 2008. The two sites are considered together, and the proportional allocation of expenditures is shown below.

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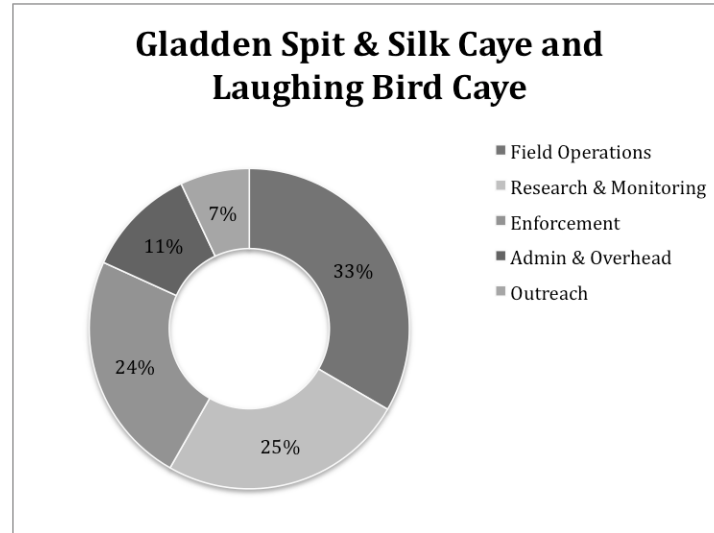
matching the items in the legend, and are sorted in descending order. E.g., at Abrolhos, Admin and Overhead is the largest single expenditure, 40% of the total; Research and Monitoring is next at 25%, and so on.



**3.3. Gladden Spit and Silk Cayes Marine Reserve; and Laughing Bird Caye, Belize**

Gladden Spit and Silk Cayes Marine Reserve (GSSCMR) was declared in 2001. The area on the Belize Barrier Reef is known for its spawning aggregations of snapper and grouper, and the associated whale sharks. In 2002, the local NGO Friends of Nature Belize (FON) signed a Memo Of Understanding with the Government of Belize to co-manage the Reserve. FON is now known as Southern Environmental Association (SEA Belize), and manages GSSCMR and the Laughing Bird Caye Marine Reserve (LBCMR). SEA conducts biological research on the spawning fish populations, and manages whale shark tourism.

LBCMR is 11 miles off the coast from Placencia Village in the Stann Creek District of Belize. LBC was declared a protected area in 1981 under the National Parks System Act, and is part of the Belize Barrier Reef World Heritage Site. We have data on estimated expenditures for GSSC and LBC together, for 2006-2008. The allocation of expenditures to various purposes is shown below.



### 3.4. Cocos Island National Park, Costa Rica

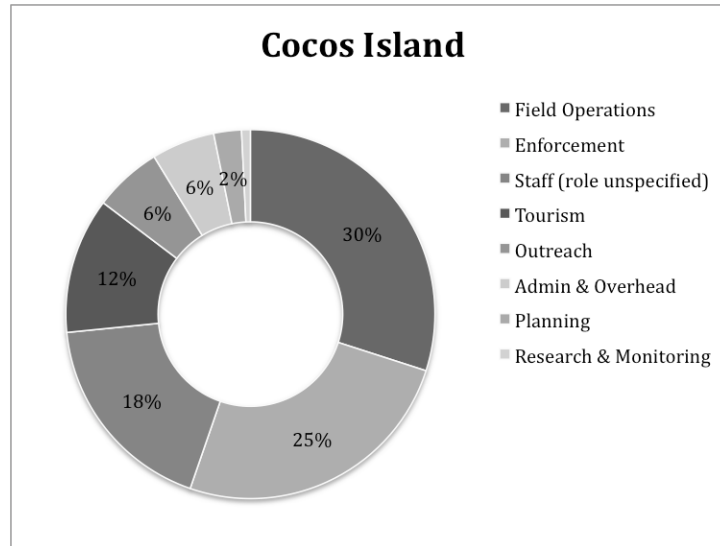
Cocos Island and its islets were designated as Cocos Island National Park (NPCI) in 1978 to protect its natural resources. The island is located 500 km from the Costa Rican coast. It was declared a World Heritage Site by UNESCO in 1967 and a National Heritage Site in 2002. The Cocos Island Area Bioregion was defined and demarcated in 1999 and declared as a priority for marine conservation by The Nature Conservancy (TNC).

Among the challenges faced by the site are controlling illegal fishing, diving in an environmentally friendly way, introduced species, and the solid waste management. The park's distance from the coast makes it a unique component of the National System of Conservation Areas, but also creates its own management challenges. The staff require different skills from the staff of other national parks, for example, knowledge of navigation. However, the distance from the mainland significantly increases the cost of conservation and protection. For example, transporting a staff member to the Island costs about \$1,000, compared with less than \$50 for transport to a park on the mainland. Similarly, any equipment, materials or construction cost much more once transportation is considered.

Management of the park is supported by the Global Environment Facility (GEF), the French Fund for the Environment (FFEM), MarViva, Conservation International (CI) and The Nature Conservancy (TNC). The park also receives support from national institutions such as the Ministry of Public Security, which supports security and surveillance and personnel transport, the Instituto Costarricense de Electricidad (ICE), which installed a hydroelectric plant and RACSA, which provides telecommunications and Internet services. The Foundation of Friends of Isla del Coco (FAICO) also manages projects

related to the Island, and raises funds for various projects from private donors.

The data for Cocos come from a report laying out a cost model, projecting costs and revenues over a six year period. However, we use the actual data for 2006 presented in the report. Allocations of expenditures are below.

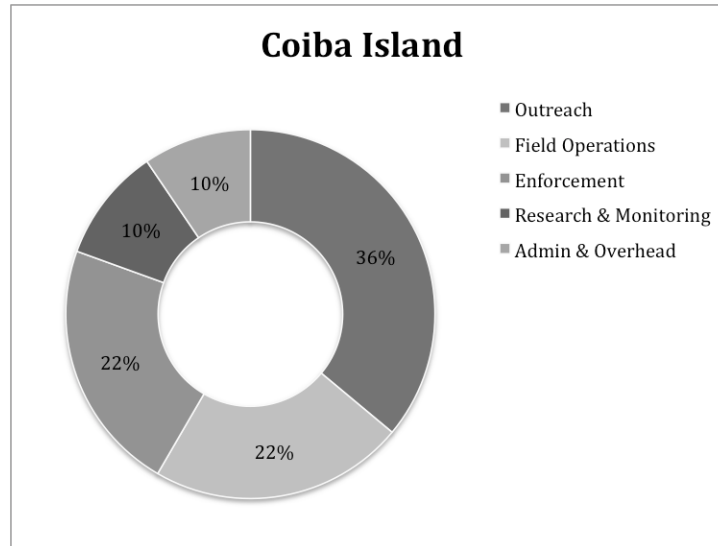


### 3.5. Coiba National Park, Panama

Coiba National Park was established in 2004, covering 270,125 hectares of which 216,543 is marine. The largest island of the group is Coiba, which is 50,314 hectares. Coiba Island is heavily forested, but this has been depleted by a penal colony and logging.

Fishing and tourism are recognized as the most important economic activities carried out in the Protected Marine Area of Coiba and the surrounding area. Artisanal fishing has proven to be an important source of income for communities in the area Buffer Park. While tourism to the island remains modest in scale, it has been increasing in recent years. Nearly a decade ago, the Panamanian government considered developing hotels in the national park, but this was challenged by national and international environmental groups who felt that tourism development based on investment in infrastructure is incompatible with conservation objectives. Today, this poses a challenge to the administration of the park because well-managed tourism could be a helpful source of long-term financing for the conservation of the Park if it is sustainably conducted. UNESCO declared the entire Coiba National Park a "World Heritage Site" in July 2005.

Our data come from a planning document for 2009-2013. Data presented are the average annual planned expenditure under the ‘basic’ scenario (i.e., the minimum amount required to ensure basic function of the protected area).



### 3.6. Galapagos Marine Reserve, Ecuador

The Galapagos Marine Resource Reserve was officially established in 1986, with the first management plan being issued in 1992. The Reserve was declared a National Park in 1996, and in 1998 the National Congress passed the Special Law for Galapagos, which created the Galapagos Marine Reserve (GMR). Through this law, the Ecuadorian government officially protected the islands to ensure the sustainable use and conservation of its resources. With an area of approximately 135,000 km<sup>2</sup>, the Galapagos Marine Reserve is one of the largest marine reserves in the world and one of the best preserved

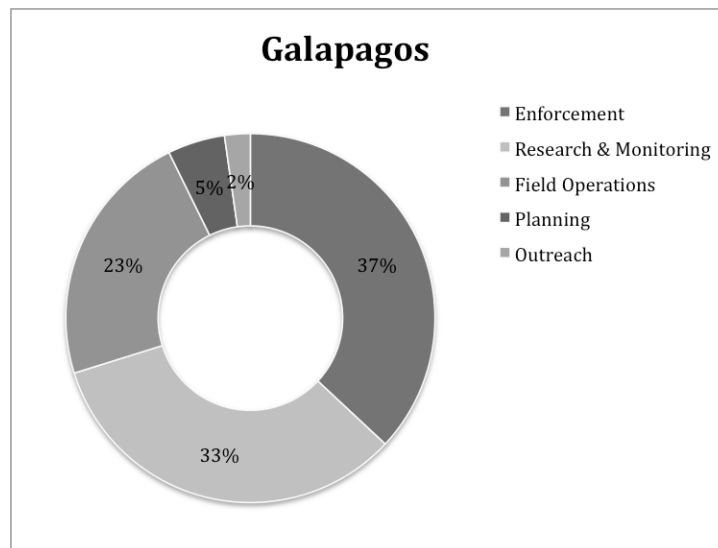
A Special Law excludes commercial fishing within the GMR and establishes a new regime for management and administration, including a participatory management scheme from a defined group of users and authorities.

The importance of the biodiversity in the GMR is recognized worldwide. In 2001 UNESCO designated the Galapagos Marine Reserve under the category Natural Heritage of Humanity. This recognition coupled with the reputation of the Galapagos National Park has drawn a number of major financial contributions to the GMR in a relatively short time. However, political instability and continuing changes within the Galapagos National Park and GMR have affected the confidence of donors, potentially undermining financial sustainability.

Virtually the entire island population benefits directly or indirectly from the resources of the Galapagos Marine Reserve, so management should ensure a balanced socio-economic stability of the local population and maintenance of marine and terrestrial protected areas. In late 2002 there was an artisanal fishing fleet of 446 boats and 956 fishermen registered, generating a gross annual income of approximately 4.6 million USD. Tourism is another activity carried out in the GMR; the Galapagos Islands are Ecuador's main tourist destination and an important source of income. In 2003, a total of 91,293 tourists visited the islands, of whom 69% were foreigners.

The GMR is financially and administratively run by the Galapagos National Park (GNP) Service, which manages not accounting for the GMR as a separate entity. The GMR receives 5% of total revenue per admission of visitors to the Galapagos, which in recent years has fluctuated around 300,000 USD annually. This amount is widely seen as insufficient to manage the GMR, so management of the GMR and its system of participatory decision making, is covered by other resources of the GNP and the support of the national government, the navy, and NGOs.

We obtained data from a planning document covering a ten-year period, from 2005-2014. The data presented below are the proposed allocations for 2005 only, under the 'basic' scenario (defined as above).

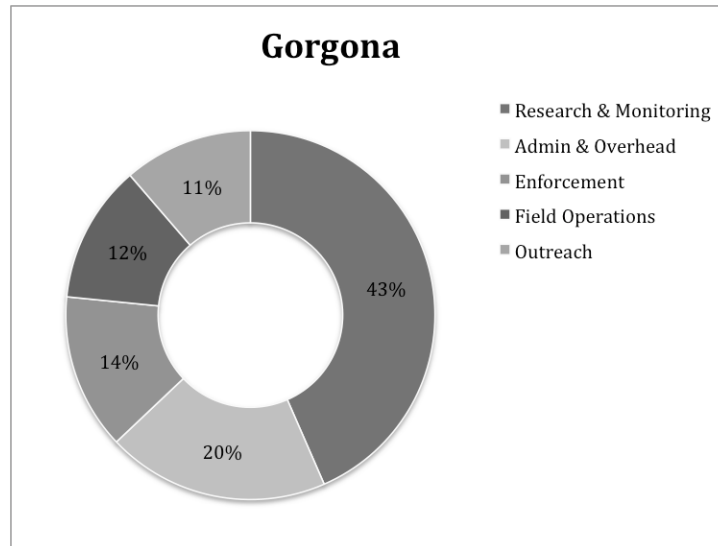


### 3.7. Gorgona National Natural Reservation Park, Colombia

Gorgona island sits about 50 km off the west coast of Colombia, and has been a National Natural Reservation Park since 1985. The island has no population except for the park

staff, and most of the activity on the island relates to tourism. The island has endemic species of birds, reptiles, fish and invertebrates, and is home to and visited by a great variety of marine species.

We obtained planned expenditures from a report laying out a long-term plan for the administration and management of Gorgona National Natural Park. The allocations shown below are for the basic budget scenario.

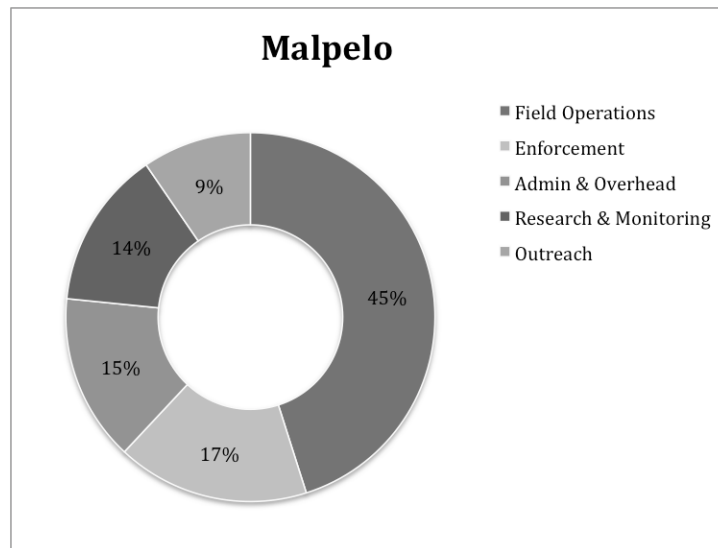


### 3.8. Malpelo Island, Colombia

The island of Malpelo is an important habitat for internationally threatened marine life. Its surrounding waters support massive populations of pelagic bony fish, sharks, marine mammals and sea turtles. Its coral formations are one of the few colonies of the Eastern Tropical Pacific Ocean. The island is considered a key location for bird conservation and is home to the largest colony of masked boobies in the world, with over 40,000 individuals. Malpelo is part of a regional conservation initiative known as the Marine Biological Corridor of the Eastern Tropical Pacific (ETP), which encompasses over 211 million hectares and includes the World Heritage Site islands of Galápagos (Ecuador), Cocos (Costa Rica), Coiba (Panama) and Malpelo, while Gorgona (Colombia) is currently being considered.

Malpelo Island is approximately 500 km west of the Colombian Pacific coast. It was declared a Fauna and Flora Sanctuary (FFS) in 1995, and is one of 52 protected areas of the Colombian National Parks System. The marine protected area was expanded from 113 to 2,500 square nautical miles (8,575 km<sup>2</sup>) in 2005.

Our data for this site, as for Gorgona, come from a planning document budget.



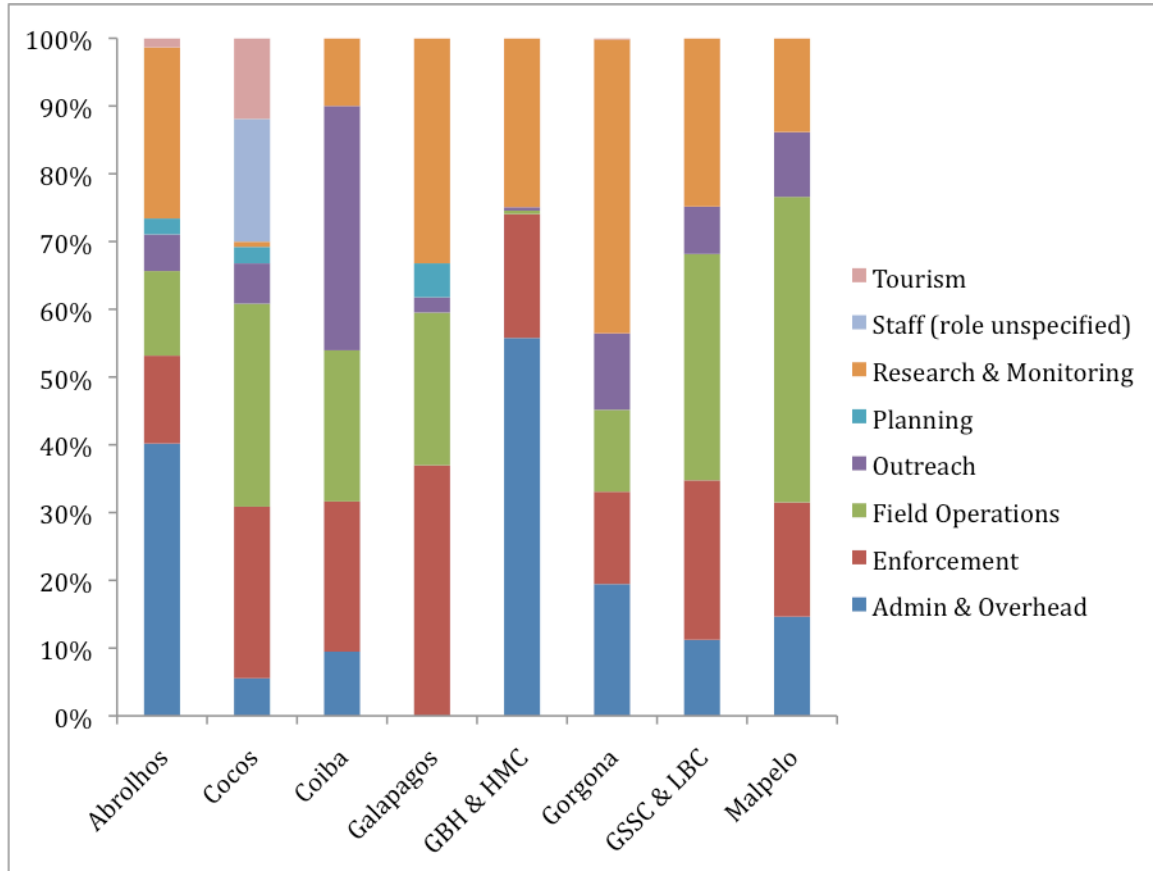
#### 4. Analysis

The initial plan was to run and estimate multiple regression/correlations for relationship between management components, covariates, and MMAs effectiveness variables. As stated earlier, the lack of relevant data in adequate amounts has force us to limit our analysis to examining how money is allocated among uses at the MMAs for which we have data; examine differences among sites and how these differences relate to the nature of the MMA; and conduct a qualitative analysis of whether current MMAs budgets are allocated to management components considered to be effective.

##### 4.1. Allocation of budget among uses

The analysis to follow draws on the background information about each site as outlined above, and on other considerations laid out in the five detailed planning documents.

The charts in the previous section showed expenditures as a proportion of the total for that site. These are compiled into one chart for the purposes of comparison (Figure 2).



**Figure 2. Proportional expenditure allocations at each MMA site.**

It is difficult to compare allocations across sites, since it seems likely that there is substantial variation in how expenditures are categorized by managers at each MMA. For example, field operations accounts for 45% of expenditures at Malpelo but less than 1% of expenditures at GBH & HMC. This reflects the fact that data for Malpelo were more precisely divided between expenditure types than at other sites. In reality, field operations (e.g., field equipment, fuel, etc) would typically be for one of the other purposes included, e.g., enforcement, research. However, at most sites these costs were not allocated by purpose, so they were kept separate.

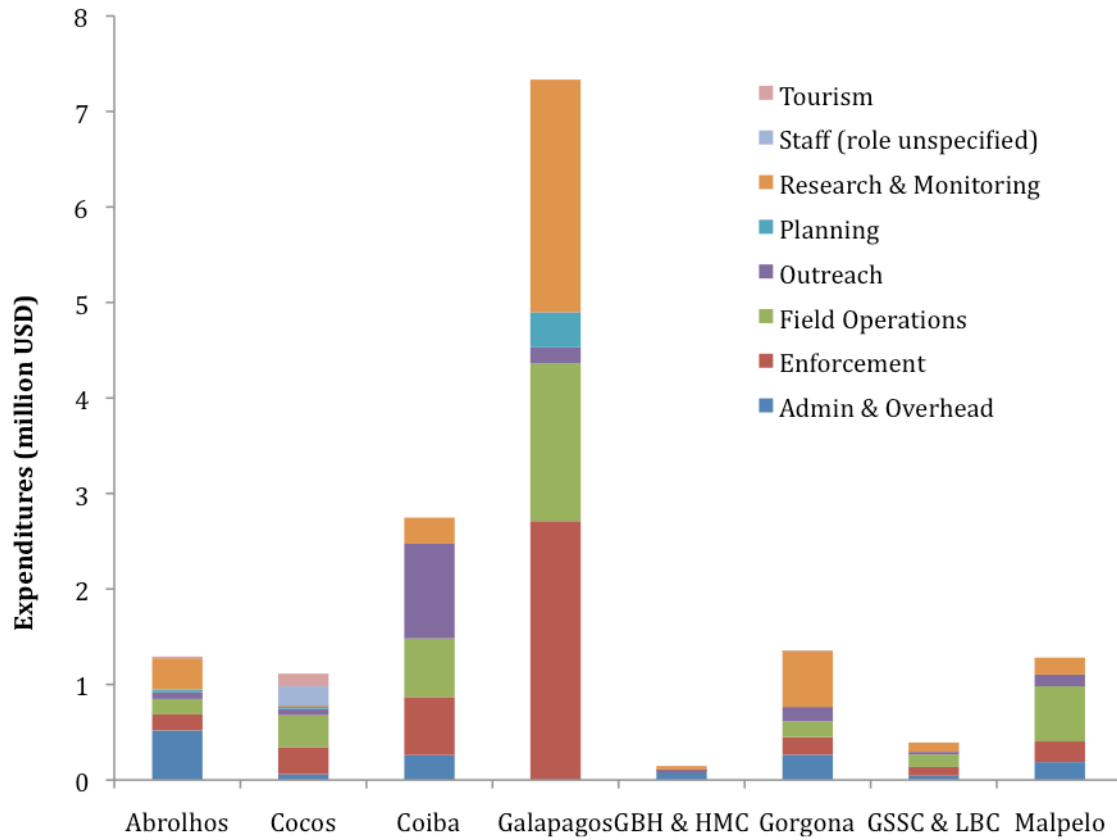
Several types of expenditures appear consistently at all MMAs:

- Administration and overhead are apparent as costs at every site, although to varying degrees. Some of this variation likely also arises from varying allocation of administration costs to specific activities such as enforcement, as opposed to putting

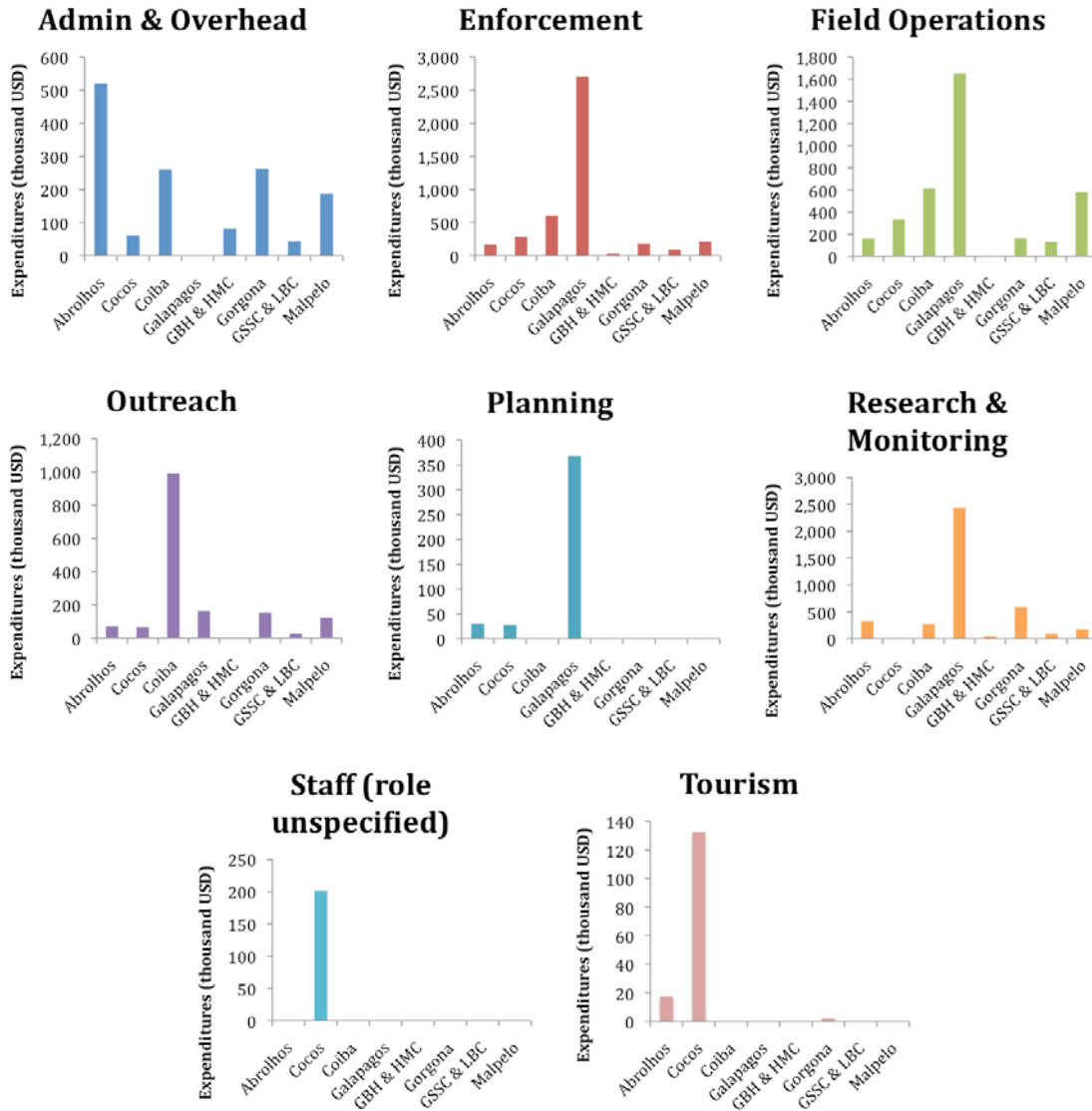
them into a general administration category.

- Enforcement comprises a significant proportion of expenditures at every site, ranging from 13% (at Gorgona) to 37% (at Galapagos). This high number for Galapagos is likely related to its extraordinarily large size – all other sites have expenditures of <25%.
- Research and monitoring are significant expenditures at all sites except Cocos, but the proportion of spending on these items varies widely, from 10% at Coiba to 43% at Gorgona.
- In most cases outreach and tourism support are relatively small proportions of expenditures, with Coiba and Cocos being notable exceptions, respectively.

Below, we summarize the actual expenditures, again separated by type (Figure 3 and Figure 4). In these figures, we see a wide variety of expenditures in the various MMAs on a raw basis, i.e., without controlling for potential determining factors such as MMA size. For example, at Galapagos, almost as much is spent on each of its two most-funded activities (enforcement, and research and monitoring) as is spent on *every* aspect of the management of the next most funded MMA, Coiba.

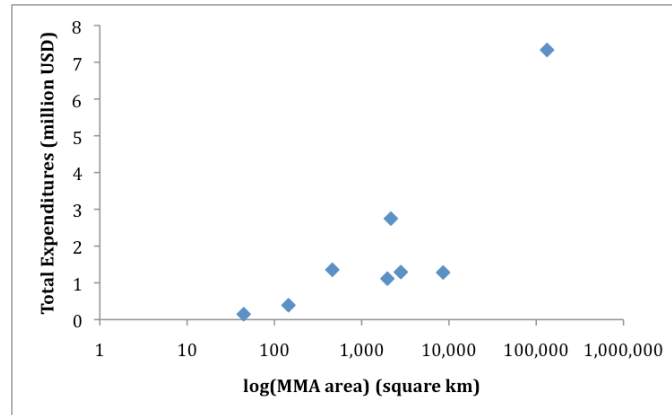


**Figure 3. Total expenditures at the eight MMA sites, by type of expenditure. Amounts are in millions of USD.**

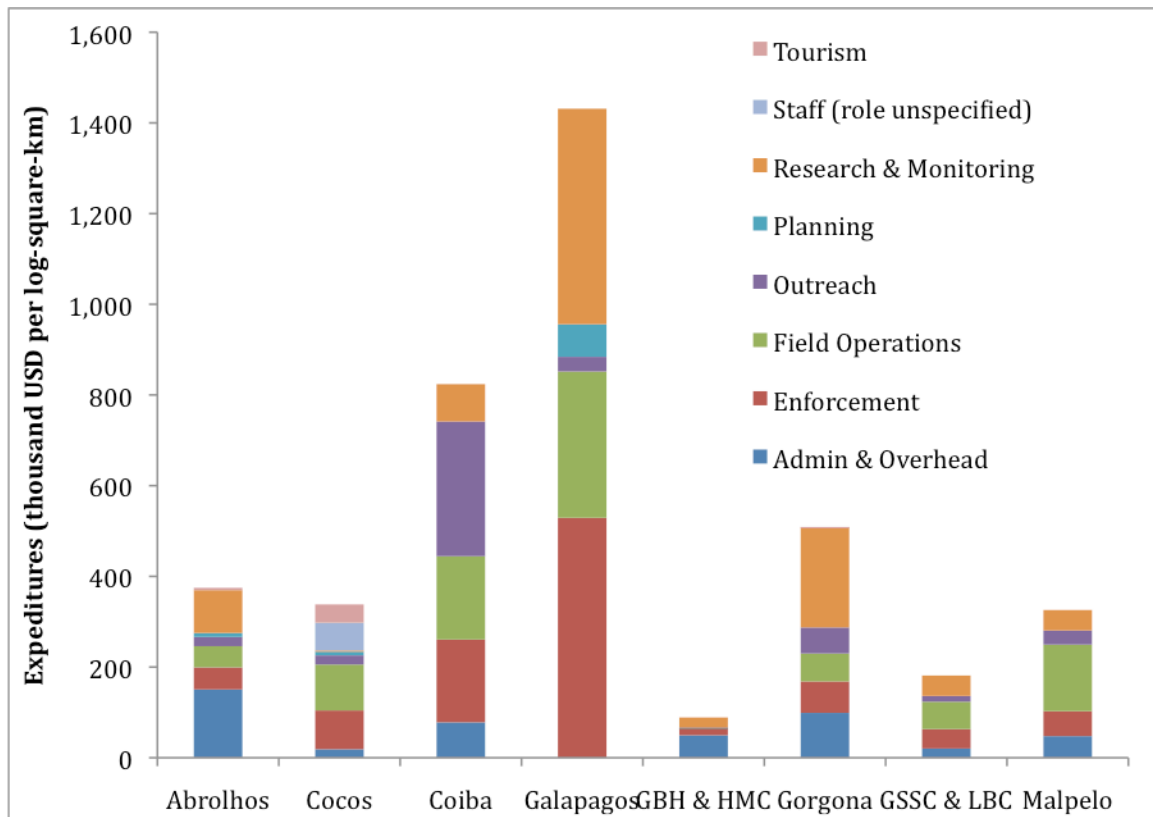


**Figure 4. Expenditures at each of the MMA sites, in separate graphs for each expenditure type. All amounts in thousands of USD.**

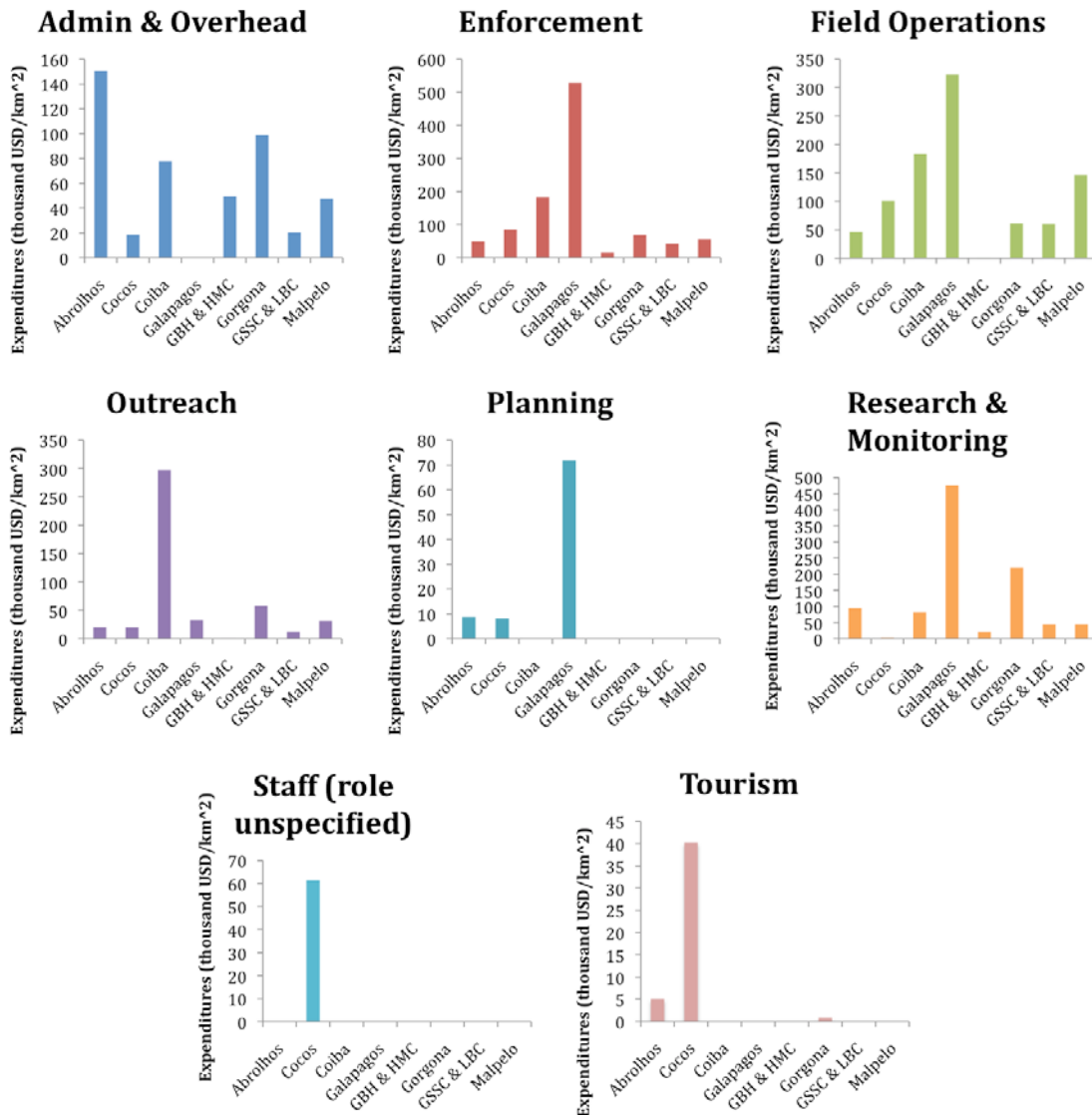
Unfortunately, these data are difficult to interpret because of the wide variety of expenditures. Past results from other studies suggest that this variation is likely in part related to the varying sizes of the MMAs, which range from 45 to 133,000 km<sup>2</sup>. A simple semi-log plot of total expenditures versus the logarithm of MMA size shows this relationship quite clearly, and it appears to be relatively linear:



To account for this effect and more meaningfully compare expenditures across sites, we present a second set of graphs below, showing expenditures per log-km<sup>2</sup>.



**Figure 5. Total expenditures at the eight MMA sites, by type of expenditure. Amounts are in thousands of USD per log-km<sup>2</sup> of area.**



**Figure 6. Expenditures at each MMA, by type of expenditure, on a per log-km<sup>2</sup> basis.**

Controlling for the size of the MMA cuts down the variability significantly, but there nevertheless remain large differences among sites, in terms of both total expenditures and those on particular aspects of management. The average funding per log-km<sup>2</sup> is 509 thousand USD. Galapagos is funded at almost three times this average level and Coiba at 60% greater than this level. In contrast, the two smaller sets of Belizean MMAs, GBH & HMC, and GSSC & LBC, are only funded at 17 and 36% of the average, respectively.

The other four sites are funded at between 64 and 100% of the average.

It is notable that the two least-funded MMAs are in the same country (Belize), and are run and funded primarily by local NGOs and the national government, which presumably comes with funding constraints. In contrast, the most heavily funded MMAs have substantial involvement from abroad, primarily from international NGOs.

Given the wide variety in sizes of MMAs that we examined, we wondered if there might be some economies of scale in management, i.e. if per-area management costs might be lower for larger MMAs. We examined this by plotting expenditures per log-km<sup>2</sup> against both raw MMA area and log-MMA area (Figure 8). We omitted unspecified staff, planning, and tourism from this analysis since there were very few actual data points for these types of expenditures, and we felt that the (likely false) zeros would distort any patterns in the data. Also, in the raw MMA plots we omitted Galapagos because its size is so great as to obscure the pattern in the rest of the data.

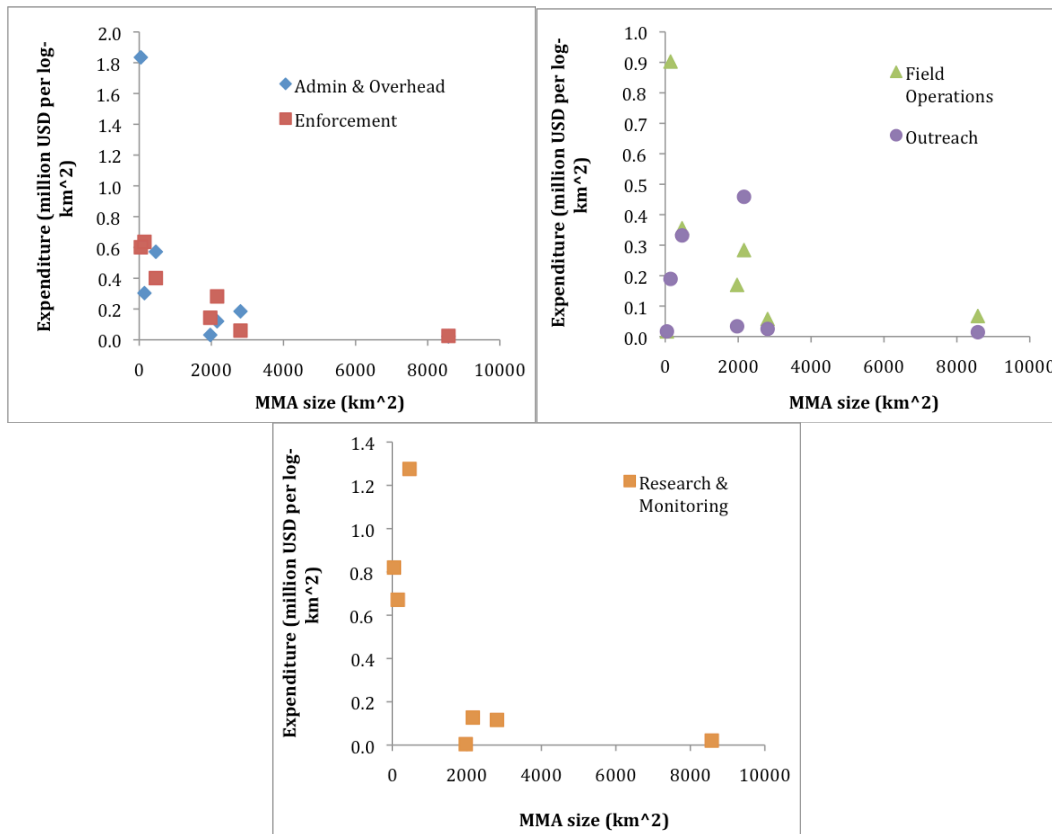
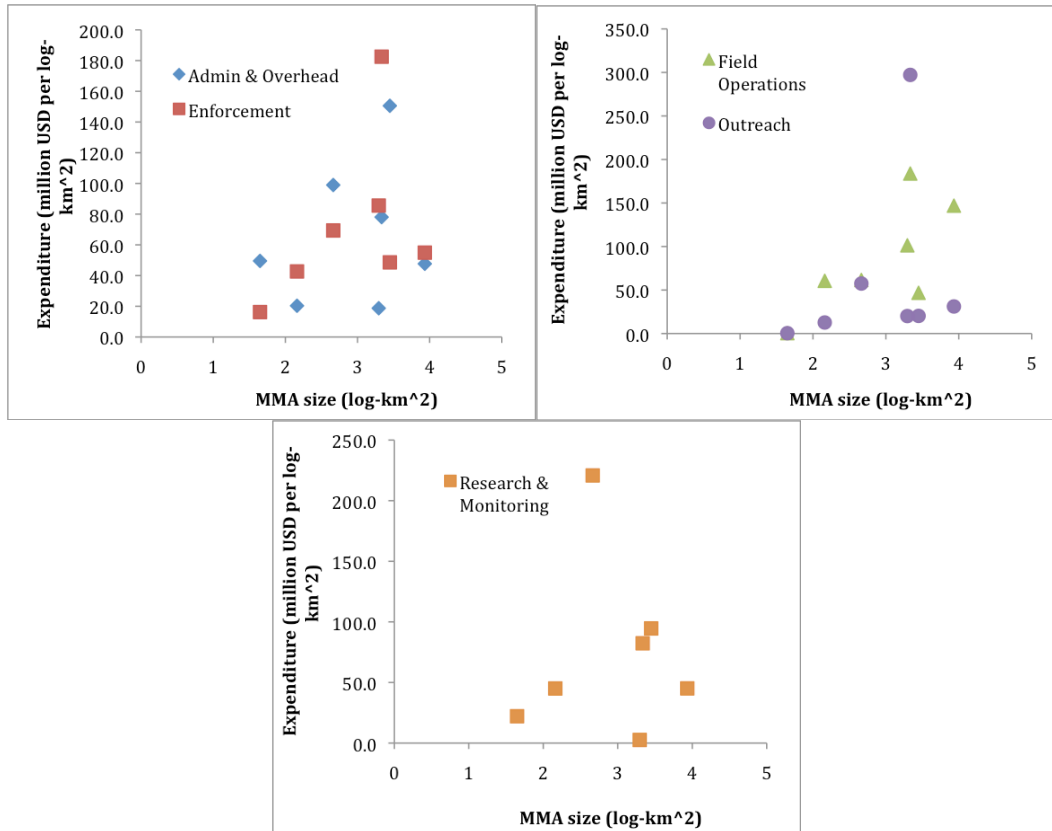


Figure 7. Expenditure per log-km<sup>2</sup> plotted versus MMA size.



**Figure 8. Expenditure per log-km<sup>2</sup> plotted versus the logarithm of MMA size.**

Some degree of economy of scale is apparent when we look at expenditures per log-area versus raw area, but not versus log-area. In examining the first set of graphs, it appears that there are differing degrees of economy of scale depending on the type of expenditure:

- Administration and overhead appear to fall off relatively quickly with increasing MMA size. This should not be unexpected given the fact that these are, to some extent, fixed costs of operating an MMA.
- Enforcement, however, declines less significantly with increasing area, again as we might expect since enforcement should be more strongly related to MMA area than administration.
- The cost of field operations declines substantially with increasing MMA size, which is likely driven more by fixed field operations, e.g., buildings, than by vehicles, fuel,

etc. However, this probably reflects some of the uncertainty noted above about data on field operations.

- Outreach does not appear to have a strong relationship to MMA size. This seems intuitive on one hand with respect to outreach to local communities and stakeholders, but perhaps less so with respect to outreach to, e.g., visitors, since a larger MMA might be expected to have more visitors.
- Lastly, research and monitoring costs decline substantially with increasing MMA size. Again, this decline is likely driven by the fixed aspects of these activities.

#### **4.2. Qualitative analysis MMAs budgets to management components**

We assigned ranks of 1, 2 and 3 to the investment components identified for each of our eight case studies. We then counted the number of times each one of the components was among the top 3. Looking at the definitions of the investment components ‘Administration & overhead’ and ‘field operations’ given in Table 2, it is clear that the two are virtually the same. We therefore combine the scores of these two categories under the banner of ‘Administration & overhead’ for our purposes here.

This simple analysis revealed that ‘Administration and overhead’ was at the top of current budgetary allocation with a count of 9 out of the possible 24; followed by enforcement at 8; and ‘Research and monitoring’ in third position with a count of 5. Other investment components had counts of 1 or 0.

We also calculated the average percentage of the total budget or MMAs investment that is allocated to the above three components. Using this metric ‘Administration and overhead’ tops with 42% of the average total MMAs investments allocated to it. ‘Research and monitoring’ narrowly beats out ‘Enforcement’ with 22% versus 21% for the latter.

A read of the MPA effectiveness literature reveals that the following three components of MMA/MPA management are mentioned again and again as crucial to their success: (i) improving the social context; building local community capacity through effective outreach (e.g., Fiske, 1992; Alder et al., 1994; Neis, 1995; (ii) having effective and fair enforcement (e.g., Christie et al. 2009); and (iii) conducting research and monitoring, including local ecological knowledge (e.g., Sumaila et al., 2000).

Comparing the current allocation of total MMAs investments and what the literature identifies as crucial management components to the success of MMAs, it will seem to us from this simple analysis that there is much to be desired if the current allocation is to be aligned to the success of MMAs. In particular, the huge allocation of budgetary funds to ‘Administration and overhead’ and the fact that ‘Outreach’ does not appear at all among the top 3 currently allocated investment components is worrisome.

## **5. Conclusion and next steps**

The above summary of data and analysis reveal some patterns in MMA costs and how these relate to the nature of the MMAs and whether, in a qualitative sense, current MMAs investments are allocated to management components considered to be most effective at meeting the goals of establishing them.

As we said earlier, the originally planned study is premature. To lay the foundation for such work, we first need to develop a global database of MMAs investments and allocations to different management components. The data we have already collected could form a good starting point for such a database. Given our experience at the Fisheries Centre in creating databases, this will be a task we are well positioned to continue to work on. After building this global database to an extent that it holds a critical mass of data, we will be in a position to revert back to our original study and carry it out.

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## 8. Appendix – Data sources

The following table lists the sources of the data on which we based our report. The associated electronic files contain nine folders. One is called “main data sources”, and contains the files from which we gathered most of our data. However, many of these files are difficult to read because many have been automatically translated from Spanish to English. We therefore include in eight separate folders all of the data we obtained for each site. Users requiring further information or guidance in how these files were used should contact Dale Marsden ([d.marsden@fisheries.ubc.ca](mailto:d.marsden@fisheries.ubc.ca)).

Site	Data available	Data source(s)
Abrolhos Marine National Park	Budget	Spreadsheets of expenditure estimates obtained from Rodrigo Leão de Moura, Programa Marinho, Conservação Internacional, Brazil.
Cocos Island National Park	Detailed plan	“Implementation Costs of the Management Plan for the Cocos Island National Park” by Jaime Echeverria. Obtained from Ana Maria Rodriguez, CI.
Coiba National Park	Detailed plan	“Análisis de costos del plan de manejo del parque nacional Coiba” by Ricardo G. Montenegro G. Obtained from Ana Maria Rodriguez, CI.
Galapagos Marine Reserve	Detailed plan	Informe final: estudio sobre las necesidades de financiamiento de la reserva marina de Galápagos/Final report: study on the needs of financing the Galapagos marine reserve”, author unknown. Obtained from Ana Maria Rodriguez, CI.
Gorgona National Natural Reservation Park	Detailed plan	“Diseño del Fondo Patrimonial para Gorgona, análisis de costos de manejo del EEZ Colombia, junto con el análisis integral de costos de manejo dentro de los Parques Naturales del Corredor Marino de Conservación del Océano Pacífico Tropical (CMAR)”, by Juan Manuel Soto D. Obtained from Ana Maria Rodriguez, CI.
Great Blue Hole and Half Moon Caye (GBHHMC)	Expenditures for 2008	Management cost questionnaire filled out by Losita Lee, Marine Protected Area Programme Manager. Obtained via Tammy Warner Campson.
Gladden Spit and Silk Cayes Marine Reserve (GSSC)	Expenditures for 2006-08	Management cost spreadsheet constructed and filled out by Nigel Martinez, Accountant for SEA Belize. Obtained via Tammy Warner Campson.
Laughing Bird Caye National Park (LBC)	Expenditures for 2006-08	Management cost spreadsheet constructed and filled out by Nigel Martinez, Accountant for SEA Belize. Obtained via Tammy Warner Campson.
Malpelo Island	Detailed plan	“Long-term Financing Funding Request for the Global Conservation Fund”, author unknown. Obtained from Ana Maria Rodriguez, CI.