SUPPLEMENTARY MATERIAL

How Are Our MPAs Doing? Challenges in Assessing Global Patterns in Marine Protected Area Performance

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Methods

Goals and objectives: Data analysis

All *HIYMPAD* goals and all but four listed objectives are linked to at least one indicator, however some objectives and goals can be measured by up to seven or ten indicators, respectively. To explore which goals and objectives received the most attention from the monitoring and evaluation efforts, two indices were calculated: 1) representation and 2) effort.

The representation index represents the proportion of MPAs that included a particular goal or objective in their assessment, no matter how many of the potential goal-/objective-specific indicators outlined in *HIYMPAD* are measured. The effort index represents how comprehensive the evaluation is of each specific goal or objective by calculating the proportion of all potential *HIYMPAD* indicators measured for each specific goal or objective (e.g., if five different indicators can be used to assess a particular objective, a more complex picture of performance will come from measuring all five of the indicators, rather than only one).

The representation index was calculated using the following formula:

$$Representation(x) = \frac{\sum n(x)}{N}$$

The effort index was calculated using the following formula:

$$Effort(x) = \frac{\sum_{i=1}^m n(x_i)}{m * N}$$

Where: x = the given goal or objective

n = number of MPAs evaluating

N = the total number of MPAs

m = number of indicators linked to x

i = indicator linked to x

Objectives and goals were ranked by each of these indices (see Table S3 for number of indicators per objective and goal).

Non-management factors

To examine the effect of age of MPA or national differences, the area of each country and the length of its coastline was obtained (CIA 2008) as well as metrics on demographics and socioeconomic status (World Bank's 2006 data on population and purchasing power parity (PPP) gross national income) (World Bank 2008). PPP was transformed into its natural logarithm. 2005 Human Development Index (HDI) scores from the United Nations Development Programme (UNDP) were used to assess countries' level of development (UNDP 2008). Guam and the Commonwealth of the Northern Mariana Islands (CNMI) are not UN members and therefore do not have HDI scores, so instead were assigned average values for their income class. The Federated States of Micronesia lacked education index data, so an HDI value based on the other two component indices was calculated. 2006 data for the six components of the World Bank Institute's Worldwide Governance Indicators Project (WGI) was averaged to form a mean governance score for comparison (World Bank 2008). Lastly, each country's involvement in fishing was proxied using the UN Food and Agriculture Organization data on (1) the number of fishers in-country in 2000 and (2) the amount of fish or fisheries products exported in 2004 (WRI 2007). Guam and CNMI lacked data for this latter value and had to be excluded from analysis for these variables.

Supplementary References

CIA (Central Intelligence Agency). 2008. The World Factbook. CIA (Central Intelligence

Agency), <https://www.cia.gov/library/publications/the-world-factbook>

UNDP (United Nations Development Programme). 2008 Human Development Report

2007/2008: Fighting climate change: Human solidarity in a divided world. UNDP: New

York, NY; 384 pp., <http://hdr.undp.org/en/statistics/data/>

World Bank. 2008. Governance matters 2007: Worldwide governance indicators, 1996-2006.

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WRI (World Resources Institute). 2007 EarthTrends: Environmental information. World

Resources Institute. <http://earthtrends.wri.org>

Table S1. Descriptions of sites piloting the *How is your MPA doing?* methodology. Sites in italics had no scores in the final set of 157 site indicators used for analysis. If protected area includes both marine and terrestrial areas, only marine area is reported in MPA area column.

Site Name	Country	Region	Geographic Location	Date Established	Size (km ²)
Achang Reef Flat Preserve	Guam	Pacific	13° 14' 43" N 144° 42' 49" E	05/16/97	4.85
<i>Banc d'Arguin National Park</i>	<i>Mauritania</i>	<i>Africa</i>	20° 4' 28" N 16° 24' 31" W	06/24/76	6000
Banco Chinchorro	Mexico	Caribbean	18° 35' 12" N 87° 20' 13" W	07/19/96	1403
Biak and Padaido Islands	Indonesia	SE Asia			1940
Bird Island Sanctuary	CNMI	Pacific	15° 15' 27" N 145° 48' 5" E	04/20/01	1120
<i>Bunaken National Park</i>	<i>Indonesia</i>	<i>SE Asia</i>	1° 41' 2" N, 124° 42' 40" E	01/01/91	790.5
Channel Islands National Marine Sanctuary	USA	Eastern Pacific	34° 0' 0" N 120° 0' 0" W	1980	4294
Far Eastern Marine Reserve	Russian Federation		42° 38' 19" N 131° 20' 59" E	01/01/78	1525
Galapagos Marine Reserve	Ecuador	Eastern Pacific	0° 8' 38" N 90° 43' 13" W	11/07/96	135000
Glovers Reef	Belize	Caribbean	16° 45' 50" N 87° 49' 30" W	01/01/93	350.7
Hinatuan Bay	Philippines	SE Asia		12/1999	5.77
Hol Chan	Belize	Caribbean	17° 52' 11" N 87° 59' 52" W	07/25/87	13.89
Lenger Island Marine Protected Area	Pohnpei, FSM	Pacific	7° 0' 34" N 158° 13' 43" E	01/01/01	0.006
Loreto Bay National Park	Mexico	Caribbean	25° 38' 24" N 110° 48' 55" W	07/19/96	1834
Mafia Island	Tanzania	Africa	7° 37'-8° 10' S 39° 30'-39° 55' E	07/01/95	615
Miramare Natural Marine Reserve	Italy	Europe	45° 40' 0" N 13° 34' 60" E	05/26/05	1.2
Piti Bomb Holes Preserve	Guam	Pacific	13° 28' 34" N 144° 42' 16" E	05/16/97	3.36
Saguenay-St. Lawrence Marine Park	Canada	NW Atlantic	48° 2' 44" N 69° 45' 3" W	1/1/1997	1138
<i>Sapodilla Cayes Marine Reserve</i>	<i>Belize</i>	<i>Caribbean</i>	16° 8' 46" N 88° 17' 24" W	08/28/96	172.2
Sian Kaan	Mexico	Caribbean	19° 31' 33" N 87° 39' 28" W	01/01/86	1532
Trao Reef	Vietnam	SE Asia		2001	
Tubbataha Reef National Marine Park and World Heritage Site	Philippines	SE Asia	8° 50' 12" N 119° 44' 49" E	11/08/88	331.5
Tumon Bay Marine Preserve	Guam	Pacific	13° 31' 0" N 144° 48' 10" E	05/01/97	408.7
<i>Upper Gulf of California and Colorado River Delta Biosphere Reserve</i>	<i>Mexico</i>	<i>Caribbean</i>	31° 34' 47" N 113° 58' 42" W	1945	5416

Table S2. Coding schema of *HIYMPAD* indicator scores for analysis. All biophysical indicators were coded in the same way; likewise all socioeconomic indicators were coded in the same manner (though differently from the biophysical indicators). Governance indicators were coded differently because they relied on qualitative data.

		Indicator	All B (biophysical) indicators	All S (socioeconomic) indicators	G2-Existence of a decision-making and management body	G3 - Existence and adoption of a management plan
Coded score		0	Baseline	Baseline	Baseline	Baseline
	negative trend	1	-Statistically significant - Strong methods	0% - 12.5%	Decision-making and management body does not exist - Likert score set at 2.5	Management plan does not exist - Likert score set at 2.5
		2	-Not statistically significant - Temporal and reserve/control sampling -Strong methods	12.6% - 25%		
		3	Not statistically significant - Temporal or reserve/control sampling -Strong methods	25.1% - 37.5%		
		4	Not statistically significant - Weak methods -Statement provided, but no data - Judgement call	37.6% - 49.9%	Management body exists but not functioning effectively	
		5	No change	50%		
	positive trend	6	Not statistically significant - Weak methods -Statement provided, but no data - Judgement call	50.1% - 62.5%	Non-formal decision-making and management body exists	MPA Guided by goals and objectives to achieve certain outcomes -----or----- Memorandum of understanding exists
		7	Not statistically significant - Temporal or reserve/control sampling -Strong methods	62.6% - 75%	Decision-making and management body comprised of numerous stakeholders	Existence of an MPA management plan
		8	Not statistically significant - Temporal and reserve/control sampling -Strong methods	75.1% - 87.5%	Decision-making and management body are the same body and have a legal mandate	Existence of an MPA management plan, - Basic strategy exists to achieve MPA goals and objectives
		9	-Statistically significant -Strong methods	87.6% - 100%	Decision-making and management body are the same body, have a legal mandate, and are comprised of numerous stakeholders	Existence of an MPA management plan, - Basic strategy exists to achieve MPA goals and objectives, - Management plan has legal mandate for implementation
		99	Data missing	Data missing	Data missing	Data missing

		Indicator	G4 - Local understanding of MPA rules and regulations	G5 - Existence and adequacy of enabling legislation	G6 - Availability and allocation of MPA administrative resources			G8 - Existence and activity of level of community organization(s)
Coded score		0	Baseline	Baseline	Baseline			Baseline
	negative trend	1	0% - 12.5%	Legislation does not exist to enable the MPA to accomplish its goals and objectives - Likert score set at 2.5	0% - 12.5%	5	Defecit in both personnel and funds - Likert score set at 2.5	No community organizations exist - Likert score set at 2.5
		2	12.6% - 25%		12.6% - 25%			
		3	25.1% - 37.5%		25.1% - 37.5%			
		4	37.6% - 49.9%		37.6% - 49.9%		Defecit in either personnel or funds	
		5	50%		50%			
	positive trend	6	50.1% - 62.5%	Legislation exists to support the MPA -Legislation is slightly compatible with MPA management plan	Due to data constraints (e.g. no comparison between planned number of personnel and equipment called for in the management plan versus actual personnel and equipment), the sites were ranked in comparison to one another			One or more community organizations exist
		7	62.6% - 75%	Legislation exists to support the MPA -Legislation is slightly compatible with MPA management plan, and somewhat supportive of MPA management activities and interventions				One or more community organizations exist and are effectively organized
		8	75.1% - 87.5%	Legislation exists to support the MPA -Legislation is very compatible with MPA management plan, and mostly supportive of MPA management activities and				One or more community organizations exist, are effectively organized, and are somewhat active
		9	87.6% - 100%	Legislation exists to support the MPA -Legislation is very compatible with both the MPA management plan, and MPA management activities and interventions				One or more community organizations exist, are effectively organized, and are very active
		99	Data missing	Data missing				Data missing

		Indicator	G10-G11 - Proportion of stakeholders trained (G10) and level of training (G11) in sustainable use	G12 - Level of stakeholder participation and satisfaction in management processes and activities	G13 - Level of stakeholder involvement in surveillance, monitoring, and enforcement
Coded score		0	Baseline	Baseline	Baseline
	negative trend	1	Low amount of training or downward trend in proportion of stakeholders trained in sustainable use - Likert score set at 2.5	0% - 12.5%	0% - 12.5%
		2		12.6% - 25%	12.6% - 25%
		3		25.1% - 37.5%	25.1% - 37.5%
		4		37.6% - 49.9%	37.6% - 49.9%
		5	No change	50%	50%
	positive trend	6	Variety of workshops and training sessions held with stakeholders during the planning and implementation phases to disseminate information on sustainable resource use	Stakeholders attend the meetings	50.1% - 62.5%
		7	The capacity-building activities undertaken during the implementation phase are still provided to date	Stakeholders have the opportunity to express their opinions	62.6% - 75%
		8	The stakeholders are satisfied with the capacity-building activities	The opinions expressed by stakeholders are considered by MPA managers	75.1% - 87.5%
		9	The workshops and training courses affected the way people use the resources	Stakeholders are satisfied with their level of participation	87.6% - 100%
		99	Data missing	Data missing	Data missing

		Indicator	G14 - Clearly defined enforcement procedures	G15 - Enforcement coverage	G16 - Degree of information dissemination to encourage stakeholder compliance
Coded score		0	Baseline	Baseline	Baseline
	negative trend	1	The sites were ranked in comparison to one another	Due to data constraints (e.g. no comparison between planned patrol schedule and procedures called for in the management plan versus actual surveillance and monitoring patrols), the sites were ranked in comparison to one another	0% - 12.5%
		2			12.6% - 25%
		3			25.1% - 37.5%
		4			37.6% - 49.9%
		5	No change	No change	50%
	positive trend	6	The sites were ranked in comparison to one another	Due to data constraints (e.g. no comparison between planned patrol schedule and procedures called for in the management plan versus actual surveillance and monitoring patrols), the sites were ranked in comparison to one another	50.1% - 62.5%
		7			62.6% - 75%
		8			75.1% - 87.5%
		9			87.6% - 100%
		99	Data missing	Data missing	Data missing
					<p>Variety of workshops and training courses held with stakeholders during the planning and implementation phases to disseminate information about the MPA -Capacity-building activities provided during planning for MPA on rules, regulations, and enforcement arrangements</p> <p>The capacity-building activities undertaken during the implementation phase are still provided to date -Capacity building activities (number and type) determined by both MPA managers and stakeholders</p> <p>The stakeholders are satisfied with the workshops and training courses</p> <p>The workshops and training courses affected the compliance behavior and enhanced stakeholder understanding of the rules, regulations, and purpose of the MPA</p>

Table S3. The number of indicators that can be used to assess each goal and objective. In this table, “Total” refers to the overall number of indicators that can be used to assess a goal, and is not a sum of the indicator count per objective (many indicators can be used to assess multiple objectives). There are 26 biophysical objectives (5 goals), 21 socioeconomic objectives (6 goals), and 21 governance objectives (5 goals).

Biophysical goals	Objective	Indicator count	Socioeconomic goals	Obj.	Ind. count	Governance goals	Obj.	Ind. count	
1. Marine resources sustained or protected	A	4	1. Food security enhanced or maintained	A	1	1. Effective management structures and strategies maintained	A	2	
	B	4		B	2		B	1	
	C	7		Total	2		C	1	
	D	6	2. Livelihoods enhanced or maintained	A	4		D	1	
	E	5		B	4		E	0	
	F	4		C	2		F	1	
	Total	10		D	3		Total	5	
2. Biological diversity protected	A	5	Total		8	2. Effective legal structures and strategies for management maintained	A	1	
	B	3	3. Non-monetary benefits to society enhanced or maintained	A	1		B	0	
	C	3		B	1		C	1	
	D	5		C	1		D	0	
	E	3		D	1		E	3	
	F	0		E	1		Total	3	
	G	2		F	1	3. Effective stakeholder participation and representation ensured	A	1	
	Total	10	Total	1	B		1		
3. Individual species protected	A	6	4. Benefits from the MPA equitably distributed	A	2	4. Management plan compliance by resource users enhanced	C	1	
	B	6		B	5		Total	3	
	C	3		C	1		4. Management plan compliance by resource users enhanced	A	4
	D	3	Total	7	B	3			
	Total	9	5. Compatibility between management and local culture maximized	A	2	C		1	
4. Habitat protected	A	5		B	2	D		1	
	B	5		6. Environmental awareness and knowledge enhanced	Total	3		E	2
	C	5	A		2	F		1	
	D	4	B		3	Total	9		
	Total	7	C	2	5. Resource use conflicts managed and reduced	A	1		
5. Degraded areas restored	A	4		D		2	Total	1	
	B	5		Total		4			
	C	5							
	D	5							
	E	4							
	Total	9							