

THE MARINE MAMMAL PROTECTION INDEX: RANKING COUNTRIES' CONSERVATION PERFORMANCE¹

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ABSTRACT

This paper presents a composite performance index, Marine Mammal Protection Index (MAM_{prot}), that evaluates the performances of maritime countries based on three components of marine mammal protection – degree of pressure exerted on marine mammal species through human activities; their conservation status; and government response in mitigating or preventing human-induced damages to marine mammal populations.

Computation of MAM_{prot}, as an aggregated relative score of six independent indicators, enables maritime countries to be ranked based on their performance in protecting marine mammals. A composite league table presented in this paper shows Australia, followed by four European countries, Germany, UK, Sweden and the Netherlands, as the top five countries, while three countries that participate in commercial hunting of marine mammals, Canada, Japan, and Iceland, ranked amongst the bottom five. While severe data gaps at the global level, difficulties in attributing country performance to the status of highly migratory species and conceptual concerns inherent to composite indices limit the MAM_{prot}'s suitability as a definitive measure of marine mammal protection, the index is, nevertheless, a first attempt at a multi-dimensional comparison of marine mammal protection performance across maritime countries.

INTRODUCTION

A composite index is a powerful communication tool with which to present clear and simple “executive summaries” (Jesinghaus, 1999) of complex systems. Through aggregation of multiple parameters or indicators, each of which is representative of a dimension of the system in question, composite indices condense information into a single value that can be presented to non-experts requiring an overview of the system without the need for further interpretation. Because of this ability to integrate large amounts of disparate information into an easily understood format, composite indices are increasingly being used as benchmarks in comparing and ranking performances of various entities, ranging from hospital to universities to governments.

While a number of composite indices on environmental sustainability have been developed in recent years (e.g. Environmental Performance Index see Esty and Levy, 2006), none has focused exclusively on management of the oceans, or parts thereof. Yet, management of the oceans, or of at least those parts of the marine realm within the Exclusive Economic Zones of maritime countries (40%), could benefit from such an index. Unsustainable expansion of global fisheries in the latter half of the 20th century and the perilous state of marine living resources of the world is well documented (Jackson *et al.*, 2001; Myers and Worm, 2003; Pauly *et al.*, 2002; Worm *et al.*, 2006). While the intricacy of the marine environment implies that the state of world's oceans is a global responsibility, the current ocean management regime based on the principal of national jurisdiction up to 200 nautical miles out from a coast (i.e., within EEZs) dictates that coastal countries must ultimately be held accountable for addressing the conservation issues in their waters. A composite index, as a mean to tracking management performance and a benchmark for comparative cross-national assessment, thus, may serve as a

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useful tool in monitoring ocean (and EEZ) governance and the periodic publication of a composite league table should raise public awareness and recognition of the need for better governance.

Thus, the objective of this study is to construct a composite index that can serve as an indicator of marine mammal protection for an aggregated ocean management index. The index, named Marine Mammal Protection Index (MAM_{prot}), was designed based on the Pressure-State-Response (PSR) model of environmental indicators developed by the OECD (2002) and is an aggregated score of six proxy indicators representing, for each country:

- The existence of targeted hunting of marine mammals;
- The potential marine mammal bycatch within its EEZ;
- The extinction risk of marine mammals inhabiting its EEZ;
- The abundance of marine mammals inhabiting its EEZ;
- Its participation in international conservation treaties; and
- The willingness to act domestically on marine conservation.

This study presents a league table of countries based on their MAM_{prot} scores, which can be evaluated separately, or aggregated with the other indicators presented in this volume to derive and aggregated EEZ protection score.

METHODOLOGY

Theoretical framework

A composite index comprising multiple dimensions, in general, will take the form (Freudenberg, 2003):

$$I = \sum_{i=1}^n w_i X_i \quad \dots 1)$$

where I = composite index, X_i =underlying indicators or variables, w_i =weight of the X_i , $\sum w_i=1$ and $0 \leq w_i \leq 1$.

In principle, variables selected should each represent a core component of the system being analysed and weights should reflect their relative importance in the overall composite. However, in practice, it is difficult to identify a set of individual variables and integrate them in manner that accurately reflects reality. Even if such a theoretically ideal set of variables were to be identified, the non-availability of suitable data presents a major constraint in its implementation (Niemeijer, 2002). This constraint is most strongly visible when attempting to construct an index that will allow a broad cross-national comparison, as is the case with the MAM_{prot} , where data gaps and inconsistencies from one country to another are severe.

While there is no consensus on how environmental indices should be framed, the use of PSR-based models has been increasing, particularly for designing the MAM_{prot} . The OECD (2002a) model is based on the concept of causality, with an emphasis on identifying a set of indicators that represent:

- The pressure exerted on the environment through human activities ('pressure' indicators);
- Changes in the quality and quantity of the environment resulting from this pressure ('state' indicators);and
- Social response to mitigate or prevent human-induced damage on the environment ('response' indicators).

Applying this model to marine mammal protection, three questions must be addressed:

- What are the human-induced threats faced by marine mammals?
- What is the current status of marine mammal populations?
- What are governments doing to protect and conserve these species?

In selecting and aggregating individual variables, these three questions were used as our guidelines.

Variable selection

In constructing a composite index, variable selection represents the major source of uncertainties and bias. Ideally, variables should be selected based on their analytical soundness, measurability, and relevance to the system in question (OECD, 2002b). Moreover, they must reflect changes over time and should periodically be updated to sufficiently reflect the current state of the system (Hammond *et al.*, 1995). As noted above, the greatest constraint in constructing a composite index is the lack of relevant data. A composite index can only be based on existing data. Consequently, many theoretically ideal indicators were abandoned in the course of completing this contribution. For example, the use rate of by-catch reduction devices, both as an indicator of pressure on marine mammal populations and of government management policies, would constitute a valuable measurement of marine mammal protection performance. However, such assessments are generally limited to regional case studies and currently do not exist on a global scale.

In the end, six variables were selected for the MAM_{prot} , representing obvious and easily accessible aspects of marine mammal protection:

Targeted Hunts (Pressure)

Exploitation of marine mammals for consumption is the most direct pressure on populations from human activities (Jackson *et al.*, 2001). Historically, excessive commercial hunting has led to massive reductions in wild populations and such declines are well documented for both cetaceans and pinnipeds (Christensen, 2006). Despite concerns over the inherent vulnerability of marine mammals to human exploitation (Anderson, 2001), targeted hunting for marine mammals continues, including for species protected by a moratorium on commercial whaling by the International Whaling Commission (e.g. see Mulvaney, 1996 for summaries of targeted hunting of small cetaceans). Perceived conflicts between marine mammals and fisheries also lead to targeted culling and are expected to intensify with the increasing demand for seafood (Levigne, 2003).

A global database of marine mammal catch does exist, i.e., the FishStat database of the Food and Agricultural Organization of the United Nations (FAO). However, the quality of data is highly questionable, particularly for the catch of small cetaceans, with zero catch recorded for countries (e.g., Sri Lanka and the Philippines) known to participate in commercial hunting (Reeves *et al.*, 2003). However, catches for pinnipeds appear to be consistent with various qualitative assessment of pinniped exploitation. With no alternative source of small cetacean catches with a global scope, we have instead grouped marine mammals into three categories (pinnipeds, small cetaceans and great whales) and scored countries from zero to three for each marine mammal groups based on available qualitative and quantitative description of targeted hunting in a country (Table 1).

Table 1. Scoring of participation in targeting hunting by maritime countries.

Score	Pinnipeds	Small cetaceans	Great whales
3	No hunting	No hunting	No hunting
2	Hunting of a single species with average annual catch (2000-2005) <100	Participation in an 'opportunistic' hunting of a single species	Hunting of a single species with average annual catch (2000-2005) <10
1	Hunting of a single species with average annual catch ≥100 OR Hunting of multiple species with average annual catch <100 per species	Participation in a 'regular' hunting noted for a single species OR Participation in 'opportunistic' hunting noted for multiple species	Hunting of a single species with average annual catch ≥10 OR Hunting of multiple species with average annual catch >10 per species
0	Hunting of multiple species with average annual catch ≥ 100	Participation in 'regular' hunting noted for multiple species	Hunting of multiple species with average annual catch ≥10

For each country, its indicator score for targeted hunting, TH_c , equals:

$$TH_c = th_{pinniped,c} + th_{cetacean,c} + th_{whale,c} \quad \dots 2)$$

where $th_{pinniped,c}$ =country's score for participation in hunting of pinnipeds,
 $th_{cetacean,c}$ =country's score for participation in hunting of small cetaceans, and
 $th_{whale,c}$ =country's score for participation in hunting of great whales.

Incidental Kills (Pressure)

Wherever the distribution of marine mammals overlaps in space and time with fisheries, there is a potential for them to be caught and killed as bycatch. Unlike commercial hunting, such incidental kills of marine mammals are less traceable and the magnitude of their impact on marine mammal populations is only beginning to be fully understood (a first global estimate, based on the US bycatch data, places the figure in the hundreds of thousands; Read *et al.*, 2006). Concerted efforts by the international community have succeeded in reducing the level of bycatch in some fisheries (e.g. eastern tropical tuna fisheries; detailed in Hall, 1998). Nevertheless, the proliferation of synthetic fishing gear and the intensification of industrial fisheries imply that bycatch remains a serious, if not the gravest, threat to marine mammals (Reeves *et al.*, 2003; Reeves *et al.*, 2005; Read *et al.*, 2006).

Regrettably, the lack of reporting of marine mammal bycatch on a global scale and the difficulty in obtaining useful estimates render any direct comparison of bycatch across countries unfeasible. Therefore, we have adopted as our proxy indicator the relative use of gillnets as measured by gillnet-associated catch (Watson *et al.*, 2006). While we recognize the potential impact of bycatch from gear such as mid-water trawls and longlines, we have focused on the use of gillnet as its marine mammal bycatch rate is perceived to be highest among commonly used gear (Hofman, 1995; Read *et al.*, 2006). In order to facilitate cross-national comparison, catches were re-expressed as catch per are; of EEZ. Indicator score of incidental kills, IK_c , is expressed as:

$$IK_c = \frac{g_c}{EEZ_c} \quad \dots 3)$$

where g_c =total estimated gillnet-associated catch for 2004 in the EEZ of country c , and EEZ_c =total EEZ area of country c .

Species Extinction Risk (State)

While the conservation status of marine mammal species in its EEZ is an excellent measure how a country fares with regards to marine mammal protection, the status of marine mammal species, in particular of small cetaceans, is difficult to assess (Mulvaney and McKay, 2003). Moreover, while, of the 115 species of marine mammals considered in this study, extinction risk for 111 species has been assessed by the IUCN Red List (2007), 40 species are still classed as 'data deficient,' and many of the assessments have not been updated since 1994. While aware of these issues, we developed a scoring system based on the Red Book status of marine mammal species (Table 2).

Table 2. Species scoring of the IUCN Red List status.

Status	Score
Of least concern	10
Near threatened or conservation dependent	6
Vulnerable or data deficient	4
Endangered	2
Critically endangered	0

The highly migratory nature of many marine mammal species, and the fact that their distributions often encompass multiple national jurisdictions and high seas, imply that the contribution of maritime countries to the status of marine mammal populations will vary between species and countries. We have, therefore, applied the proportion of species distribution² that falls within the EEZs as weighting for the aggregated score of Red List status. The weighting assumes that the status of endemic species better represents the management performance of a country. Species with $w < 0.01$ (i.e., less than 1% of its habitat falling within an EEZ) were not considered. The extinction risk indicator for a country, ER_c , is thus expressed as:

² The distribution ranges of marine mammal species are estimated based on the Relative Environmental Suitability model of Kaschner *et al.* (2006), using RES threshold of 0.2 and are available online at www.seararoundus.org.

$$ER_C = \frac{\sum_{i=1}^{n_c} s_i w_i}{\sum_{i=1}^{n_c} w_i} \quad \dots 4)$$

where n_c = number of marine mammal species found with in the EEZ of c , s_i = status score of marine mammal species I , and w_i = proportion of I 's habitat occurring within the EEZ..

Species Abundance (State)

As noted above, historical overexploitation of marine mammals has reduced many populations to fractions of their previous abundance and in many cases these species have yet to recover despite conservation measures implemented by national governments. Therefore, relative abundance estimates of historically exploited species (from Christensen, 2006), originally presented as % depletion, were used as our second indicator of species health. Again, weighting based on the species distribution was used to compute the aggregated species abundance score, SA_c , for each country:

$$SA_C = \frac{\sum_{i=1}^{n_c} a_i w_i}{\sum_{i=1}^{n_c} w_i} \quad \dots 5)$$

where nc = number of marine mammal species found with in the EEZ of c , a_i = relative abundance of marine mammal species i , and w_i = proportion of i 's habitat occurring within the EEZ.

It must be noted here that the estimation of percent depletion of Christensen (2006) was computed from reconstruction of historical abundances using reported catches, which tend to be underestimates. Also, Christensen (2006) used a model for population reconstruction which tended to overestimate the growth of formerly depleted populations. For these reasons, the percentage depletion she obtained by contrasting present and unexploited populations may have been underestimated. As well, the population size of species for which no directed hunt were performed (and/or catches available) were assumed constant, which is likely to also be a conservative assumption. Finally, in cases where no estimates were available for all marine mammal species found within the EEZ of a country, no SA score for that country was estimated.

International Treaties (Response)

Extensive distribution of many marine mammal species necessitates mechanisms for protection on an international level, and the United Nations Convention on the Law of the Sea (UNCLOS) explicitly requires countries to work through “appropriate international organizations for their (marine mammals) conservation, management and study” (Article 65). As our indicator of national responses to marine mammal protection, we have, therefore, assessed the participation of countries in selected international treaties (Table 3). While

Table 3. Scoring for participation in international treaties.

Degree of commitment	Score
Full ratification, acceptance or approval with no objection or reservation	3
Ratification, acceptance or approval with objections or reservations ³	2
Signature, subject to ratification, acceptance or approval	1
Non-party	0

participation in international treaties, by itself, is simply a measure of intent rather than performance, similar use of treaty ratification as a measure of countries ‘environmentalism’ has been made by Dietz and Kalof (1992), Alder and Lugten (2002) and Roberts *et al.* (2004).

³ Countries were assigned a score of 2 for ICRW, if they entered an objection against the moratorium on commercial whaling (Paragraph 10(e) of the Schedule) and for CITES, if they have entered a reservation against listing of marine mammal species in either of the Appendices.

Moreover, our scoring system, which differentiates signature and ratification of, and objections, to relevant treaties, should capture the varying degrees of commitments by a country. Whilst we recognize the sovereign right of countries to enter objections, we have nonetheless assigned a lower value to ratification with objections, as such a response denotes deviation from the international conservation norm.

Four treaties and one system of treaties were selected for our assessment (their relevance to marine mammal conservation are noted in Appendix 1) based on three criteria:

- The treaty must be open for accession by any state;
- The scope of the treaty must be global; and
- The treaty must explicitly or implicitly address the issue of marine mammal protection.

We have, however, included the Antarctic Treaty System in our assessment as an exception, recognizing the international interest in management of Antarctica. Lists of parties for each treaty were obtained via their respective websites (Antarctic Treaty Secretariat (www.ats.aq); CBD (www.cbd.int); CITES (www.cites.org); CMS (www.cms.int); IWC (www.iwcoffice.org)).

No weighting between conventions was applied in our assessment, except for the three instruments of the Antarctic Treaty System⁴ (Antarctic Treaty, Environment Protocol and Antarctic Seal Convention) which were aggregated (represented as $\sum IT_{ANT,c}$ below) so that they weigh equal to other treaties as a system of treaties, not as individual instruments:

$$IT_c = 10 \left[\frac{IT_{CBD,c}}{IT_{CBD,max}} + \frac{IT_{CITES,c}}{IT_{CITES,max}} + \frac{IT_{CMS,c}}{IT_{CMS,max}} + \frac{IT_{ICRW,c}}{IT_{ICRW,max}} + \frac{\sum IT_{ANT,c}}{\sum IT_{ANT,max}} \right] \quad \dots 6)$$

where IT_c = indicator score for international treaties; $IT_{X,c}$ = country's score for participation in Treaty X, and $IT_{X,max}$ = maximum possible score for participation in X (i.e., 3).

Two points to note: for the Faroe Islands, scores were assigned based on the participation in the treaties by Denmark, and Taiwan was omitted from the assessment of international conservation due to its lack of representation in the United Nations, and hence its restricted participation in international treaties.

Domestic Policies (Response)

Variation in conservation strategies (e.g., restriction on kills, habitat protection and pollution control) and need for management schemes to be tailored to particular local or regional conditions make broad comparison of national policies difficult. Moreover, the last comprehensive compilation of national marine mammal legislation is over 20 years old (Marashi, 1986), and likely does not reflect the current policies of the listed countries. We have, therefore, selected the size of marine protected areas (MPAs) as our proxy for willingness to act on conservation domestically. The number of national MPAs has been rising in recent decades (Woods *et al.* 2008), and they are increasingly being regarded as an essential tool in the conservation of marine mammals (Hoyt, 2005; Reeves *et al.*, 2003). More importantly, a global database of MPAs has recently been updated and is readily available online (MPA Global www.mpaglobal.org). As was the case in the use of gillnet-associated catch, the sizes of marine protected areas were re-expressed as a fraction of the total EEZ area. Hence, the domestic policies score, DP_c , for a country is expressed as:

$$DP_c = \frac{MPA_c}{EEZ_c} \quad \dots 7)$$

⁴ Participation to the Convention on the Conservation of Antarctic Marine Living Resources was not included as a part of the Antarctic Treaty System for this study, as the Convention specifically excludes provisions for marine mammals (Art. VI).

where MPA_c =total size of MPAs in country c , and EEZ_c = total size of EEZ in country c .

Transformation of variables

Because the six variables identified above do not have the same dimension, it is necessary to transform them into a common scale comparable with the final scale of the index (OECD, 2002b). Transformation of two variables, gillnet catch and MPA coverage, relative to EEZ areas of countries, have already been noted. It is also necessary to remove any substantial skewness in variables prior to their aggregation in order to avoid distortion of the final index (Gilthorpe, 1995). Distortion of the aggregated index due to skewness in underlying variables is of serious concern, particularly when standardization of variables is heavily dependent on two extreme values as is the case with the MAM_{prot} (see below). Therefore, each variable was tested for normality of distribution using:

$$S = \frac{n}{(n-1)(n-2)} \sum \left(\frac{x_i - \bar{x}}{s} \right)^3 \quad \dots 8)$$

If a considerable skewness in the distribution of indicator variables was observed ($|S|>2$), the extreme values were standardized through the use of a logarithmic transformation.

In order to standardize variables on a scale of zero to ten, from worst performance to best performance, the 'minimum-maximum' technique was used. This method, which uses highest (leader) and lowest (laggard) values as benchmarks, positions values in relations to the global maximum and minimum:

$$10 \left(\frac{\text{actual value} - \text{minimum value}}{\text{maximum value} - \text{minimum value}} \right) \quad \dots 9)$$

Therefore, the final MAM_{prot} score is an ordinate score of marine mammal protection performance of a country relative to best and worst performances among the countries evaluated. It is not an absolute, cardinal score and consequently the valuation will vary from one assessment to another.

Weighting and aggregation

The final step in the construction of a composite index involves the weighting of variables before aggregating them into a final score. Assimilation of multiple variables into a single composite value implicitly implies substitutability of variables, while the weighting used to represent the relative importance of underlying variables is often viewed as a major source of subjectivity (OECD, 2002b; Freudenberg, 2003). The weights given to different variables heavily influence the outcomes of an index, particularly if there is polarity in variables. Largely for reasons of simplicity and the lack of viable alternatives, all variables were given equal weight in MAM_{prot} .

$$MMPI_c = wTH_c + wIK_c + wER_c + wSA_c + wIT_c + wDP_c \quad \dots 10)$$

where $w=1/6$.

It should, however, be noted that by selecting two variables per each component of the PSR framework, three components are equally represented in the final MAM_{prot} score.

Choice of countries

The 53 countries assessed here are those evaluated in Alder and Pauly (this volume) and jointly account for about 95% of global reported landings. Boundaries of EEZ are limited to waters around countries' 'mainland'

(except for the EEZs off Alaska and Hawaii which were included as a part of the US EEZ) and do not include EEZs off overseas territories⁵.

DATA SOURCES

Pinnipeds were scored based on FishStat (FAO, 2007), small cetaceans based on the qualitative descriptions in the IUCN Conservation Action Plans (Reeves *et al.*, 2003) and great whales based on the catch statistics from the International Whaling Commission (IWC, 2007). Scoring is detailed in Table 1. The levels of gillnet use as a proxy for incidental kills was obtained from Watson (2006) while data on species extinctions were from IUCN's Red List (IUCN, 2007). The estimates of species abundance were based on Christensen (2006). Data on country participation in international treaties were derived from relevant convention websites and data on MPAs were from the MPA Global website (www.mpaglobal.org).

RESULTS AND DISCUSSION

Of the six variables assessed, substantial skewness occurred in variables related to incidental kills and domestic policies ($S=5.6$ and $S=4.3$, respectively); these variables were log-transformed. Significant skewness ($S=-1.9$) was also observed in the variable for targeted hunting, though it was below the pre-determined threshold, and, indeed, was expected, considering that a large majority of countries assessed do not currently participate in hunting of marine mammal at all.

A composite league table, ranking maritime countries based on their MAM_{prot} score, is presented in Table 4. The MAM_{prot} scores ranged from 4.0 (North Korea) to 8.9 (Australia) with an average score of 6.2. Australia, followed by four European countries, Germany, UK, Sweden and the Netherlands ranked the top five in the table while countries that participate in commercial hunting of marine mammals, Canada, Japan and Iceland ranked among the bottom five.

At a sub-index level, Canada, with its participation in hunting for pinnipeds (harp seals and ringed seals), small cetaceans (white-beaked dolphin, beluga and narwhal) and great whales (bowhead) scored zero, while Bangladesh scored lowest in the incidental kills for its high use of gillnet (with nearly half of the reported landings in its EEZ associated with gillnet). Italy and Turkey scored lowest in the extinction risk indicator, due to the 'critically endangered' status of Mediterranean monk seals, the only marine mammal species with over 1% of its distribution falls within the EEZs of these countries, while Germany scored highest based on the low extinction risk assessed for gray seals and harbour seals. Extremely low relative abundance of North Atlantic right whales was the main factor in the low species abundance score for Canada. Again, the relatively healthy state of gray seals and harbour seals resulted in high scores for Poland and Germany. In the international treaties, nine countries that have ratified all treaties assessed scored 10, while North Korea, which has only ratified the Antarctic Treaty and CBD, scored lowest. As for the domestic policies indicator, Germany, with close to 15% of its EEZ protected, scored highest while countries with no MPAs (Faroese, Ghana and Nigeria) scored lowest.

Table 4. Composite league table of 53 maritime countries on their marine mammal protection performance (ranking based on MAM_{prot} scores). TH=standardized score for targeted hunt, IK=incidental kills, ER=extinction risk, SA=species abundance, IT=international treaties and DP=domestic policies.

Country	TH	IK	ER	SA	IT	DP	MAM_{prot}
Australia	10.0	10.0	7.3	6.7	10.0	9.2	8.9
Germany	10.0	3.2	10.0	9.9	10.0	10.0	8.8
UK	10.0	2.6	8.6	8.3	10.0	8.3	8.0
Sweden	10.0	2.8	8.9	9.0	9.1	8.0	8.0
Netherlands	10.0	3.9	9.1	9.0	9.1	6.2	7.9
Denmark	10.0	2.4	9.1	9.0	8.2	8.3	7.8
South Africa	10.0	7.7	5.8	7.3	10.0	5.7	7.7

⁵ EEZ boundaries are available online at www.seaaroundus.org; for Germany, Japan, Malaysia, Russia and Turkey, these boundaries are presented as regional 'sub-EEZ'.

Table 4 (cont'd).

Country	TH	IK	ER	SA	IT	DP	MAM _{prot}
Poland	10.0	2.0	10.0	10.0	7.3	6.3	7.6
Portugal	0.0	6.6	6.4	8.8	7.3	5.5	7.4
France	10.0	4.4	6.7	8.3	10.0	5.0	7.4
Argentina	7.1	8.5	6.1	5.0	10.0	5.9	7.1
Latvia	10.0	2.8	10.0	9.6	4.5	5.5	7.1
Spain	10.0	5.5	4.0	8.8	9.1	5.0	7.1
Brazil	10.0	7.5	4.9	6.2	7.3	6.2	7.0
Chile	7.1	6.8	5.3	4.6	10.0	8.0	7.0
Mexico	10.0	8.0	4.7	6.8	4.5	7.4	6.9
New Zealand	10.0	8.5	5.2	1.6	9.4	5.5	6.7
Ireland	10.0	4.3	8.0	7.8	7.3	1.9	6.6
Ukraine	10.0	7.0	4.0	4.4	6.4	7.0	6.5
Ecuador	7.1	6.7	4.0	n.a	9.1	5.0	6.4
Italy	10.0	5.5	0.0	n.a	10.0	6.5	6.4
Peru	5.7	7.1	4.7	5.5	9.1	5.8	6.3
Thailand	10.0	6.4	4.0	8.2	1.8	7.3	6.3
Senegal	10.0	4.5	4.0	n.a	7.3	5.7	6.3
Namibia	7.1	7.1	5.4	8.3	1.8	7.8	6.3
Viet Nam	10.0	6.3	4.1	8.7	1.8	5.9	6.1
India	7.1	3.0	4.2	7.7	9.1	5.4	6.1
Yemen	10.0	7.0	4.0	n.a	4.5	4.7	6.0
Taiwan	7.1	7.4	4.7	7.3	n.a	3.4	6.0
Angola	10.0	7.0	4.0	n.a	1.8	7.0	6.0
Egypt	10.0	5.3	1.3	n.a	4.5	8.5	5.9
Pakistan	10.0	4.5	4.0	n.a	4.5	6.4	5.9
Sri Lanka	5.7	7.1	4.0	8.2	4.5	5.5	5.9
Morocco	10.0	4.5	1.9	n.a	7.3	5.4	5.8
Philippines	5.7	5.0	4.8	7.3	4.5	7.2	5.7
Myanmar	10.0	2.2	4.0	8.2	1.8	6.8	5.5
Korea (South)	10.0	2.3	4.9	1.3	6.4	7.0	5.3
Iran	10.0	3.7	4.0	n.a	1.8	6.9	5.3
Russian Fed	1.4	5.9	6.6	2.5	6.4	8.2	5.2
Faroese	5.7	3.6	8.1	5.4	8.2	0.0	5.2
China Main	10.0	3.1	4.6	2.7	6.4	4.1	5.1
Malaysia	10.0	3.1	4.0	n.a	1.8	6.6	5.1
Bangladesh	10.0	0.0	4.0	n.a	4.5	6.9	5.1
Norway	2.9	3.0	8.3	4.3	8.2	3.8	5.1
Indonesia	5.7	4.2	4.4	6.3	1.8	7.4	5.0
USA	0.0	7.4	5.5	2.7	5.5	8.8	5.0
Ghana	10.0	6.1	4.0	n.a	4.5	0.0	4.9
Turkey	10.0	5.2	0.0	n.a	2.7	6.6	4.9
Iceland	7.1	2.9	8.3	3.6	2.7	3.2	4.6
Nigeria	10.0	4.3	4.0	n.a	4.5	0.0	4.6
Japan	1.4	3.8	5.3	1.9	6.4	7.4	4.4
Canada	0.0	7.6	7.1	0.0	4.5	6.8	4.4
Korea (North)	10.0	4.6	4.3	1.8	0.0	3.1	4.0

MAM_{prot} is by no means a definitive measure of a country's performance in marine mammal protection. As mentioned in relation to variable selection, an ideal set of indicators would extend beyond the six incorporated into the index. Considering human induced pressures to marine mammals, for example, the IUCN Conservation Action Plans identified many other threats to marine mammal conservation, including ship strikes, habitat degradation and pollution (Reeves *et al.*, 2003). In data-rich countries like the US and Australia, in-depth examination of marine mammal protection performance that incorporate wider dimension of conservation drivers is possible and undoubtedly, such examination would yield more comprehensive assessment of country performance. However, in the context of the study, that is, to provide an indicative measurement of country performance for a broad group of maritime countries, it was necessary to sacrifice precision of assessment for few countries in order to maintain equal evaluation standards for all countries. Improvements in data availability and coverage on a global scale should greatly enhance the breadth of the index in future.

Moreover, the indicators selected have inherent weaknesses and biases. Lack of reliable global databases for targeted and incidental kills of marine mammals has already been noted, and scoring based on the qualitative description of hunts is susceptible to criticism of their subjectivity. The use of number of species hunted as an additional criterion was an attempt to reduce the potential bias in the scoring of targeted kills. It is also likely that the reports of targeted hunting cited in the IUCN Conservation Action Plans were not exhaustive and may be biased toward countries with better reporting infrastructures. Nevertheless, we believe the selection of targeted kills as an underlying indicator of the MAM_{prot} is critical, not only as an indicator of the threat to conservation, but also as an identifier of countries' positions in the sustainable use-preservation spectrum. Similarly, relative gillnet use estimated from gear associated catch data, applied in the model as a proxy indicator for bycatch, implicitly assumes a constant bycatch rate for the gear and ignores regional variations in the utilization of bycatch reduction devices. The indicator was, nonetheless, incorporated in the index in recognition of bycatch as a significant direct and immediate threat to marine mammals.

It must be noted, however, that the assumption of substitutability of variables inherent to composite indices implies that an increase in a number of parameters could possibly weaken the diagnostic feature of an index, by diluting the effect of individual parameters. We believe, therefore, the six sub-indicators selected in MAM_{prot}, though limited in scope, represent a set of indicators most closely associated with marine mammal conservation and should sufficiently encapsulate country performance.

Standardization of the indicators using the 'minimum-maximum' approach denotes that MAM_{prot} scores are ordinal values beneficial for ranking but their valuation is susceptible to change and do not provide information as to absolute performance. A possible solution is to anchor each indicator using a defined policy target and standardize variables based on their proximity to the target (e.g. the Environmental Performance Index: www.yale.edu/epi/). The stated goal of protecting "at least 10% of each of the world's ecological regions [by 2010]" of the Eighth Ordinary Conference of the Parties to the CBD in 2006, for example, could be used as anchoring value (i.e., score of 10) for our domestic policies indicator. Consultation with experts should help identify a target value for each variable.

Lastly, when interpreting the composite league table of MAM_{prot}, it must be noted that there is still no global consensus on 'marine mammal conservation.' The schism within the International Whaling Commission (IWC) between those who contend that certain species of whales, provided that they have sufficiently recovered from historical overexploitation, can be subjected to sustainable exploitation and those who maintain that whales should be permanently protected from commercial exploitation, is well documented (Friedheim, 2001). This fundamental debate between using and preserving natural resource, or whether marine mammal should even be seen as a 'resource', is beyond the scope of the present study. The MAM_{prot} presented in this study is strictly a measurement of marine mammal protection. Despite its various shortcomings, the index is, nevertheless, a first attempt at a multi-dimensional comparison of marine mammal protection performance across maritime countries. As such, it may also serve as an indicative measure of marine mammal conservation for a comprehensive EEZ management index presented elsewhere in this report.

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APPENDIX 1: LIST OF INTERNATIONAL TREATIES CONSIDERED FOR THE MARINE MAMMAL PROTECTION INDEX (IN CHRONOLOGICAL ORDER, DATE OF ADOPTION IN PARENTHESES AND NUMBER OF CONTACTING PARTIES AS OF NOVEMBER 2007).

International Convention for the Regulation of Whaling (02/12/1946)

Contracting Parties: 77

For protection of all species of whales from over-exploitation and for establishment of a “system of international regulation for the whale fisheries to ensure proper and effecting conservation and development of whale stocks.” Since 1986, a moratorium on the commercial whaling has been put in place through enforcement of zero catch limits for all whale stocks (Paragraph 10(e) of the Schedule).

Antarctic Treaty (01/12/1959)

Contracting Parties: 46

For peaceful use of Antarctica with preservation and conservation of its living resources (Art. IX 1(f)).

Convention for the Conservation of Antarctic Seals (01/07/1972)

Contacting Parties: 17

For ‘the objectives of protection, scientific study and rational use of Antarctic seals, and to maintain a satisfactory balance within the ecological system.’ Conservation measures include permissible catch limits and designation of protected species⁶ (Art. III).

Convention on International Trade in Endangered Species of Wild Fauna and Flora (03/03/1973)

Contracting Parties: 104

For ‘the protection of certain species of wild fauna and flora against over-exploitation through international trade.’ All cetacean listed under appendix I, which includes all species threatened with extinction which are or may be affected by trade, and Appendix II which include all species which although not necessarily threatened may become so unless trade is regulated. *Monachus* spp., *Arctocephalus* spp. and *Mirounga leonina* are listed in Appendices I & II, and *Odobenus rosmarus* in Appendix III.

Convention on the Conservation of Migratory Species of Wild Animals (23/06/1979)

Contracting Parties: 101

Parties ‘should endeavour to provide immediate protection for migratory species included in Appendix I’ and to ‘conclude agreements covering the conservation and management of migratory species included in Appendix II’ (Article II 3). 12 cetacean species and one pinnipeds species of pinniped listed in Appendix I and 38 cetacean species and 5 pinniped species in Appendix II.

Protocol on Environmental Protection to the Antarctic Treaty (04/10/1991)

Contracting Parties: 32

For ‘comprehensive protection of Antarctic environment and dependent and associated ecosystems’ (Art. II). Protection of native marine mammals designated in Annex II, including prohibition on the taking of Specially Protected Species without a permit⁷.

⁶ Prohibition on killing or capturing of *Ommatophoca rossii*, *Mirounga leonine*, and *Arctocephalus* spp. as well as adult *Leptonychotes weddelli* during the breeding season (1 Sep to 31 Jan).

⁷ Specially Protected Species under the Protocol originally defined as all species of the genus *Arctocephalus*, and *Ommatophoca rossii*. *Arctocephalus* spp. de-listed effective June, 2007.

Convention on Biological Diversity (22/05/1992)

Contracting Parties: 190

Although no explicit reference to marine mammal protection in the Convention, conservation of coastal and marine biodiversity has been identified as one of its seven thematic areas (Decision II/10).