Country performance in living marine resources exploitation and governance

a foundation for decision-making

The Rockefeller Foundation

COUNTRY PERFORMANCE IN LIVING MARINE RESOURCES EXPLOITATION AND GOVERNANCE:

A FOUNDATION FOR DECISION-MAKING

K. KLEISNER, D. PAULY, D. ZELLER , M.L.D. PALOMARES, D. KNIP, A. TAVAKOLIE,

L. BOONZAIER AND A. CISNEROS MONTEMAYOR

A REPORT PREPARED BY THE *SEA AROUND US* PROJECT

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Executive Summary

This report, commissioned by the Rockefeller Foundation (RF), presents an analysis of criteria and indicators related to marine resources, their exploitation and governance and the prospect for their improvement in 45 developing countries, with the goal of identifying a subset of 25 countries in which the RF may consider operating.

The analysis of indicators and criteria, which are explained in some details, combined with external inputs from RF staff, yielded a list of 25 countries, each of which is presented individually through a short text and a map recalling its geography, including that of its marine Exclusive Economic Zone (EEZ), and economy, with some emphasis on its fisheries.

Jointly, these elements may contribute to the information required for decisions on where to focus philanthropic activities designed to address, with some hope of success, issues of rural poverty and food security.

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Introduction

This report, commissioned by the Rockefeller Foundation (RF) to assist in their strategic planning, consists of two parts. In the first part, a list of criteria specified by RF staff for the identification of countries where RF activities should be focused is operationalized via the specification of suitable indicators, which were quantified, then applied to a list of 45 countries also supplied by RF staff.

Suitable data sets were identified and tested for each of the indicators. Combined with external inputs from RF staff, the list of 45 countries yielded a shorter list of 25 with characteristics deemed as suitable to the RF.

In the second part of this report, each of the 25 countries in question is documented, if briefly, in terms of its geography, governance and economy, with a bias toward marine fisheries.

Methodology

The *Sea Around Us* project assembled indicators and a broad array of data for 45 countries (Figure 1, Table 1) along five criteria that were defined by the RF as important for determining the potential for future outreach work:

1. Potential for impact on the marine ecosystem;
2. Potential impact on the lives of poor or vulnerable people;
3. Potential for market-based solutions to succeed;
4. Governance and policy dynamism; and
5. Strong existing body of knowledge/evidence base.

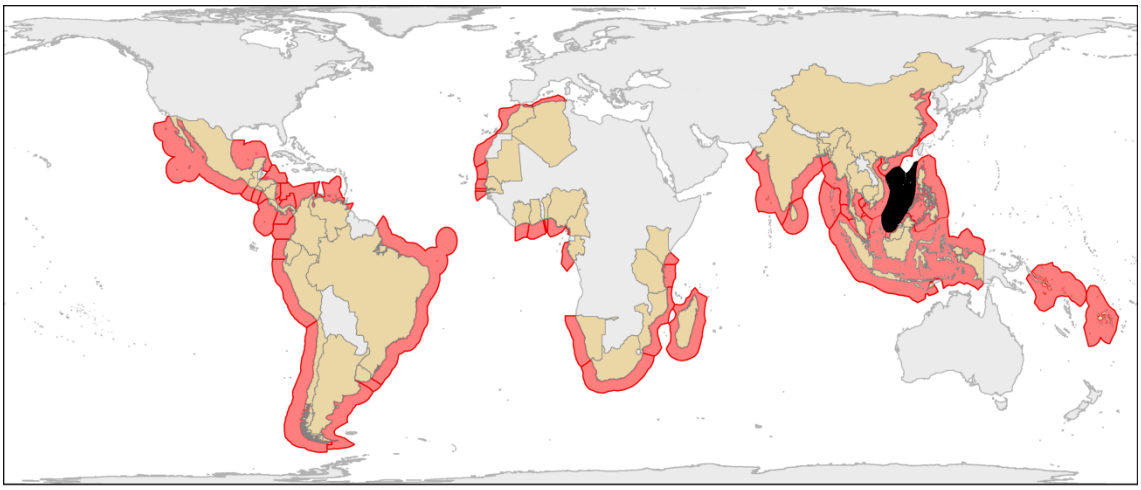

Figure 1. Extent of the EEZ (reddish) of the 45 countries (light brown) to be included in our analysis. The black 'cow tongue' near China is the area claimed by China as a part of its EEZ, and which includes much of the EEZ area that the other countries of the region could legitimately claim. Thus, this is probably an area of future conflicts.

The 45 original countries are listed according to EEZ area in Table (1).

Table 1. The 45 countries to be covered in the proposed study, ranked by the size of their Exclusive Economic Zones (EEZ; see also Figure 1).

No	Country	EEZ ($10^3 \cdot km^2$)	No	Country	EEZ ($10^3 \cdot km^2$)	No	Country	EEZ ($10^3 \cdot km^2$)
1	Indonesia	6,079	16	Morocco[f]	573	31	Gabon	194
2	Mexico	3,269	17	Costa Rica	572	32	Côte d'Ivoire	175
3	Brazil[a]	3,180	18	Mozambique	572	33	Senegal	158
4	China[b]	2,286	19	Namibia	560	34	Mauritania	155
5	Philippines	2,266	20	Sri Lanka	531	35	Uruguay	132
6	Chile[c]	2,009	21	Myanmar	521	36	Algeria	129
7	India[d]	1,630	22	Venezuela	472	37	Nicaragua	127
8	Solomon Is.	1,597	23	Malaysia[g]	447	38	Guatemala	118
9	Vietnam	1,396	24	Panama	331	39	Kenya	112
10	Fiji	1,281	25	Thailand	306	40	El Salvador	94
11	Madagascar	1,199	26	Tanzania	242	41	Bangladesh	79
12	Argentina	1,084	27	Honduras	240	42	Cambodia	48
13	S. Africa[e]	1,067	28	Ecuador[h]	237	43	Benin	30
14	Peru	906	29	Ghana	225	44	Gambia	23
15	Colombia	818	30	Nigeria	217	45	Cameroon	15

a) Mainland Brazil, excludes Trinidade and Martin Vaz Islands; b): Mainland China only, and not including her vast claim to the South China Sea (see Fig. 1); c) Mainland Chile, not including the oceanic Desventuradas, Easter, Juan Fernandez, Felix and Ambrosio Islands; d) Mainland India, excludes Andaman and Nicobar Islands; e) Mainland South Africa, excludes Prince Edward Island; f) Including the Western Sahara; g) East and West Peninsula, Sabah and Sarawak; h) Mainland only, excludes Galapagos Islands.

During the initial phase of the work, 38 indicators were proposed and the data were assembled which allowed for these indicators to be quantified. However, during the review of these indicators, it was found that some of them were correlated or otherwise provided redundant information, so the final suite of indicators was pared down to 30. Two of the indicators, the proportion of small-scale fisheries catches from the *Sea Around Us* catch reconstructions (SSF_{prop}) and fisheries status estimated from the Catch-MSY method ($CMSY_{B/Bmsy}$) were averaged as a single indicator, as they provide similar kind of information on the status of fisheries. These 30 indicators are described in detail in the following section. Of the final 30 indicators, there were three - the proportion of small-scale fisheries landings (SSF_{prop}), the multidimensional poverty index (MPI), and the FAO Code of Conduct compliance (FAO_{code}) - that were kept as secondary indicators because they did not have complete coverage for the majority of the 45 countries (e.g., the SSF_{prop} only covers 12 countries and the FAO_{code} only covers 22), or because the information they provided was correlated with that of another indicator. Thus, ultimately only 27 indicators were used for analyses across all countries (see Appendix Tables A1-A5).

Indicator descriptions

Major criteria #1: Potential for impact on the marine ecosystem

Biodiversity: Uncertainty of threat levels and proportion of catch from threatened species (BIO_{threat}):

One of the key pieces of information integrated in FishBase, the global encyclopedia of fishes (www.fisbase.org), is the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species (www.iucsnredlist.org) designations of conservation status or risk level from assessments of population statistics, habitat and ecology, threats, and conservation actions for a given taxon across its entire range. These data are also available for other marine vertebrates, a group that is fully covered by FishBase's younger sibling, SeaLifeBase (www.sealifebase.org), a similar global information system, but for marine organisms other than fish.

The status of threat categories are 'vulnerable', 'near threatened', 'endangered', 'critically endangered', 'extinct in the wild', 'extinct', 'of least concern' and 'low risk'. For this analysis, we lumped the first 4 categories together as 'threatened'. Extinct species are not included in this analysis. The Red List also categorizes species included in high-risk groups under the status 'data deficient' when there is not sufficient information available to make an assessment. Thus, a 'not evaluated' category for groups not included in the Red List can be created to differentiate between 'data deficient' species and those, which have not yet been explicitly assessed by the IUCN.

Quantifying, on a country basis, the number of taxa that have not been assessed by the IUCN, or which are listed as data deficient, provides an understanding of the uncertainty of the risk level of the commercial catch. If the catch level of a country is such that the there uncertainty as to the risk level of the species caught, this means that a country cannot assess the sustainability of its catch. Additionally, if a high proportion of the catch of a country comes from species listed as threatened; this has negative implications for food security in that it will be difficult to maintain catch levels into the future. Therefore, the uncertainty of risk level and the proportion of catch of threatened species provide two indicators of the sustainability of the catch.

However, each of these metrics depends on the ratio of the indicator to the total number of commercially caught species. As the regional taxonomic reporting indicator (see below) suggests, there are significant issues with the misidentification or mislabeling of catch, which can result in an underestimate of the number of commercially-caught species in a country. FishBase contains information on (a) whether a species is commercially important and (b) whether the species is misidentified or mislabeled as another species. Each species that is found in the commercial catch statistics is identified by a unique taxon code. A species that is misidentified, but is likely a commercially-caught species will not have this unique code. Therefore, it is possible to evaluate the proportion of commercial catch recorded in national catch statistics to potential total commercial catch (i.e., species listed in the commercial catch plus misidentified species). This proportion was used as a correction factor for each indicator.

We scaled the indicator such that a high score (i.e., 1) is indicative of a greater threat to biodiversity as this signifies a country that could benefit from external assistance.

Ocean Health Index (OHI): *Fisheries score from the Food Provision goal (FIS_{FP}):*

The fisheries model measures a country's status in terms of sustainably providing the optimal amount of wild-caught seafood now and in the future, such that a low score can represent either under or overharvest. Fisheries Status (x_{FIS}) was assessed based on the comparison of current catch levels with an estimate of multi-species maximum sustainable yield ($mMSY$), i.e., the summed Maximum Sustainable Yields (MSY) values of the species in spatially disaggregated FAO

landing data (Watson *et al.* 2004). Here we made the distinction between 'landings', which are the fish that are kept from primarily commercial fisheries, rather than 'catches', which could include both landed catch and discarded by-catch (which is often not reported). Since many countries do not fully report their commercial landings, estimates were modified by a correction factor that added a penalty based on the taxonomic reporting quality of the data (T_C). Given that lack of reporting implies poor monitoring and, therefore, lack of management, we used T_C as a proxy for the likely condition of the country's stocks, i.e., stock status.

Because some commercial stocks did not have formal stock assessments that would allow for the derivation of single-stock *MSY* through population dynamics models, *MSY* reference points for individual species (k) were estimated from catch data using a log-linear regression of peak catch (C_P) and *MSY* estimates based on the method developed by Srinivasan *et al.* (2010) for stocks in the Northeast U.S. It was applied to a broader suite of ~80 U.S. and European stocks that have been assessed, obtaining the following regression equation:

$$\ln(MSY_k) = 0.92*\ln(C_{P,k}) \quad \text{Eq. 1}$$

These *MSY* values were then summed annually to estimate multispecies *MSY* (*mMSY*) for each year. Recently, Costello *et al.* (2013) updated this relationship by treating the 'retransformation bias' due to the fact that the model is non-linear and therefore may underestimate *MSY* and re-parameterize the model with more stocks (as we have done here) from the RAM II global database of stock assessments. They claim that their changes illustrate that the approach significantly underestimates *MSY*, especially for large stocks. However, Srinivasan *et al.* (2013) responded to this work and found that, while the updated model is more representative of global fisheries than the original model (Srinivasan *et al.* 2010), when they applied it to global stocks, the relationship between peak catch and *MSY* was stronger.

Landing data from 1950 to 2006 reported to FAO by country and spatially allocated by the *Sea Around Us* project (Watson *et al.* 2004), smoothed with a 4-year running mean were used in the fisheries model. Smoothing reduced the effect of strong interannual variability in the time series resulting from anomalous reporting. These values then served as the basis for the reference point for fisheries; the actual reference point ($mMSY_R$) was reduced below $mMSY$ such that $mMSY_R = 0.75*mMSY$. The reference point, $mMSY_R$, was reduced to protect against possible overestimation of $mMSY$ resulting from summing many individual *MSY* values without adequate knowledge of species interactions (Walters *et al.* 2005; Link *et al.* 2012), and to penalize countries more for overfishing than underfishing (although one might argue that underfishing might only be a problem if the natural capital is lost, i.e., short-lived species). To estimate current landings (B_T), total landings from the most recent year for which spatially disaggregated data were available (2006) were used. Current fisheries Status (x_{FIS}) was then calculated as:

$$x_{FIS} = \left(1 - \frac{\delta B_T}{mMSY_R}\right) \quad \text{Eq. 2}$$

where

$$\delta B_T = \begin{cases} 0 & if \left|mMSY_R - B_T\right| < 0.05 \cdot mMSY_R \\ \left|mMSY_R - B_T\right| & if \ 0.05 \cdot mMSY_R < \left|mMSY_R - B_T\right| < mMSY_R \\ mMSY_R & otherwise \end{cases} \quad \text{Eq. 3}$$

Equation 3 illustrates that Index reporting units with the highest Status score were those that were fishing within the 5% buffer around the reference point (and were assessing most to all of their stocks), while countries that were fishing outside the buffer were penalized according to how far below or above the buffer boundary they were. A country or region received a score of zero (0) if it fished at levels that exceeded $mMSY_R$ by 200%.

We scaled the indicator such that a high score (i.e., 1) is indicative of food provision from fisheries that is not optimal as this signifies a country that could benefit from external assistance.

Proportion of small-scale fisheries catch ($SSF_{proportion}$):

Many countries around the world, especially small island nations, rely heavily on marine fisheries resources for nutrition (fish are often the primary source of protein), revenues and jobs. Indeed, the food security of many coastal communities around the world, particularly in developing countries, depends on the ability to obtain food fish from the sea. Moreover, most fishing by inhabitants of the small island states is small-scale, with fish being caught mainly for subsistence or local artisanal purposes. Currently, national fisheries statistics, and the numbers submitted by member countries to the FAO, do not consistently account for the catches of thousands of small-scale fishers. The result of this poor accounting is that official catch records largely underestimate the true catch of a country, and hence underestimate the economic and social reliance on marine resources by these countries. By default therefore, small-scale fisheries end up accounting for a substantial component of unreported catches as part of global Illegal, Unreported and Unregulated (IUU) fishing. Hence, fisheries landings statistics, as supplied to the United Nation‘s Food and Agriculture Organization (FAO), represent mainly the commercial and larger-scale fisheries. Artisanal, subsistence and recreational fisheries are mostly overlooked. Discarded by-catch and baitfish associated with certain fishing techniques are also rarely included in the official statistics. The catch reconstruction process is a method used to provide a more comprehensive accounting of the total catches from all sectors, including small-scale fisheries.

Of the 45 countries evaluated here, presently 12 have catch reconstructions completed. Using these data, which contain catches by sector, we calculated the proportion of catch coming from small-scale fisheries out of the total catch taken from within the EEZ of a given country. We defined small-scale catch to be catch from the artisanal, subsistence, and recreational sectors. A high proportion of small-scale catch is indicative of the importance of this sector to a particular country.

We scaled the indicator such that a high score (i.e., 1) is indicative of a higher proportion of small-scale fisheries catches as this signifies a country of interest to the Rockefeller Foundation.

Status:

Scores for the following two indicators, fisheries status estimated from the Catch-MSY method ($CMSY_{B/Bmsy}$) and the proportion of stocks that are collapsed and overexploited (SSP_{coe}) were averaged. The rationale for their combination was that they are potentially correlated although they are measuring status in different ways.

Fisheries status estimated from the Catch-MSY method ($CMSY_{B/Bmsy}$):

The simplest model-based methods for estimating *MSY* are production models such as the surplus-production model detailed in Schaefer (1954). At a minimum these models require time series data of abundance and removals to estimate two model parameters: the carrying capacity *k* and the maximum rate of population increase *r* for a given stock in a given ecosystem. Martell and Froese (2012) proposed a new method (parameters listed in Table 2) for estimating maximum sustainable yield (*MSY*) from a time series of catch data from a specific area (item 1, Table 2), normally defined as a unit stock where the

population is closed to immigration and emigration, resilience of the species, and estimations about depletion, i.e., relative stock abundances at the beginning and the end of the time series. These depletion levels are denoted by λ_0 (item 2) for the initial stock size and by λ_1 and λ_2 (item 3) for the final lower and upper limits, respectively. The *r* and *k* parameters are uniformly distributed (items 4, 5) and process errors are assumed lognormal, independent, and identically distributed (item 6). If $\sigma v = 0$, this is equivalent to assuming a deterministic model. The model parameters of interest are the carrying capacity *k* and the maximum intrinsic rate of population growth *r* (item 7). Starting with an assumed relative biomass of $B1 = \lambda_0 k$ in the first year (item 8), biomass in subsequent years is calculated based on (item 9), where the observed catch is subtracted from the start of the year biomass. This assumes catch is measured without error, unless $\sigma v > 0$.

A very simple importance sampling procedure is then used to map the joint distribution of model parameters (in this case, *r* and *k* of the Schaefer production model) that lead to current depletion levels between λ_1 and λ_2. In cases where combinations of (*r, k*) lead to the population going extinct or overshooting *k* before the end of the time series, a 0 is assigned for that parameter combination. For combinations of (*r, k*) that result in final stock sizes between λ_1 and λ_2 we assign a value of 1 (item 10). Then for each parameter combination that results in a viable population at the end of the time series, estimates of *MSY* can be calculated from the population parameters (item 11).

Table 2. A simple Schaefer production model and corresponding management parameters.

Data		**Item**
c_t observed catch from $t = 1$ to $t = n$ years		1
λ_0 depletion level in year 1		2
λ_1, λ_2 lower and upper bounds for depletion level σv process error standard deviation		3
Prior densities		
$p(\log(k)) \sim \text{uniform}(\log(l\ k), \log(u\ k))$		4
$p(\log(r)) \sim \text{uniform}(\log(l\ r), \log(u\ r))$		5
$p(v\ t) \sim \text{normal}(0, \sigma v)$		6
Parameters		
$\Theta = [k, r]$		7
Initial states $t = 1$		
$B_t = \lambda_0\ k \exp(v\ t)$		8
Dynamic states $t > 1$		
$B_{n+1} = [B_t + r\ B_t(1 - B_t/k) - c_t] \exp(v\ t)$		9
Likelihood		
$l(\Theta \mid c_t) = 1$	$\lambda_1 \le B_{n+1}/k \le \lambda_2$	10
$= 0$	$\lambda_1 > B_{n+1}/k > \lambda_2$	
Management quantities		
$MSY = ¼\ r\ k$		11
$B_{msy} = ½\ k$		
$F_{msy} = ½\ r$		

Overall, Martell and Froese (2012) found that given only a time series of removals, a surprisingly narrow range of *r*-*k* combinations is able to maintain the population such that it neither collapses nor exceeds the assumed carrying capacity. Possible *r*-*k* combinations can be restrained further by adding estimations of relative population sizes at the beginning and end of the time series, effectively adding stock-depletion information to the analysis. The set of viable *r*-*k* combinations can be used to approximate *MSY*.

Using this approach, we extended the method to also produce biomass (and B/B_{MSY}) time series. To do this, we ran the Schaefer model on all viable *r*-*k* pairs and then selected the arithmetic mean biomass in each year with upper and lower quartiles.

Stock Status Plots (SSP_{coe}):

Species that are being overfished are producing catches that are below the level that could be sustainably derived. As a result of intense exploitation, most fisheries generally follow sequential stages of development (i.e., developing, fully exploited, overfished, collapsed, and possibly recovering). Stock-status plots (SSPs) use catch time series to assign development stages to individual stocks based on catch levels in relation to the maximum or peak catch of the time series. For example, overexploited classifications occur after the time series peak and for catch levels that are between 10 and 50% of the peak catch. Collapsed classifications also occur after the time series peak, but for catch levels lower than 10% of the peak catch (see Kleisner *et al.* 2012 for details of the complete SSP algorithm). The algorithm can be applied to both the numbers of stocks and to catch tonnage to highlight the annual proportions of stocks and total catch in a particular category. Stocks that are classified as overexploited or collapsed are indicative of possible unsustainable catch, especially when the bulk of the catch tonnage is from taxa with these designations. Therefore, this indicator is defined as the product of the percentages of catch and numbers of stocks from the overexploited and collapsed categories. This value is subtracted from unity (i.e., 1) so that a lower number is indicative of a worse condition.

Here we provide both the plots and the proportion of collapsed and over-exploited stocks as an indicator of the level of overfishing that may be occurring in a country.

We scaled these two indicators such that a high score (i.e., 1) is indicative of a high B/B_{MSY} (i.e., an overfished status) and a high proportion of collapsed or overexploited stocks. The rationale was that this signifies a country that could benefit from external assistance.

MPA area (MPA_{area}):

To better understand the level of marine protection within the EEZs of the 45 countries assessed, information regarding the marine protected areas (MPAs) established by each of these countries was analyzed. The *Sea Around Us* Project maintains a global database of MPAs (see individual country pages at www.seaaroundus.org) from which the data presented here were gathered. This database includes information describing MPA size, location, year of establishment, as well as governance and management. It does not include information on proposed MPAs. To ensure that this information is current and accurate for each country, this database is continually updated using data compiled from peer-reviewed and grey literature, including government documents and websites (though the website does not reflect all updates). Still, for certain countries assessed here, the information is not current to 2013, but represents the data as collated and analyzed by (Wood *et al.* 2008), or a partially updated version. An exception to this is China, in which case aggregated MPA data were taken from (Qiu *et al.* 2009).

In most countries, MPAs are predominately located adjacent to the coast. Therefore, it was necessary to include MPAs designated within the territorial waters extending up to 12 nm from the shoreline, in addition to MPAs situated offshore within the EEZ waters, which are generally defined as extending from the outer limit of territorial waters of a country out to a maximum distance of 200 nm from shore. For simplicity, we treat territorial waters as part of a country's EEZ in the present context.

For each country, the total marine area encompassed by all MPAs was computed. However, not every 'MPA' is entirely 'marine', as the boundaries of MPAs may encompass both land and sea. When available documentation for an MPA only indicates total area, we estimated the marine area using the median fraction of marine area relative to total area for those MPAs for which this quantity was known in that country. In the case of Côte d'Ivoire, where there is just one MPA with no information on marine area, the median fraction of marine area relative to total area for MPAs in neighboring Senegal and Gabon was applied instead. Sites designated under the international UNESCO (United Nations Educational, Scientific and Cultural Organization) Man and the Biosphere Programme, World Heritage Convention and Ramsar Convention were excluded from

this report because of the high level of overlap of such sites with nationally designated protected areas (Wood *et al.* 2008). Additionally, MPAs for which there was no information on areal extent were excluded from areal calculations.

We scaled the indicator such that a high score (i.e., 1) is indicative of a higher proportion of protected area. The rationale was that this signifies a country that has potentially better governance.

Major criteria #2: Potential impact on the lives of poor or vulnerable people

Number of fisheries related jobs (FIS_{jobs}):

Understanding the contribution of marine fisheries to the global economy, from catching fish to the provision of support services for the fishing industry, is important for accurately quantifying fishing effort and estimating the economic and societal costs and benefits of fisheries. Until recently, global data on marine jobs was sparse. To address this gap, a database of marine fisheries employment for 144 coastal nations was compiled (Teh and Sumaila 2011). Gaps in employment data that emerged were filled using a Monte Carlo approach to estimate the number of direct and indirect fisheries jobs. This work focused on estimating jobs in the small-scale fishing sector. Teh and Sumaila (2011) characterized small-scale fishing as (i) primarily geared towards household consumption or sale at the local level; (ii) conducted at a low level of economic activity; (iii) minimally mechanized; (iv) conducted within inshore areas; (v) minimally managed; and/or (vi) undertaken for cultural or ceremonial purposes. Here, we compare the total number of fishing-related jobs in each country to total labor to understand the significance of the marine sector in each of the 45 countries.

We scaled the indicator such that a high score (i.e., 1) is indicative of a higher proportion of fisheries-related jobs. The rationale was that this signifies a country in which fisheries may be more important.

Coastal population (POP_{coast})

The *National Aggregates of Geospatial Data* collection converts geospatial data into national level data in tabular formats as a service to researchers and analysts who do not have access to geoprocessing tools (CIESIN 2012). The Population, Landscape, and Climate Estimates (PLACE) dataset provides country level measures of population and land area for 232 statistical areas (countries and other UN recognized territories). Data were chosen that met the following criteria:

1. They were global in scope (though some omit coverage for Polar Regions);
2. They were capable of meaningful aggregation at the national level;
3. They were relevant to understanding human-environment interactions.

PLACE III estimates the number of people (head counts and percentages) and the land area (square kilometers and percentages) within multiple themes for statistical areas around the world. These themes include: biomes, climate zones, coastal proximity zones, elevation zones, and population density zones. Within these thematic zones, population and land area estimations are further differentiated by urban and rural designations.

Coastal proximity zones (regions within 5, 10, 100 or 200km of a coast) were created from the GRUMPv1 shoreline. The vector was converted into points, from which geodesic buffers were created and dissolved into polygons. The inland areas were extracted. Here we present coastal population within 100km of the coast for 1990, 2000, and 2010 along with the percentages of the total population these estimates represent. This gives a sense of the vulnerability of coastal

populations to further growth and potential for impact on the marine ecosystems and reliability of a country on marine and coastal resources.

We scaled the indicator such that a high score (i.e., 1) is indicative of a higher coastal population. The rationale was that this signifies a country in which fisheries may be more important.

Nutrition:

The 2009 FAO Yearbook of Fishery and Aquaculture Statistics contains food balance sheets, which present a comprehensive picture of the pattern of countries' food supply during a specified reference period. The balance sheet shows for each food item i.e., each primary commodity available for human consumption that corresponds to the sources of supply and its utilization. The total quantity of foodstuffs produced in a country added to the total quantity imported and adjusted to any change in stocks that may have occurred since the beginning of the reference period gives the supply available during that period. On the utilization side, a distinction is made between the quantities exported, fed to livestock + used for seed, losses during storage and transportation, and food supplies available for human consumption. The per capita supply of each such food item available for human consumption is then obtained by dividing the respective quantity by the related data on the population actually partaking in it. Data on per capita food supplies are expressed in terms of quantity and by applying appropriate food composition factors for all primary and processed products also in terms of dietary energy value, protein and fat content.

FAO fish consumption statistics ($FAO_{consumption}$):

For each country presented here, we have assembled the food consumption metrics pertaining to fish and seafood for 2009 that are presented in the consumption section of the food balance sheets. These statistics consist of the total food supply in tonnes, the quantity of food supply (in $kg \cdot capita^{-1} \cdot year^{-1}$, $g \cdot capita^{-1} \cdot day^{-1}$ and $kcal \cdot capita^{-1} \cdot day^{-1}$), the protein supply ($g \cdot capita^{-1} \cdot day^{-1}$) and the fat supply ($g \cdot capita^{-1} \cdot day^{-1}$).

We scaled the indicator such that a high score (i.e., 1) is indicative of a higher consumption. The rationale was that this signifies a country in which fisheries may be more important.

Ratio of marine protein to animal protein (PRO_{animal}) and to total protein (PRO_{total}):

Additionally, we use these data to estimate the contribution of fish to global and country-level protein supply. We calculate the percentage of fish protein relative to the total amount of protein from animal sources and relative to total protein consumption. A higher ratio reflects a greater importance of protein from marine sources.

We scaled the indicators such that a high score (i.e., 1) is indicative of a higher fish and animal protein consumption. The rationale was that this signifies a country in which fisheries may be more important.

Distribution of income (GINI):

The Gini coefficient is commonly used as a measure of inequality of income or wealth. A higher Gini is indicative of a country with greater inequality. When interpreting the Gini coefficient it is important to take into account the demography of a country as an aging population or baby boom may result in a higher Gini even if the real income distribution of working adults remains constant. Note that for presentation here and comparability with other indices, the values are inverted so that a higher score reflects more equality.

We scaled the indicator such that a high score (i.e., 1) is indicative of higher inequality. The rationale was that this signifies a country in which external assistance may be important.

Human Development Index (HDI):

The HDI is a composite index of life expectancy at birth, education (mean and expected years of schooling), and income (Gross National Income per capita) indices that are used to rank countries into four groups of human development. The HDI has been criticized for its exclusive focus on national performance and ranking, issues with measurement error in the underlying indicators, and the fact that it does not include ecological indicators.

We scaled the indicator such that a high score (i.e., 1) is indicative of lower development. The rationale was that this signifies a country in which external assistance may be important.

Multidimensional Poverty Index (MPI):

Multidimensional poverty is measured with a composite of indices which measure health standards, levels of education, living standards, lack of income, disempowerment, poor quality of work, and threat from violence. The MPI complements money-based measures by considering these multiple deprivations and their overlap. The index identifies deprivations across the same three dimensions as the HDI and shows the number of people who are 'multidimensionally' poor (suffering deprivations in 33% of weighted indicators) and the number of deprivations with which poor households typically contend.

We scaled the indicator such that a high score (i.e., 1) is indicative of greater poverty. The rationale was that this signifies a country in which external assistance may be important.

Economy:

Subsidies relative to landed value (SUB_{LV}):

Subsidies relative to landed value are computed from total subsidies relative to the value of the catch (Sumaila and Pauly 2006), expressed on a scale from zero to ten as detailed in Mondoux *et al.* (2008). Countries with higher levels of subsidies relative to the value of the landings have less incentive to manage their fisheries sustainably (Sumaila and Pauly 2006). Total subsidies data are derived for the year 2003 from Sumaila *et al.* (2010) and landed values for 2005 from Dyck and Sumaila (2010).

We scaled the indicator such that a high score (i.e., 1) is indicative of lower subsidies. The rationale was that higher subsidies relative to landed values create incentives for poor management.

Proportion of marine GDP to total GDP (MAR_{GDP}):

Gross domestic product (GDP) is the market value of all officially recognized goods and services produced within a country within a given period of year. This metric, when related to population, is considered to be an indicator of a country's standard of living. As another means of looking at the economic importance of fisheries, here we calculate the proportion of marine GDP relative to total GDP. A higher proportion indicates that fisheries are an important source of income and livelihood in a country.

We scaled the indicator such that a high score (i.e., 1) is indicative of greater marine GDP. The rationale was that this signifies a country in which fisheries may be important.

Major criteria #3: Potential for market-based solutions to succeed

Ease of Doing Business Index (BUS_{ease})

A high ranking on the ease of doing business index means the regulatory environment is more conducive to the starting and operation of a local firm. This index averages the country's percentile rankings on 10 topics: ease of starting a business, ease of dealing with construction permits, ability to get electricity, ease of registering property, ease of obtaining credit, protection for investors, payment of taxes, ability to trade across borders, enforcement of contracts, and ability to resolve insolvency. Each of these topics is given equal weight in the index. The rankings for all economies are benchmarked to June 2012.

We scaled the indicator such that a high score (i.e., 1) is indicative of greater ease of business. The rationale was that this signifies a country in which governance may be better.

Value of the landings ($VALUE_{tonne}$)

Landed value is derived from a species-specific and gear specific database and presented in year 2005 US dollars. We scaled the indicator such that a high score (i.e., 1) is indicative of higher value.

Tourism potential of non-extractive activities ($POT_{tourism}$):

High levels of marine tourism are indicative of the current socioeconomic importance of this industry for each country. Marine tourism is defined here as any form of tourism wholly dependent on the marine ecosystem. We thus include here data for recreational fishing (Cisneros-Montemayor *et al.* 2010), whale watching (O'Connor *et al.* 2009; Cisneros-Montemayor *et al.* 2010), and shark watching (Cisneros-Montemayor *et al.* 2013a). Recreational fishing is defined here as any form of fishing where consumption and/or sale of catch is not the primary motivation; whale watching refers to any form of tourism centered on watching marine mammals in the wild, either from a boat, airplane or onshore; shark watching is any form of tourism centered on watching sharks, from above or below water.

For each country included, the indicator comprises three separate figures: recreational fishers (2003 baseline data) weighed by the total population, and whale and shark watchers (2010 baseline data) weighed by total tourist arrivals. Each data set was scaled to one (with the highest-performing country being one), all three averaged for each country and then re-scaled to one. By incorporating both the total tourist arrivals and local population, this indicator represents the socioeconomic importance of ecotourism for each of the countries. Recreational fishers, as opposed to shark and whale watchers, very often include local inhabitants of a country just as much as tourists, so population estimates were used instead of tourist arrivals. In the case of whale watching, we also include available data on the potential importance of the activity for countries that do not currently engage in the industry.

We scaled the indicator such that a high score (i.e., 1) is indicative of higher tourism potential. The rationale was that this signifies a country in which the marine economy may be very important.

Major criteria #4: Governance and policy dynamism

Foreign fishing pressure (FOR_{press})

The *Sea Around Us* project database of fishing access agreements (Watson *et al.* 2004) was used to calculate the years of fishing access for countries accessing the waters of a country of interest. Years of fishing access allow for comparison between the various countries to be made regarding the level of access each country provides and some indication of the potential effect that foreign fleets can have on domestic fisheries and fleets. Foreign fishing pressure is determined by adding the number of years a foreign country had access through an agreement to a specific country's EEZ for all countries with access. This is a measure of the foreign fishing pressure on a country.

We scaled the indicator such that a high score (i.e., 1) is indicative of lower pressure from foreign fleets. The rationale was that this signifies a country in which governance may be stronger.

Beneficial subsidies relative to total subsidies (SUB_{bene}):

The 'good' to 'good + bad' subsidy ratio indicator measures the financial resources allocated to subsidies that are beneficial (i.e., 'good') for sustainability versus those that are harmful (i.e., 'bad'). Examples of good subsidies are monies allocated to fisheries management, research, and maintenance of MPAs, and which do not contribute to capacity enhancement. Some examples of harmful subsidies (i.e., those which are capacity enhancing) are boat construction, renewal, and modernization subsidies; fishery development and support services; fishing port construction and renovation; marketing support and storage infrastructure; tax exemptions; foreign access agreements; and fuel subsidies. The ratio of good subsidies to the sum of good and bad subsidies represents efforts towards fisheries management, services and research, and therefore can be expected to improve the sustainability of fisheries. The subsidies refer only to marine capture fisheries and were based on both reported and estimated data (Khan *et al.* 2006). Subsidies data are derived for the year 2003 from Sumaila *et al.* (2010).

We scaled the indicator such that a high score (i.e., 1) is indicative of higher levels of beneficial subsidies. The rationale was that this signifies a country in which the marine economy may be very important.

Governance (from World Bank):

Governance, as defined by the World Bank, can be measured and characterized by the traditions and institutions by which authority in a country is exercised. This comprises the selection, monitoring and replacement of governments; the capacity for effective formulation and implementation of policies that are robust; and the respect of citizens and the state for the institutions that govern economic and social interactions among them. For all of the governance indicators, we standardized such that a high score (i.e., 1) is indicative of higher levels of governance.

The Worldwide Governance Indicators report on six broad dimensions of governance for over 200 countries over the period 1996-2011:

> *Voice and accountability (GOV_{va}):* captures perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media.

Political stability and absence of voice (GOV_{ps}): measures perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including politically-motivated violence and terrorism.

Government Effectiveness (GOV_{eff}): captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies.

Regulatory Quality (GOV_{reg}): captures perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.

Rule of Law (GOV_{rol}): captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence.

Corruption (GOV_{corr}): captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as 'capture' of the state by elites and private interests.

Each of these indicators was assessed on a scale of -2.5 (weak governance) to 2.5 (strong governance) in the original World Bank data. Here we extracted the value for each indicator for all 45 countries. For comparability we rescaled the indicator values from 0 (weak governance) to 1 (strong governance).

Compliance with the FAO Code of Conduct ($CODE_{FAO}$):

This is an indicator based on a systematic scoring of a country's level of compliance with Article 7 (Fisheries Management) of the FAO Code of Conduct for Responsible Fisheries (Pitcher *et al.* 2009). The scoring is based on 44 semi-quantitative questions, which have been developed to better cover all of the code's issues and themes while maintaining a balance between the various clauses (Pitcher *et al.* 2006). The questions (Appendix Table A6) fall under six topics: (1) management objectives; (2) framework (data and procedures); (3) precautionary approach; (4) stocks, fleets, and gears; (5) social and economic; and (6) monitoring, control, and surveillance (MCS). Each of the questions is scored on a scale from zero to ten, with the answers to the questions based on published and unpublished literature, and expert opinion (Pitcher *et al.* 2009). Compilation of the final scores by country is based on a method of ordination analysis using a rapid appraisal technique, Rapfish (Pitcher and Preikshot 1999). Rapfish is an anchored non-parametric ordination technique for the rapid appraisal of fishery status in relation to some defined goal or norm (Pitcher 1999).

We scaled the indicator such that a high score (i.e., 1) is indicative of greater compliance with the Code of Conduct. The rationale was that this signifies a country in which governance may be stronger.

Major criteria #5: Strong existing body of knowledge/evidence base:

Knowledge of (marine vertebrate) biodiversity: the ratio of species with information on habitat, depth and maximum length to all vertebrate species encoded in FishBase and SeaLifeBase (REF_{FB_SLB}*) and the ratio of peer-reviewed references on marine biology and fisheries to all resources available via online bibliographic indexes (*$REF_{literature}$*):*

The body of knowledge on fish biology, ecology and biogeography, accumulated within the FishBase information system for over 80% of the more than 32,000 fish species worldwide (including the about 2,000 commercially important species as defined by the *Sea Around Us*) permits an evaluation and comparison of this knowledge at the national level. The FishBase encoders extracted these data from a wide array of scientific literature (more than 70% of which are peer-reviewed), including national checklists among others. Of the numerous biological parameters included in FishBase, we picked three key parameters (habitat, depth range, and maximum length) for which FishBase assures completion across fish taxa, and which have been used in metadata analyses, e.g., on the effect of global warming on the size of fish (Cheung et al., 2013). The ratio of the number of fish species with data for all of these three parameters to the total number of fish species occurring in a given country represents the body of knowledge that is currently available in FishBase for that country. Similarly, SeaLifeBase, with a more than 90% coverage of all non-fish marine vertebrates (marine mammals, seabirds, sea turtles and sea snakes) of the world, can be used to estimate this ratio. We expect that this ratio will be high for countries with species which are well represented in the scientific literature, which will reflect on the capacity of such countries to provide pertinent data for the management of their exploited marine resources.

We refine this ratio to quantify the number of threatened vertebrate species (see section on BIO_{threat} for definitions) for which these two information systems have key parameters, to the total number of marine vertebrate species (fish, marine mammals, seabirds, sea turtles, and sea snakes) in a country. A high proportion of well-studied threatened species will reflect on the ability of a country to provide data for the conservation of its marine vertebrate biodiversity, the group that is most affected by exogenous activities, fisheries having the most considerable impacts.

Though the body of knowledge that is available through FishBase is considerable, certain data types, e.g., annual catches, are not specifically covered because FishBase focuses on ecological and biological data. The Web of Science, an amalgamation of several bibliographic databases, mostly of peer-reviewed articles on all scientific literature, on the other hand, covers subject areas such as general marine and freshwater biology, oceanography and fisheries. It also makes possible querying these various databases according to the subject and location of study. Quantifying the number of references published so far in peer-reviewed journals on marine biology, oceanography and fisheries science to the total number of publications assigned to a country provides a good basis of comparison on the knowledge base available on a country. Similarly, quantifying the number of peer-reviewed articles listed in 'Aquatic Sciences and Fisheries Abstracts' using its 'marine' filter provides another measure of the knowledge base on marine and fisheries sciences by country. These two ratios combined, ranked through percentile analysis, will identify countries whose capacity to provide management options for their fisheries is shaped by existing knowledge or the lack of it.

We scaled the indicator such that a high score (i.e., 1) is indicative of higher proportions of relevant references. The rationale was that this signifies a country in which fisheries may be very important.

Quality of taxonomic reporting of catch data (TAX_{rep}):

This indicator is the proportion of reported commercial taxa to total commercial taxa presumed to occur in an Exclusive Economic Zone (EEZ). The taxa that were presumed to occur in an EEZ were estimated based on the overlap of at least 10% of a country's EEZ with the species range maps of the *Sea Around Us* project (Pauly and Watson 2008). The assumption here was that the ecological distribution range map of a given reported commercial taxon (defined as a taxon included in the marine catch statistic by a least one FAO member country) will overlap with the EEZ of at least one country, and will often overlap with the EEZs of other countries. Given that different countries may report the same fish or invertebrates at different taxonomic levels, both reported taxa and presumed taxa were weighted by the resolution of the taxonomic group, where the weight (w) was highest for fine-scale species-level classification (e.g., dusky grouper, *Epinephelus marginatus*; w = 6) and lowest for broader taxonomic groupings (e.g., 'groupers' or 'demersal fish'), with the lowest weight given to ISSCAAP groups (w = 1). Therefore, the numerator was a weighted sum of the number of taxa reported (n_{rm}) at each taxonomic aggregation level (m) compared to the weighted sum of the total number of commercial taxa distributions (n_{tm}) for each taxonomic aggregation level:\

$$T_C = \frac{\sum_{m=1}^{6} n_{rm} * w_m}{\sum_{m=1}^{6} n_{tm} * w_m} \qquad \text{Eq. 4}$$

We scaled the indicator such that a high score (i.e., 1) is indicative of higher levels of reporting. The rationale was that this signifies a country in which governance may be better.

Selection of 25 countries for further evaluation

Each of the 27 finally used indicators was combined to yield an overall index that was used to assist in the selection and determination of 25 countries with the greatest potential for future work by the Rockefeller Foundation (Figure 2). To combine the indicators, two averaging techniques were used: (1) straight average and (2) a weighted average using the standard deviations of each indicator (i.e., across all countries). We used the standard deviation within an individual indicator as a means of assigning more weight to indicators that were more variable, under the assumption that these indicators had greater contrast in their response between countries.

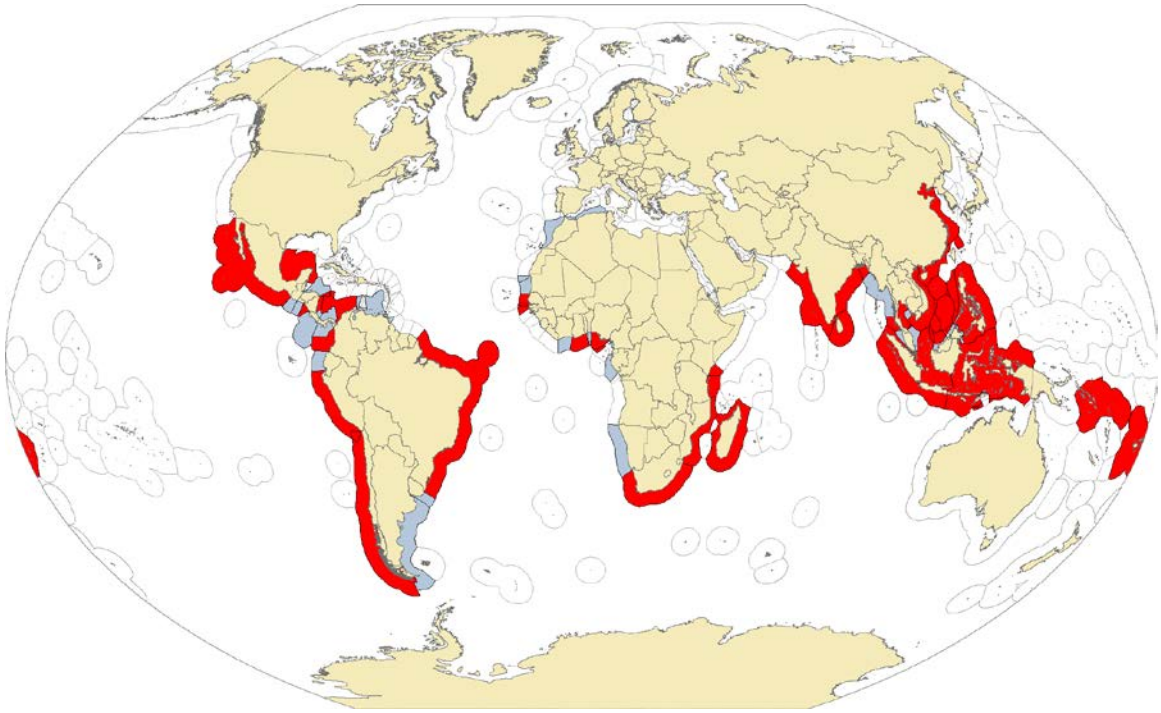

Figure 2. The extent of the EEZs of the 45 countries initially selected and included in our analysis. In red are shown the EEZs of the 25 final sub-selected countries, with the remaining 20 countries indicated in grey.

The countries were ranked from highest score to lowest according to each averaging method. The second weighting scheme was used as the guideline for selecting the subset of 25 countries. Table 5 lists the top 25 countries that were ultimately selected by the RF staff, using our indicator scores and other criteria. Table (3) indicates whether these countries were ranked low, medium, or high under each averaging scheme. Under the weighted averaging, 12 of the top 15 countries were selected. Only Costa Rica, Cambodia, and Malaysia were not included. The inclusion of the remaining 13 countries was based on expert opinion, external information, and determinations by RF staff that certain countries were of importance for future exploration, regardless of the indicators scores.

Table 3. Ranking of the 25 selected countries under two different averaging methods. Red signifies countries ranked in the top 15 (out of the original 45 countries), grey signifies a middle ranking, and blue signifies countries ranked in the bottom 15. Note that under the weighted averaging scheme, 12 of the top 15 countries were selected. 'Top' ranking indicates that the country scored, on average, higher for indicators, which suggests that the country might be of higher interest for future work by the Rockefeller Foundation.

Countries	Standard average	Weighted average
Philippines		
Solomon Islands		
Ghana		
Senegal		
China Main		
Fiji		
Gambia		
Nicaragua		
Brazil		
Indonesia		
Chile		
Mexico		
Viet Nam		
Thailand		
Peru		
Colombia		
Nigeria		
Bangladesh		
Sri Lanka		
Mozambique		
South Africa		
Kenya		
India		
Tanzania		

A Principal Components Analysis (PCA) was used to examine the relationships between the indicators and the 45 countries of interest to the RF. PCA is a non-parametric method for extracting relevant information from a multivariate dataset, wherein the idea is to compute the most meaningful basis or axis along which to re-express the noisy data and extract the important dynamics. We present distance biplots where distances among objects (in this case the countries) in the biplot are approximations of their Euclidean distances in multidimensional space and the projection of an object at a right angle on a descriptor (in this case the indicators) approximate its position along that descriptor. In a distance biplot, the length of the projection indicates how much it contributes to the formation of that space, while the angles among descriptor vectors are meaningless. A second type of plot typically constructed for presenting PCA results are correlation biplots, where distances among objects in the biplot are not approximations of their Euclidean distance, the length of the projection of a descriptor is an approximation of its standard deviation, and angles between descriptors reflect their correlations. Here, we only present distance biplots due to the fact that when the relationships among objects (i.e., indicators) are important for interpretation, the correlation biplots are inadequate and the recommendation is to use a distance biplot (Legendre and Legendre 1998).

In a PCA, each successive principle component explains less of the overall variance in the system, so typically one looks at only the first few principle components for determining patterns. When we examine the biplot of principal component one versus principal component two (Figure 3), the main patterns are the cluster of South and Central American countries along the descriptor axes for the governmental indicators and taxonomic reporting. This reflects the fact that higher government effectiveness is positively correlated with better reporting in these countries. Additionally, there is a cluster of Asian countries along the consumption/protein availability and the fisheries jobs dimensions. This pattern seems logical, as fish is important as a protein source and for food security in these countries.

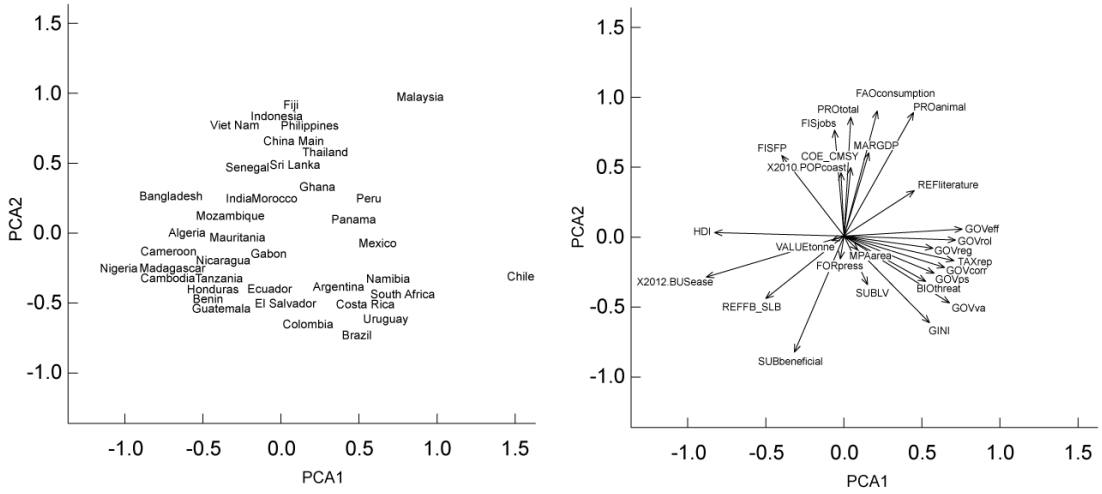

Figure 3. Distance biplot based on a Principal Components Analysis (PCA) for the 45 countries and the chosen indicators. The plot on the left illustrates the relationship between the objects (countries) and the plot on the right illustrates the relationship between the descriptors (indicators). The main patterns are a cluster of South and Central American countries along the descriptor axes for the governmental indicators and taxonomic reporting and a cluster of Asian countries along the consumption/protein availability and the fisheries jobs dimensions.

Profiles for the sub-selected 25 countries

The following brief country reports are presented in alphabetical order by country.

Bangladesh[1]

Bangladesh is a low-lying South Asian country of 147,000 km^2 situated between India and Myanmar and bordered by the Bay of Bengal in the south (Figure 4). The country has a humid, tropical climate with a milder winter (October to March), a hot, humid summer (March to June), and a humid, warm rainy monsoon (June to October). The country has a population of 156 million, of which 23% (35.1 million) live in the coastal zone.

Figure 4. Extent of the EEZ and shelf waters (to 200 m depth) for Bangladesh.

In 1947, when British India was partitioned, Bangladesh became a part of the newly independent Pakistan, i.e., East Pakistan. However, Pakistan's history from 1947 to 1971 was marked by political instability and economic difficulties, and continuous frictions between East and West Pakistan resulted in independence and the formation of Bangladesh in 1971.

Bangladesh is endowed with vast marine resources in the Bay of Bengal and a high fisheries potential. In 1974, after the declaration of the 200 nm Exclusive Economic Zone (EEZ), the country gained an area of 166,000 km^2 under its economic jurisdiction for exploration, exploitation, conservation and management of its living and non-living resources. The Ganga, Brahmaputra and Meghna riverine system drain vast areas of the Indian subcontinent, contributing about 85% of the total water volume which reaches the Bay of Bengal, making local waters highly productive.

In early 2000, at least 444,000 people were involved in the coastal and marine fisheries. The marine capture fisheries represented 22% of the total fishery catches in 2001-2002 and made a sizeable contribution to the national GDP. The marine capture fisheries of Bangladesh exploit a complex, multi-species resource. The marine capture fisheries of Bangladesh can be subdivided into subsistence, artisanal and industrial fisheries, with the last two considered as the commercial fishery. Over 90% of marine catches comes from artisanal fishing, while industrial fisheries contribute around 6%.

Commercial trawling in offshore waters commenced in 1972 with the introduction of 10 trawlers. Some commercial shrimp grounds were also identified in 1976 – 1977. Consequently, Bangladeshi

[1] Based on material in a currently unpublished fisheries report by Ullah (in prep).

and foreign business interests became interested in shrimp trawling, and between 1972 and 1980, the government issued a total of 140 trawler permits.

By the early 1980s, the total number of fishers was estimated at 412,000 while by the mid-1980s, this had risen to 515,000, indicating an annual increase of 8%. At that time, a frame survey carried out by the Department of Fisheries (DOF) estimated a total of 17,331 boats operating in the marine artisanal fishery, of which 3,317 were mechanized.

Bangladesh has a centralized fisheries management system, under the Department of Fisheries, where three principal directors and principal scientific officers enact the implementation of management measures through district and sub-district offices. At present, reported marine catches contribute around 19.4% of total fish catches of Bangladesh, and about 90% of this is landed by artisanal fishers. The sector has an estimated 22,500 non-mechanized and 21,400 mechanized fishing boats. Due to the adverse impact of trawling and illegal fishing, the trawler fleets were reduced to around 100 vessels and joint ventures between Thailand and Bangladesh were stopped. The major shrimp and fish species that are currently exploited by trawl nets are shrimp (*Penaeus monodon*, *P. merguiensis*, *P. indicus*, *Metapenaeus monoceros*, *M. brevicornis*), hairtail, pomfret, goat fish, cat fish, croakers, Bombay duck and lizard fish. A large quantity of trawl by-catch is generally discarded. Thus, discards may be up to 80% of the actual catch, which is equivalent to 30–35,000 tonnes annually. CPUE of shrimp has steadily decreased to around 50% of the level of the early nineties. This is assumed to be due to a combined impact of trawling and set-net bag fishery (SBN), which has damaged the coastal resource base over the last 20 years. The SBN fishery still dominates the catch in artisanal fisheries. The pressure of small-scale subsistence fishery on the marine resources cannot be ignored. However, there are currently insufficient data on this component of the fishery to formulate proper management measures.

Indicator scores as derived here for Bangladesh are presented in Table (4).

Table 4. Indicator scores for Bangladesh according to the five major criteria.

Criteria	Indicator	Score
Potential for impact on the marine ecosystem	BIO_{threat}	0.22
	COE_CMSY	0.52
	FIS_{FP}	0.95
	MPA_{area}	0.43
Potential impact on the lives of poor or vulnerable people	FIS_{jobs}	0.48
	2010 POP_{coast}	0.19
	$FAO_{consumption}$	0.33
	PRO_{animal}	0.06
	PRO_{total}	0.16
	GINI	0.00
	HDI	0.62
	SUB_{LV}	0.76
	MAR_{GDP}	0.35
Potential for market-based solutions to succeed	2012 BUS_{ease}	0.70
	$VALUE_{tonne}$	0.07
	$POT_{tourism}$	0.00
Governance and policy dynamism	FOR_{press}	0.99
	$SUB_{beneficial}$	0.56
	GOV_{va}	0.52
	GOV_{ps}	0.15
	GOV_{eff}	0.28
	GOV_{reg}	0.36
	GOV_{rol}	0.30
	GOV_{corr}	0.21
Strong existing body of knowledge/evidence base	REF_{FB_SLB}	0.55
	$REF_{literature}$	0.44
	TAX_{rep}	0.07

Brazil[2]

The Brazilian EEZ spans the northeast and central eastern coast of South America from approximately 5 °N, at the border with French Guyana, to about 33 °S, at the border with Uruguay (Figure 5). There are 17 maritime states in Brazil. In northern Brazil, the states are Amapá and Pará. There are nine states in northeast Brazil: Maranhão, Piauí, Ceará, Rio Grande do Norte, Paraíba, Pernambuco, Alagoas, Sergipe, and Bahia. In southeast Brazil, the maritime states include Espirito Santo, Rio de Janeiro, and São Paulo. Finally, in the south, we find the states of Paraná, Santa Catarina, and Rio Grande do Sul. The Brazilian EEZ encompasses three Large Marine Ecosystems, the North Brazil Shelf (in part), the East Brazil Shelf, and the South Brazil Shelf LME. Also, the EEZ of Brazil includes oceanic islands, Trinidade and Martin Vaz Islands, which are located 1,200 km off the coast.

Figure 5. Extent of the EEZ and shelf waters (to 200 m depth) for Brazil.

Within the Brazilian EEZ, there is a wide range of ecosystem types resulting in differences between the fisheries exploiting the diverse array of marine resources. In the southern states of Brazil, these fisheries tend to concentrate on a few temperate species, notably the much diminished, but once very abundant Brazilian sardine (*Sardinella brasiliensis*). Conversely, in the tropical northern states of Brazil, the fisheries exploit a diverse array of tropical species, most of which have not been assessed as to their status.

One of the key issues plaguing Brazilian fisheries is the fact that there are many national and state fisheries agencies, which may collaborate in varying degrees, but have not settled on a standardized list of common names for the fish whose catches they report. This results in national catch statistics that are even more unreliable than catch statistics in biodiverse tropical/subtropical countries usually are. In Brazil, the collection system of catch statistics has imploded. Currently, there is no national standardized collection system in place and has been as such for some time. The compilation of heterogeneous data has ended in 2007.

Moreover, while there are numerous publications on Brazilian marine biodiversity, there is, in Brazil a scarcity of fish stock assessment. The only exception to this may be the Brazilian sardine (*Sardinella brasiliensis*), which has received a lot of attention because of the strong fluctuations of its biomass and catches, and also because this stock occurs in the south of the country, off the coast of São Paulo state, where living standards are higher than along the more northern shores of Brazil, with consequent effects for fisheries research.

[2] Based on material in Kleisner *et al.* (2012) and a currenlty unpuplished fisheries report by Freire *et al.* (in prep).

Table 5. Indicator scores for Brazil according to the five major criteria.

Criteria	Indicator	Score
Potential for impact on the marine ecosystem	BIO_{threat}	0.56
	COE_CMSY	0.22
	FIS_{FP}	0.00
	MPA_{area}	0.54
Potential impact on the lives of poor or vulnerable people	FIS_{jobs}	0.10
	2010 POP_{coast}	0.27
	$FAO_{consumption}$	0.12
	PRO_{animal}	0.05
	PRO_{total}	0.00
	GINI	0.73
	HDI	0.18
	SUB_{LV}	0.81
	MAR_{GDP}	0.05
Potential for market-based solutions to succeed	2012 BUS_{ease}	0.70
	$VALUE_{tonne}$	0.37
	$POT_{tourism}$	0.26
Governance and policy dynamism	FOR_{press}	0.85
	$SUB_{beneficial}$	0.43
	GOV_{va}	0.79
	GOV_{ps}	0.66
	GOV_{eff}	0.58
	GOV_{reg}	0.63
	GOV_{rol}	0.55
	GOV_{corr}	0.57
Strong existing body of knowledge/evidence base	REF_{FB_SLB}	0.64
	$REF_{literature}$	0.46
	TAX_{rep}	0.79

Because of this socio-economic gradient, the fisheries of north and northeastern Brazil are understudied, which is aggravated by the large number of exploited species, as occur in other tropical regions of the world. In recent years, however, this situation is slowly being resolved through an improvement of catch statistics, including the nomenclatural problems associated with these statistics. This has enabled detecting the occurrence of the 'fishing down' phenomenon in northeastern Brazil, and constructing ecosystem models, on whose basis it became possible to identify elements of what could become an ecosystem-based management plan for the fisheries of northeastern Brazil.

Indicator scores as derived here for Brazil are presented in Table (5).

Chile[3]

The Republic of Chile is located in South America (Figure 6). The narrow, elongated shape of Chile has resulted in a population with strong ties to the sea. Indeed, although nationally, fishing accounts for only 0.4% of GDP, dwarfed by mining, Chile's overall landings in 2010 were the seventh largest in the world. In addition to the mainland EEZ, which encompasses over 2 million km^2, Chile holds several oceanic islands: the Desventuradas Islands, which are 850 km from the Chilean coast (EEZ area: 449,000 km^2), the Juan Fernandez, Felix and Ambrosio Islands 890 km west of Chile (EEZ area: 500,000 km^2), and Easter Island (EEZ area: 720,000 km^2), which is known as the most remote inhabited island, and is over 3,500 km from Chile in the central south Pacific.

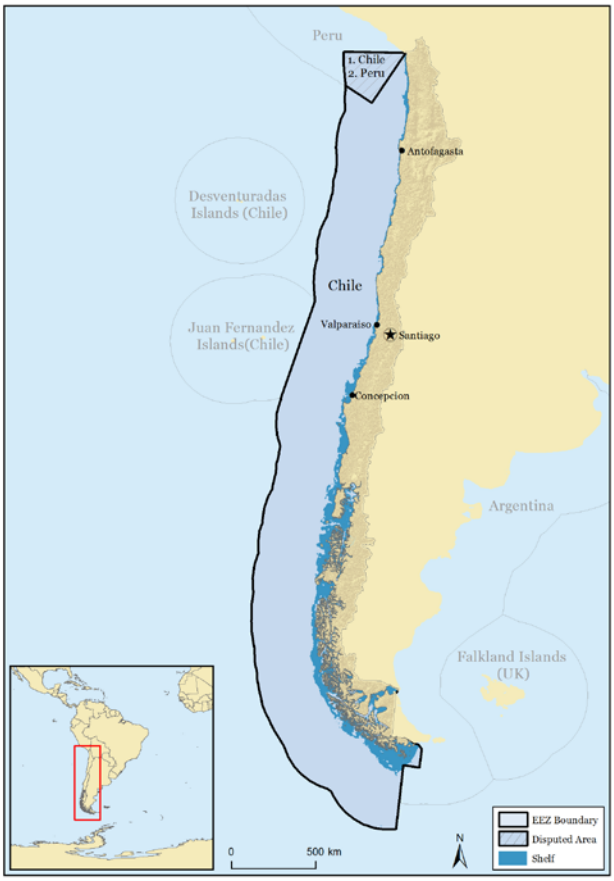

Figure 6. Extent of the EEZ and shelf waters (to 200 m depth) for Chile.

Mainland Chile is divided into 15 administrative 'regions', all but one of which are coastal. The northern regions include Arica, Tarapaca, Antofagasta, Atacama, Coquimbo, and Valaparaiso, while the southern states include Libertador, Maule, Blobio, Araucania, Los Rios, Los Lagos, Aisen, and Magallanes. In terms of biology and biodiversity, marine scientists consider Chile's EEZ as consisting of four main regions: northern, central, southern and austral zones, each characterized by specific environmental and biological conditions.

The mainland EEZ largely overlaps with the southern half of the Humboldt Current Large Marine Ecosystem. The Eastern Boundary Humboldt Current (EBHC) is one of the largest and most productive marine ecosystems in the world, and is highly variable due to El Niño events. The EBHC is a classical eastern boundary zone, where strong coastal winds drive water northward and offshore, resulting in upwelling of deeper nutrient-rich waters that allow for strong primary production. The large amount of plankton in this region allows, in turn, for a high abundance of zooplankton, which eventually translates to fish and other vertebrates, i.e., seabirds and marine mammals.

Thus Chile, similar to Peru, which occupies the northern part of the Humboldt Current LME, is one of the richest countries in the world in terms of marine fisheries resources. The high fish catches that this allows, however, are concentrated on a few species, notably forage fish, sardine and anchovy, as well as chub and horse mackerel – most of which are fed to reduction plants, i.e., turned into fishmeal and related products. Pelagic species represent 85% of reported catch, with anchovies and South American pilchards comprising 65% of the catch. Demersal species account for only 3.6% of reported catch and include species such as Pacific hake and Patagonian

[3] Based on material in Kleisner *et al.* (2012) and a currently unpublished fisheries report by van der Meer *et al.* (in prep).

grenadier. These species are of higher value and are exported as frozen or chilled seafood products. Overall, an average of 4.76 million t·year^{-1} were landed in the last decade. While artisanal fisheries have increased their catch, the catch of the industrial fisheries have declined, such that overall landings have decreased by an estimated 17% in the last decade.

Fisheries in Chile consist of large-scale industrial fisheries and small-scale artisanal fisheries. Industrial fisheries operate vessels greater than 18 m in length, and correspondingly, small-scale (or artisanal) fisheries refer to landings from vessels under 18 meters in length and with a hold capacity not exceeding 80 m^3. Both industrial and artisanal fishers must be registered with the National Registry of Industrial Fisheries (NRIF) and National Registry of Artisanal Fisheries (NRAF), respectively.

In terms of tonnage, the main Chilean industrial fishing activities are related to pelagic resources, both in the north and central part of the country. In the northern regions, anchovy account for most of the landings, followed by jack mackerel and American mackerel. The largest quantities of mackerel and sardine are caught in central and southern Chile. Up to 80% of the industrial landings are used by the local fishmeal industry to produce fishmeal and fish oil directed to salmon aquaculture, while the rest is exported chilled or frozen. In 1994, landings reached a record of 7.5 million tonnes and have declined since, particularly since 2004, and were 3.55 million tonnes in 2010.

Table 6. Indicator scores for Chile according to the five major criteria.

Criteria	Indicator	Score
Potential for impact on the marine ecosystem	BIO_{threat}	1.00
	COE_CMSY	0.45
	FIS_{FP}	0.26
	MPA_{area}	0.01
Potential impact on the lives of poor or vulnerable people	FIS_{jobs}	0.09
	2010 POP_{coast}	0.04
	$FAO_{consumption}$	0.38
	PRO_{animal}	0.55
	PRO_{total}	0.34
	GINI	0.61
	HDI	0.00
	SUB_{LV}	1.00
	MAR_{GDP}	0.14
Potential for market-based solutions to succeed	2012 BUS_{ease}	0.15
	$VALUE_{tonne}$	0.03
	$POT_{tourism}$	0.03
Governance and policy dynamism	FOR_{press}	0.77
	$SUB_{beneficial}$	0.48
	GOV_{va}	0.98
	GOV_{ps}	0.87
	GOV_{eff}	1.00
	GOV_{reg}	1.00
	GOV_{rol}	1.00
	GOV_{corr}	1.00
Strong existing body of knowledge/evidence base	REF_{FB_SLB}	0.05
	$REF_{literature}$	0.00
	TAX_{rep}	1.00

A relatively recent development is that Inca scad (*Trachurus murphyi*) and chub mackerel (*Scomber japonicus*) are also caught in increasing quantities outside of the Chilean EEZ, which has required the deployment of large vessels with adequate autonomy and refrigeration capacities. The rest of the industrial fleet is composed of several factory vessels, which are allowed to fish only in the Austral zone and international waters, and target South Pacific hake, conger eels and 'Chilean seabass' (Patagonian toothfish, *Dissostichus eleginoides*) for local consumption and export.

Artisanal fisheries are widely practiced along the Chilean coastline, with participation having substantially increased in the past 10 years. Today these fisheries contribute to almost half of the fish and crustacean landings in the country. Artisanal fisheries land their products in coastal villages ('*caletas*') or at wharfs, most of the latter located in rural areas where most livelihoods depend directly on fishing. Historically, artisanal fisheries have targeted shell-fish such as 'Chilean abalone' or '*loco*' (*Concholepas concholepas*, a snail species), mussels, and demersal fish. Most of the artisanal landings are used for local consumption since most of the *caletas* lack freezing capacity. The remaining part of the artisanal landings are directly sold to seafood exporters.

Artisanal fishers are required to register with the NRAF in the particular area where they reside and can only operate in that area. They are allocated exclusive rights to 5 nm from the coastline.

The most southern regions are also allowed to fish in 'interior marine waters', i.e., waters out to 12 nm, but industrial fisheries are not. Artisanal fishers are typically allocated free access to these zones, but once the stock is considered 'fully exploited', access can be limited.

As a result of the overexploitation of benthic resource such as Chilean abalone or *loco*, an area-based cooperative system was introduced after the fishery was officially closed in 1989. This new form of management was established in 1997 and established the Management Areas for the Exploitation of Benthic Resources (MAERB). Through this policy, the Undersecretary of Fisheries (SUBPESCA) gives formal property rights to certain natural resources in defined geographical areas of the seabed to registered syndicates. This includes the right to exclude non-members from exploiting that area of the seabed. After this measure was established, the stocks recovered, and now provide steady income for some 50,000 artisanal fishers

As artisanal fisheries have grown in importance, the government is realizing the need to regulate the artisanal fleet. As an initial step, an official distinction is being made between medium-sized boats (those between 12 and 18 meters in length) and boats that are less than 12 meters long. The medium-sized boats represent only 10% of the artisanal fleet, but account for 90% of its catch. Other measures include the mandatory installation of satellite transponders (www.businesschile.cl/en/news/cover-story/fishing-chile-race-against-time).

The new laws will create scientific committees which will intervene in the decision making process of quota allocations of marine resources. There have been several other successful policy and environmental campaigns in Chile over the past decade. In July 2001, a national ban on shark-finning was implemented. A multi-year campaign to raise the awareness about the overfishing of jack mackerel resulted in a considerable quota reduction in October 2010.

Indicator scores as derived here for Chile are presented in Table (6).

China[4]

The People's Republic of China (here: China, excluding Hong Kong and Taiwan, but including Macau, Figure 7) is rapidly growing to regain its historic role as one of the leading economies of the world. Its enormous consumption of resources of all kinds and output of a huge variety of manufactured and other products have huge impacts on the economies of other countries.

Figure 7. Extent of the EEZ and shelf waters (to 200 m depth) for China.

However, China, which is leading the world in a number of scientific and technological fields, remains saddled with an opaque statistical system which not only does not keep up with the country's development, but actively distorts production figures. Indeed, not a week passes without international news outlets picking up on this, either for China massaging its population statistics or its economic indicators. With regards to living marine resources, this statistical issue manifests itself in (i) an inflated 'domestic' catch (i.e., from the Exclusive Economic Zone [EEZ] claimed by China, and (ii) a huge unreported catch by China's distant-water fleet. It is further suggested that China may also over-report its aquaculture production.

The Chinese EEZ, which is the 15th largest in the world at over 2.2 million km^2, spans across three Large Marine Ecosystems, the Yellow Sea and the East China Sea, both highly productive ecosystems, and the South China Sea, a moderately productive ecosystem. China has areas of disputed claims in the East China Sea over the Senkaku/Diaoyu Islands (with Japan and Taiwan) and the Socotra Rock (with the Republic of Korea) and in the South China Sea over the Spratly Islands (with Taiwan, Vietnam, Malaysia, Brunei and the Philippines), the Paracel Islands (with Taiwan and Vietnam), the Pratas Islands (with Taiwan), the Macclesfield Bank (with Taiwan and the Philippines), and the Scarborough Shoals (with Taiwan and the Philippines). Thus, a large section of the South China Sea is disputed, making management of the fisheries and marine resources in the area politically charged and difficult.

The Yellow Sea contains 10 major estuaries, including the Yangtze and Huanghe Rivers, which provide nutrient-rich waters to the ecosystem. The region is the largest shallow continental shelf in the world with an average depth of less than 50 m, supporting well-developed multi-species fisheries with about 100 species of fish, squid and crustaceans that are commercially fished. The ecosystem has been exploited by fishing vessels from China, Korea and Japan for centuries, targeting stocks such as Pacific saury (*Cololabis saira*), chub mackerel (*Scomber japonicus*), largehead hairtail (*Trichiurus lepturus*), Japanese anchovy (*Engraulis japonicus*), yellow croaker (*Larimichthys polyactis*) and Japanese flying squid (*Todarodes pacificus*).

[4] Based on materials in Kleisner *et al.* (2012) and Pauly and Le Manach (in prep).

Further south, the East China Sea is a vast, semi-enclosed ecosystem, bordered by the Ryukyu Islands and the Taiwan Strait. It is a highly productive region with shallow coastal waters providing spawning and nursery grounds for many species of pelagic fish, including some stocks of tunas and swordfishes. About 200 species of finfishes and invertebrates are commercially exploited in the region.

The South China Sea has relatively shallow coastal waters (less than 200 m) with the South China Sea Basin and Palawan Through running through the middle at depth over 1,000 m. Over 100 rivers drain into the region and primary productivity is governed by river run-off and seasonal monsoons. Productivity of the South China Sea is also sensitive to the El Niño-Southern Oscillation (ENSO), which drives rainfall patterns in the region. Main target species include large pelagics such as tuna, billfish and sharks, and a large array of demersal fish and invertebrates, especially penaeid shrimp. The landings are dominated by small coastal pelagic fishes such as herring, sardine and anchovy.

The Chinese marine capture fisheries experienced considerable growth since the founding of the People's Republic of China, in 1949. However, this growth was irregular, due to a series of political crises, and the ensuing recoveries. The major steps in this uneven development are: (a) Postwar Recovery (1949-1952); (b) First 5-Year Plan (1953-1957); (c) Second 5-Year Plan/Great Leap Forward (1958-1962); (d) Three-Year Re-Adjustment Period (1963-1966); (e) Cultural Revolution and Aftermath (1966-1978); and (f) Return to normalcy and growth (1978-present). However, the official Chinese fisheries statistics, as submitted to FAO, reflect the changes and upheavals that went along with these events only imperfectly, if at all.

Table 7. Indicator scores for China according to the five major criteria.

Criteria	Indicator	Score
Potential for impact on the marine ecosystem	BIO_{threat}	0.45
	COE_CMSY	0.80
	FIS_{FP}	1.00
	MPA_{area}	0.31
Potential impact on the lives of poor or vulnerable people	FIS_{jobs}	0.07
	2010 POP_{coast}	1.00
	$FAO_{consumption}$	0.57
	PRO_{animal}	0.22
	PRO_{total}	0.19
	GINI	0.20
	HDI	0.24
	SUB_{LV}	0.79
	MAR_{GDP}	0.13
Potential for market-based solutions to succeed	2012 BUS_{ease}	0.47
	$VALUE_{tonne}$	0.23
	$POT_{tourism}$	0.06
Governance and policy dynamism	FOR_{press}	0.84
	$SUB_{beneficial}$	0.32
	GOV_{va}	0.07
	GOV_{ps}	0.43
	GOV_{eff}	0.63
	GOV_{reg}	0.52
	GOV_{rol}	0.40
	GOV_{corr}	0.33
Strong existing body of knowledge/evidence base	REF_{FB_SLB}	0.07
	$REF_{literature}$	0.94
	TAX_{rep}	0.38

By the late 1970s, the economically important species targeted during the previous period had been largely depleted, and species such as filefishes, and herring, which had been spurned earlier, became the target of directed fisheries, and contributing increasingly to total landings.

However, overall economic growth started to pick up as successive reforms were launched, the first of these, promulgated in 1978, being devoted to the agricultural and fisheries sectors. In its first stage (1978-1984), this reform abolished the People's Commune system that had been in place since 1958, and replaced it with a 'household contract responsibility' system that linked remuneration to output. However, nominal landings grew only 1.2 %, from 3.5 million tonnes in 1976 to 3.9 million tonnes in 1985.

Indeed, this period bracketed a net decline in nominal catches, from about 1978 to the early 1980s. A government report of 1979 on the state of the country's fisheries pointed out that the expansion of bottom trawling and stake nets had depleted the resources, and induced the collapse of several species. That same report called for a stabilization of overall fishing effort at current levels, the replacement of trawling by gillnetting and other fixed gear, etc. Given the manifest decline of China's own coastal resources, this report also suggested distant-water fishing as outlet for its excess fishing capacity, and as source of fish. The conservation measures proposed in that report were not implemented, but the expansion into distant water fishing was.

At the onset of the 21st century, however, Chinese distant-water fisheries had heavily developed, with specialized 'catcher' vessels (bottom trawlers, but also purse seiners, squid jiggers, longliners, etc.) linked to motherships delivering their catch to strategically located freezer facilities, and supplying local, international and domestic markets. These are all remarkable achievements in technology, logistics, and business, mirroring other sectors of the Chinese economic expansion into the rest of Asia, Africa, Latin America and Oceania.

Unfortunately, what did not improve in the transition to the 21st century – occasionally seen as the start of an age of transparency – is the tendency toward secrecy in fisheries data, and the near complete disregard for public accountability of the use of public fisheries resources. Thus, there are no publically accessible databases of access agreements between China (or Chinese companies) and the countries in the Exclusive Economic Zone (EEZ) where Chinese fishing vessels operate, unlike the European Union (EU), which provides in its law database all texts related to fishing access agreements with other countries, even if the agreements themselves are often questionable. Therefore, the activities and catches of the Chinese distant-water fleets are almost completely undocumented and unreported, often spanning the entire gamut of activities implied by the 'IUU' acronym.

A related problem is posed by the Chinese fisheries statistics. The factors which cause China to massively over-report the catch of its domestic marine fisheries are essentially a perverse result of a planned centralized economy that rewards individuals for appearing to fulfill the plan (thus providing a powerful incentive for over-reporting catches, combined with the absence of an independent statistical system. There are indications that this situation is being overcome, but it will take time.

Indicator scores as derived here for China are presented in Table (7).

Colombia[5]

Colombia has coasts on the Atlantic (Caribbean Sea) and Pacific Oceans, and an EEZ of 818,000 km^2 (Figure 8). Its fisheries, however, although diverse, have been limited by the relatively small size of commercially important stocks. Nonetheless, fishery resources historically have been an important part of the livelihood of human communities on both coasts. Fisheries management in Colombia has been impaired by frequent transfers of management responsibilities between government agencies. In past years, the National Institute of Fisheries and Aquaculture (INPA) was responsible for the collection and analysis of fisheries statistics and the regulation of fishing activities from 1990 to 2003. With its closure, these responsibilities were assigned to the Colombian Institute of Rural Development (INCODER), part of the Ministry of Agriculture and Rural Development.

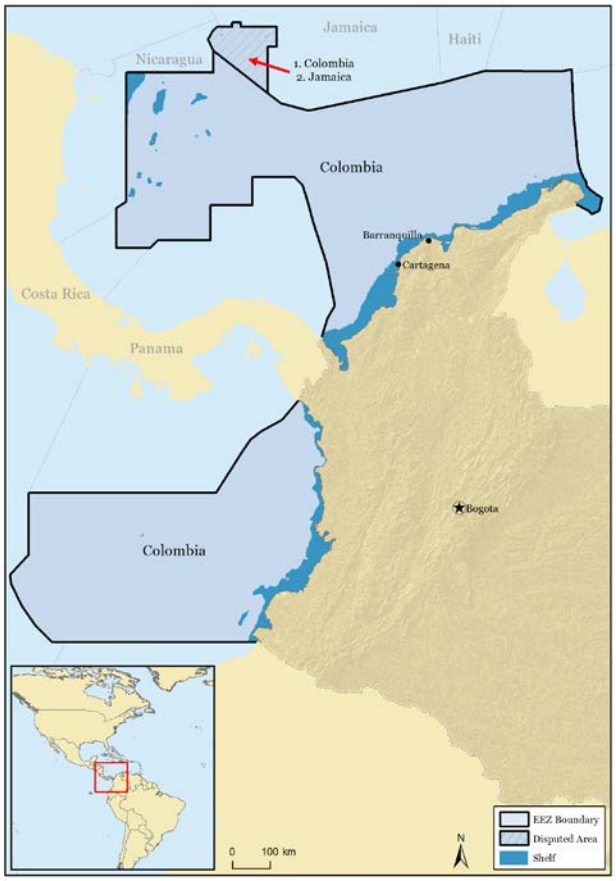

Figure 8. Extent of the EEZ and shelf waters (to 200 m depth) for Colombia.

Industrial fishing in Colombia (defined as boats larger than 15 m) began with shallow-water shrimp trawling in the Pacific Ocean (for *Penaeus occidentalis*, *Xiphopenaeus riveti*, and *Trachypenaeus* spp.) in the late 1950s, and in the Caribbean Sea (for *Farfantopenaeus brasiliensis*, *F notialis, and F. schmitti*) in the mid-1960s. Shrimp was the most important contribution of the industrial fishery to total reported landings in both oceans until the mid-1980s, when overfishing began. Since then, tuna has been the most important component of industrial landings. Tuna fishing takes place in EEZ waters of the Atlantic and Pacific with boats of less than 400 tonnes capacity, and in international waters (for *Thunnus albacares* and *Katsuwonus pelamis*) with larger boats.

The industrial shrimp trawlers have remained virtually unchanged since they began operating in Colombia, and most trawlers have a capacity of 20-40 t. They are fuel inefficient, and, as their gear is unselective, a large proportion of the by-catch is discarded, or is retained and marketed without being reported to the fisheries authorities. Shrimp trawlers in the Caribbean are based in Barranquilla, Cartagena, and Santa Marta, but they fish along the entire coast. In the Pacific Ocean, there are shrimp trawlers in Buenaventura and Tumaco. The Buenaventura trawlers operate along the entire Pacific coast, while the trawlers based in Tumaco operate only in the local waters.

In the Pacific, Colombia also has an industrial fishery for anchoveta (*Cetengraulis mysticetus*) and thread herring (*Opisthonema* spp.), which are used in fish-meal and fish-oil production. There are small industrial fisheries for spiny lobster (*Panulirus argus*) and queen conch (*Strombus gigas*) off the San Andrés Archipelago in the Caribbean. Also, there is industrial

[5] Based on material in Wielgus *et al.* (2007) and Wielgus *et al.* (2010).

fishing for fish of high value (e.g., snappers, groupers, sharks) in the Caribbean and Pacific Ocean. Most of the products of the industrial fisheries are exported.

Table 8. Indicator scores for Colombia according to the five major criteria.

Criteria	Indicator	Score
Potential for impact on the marine ecosystem	BIO_{threat}	0.36
	COE_CMSY	0.51
	FIS_{FP}	0.52
	MPA_{area}	1.00
Potential impact on the lives of poor or vulnerable people	FIS_{jobs}	0.04
	2010 POP_{coast}	0.04
	$FAO_{consumption}$	0.06
	PRO_{animal}	0.07
	PRO_{total}	0.03
	GINI	0.67
	HDI	0.20
	SUB_{LV}	0.92
	MAR_{GDP}	0.00
Potential for market-based solutions to succeed	2012 BUS_{ease}	0.20
	$VALUE_{tonne}$	0.08
	$POT_{tourism}$	0.17
Governance and policy dynamism	FOR_{press}	0.88
	$SUB_{beneficial}$	0.84
	GOV_{va}	0.57
	GOV_{ps}	0.24
	GOV_{eff}	0.67
	GOV_{reg}	0.68
	GOV_{rol}	0.46
	GOV_{corr}	0.43
Strong existing body of knowledge/evidence base	REF_{FB_SLB}	0.90
	$REF_{literature}$	0.33
	TAX_{rep}	0.53

Small-scale fisheries (nets cast from the shore and boats less than 15 m) target coastal resources in both oceans and supply a large part of the marine fish landed in Colombia. There are approximately 14,000 small-scale fishers along the Caribbean coast, and approximately 15,000 on the Pacific side. The most common fishing gears used by small-scale fisheries are cast nets, gill nets, surrounding nets, traps, and long lines. Surrounding nets are widely used by small-scale fishers to capture shrimp, and their mesh size is frequently below the legal limit, and capture large numbers of immature shrimp and fish. In 1986 (the last year for which data were available), 36% of the reported catch of *Penaeus occidentalis* landed in the port of Buenaventura was captured by the small-scale fishery using surrounding nets. In the Tumaco area, shrimp fishing is done with artisanal trawl nets that are operated from motorized canoes. The small mesh size of these nets (1.0-2.5 cm) and their deployment in mangrove areas results in the substantial catch of juvenile fish. Although small-scale fisheries supply the majority of seafood consumed in Colombia, part of this catch is purchased by the industrial sector and exported.

Indicator scores as derived here for Colombia are presented in Table (8).

Fiji[6]

The Republic of Fiji is an archipelago in the south-west Pacific Ocean, which consists of 322 volcanic or limestone islands, as well as numerous other cays and islets (Figure 9). Fiji is located at 15-23°S and 177°E-178°W with a land area of 18,500 km^2, and an Exclusive Economic Zone (EEZ) of 1.28 million km^2. There is a mixture of fringing and barrier reefs surrounding almost all of the islands. The climate is tropical but relatively mild due to the position of the islands, which puts them in the path of easterly instead of south-easterly trade winds. Fiji also experiences heavier rainfall than most tropical countries and in the wet season monsoonal winds accompany the rain. Suva, the capital of Fiji, is located on the largest and most populous island, Viti Levu. Although 70% of Fiji's population resides in Viti Levu, the majority are located in coastal areas due to the rough terrain of the interior. The second largest island is Vanua Levu.

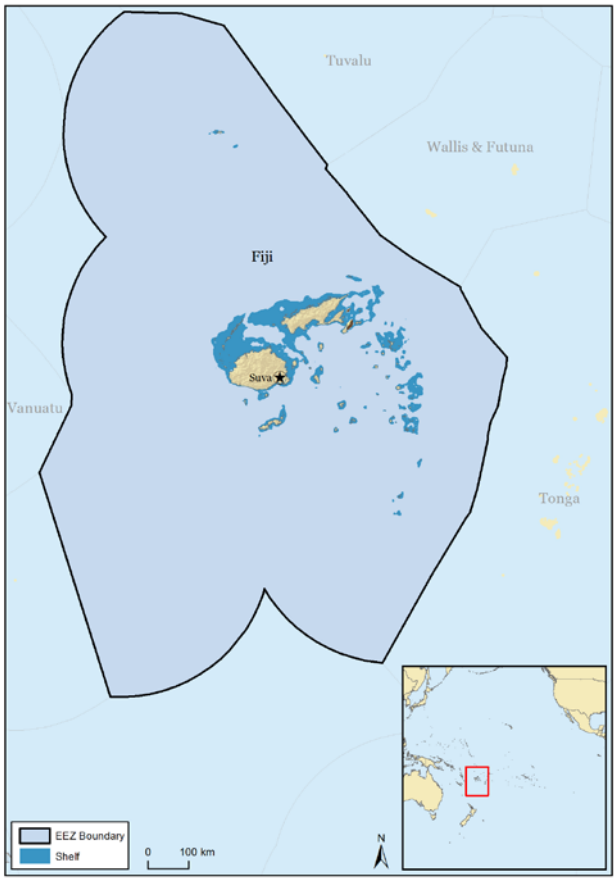

Figure 9. Extent of the EEZ and shelf waters (to 200 m depth) for Fiji.

Fijians are of Polynesian and Melanesian descent, and the current population of Fiji consists of mostly Fijians and Indians, but also includes Europeans, Chinese, and other Pacific Islanders. Fiji was proclaimed a British dependency in 1874, and in 1879, was opened to immigration by Indians who were essentially brought in to work as labourers in the sugar mills, as well as cotton, coconut, and coffee plantations. In 1970, Fiji gained its independence, after which native Fijians spent the next 17 years struggling to accept Indo-Fijian rule. In 1987, two consecutive military coups overthrew the government and the country officially became the Republic of Fiji. Despite these tensions, there has been very little ethnic violence within the country.

Important sectors of Fiji's economy are sugar, fisheries, and tourism. Marine resources have always been important to the Fijian diet, although market-based economic use developed relatively recently. There has recently been a strong trend of urbanization in Fiji and this has contributed to changes in fisheries.

Early fishing by the Fijians was almost exclusively subsistence based, with effort focused on reef and coastal areas. Fisheries were controlled through long standing customs and administered by chiefs, when necessary. Fishing areas, known as *qoliqoli*, were controlled by individual families with well recognized boundaries. Around the 1950s, the nature of Fiji's fisheries began to change. The open ocean was relatively untapped and traditional methods were still in use; however, newly acquired equipment and technology started to be incorporated. Furthermore, local fish trade increased, which gave way to the commercialization of Fijian fisheries. At the

[6] Based on material in Zylich *et al.* (2012).

time (1950s), three ports existed. Suva was the most active, receiving cargo ships from North America, Australia, New Zealand, the United Kingdom, and other Pacific Island countries. The other two ports were located in Lautoka and Levuka. Thanks to infrastructure left over from World War II, an international airport became operational in Nadi in the late 1940s, with local air service to Nausori, Labasa, and Lautoka on Viti Levu as well as Vanua Levu and Taveuni. In the late 1940s, a small cannery opened in Pago Pago (American Samoa), as a result of efforts by a Fiji fishing company, which had been developing a pole-and-line fleet. Having a cannery in American Samoa would give access to the foreign tuna market, predominantly the United States. Unfortunately, catches were not consistent enough for the cannery to be profitable, forcing it to close. The US opened their own cannery in Pago Pago in the early 1950s, which was instrumental in the subsequent success of fishing endeavours by the US and others in the Pacific, including in Fijian waters. In 1964, the Pacific Fishing Company (PAFCO), a fish-processing facility which supports local fisheries and prepares fish for re-export, was opened. PAFCO also built a cannery in Levuka, Ovalau in 1970, and employed a large proportion of the villagers from all over the island. The IKA Corporation, a domestic fishing company, was founded in the mid-1970s to supply PAFCO with tuna. Unfortunately, IKA collapsed in the 1990s, due to the introduction of cheaper purse seine fleets.

Table 9. Indicator scores for Fiji according to the five major criteria.

Criteria	Indicator	Score
Potential for impact on the marine ecosystem	BIO_{threat}	0.40
	COE_CMSY	0.61
	FIS_{FP}	0.56
	MPA_{area}	0.14
Potential impact on the lives of poor or vulnerable people	FIS_{jobs}	1.00
	2010 POP_{coast}	0.00
	$FAO_{consumption}$	0.63
	PRO_{animal}	0.66
	PRO_{total}	0.55
	GINI	0.35
	HDI	0.24
	SUB_{LV}	0.54
	MAR_{GDP}	1.00
Potential for market-based solutions to succeed	2012 BUS_{ease}	0.29
	$VALUE_{tonne}$	0.57
	$POT_{tourism}$	0.83
Governance and policy dynamism	FOR_{press}	0.63
	$SUB_{beneficial}$	0.31
	GOV_{va}	0.29
	GOV_{ps}	0.68
	GOV_{eff}	0.33
	GOV_{reg}	0.44
	GOV_{rol}	0.24
	GOV_{corr}	0.37
Strong existing body of knowledge/evidence base	REF_{FB_SLB}	0.70
	$REF_{literature}$	0.37
	TAX_{rep}	0.45

In the mid-1980s, a deep-slope fishery in Fiji was active and would export the catches to more demanding overseas markets. In 1987, the fishery declined due to disruption in air service, and the vessels from the fleet were utilized for pelagic longlining, which saw much better returns. Unfortunately, encouragement from the government and other organizations to increase fishing efforts (through subsidies, loans, and instructional programs), has lead to problems of overcapacity in Fiji's fisheries sector. Legislation and management is more geared toward commercialization than sustainability.

The domestic, and especially the small scale, fisheries of Fiji have been largely overlooked in monitoring and management considerations. Much of the recent research highlighting the importance of these fisheries only appears in reports which are less widely accessible.

Indicator scores as derived here for Fiji are presented in Table (9).

The Gambia[7]

Bordered on three sides by the Republic of Senegal and on the west by the Atlantic Ocean, The Gambia, alias 'the Smile of Africa' is one of Africa's smallest coastal states (Figure 10). The Gambia lies almost entirely in the Savannah-Sahelian belt of West Africa and extending for a distance of over two hundred miles into the interior of Africa. It comprises a strip of land varying from 25 to 50 km on either side of the 480 km long River Gambia. Besides being located in a highly productive upwelling zone, a continental shelf of about 4,000 km^2 and a 200 nm EEZ area of approximately 10,500 km^2 make Gambian fisheries resources potentially rich in terms of species abundance and diversity. Fisheries surveys conducted between 1964 and 1965 and in 2004 indicated that the country has considerable marine and estuarine fisheries resources and that the exploitation and utilization of the resources could contribute significantly to national socio-economic development. These positive results could be attributed to the flow of nutrient from the River Gambia and the fortunate location of The Gambia in an area where trade winds, the Canary currents and the upwelling system prevail. Given this particular geography, most of the Gambian population lives close to the coast of either the Gambia River or the Atlantic coast. This along with major natural events that have negatively affected agriculture such as the floods of the 1950s and the droughts of 1962 and in the 1980s, fisheries, notably those that are small-scale most certainly gained major importance in the country.

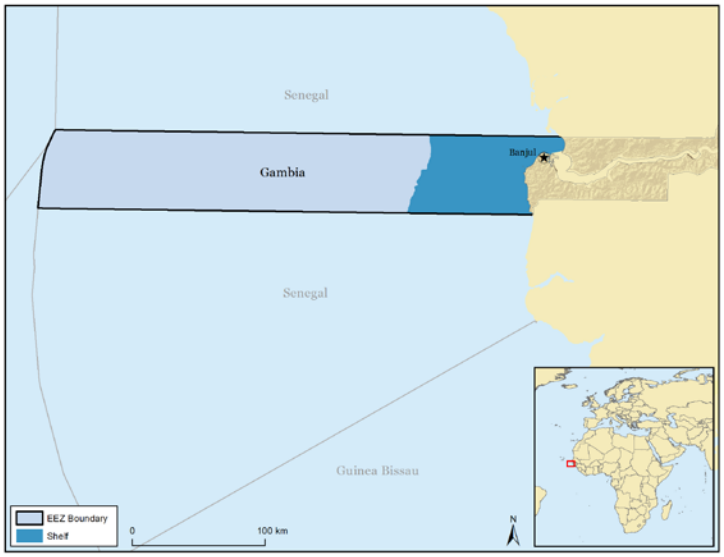

Figure 10. Extent of the EEZ and shelf waters (to 200 m depth) for The Gambia.

The artisanal fisheries have expanded considerably in the past two decades with new entrants every year. Since the introduction of motorized canoes in the mid-1960s by a migrant Senegalese fisher, The Gambia has witnessed the transformation of this fishery from paddled/oared canoes with primitive fishing techniques to new fish capturing technologies and larger canoes with outboard engines and thus the increase in fish landings. The industrial fishery, as is also the case in many West African countries, are of foreign origin. Their catches are landed elsewhere despite the current national legislation, and their impact on food security and the Gambian economy is rather low compared to artisanal fisheries.

Indicator scores as derived here for The Gambia are presented in Table (10).

[7] Based on material in Belhabib *et al.* (in prep).

Table 10. Indicator scores for The Gambia according to the five major criteria.

Criteria	Indicator	Score
Potential for impact on the marine ecosystem	BIO_{threat}	0.61
	COE_CMSY	0.16
	FIS_{FP}	0.81
	MPA_{area}	0.08
Potential impact on the lives of poor or vulnerable people	FIS_{jobs}	0.61
	2010 POP_{coast}	0.00
	$FAO_{consumption}$	0.49
	PRO_{animal}	0.52
	PRO_{total}	0.88
	GINI	--
	HDI	0.77
	SUB_{LV}	0.43
	MAR_{GDP}	--
Potential for market-based solutions to succeed	2012 BUS_{ease}	0.80
	$VALUE_{tonne}$	0.13
	$POT_{tourism}$	0.32
Governance and policy dynamism	FOR_{press}	0.48
	$SUB_{beneficial}$	0.35
	GOV_{va}	0.22
	GOV_{ps}	0.70
	GOV_{eff}	0.37
	GOV_{reg}	0.51
	GOV_{rol}	0.38
	GOV_{corr}	0.36
Strong existing body of knowledge/evidence base	REF_{FB_SLB}	0.99
	$REF_{literature}$	0.27
	TAX_{rep}	0.41

Ghana[8]

Ghana lies in West Africa, on the Gulf of Guinea, and has a land area of 238,500 km^2, and is bounded by Burkina Faso in the north, Côte d'Ivoire in the west, Togo in the east, and the Gulf of Guinea in the south (Figure 11). The country became independent from Britain in 1957 and its current population is about 25 million. Accra is Ghana's capital city, while Takoradi, Kumasi and Tamale are other important cities.

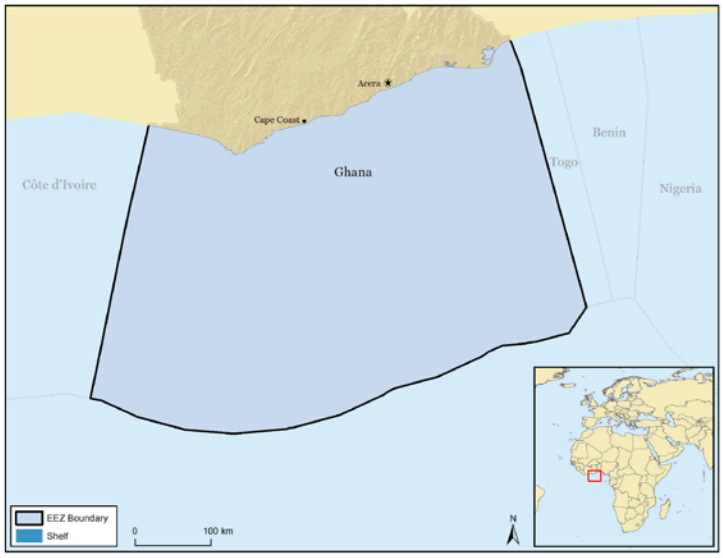

Figure 11. Extent of the EEZ and shelf waters (to 200 m depth) for Ghana.

While one third of Ghana's territory is covered with tropical rain forests, grass-covered plateau savannahs are found in the northern parts and steppes are found in some part of the southern coastal region, with major rivers in the western part, i.e., the Pra, Ankobra and Tano. In the eastern part, a plain extends all the way to the border with Togo. Within this plain, the Black Volta River flows from the northwest and the White Volta River flows through the north-central part. They empty into Volta Lake, which covers 8,500 km^2, and came about because of the Akosombo hydroelectric dam, built in 1964, which created one of the world's largest artificial lakes.

The coastline of Ghana is rather monotonous, except for relatively large lagoons that are located at its eastern and western extremities, while the continental shelf (i.e., waters down to 200 m) is relatively narrow, and ranges from 24 to 80 km offshore, with an area of 24,300 km^2 within an EEZ of 218,000 km^2.

The Guinea Current flows from west to east, but further offshore, the South Equatorial Current flows from east to west. Thus, on the continental shelf of Ghana, there are two seasonal upwellings, i.e., a major upwelling occurring from June- July to September- October, during which the sea surface temperature drops from 25° C to 17° C or lower, and a minor upwelling lasting up to a month, and occurring mainly in January or February.

The Ghanaian fisheries account for about 4.2 % of the agricultural GDP. Fish is the major source of animal protein for Ghanaians, and *per capita* consumption of fish is about 26 kg·person^{-1}·year^{-1} which represents 60% of all animal protein. Fish and fishery products are now the country's most important non-traditional exports, accounting for over 50% of earnings from non-traditional exports.

Ghana already had a fishing industry long before the introduction of mechanized fishing in 1946. From 1960 on, serious attempts were made to modernize Ghana's fisheries. In those early days, there was a large canoe-fleet using methods such as *ali*-nets, beach-seines, hooks, cast-nets, and set-nets. In short, even in that pre-mechanization era, the fishing industry was having an impact on the economy by providing food for the population and employment for coastal people.

About 85% of total fish caught in Ghana comes from the marine sector. In Ghanaian fisheries, pelagic and demersal species contribute about equally to the national catch.

[8] Based on material in Nunoo *et al.* (in prep).

Indicator scores as derived here for Ghana are presented in Table (11).

Table 11. Indicator scores for Ghana according to the five major criteria.

Criteria	Indicator	Score
Potential for impact on the marine ecosystem	BIO_{threat}	0.56
	COE_CMSY	0.45
	FIS_{FP}	0.81
	MPA_{area}	0.00
Potential impact on the lives of poor or vulnerable people	FIS_{jobs}	0.46
	2010 POP_{coast}	0.03
	$FAO_{consumption}$	0.51
	PRO_{animal}	0.66
	PRO_{total}	0.79
	GINI	0.19
	HDI	0.53
	SUB_{LV}	0.98
	MAR_{GDP}	0.06
Potential for market-based solutions to succeed	2012 BUS_{ease}	0.31
	$VALUE_{tonne}$	0.04
	$POT_{tourism}$	0.04
Governance and policy dynamism	FOR_{press}	0.94
	$SUB_{beneficial}$	0.31
	GOV_{va}	0.79
	GOV_{ps}	0.72
	GOV_{eff}	0.57
	GOV_{reg}	0.62
	GOV_{rol}	0.52
	GOV_{corr}	0.57
Strong existing body of knowledge/evidence base	REF_{FB_SLB}	0.97
	$REF_{literature}$	0.12
	TAX_{rep}	0.52

India[9]

The Republic of India is a South Asia country bounded by oceans, and it shares land borders with Pakistan on the west, China, Nepal, and Bhutan to the northeast, and Burma and Bangladesh to the east (Figure 12). India is the second most populous country in the world, with approximately 1.2 billion people, representing 17.5 % of the total world population. India covers a total land area of about 3.3 million km^2, with 28 States and 7 Union Territories, the latter under the direct authority of the central government. The west coast of India has 5 maritime States: Gujarat, Maharashtra, Goa, Karnataka, Kerala and two Union Territories, Daman and Diu, and Lakshadweep. The east coast of India has 4 maritime States: Tamil Nadu, Andhra Pradesh, Orissa, and West Bengal. The Union Territories include Pondicherry, and Andaman and Nicobar Islands. The marine waters of India encompass two LMEs, the Arabian Sea along the west coast and the Bay of Bengal along the east coast. India's EEZ covers a total area of 1.63 million km^2 (including the Lakshadweep Islands on the west coast). Off the east coast, the EEZ of the Andaman and Nicobar Islands, covers a total area of 660,000 km^2 and represents about 30% of the total Indian EEZ. As with most developing countries with vast coastlines, the resources of the surrounding ocean play an important role in the economy, diet, and culture of the Indian people.

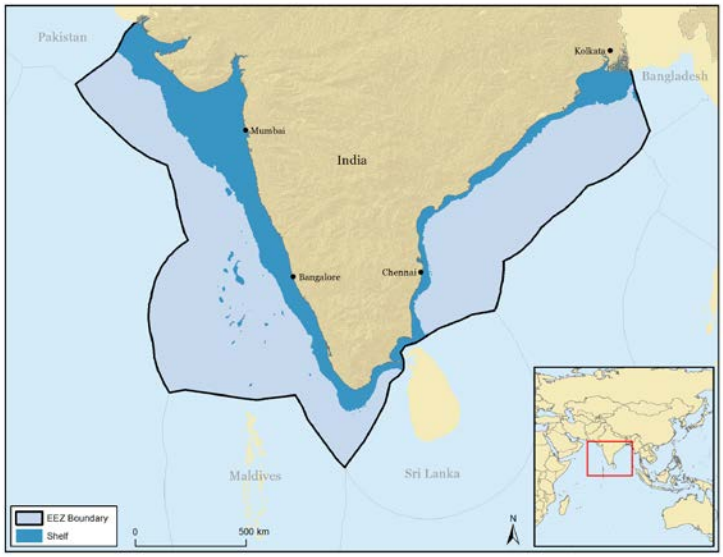

Figure 12. Extent of the EEZ and shelf waters (to 200 m depth) for India (excluding the Andaman & Nicobar Islands).

The Indian Ocean is the warmest ocean in the world, resulting, via a strong, semi-permanent stratification, in low primary productivity in most regions. Despite this low productivity, the marine fishing sector in India has shown steady growth since India's independence in 1947. India declared its EEZ in 1976, and the west coast of India, also known as the 'Malabar coast', has a broader continental shelf and a relatively high primary production, and supports over 75% of India's total fish landings. The east coast of India, also known as 'Coromandel coast', has a much narrower shelf and primary and secondary production in the Bay of Bengal is much lower than the Arabian Sea. Still, there are nearly 4,000 fishing villages and 2,000 traditional landing centers along this coast.

The growth of India's fisheries sector can be separated into three phases. In phase one (1950-1966), landings were mainly by non-mechanized traditional crafts and gears, such as hook and line, gillnets, seines, bag nets and traps, from catamarans, canoes and plank built boats. During the second phase (1967-1986), these vessels were modified to hold outboard engines of 5-9 hp (i.e., *motorization*), in order to travel farther and increase fishing effort. In the third phase from about 1987 to 2010, major endeavors were made to further increase *mechanization* (i.e., use of vessels with inboard engines) and develop the industrial fishing sector. Vessels were equipped for multi-day voyages and a large expansion of fishing grounds was observed. Despite this, India's

[9] Based on material in Kleisner *et al.* (2012) and a currently unpublished fisheries report by Hornby *et al.* (in prep), which extends the work of Bhathal (2005).

fisheries remain small-scale in nature and hard to categorize, since boundaries between subsistence (i.e., non-commercial) and artisanal (i.e., commercial) are blurred.

Trawling has emerged as the most important method of exploiting demersal resources and accounts for about half of the total Indian catch. Today, the mechanized/industrial fleets consist of small trawlers, pair trawlers, purse seiners and gillnetters. Chartered and joint-venture trawlers, tuna longliners, and other multi-purpose vessels (i.e., that catch prawn and fish), ultimately operated by foreign states, make up the bulk of the industrial fleet and have been fishing off India's coastline since 1972

The waters off India host a wide diversity of marine resources targeted by artisanal fishers, some operating with century-old methods, and by large-scale industrial fishing operations which are disrupting coastal communities and their way of life, notably through intense competition for the same resources. In general, marine resources in India are targeted by four groups, operating various types of fishing vessels and gears: (1) artisanal fishers operating non-motorized vessels, (2) artisanal fishers operating vessels with outboard motors (less than 50 hp) in inshore waters, (3) industrial fishers using vessels with inboard motors, and (4) industrial deep-sea vessels. Overall, there are approximately 1.45 million fishers in India and the bulk of marine fish landed (~68%) is taken by artisanal mechanized vessels. Trawling has emerged as the dominant gear for demersal resources and accounts for 50% of the total Indian catch.

Table 12. Indicator scores for India according to the five major criteria.

Criteria	Indicator	Score
Potential for impact on the marine ecosystem	BIO_{threat}	0.21
	COE_CMSY	0.64
	FIS_{FP}	0.66
	MPA_{area}	0.10
Potential impact on the lives of poor or vulnerable people	FIS_{jobs}	0.31
	2010 POP_{coast}	0.83
	$FAO_{consumption}$	0.07
	PRO_{animal}	0.03
	PRO_{total}	0.21
	GINI	0.03
	HDI	0.54
	SUB_{LV}	0.75
	MAR_{GDP}	0.09
Potential for market-based solutions to succeed	2012 BUS_{ease}	0.71
	$VALUE_{tonne}$	0.13
	$POT_{tourism}$	0.13
Governance and policy dynamism	FOR_{press}	0.82
	$SUB_{beneficial}$	0.13
	GOV_{va}	0.76
	GOV_{ps}	0.26
	GOV_{eff}	0.57
	GOV_{reg}	0.49
	GOV_{rol}	0.52
	GOV_{corr}	0.34
Strong existing body of knowledge/evidence base	REF_{FB_SLB}	0.23
	$REF_{literature}$	0.47
	TAX_{rep}	0.42

Valuable species such as Indian oil sardine (*Sardinella longiceps*), penaeid and non-penaeid shrimp, Indian mackerel (*Rastrelliger kanagurta*), Bombay duck (*Harpadon nehereus*), and croakers (*Micropogonias* spp.) are the preferred targets, although various types of commercial finfish are often caught as by-catch. Among the multitude of species contributing to the catch, one species, the Indian oil sardine (*Sardinella longiceps*) contributes the majority of the yield, although they fluctuate strongly.

The marine fisheries in India are regulated both by the Central and State Governments. Offshore fishing within the EEZ by domestic and foreign fleets is managed by the Central Government; however, there is no comprehensive fisheries legislation for fisheries within the EEZ. Fisheries within the 12 nm territorial waters fall under the jurisdiction of the States, which are responsible for managing and collecting official fisheries statistics under the *Marine Fishing Regulation Act* (MFRA). Along with the State governments, the Central Marine Fisheries Research Institute (CMFRI) estimates the annual fish landings by State and compiles the data for the entire country. National catch statistics prior to 1994 were obtained through a rigorous stratified sampling procedure; however, since the mid-1990s, changes to the sampling program have caused the deterioration of India's marine production statistics.

India regularly reports commercial landings from the artisanal sector. However, industrial landings and discards have historically been unreported. . It is likely that the majority of by-catch

was retained prior to 1970, as even low-value species had a market, resulting in negligible discarding during that time.

Through the 1970s, the non-mechanized sector fished primarily with hooks and lines, gillnets, seines, bag nets and traps, from catamarans, canoes and plank built boats. These vessels were gradually modified through the 1980s to hold outboard engines of 5-9 hp, in order to travel farther. Major endeavours were made to increase mechanization during the 1970s and 1980s, prompting the development of an industrial motorized fleets consisted of small trawlers, pair trawlers, purse seiners and gillnetters that could accommodate small inboard engines and fish down to 50 m. Additionally, chartered and joint venture deep-sea trawlers, tuna long-liners, and multi-purpose vessels that have the capacity to target both prawns and fish, were introduced in 1972 and now make up the bulk of the industrial fleet.

This push for modernization of the vessels in India stemmed from a desire to promote the evolution of fishery into a more industrial activity. The resulting geographic expansion into deeper waters was the main reason for the growth and maintenance of Indian fisheries catches. However, this expansion must be accounted for when evaluating the health and productivity of Indian fisheries, as true trends in the status of fisheries (e.g., declines in mean trophic level of the catch and mean size of fishes) may be masked when catch data is not disaggregated spatially. Overall, the push to expand has been fuelled mainly by the perception by Indian policy makers that the demersal fisheries could be expanded greatly by operating in deeper waters. However, the low oxygen levels in deeper water layers, especially on the West Coast, constrain this e expansion. Therefore, the new subsidized trawlers added to the Indian fleets since the 1980s tend to compete with small-scale fishers operating inshore. This indeed is one of the reasons why the conflict between small- and large-scale fisheries is most pronounced in India.

Indicator scores as derived here for India are presented in Table (12).

Indonesia[10]

Indonesia is a large archipelagic country straddling the equator in Southeast Asia, ranging from 95^0 to 141^0 E, and largely encompasses the Indonesian Sea Large Marine Ecosystem (Figure 13). Indonesia can be conveniently divided into three different parts, i.e., Western, Central and Eastern Indonesia, with the Western and Central parts accounting for the overwhelming bulk of its population and markets. Western and Central Indonesia combined has a smaller EEZ (2,464,000 km^2) than Eastern Indonesia (3,617,000 km^2), but given its larger shelf, it has more demersal fisheries.

Indonesia has a long tradition of fishing and fish is an important component of the food of Indonesians. According to the FAO, there were approximately 750,000 fishing boats in 2004, a major increase since the mid-1990s. The majority of boats are fishing around North Java, followed by Maluku-Papua, South Sulawesi, North Sulawesi, Bali-Nusa Tenggara, and East Sumatra. Most of the motorized boats fish around North Java, while non-powered boats dominate around the Maluku-Papua area.

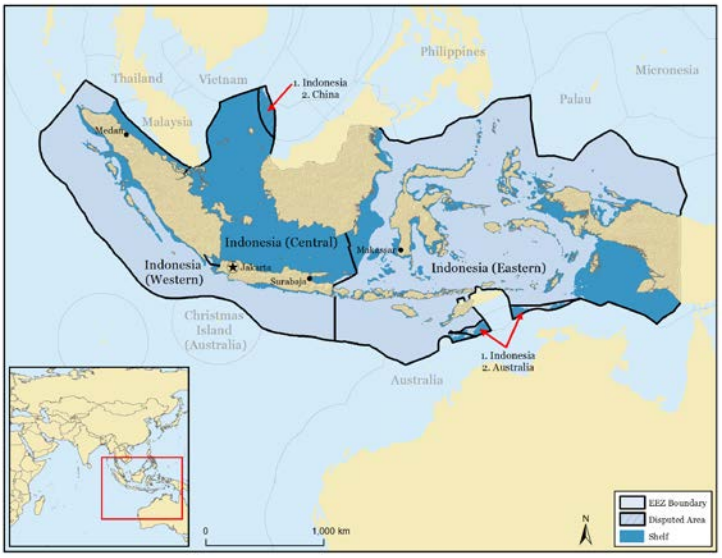

Figure 13. Extent of the EEZ and shelf waters (to 200 m depth) for Indonesia.

In Western and Central Indonesia, the majority of marine resources, including large pelagics, mackerels, sardinellas, groupers, and crustaceans, have been heavily exploited. Conversely, many of the resources in East Indonesia are still being 'developed'. Generally, marine resources are supposed to be managed through quotas based on the total allowable catch (TAC), itself based on estimates of 'potential yield'.

One important feature of Indonesian fisheries development is the 1980 trawling ban, and which, despite being partly circumvented, led to the development of a large industrial fishery for small pelagic fishes, especially in the Java Sea.

Eastern Indonesia is part of the Coral Triangle, and indeed, may be viewed as its very core. Much of the waters of Eastern Indonesia are in deep, relatively unproductive basins. The main fisheries are for tuna, which, together with shrimp trawling in the easternmost province of Papua, represent the bulk of Indonesian industrial fishing. There is a huge amount of illegal fishing, mainly for tuna, by distant water fleets from Thailand, Taiwan, China and the Philippines.

The pressure on Indonesian marine fishery resources has increased strongly in recent decades, due to a multiplicity of factors, among them increased demand from a much increased population, and the development of industrial fisheries, especially trawling, which starting in the late 1960s, gradually intensified, and led to a series of conflicts with the thousands of small-scale fishers. These conflicts which intensified through the mid-1970s caused the government of Indonesia to ban, in 1980, trawl fishing around Java and Sumatra. In 1981, this ban was extended

[10] Based on material in (Kleisner *et al.* 2012) and currently unpublished fisheries reports by Budimartono and Pauly (in prep).

to Kalimantan and Sulawesi, and in 1983 to the rest of the country, except for shrimp fisheries in its far east.

Indicator scores as derived here for Indonesia are presented in Table (13).

Table 13. Indicator scores for Indonesia according to the five major criteria.

Criteria	Indicator	Score
Potential for impact on the marine ecosystem	BIO_{threat}	0.26
	COE_CMSY	0.66
	FIS_{FP}	1.00
	MPA_{area}	0.67
Potential impact on the lives of poor or vulnerable people	FIS_{jobs}	0.30
	2010 POP_{coast}	0.68
	$FAO_{consumption}$	0.46
	PRO_{animal}	0.51
	PRO_{total}	0.70
	GINI	0.02
	HDI	0.39
	SUB_{LV}	0.77
	MAR_{GDP}	0.32
Potential for market-based solutions to succeed	2012 BUS_{ease}	0.69
	$VALUE_{tonne}$	0.07
	$POT_{tourism}$	0.03
Governance and policy dynamism	FOR_{press}	0.81
	$SUB_{beneficial}$	0.14
	GOV_{va}	0.60
	GOV_{ps}	0.39
	GOV_{eff}	0.50
	GOV_{reg}	0.49
	GOV_{rol}	0.32
	GOV_{corr}	0.32
Strong existing body of knowledge/evidence base	REF_{FB_SLB}	0.12
	$REF_{literature}$	0.36
	TAX_{rep}	0.61

Kenya[11]

The Republic of Kenya is located on the east coast of Africa, between Somalia and Tanzania (Figure 14). A major part of total Kenyan fish catches come from Lake Victoria, one of the most important fishing area on the African continent. Freshwater fisheries, and more marginally marine fisheries, are therefore of prime importance to the Kenyan economy and to its food security, yet, most monitoring infrastructures are found along the coast.

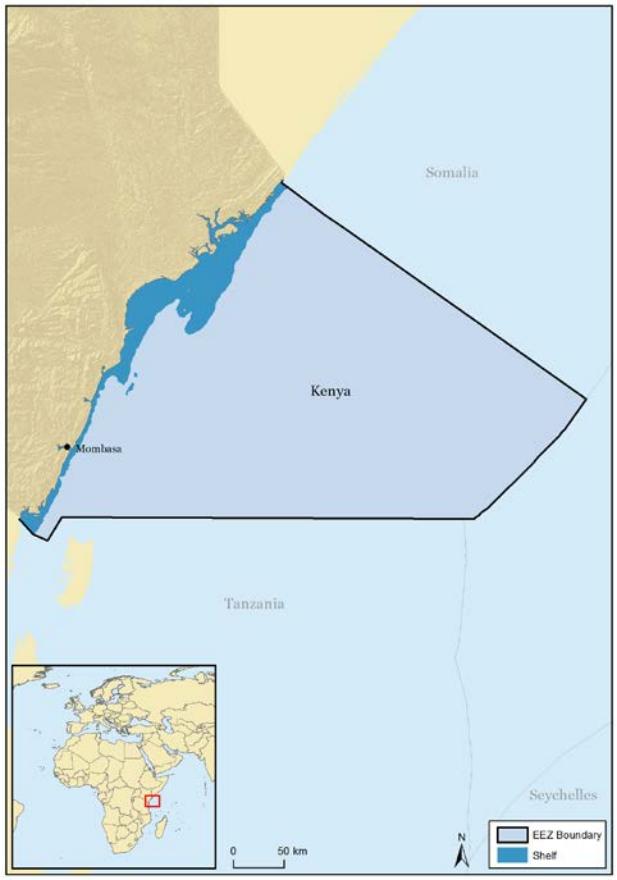

Figure 14. Extent of the EEZ and shelf waters (to 200 m depth) for Kenya.

Kenya declared its Exclusive Economic Zone (EEZ) in 1986, which amounts to just over 110,000 km². Kenya's coast is lined with coral reefs covering over 600 km² and mangrove stands, predominantly in the north. However, marine fisheries are limited due to a narrow continental shelf, resulting in a small inshore fishing area, where essentially all small-scale fisheries occur. Other factors influence small-scale fisheries, such as the northeast (December-March; resulting in local upwelling) and southeast monsoons (May-October), which further restrict fishing activities to inshore waters when the sea is too rough.

Similarly to many maritime developing countries, Kenyan marine fisheries have a critical role in domestic food security and livelihoods. For the majority of coastal communities, fisheries likely provide 80% of the total income, and the number of fishers is increasing by 2% per year. Tourism also plays an increasing role in the coastal development of Kenya and ocean-related activities, as many tourists enjoy sport fishing or wish to visit marine protected areas for their diverse fauna. Consequently, this may have resulted in declining traditional fishing activities in some areas (e.g., resort and protected areas), while others have developed (e.g., sport fishing). This may also signify that the overall fishing effort increases slower than the number of fishers. However, no reliable time-series of the number of fishers and fishing effort exist, although some figures have been published by the Government since the early 2000s. Officially, the government reports that there were approximately 13,000 fishers in 2010, however, others suggested that these numbers were likely more around 15,000 fishers in the 1990s.

The most important sector of Kenyan marine fisheries is the small-scale fleet, mostly active within the 3 nm zone. These fishers target reef fish, small to large pelagic species, as well as various invertebrates. The major fishing grounds are found around Lamu, the mouth of the Tana River, Ungwana Bay/Malindi, as well as the Mombasa area and the North Kenya Banks. It was estimated that there were approximately 125,000 tonnes of exploitable marine species within the 12 nm zone in the late 1970s/early 1980s, which would ensure an inshore sustainable yield of

[11] Based on material in Le Manach *et al.* (in prep-a).

20,000 t·year^{-1}. The Monitoring, Control and Surveillance (MCS) system remains poor in Kenya, many fishers do not report their catch, and official catch data still appear to be under-reported.

Indicator scores as derived here for Kenya are presented in Table (14).

Table 14. Indicator scores for Kenya according to the five major criteria.

Criteria	Indicator	Score
Potential for impact on the marine ecosystem	BIO_{threat}	0.23
	COE_CMSY	0.57
	FIS_{FP}	0.63
	MPA_{area}	0.14
Potential impact on the lives of poor or vulnerable people	FIS_{jobs}	0.32
	2010 POP_{coast}	0.01
	$FAO_{consumption}$	0.03
	PRO_{animal}	--
	PRO_{total}	--
	GINI	0.42
	HDI	0.61
	SUB_{LV}	0.82
	MAR_{GDP}	0.04
Potential for market-based solutions to succeed	2012 BUS_{ease}	0.65
	$VALUE_{tonne}$	0.12
	$POT_{tourism}$	0.04
Governance and policy dynamism	FOR_{press}	0.97
	$SUB_{beneficial}$	0.14
	GOV_{va}	0.55
	GOV_{ps}	0.22
	GOV_{eff}	0.39
	GOV_{reg}	0.54
	GOV_{rol}	0.21
	GOV_{corr}	0.25
Strong existing body of knowledge/evidence base	REF_{FB_SLB}	0.45
	$REF_{literature}$	0.63
	TAX_{rep}	0.28

Madagascar[12]

Madagascar is located in the western Indian Ocean, and separated from Africa by the Mozambique Channel (Figure 15). With a land area of approximately 587,000 km², and an EEZ of 1.2 million km², it is the fourth largest island in the World and an African biodiversity hotspot, with around 80% of its terrestrial species being indigenous, and its endemic biodiversity threatened by habitat loss. Given its great size, spanning 14 degrees of latitude, Madagascar exhibits a range of geological, oceanic and climatic environments, for example, the east of the country is mountainous with a narrow continental shelf facing the prevailing trade winds and oncoming east equatorial current, while the west side is characterized by large plains in a rain shadow, with the coast fringed by a wide continental shelf. The southern region is subject to more arid conditions, restricting its agricultural potential. These environmental differences have also shaped marine ecosystems: mangroves are almost exclusively present on the west coast, whereas coral reefs span the southwest, west and northeast coasts, and include one of the largest coral reef systems in the Indian Ocean, totaling approximately 2,230 km². These geographical differences have also resulted in spatial divergence in the distribution of the island's human population with the eastern part of the island having the highest density, while the west coast is home to the majority of fishers and therefore experiences the highest fishing pressure.

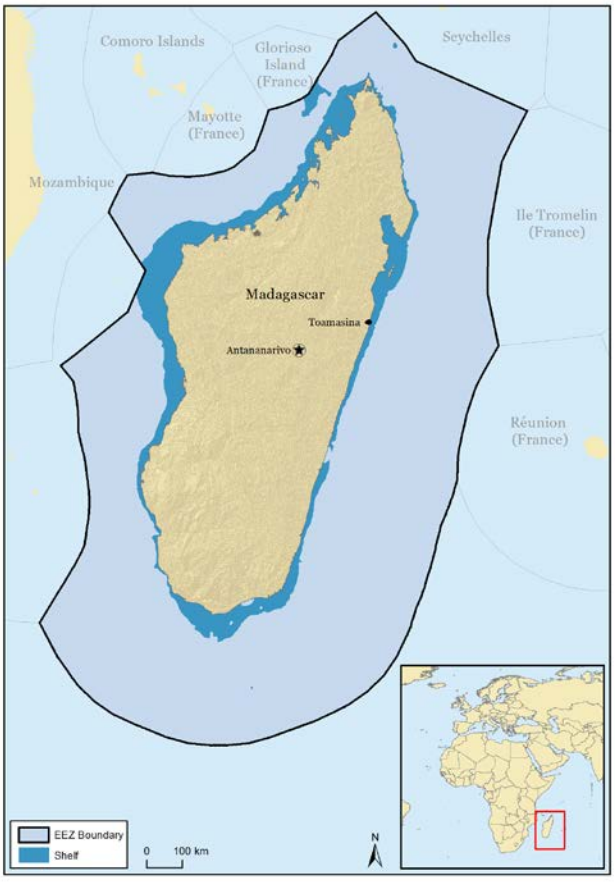

Figure 15. Extent of the EEZ and shelf waters (to 200 m depth) for Madagascar.

Historically, Madagascar has had several political regimes. After the Berlin Convention in 1885, which decided the fate of most of the African continent during colonization, Madagascar was invaded by France in 1896, turning Madagascar into a French colony and finally into a French Overseas Territory in 1946. Although the colonial power invested in national infrastructure such as trains and schools, this period was also characterized by protracted political violence. While ceding increasing power to national institutions, the French government gradually withdrew, and in 1960, the First Republic was proclaimed. However, the first Malagasy President was unpopular, mainly due to the continuing strong economic and political ties with France. In 1975, the Second Republic aligned itself with the former Soviet Union; key sectors of the economy were nationalized and the country experienced a radical socialist and authoritarian political regime. Ten years later, heavy opposition to this regime developed, and in 1992 the Third Republic was proclaimed. Political instability continues to the present day, following a military-backed coup in 2009. Madagascar's current unelected regime faces ongoing economic sanctions and is not readily recognized by the

[12] Based on material in Le Manach *et al.* (2011) and Le Manach *et al.* (2012).

international community, including the European Union (EU) or the Southern African Development Community (SADC).

Table 15. Indicator scores for Madagascar according to the five major criteria.

Criteria	Indicator	Score
Potential for impact on the marine ecosystem	BIO_{threat}	0.33
	COE_CMSY	0.21
	FIS_{FP}	0.92
	MPA_{area}	0.07
Potential impact on the lives of poor or vulnerable people	FIS_{jobs}	0.12
	2010 POP_{coast}	0.02
	$FAO_{consumption}$	0.09
	PRO_{animal}	0.14
	PRO_{total}	0.25
	GINI	0.34
	HDI	0.68
	SUB_{LV}	0.90
	MAR_{GDP}	0.13
Potential for market-based solutions to succeed	2012 BUS_{ease}	0.77
	$VALUE_{tonne}$	0.15
	$POT_{tourism}$	0.21
Governance and policy dynamism	FOR_{press}	0.84
	$SUB_{beneficial}$	0.75
	GOV_{va}	0.34
	GOV_{ps}	0.37
	GOV_{eff}	0.27
	GOV_{reg}	0.43
	GOV_{rol}	0.26
	GOV_{corr}	0.43
Strong existing body of knowledge/evidence base	REF_{FB_SLB}	0.55
	$REF_{literature}$	0.18
	TAX_{rep}	0.15

Economically, Madagascar is one of the poorest countries in the world. Per capita GDP has declined steadily since independence, having never exceeded US$ 410, and currently is at less than US$ 300. Approximately 70% of the population currently lives below the poverty threshold, and over half of the country's population is dependent on the exploitation of natural resources for their livelihoods. Subsistence fisheries are of prime importance for coastal communities, especially in the south and west of the country where agriculture is virtually impossible due to aridity. However, the importance of seafood for domestic food security has rarely been recognized by the various governments of Madagascar.

Indicator scores as derived here for Madagascar are presented in Table (15).

Mexico[13]

Mexico is a federal republic in North America, bordered in the north by the U.S., in the south by Guatemala and Belize, in the east by the Gulf of Mexico and in the west by the Pacific Ocean (Figure 16). The land area of Mexico is nearly 2 million km^2, with a population of almost 115 million, the majority of which lives along the extensive coastline. This has resulted in strong ties to fisheries and marine resources. Mexico's EEZ covers over 3.2 million km^2, with most (2.4 million km^2) being located in the Pacific, while the Caribbean side covers around 825,000 km^2.

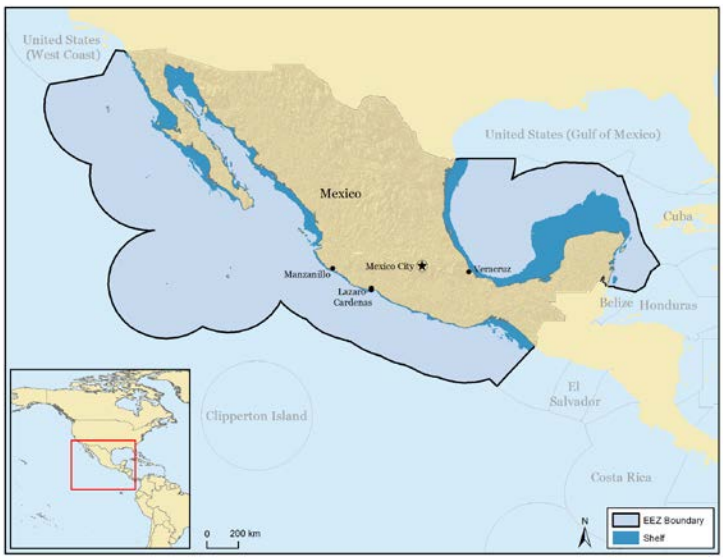

Figure 16. Extent of the EEZ and shelf waters (to 200 m depth) for Mexico.

Fisheries in Mexico, reflecting the political system, have historically been characterized by constant shifts in objectives and management schemes. They have thus evolved from an overlooked sector, to a primary source of food and job creation, to a casualty of economic reform and now to a tug-of-war between *laissez-faire* management on the one hand and ecological conservation priorities on the other. The participation and influence of scientists, academics and conservation organizations has also evolved towards a broader understanding of the socio-political and ecological context of Mexican fisheries, with increased training in and application of quantitative methods to assess fisheries' status. Unfortunately, a lack of effective fisheries governance has resulted in highly uncertain fishery statistics, which often lack the quality that is required for their use within quantitative frameworks.

In general, the Mexican fishing industry is comprised of a very large artisanal sector (>100,000 registered vessels plus an unknown number of non-registered vessels) and a smaller (<5,000) industrial fleet of (mostly aging) trawlers, seiners and longliners. The most important fisheries by volume are small pelagics, particularly Pacific sardine (*Sardinops sagax*), though environmental changes have made for substantial fluctuations in landings (from ~ 100,000 t·year^{-1} in the 1990s to over 500,000 t·year^{-1} currently). The most valuable fishery continues to be for shrimp, with a current landed value of US$ ~450 million (excluding aquaculture). Although these fisheries are usually at the forefront of management discussions, along with other valuable or large-volume fisheries such as tuna, lobster, squid and abalone, sub-tropical ecosystems along most of the Mexican coastline result in catch of many species in smaller amounts. It would be interesting to compare the social and economic value of these multi-species fisheries with that of the more prominent ones, which are usually destined for fishmeal and/or export.

In Mexico, the large fishing sector (>300,000 fishers), versatile boats and gear, a large coastline, corruption and a limited capacity for monitoring and enforcement result in significant illegal, unreported and unregulated catch. Official statistics rely on the compulsory, but unenforced submission to the local fisheries office of catch logs by (legal) fishers or buyers. There is little validation of catch, and logs are often filled in on the spot by fishery officers based on the fishers'

[13] Based on material in Kleisner *et al.* (2012) and Cisneros-Montemayor *et al.* (2013b).

accounts from memory. 'Irregular' fishing (unreported and illegal) is thought to currently represent 40-60% of reported catch. This estimate does not account for discards in shrimp trawls, which historically have had a 1:10 shrimp to by-catch ratio and are widely regarded as the single most important source of unreported by-catch.

Table 16. Indicator scores for Mexico according to the five major criteria.

Criteria	Indicator	Score
Potential for impact on the marine ecosystem	BIO_{threat}	0.74
	COE_CMSY	0.63
	FIS_{FP}	0.56
	MPA_{area}	0.36
Potential impact on the lives of poor or vulnerable people	FIS_{jobs}	0.03
	2010 POP_{coast}	0.10
	$FAO_{consumption}$	0.18
	PRO_{animal}	0.18
	PRO_{total}	0.14
	GINI	0.48
	HDI	0.09
	SUB_{LV}	0.91
	MAR_{GDP}	0.03
Potential for market-based solutions to succeed	2012 BUS_{ease}	0.21
	$VALUE_{tonne}$	0.17
	$POT_{tourism}$	0.06
Governance and policy dynamism	FOR_{press}	0.94
	$SUB_{beneficial}$	0.06
	GOV_{va}	0.65
	GOV_{ps}	0.43
	GOV_{eff}	0.70
	GOV_{reg}	0.68
	GOV_{rol}	0.38
	GOV_{corr}	0.41
Strong existing body of knowledge/evidence base	REF_{FB_SLB}	0.45
	$REF_{literature}$	1.00
	TAX_{rep}	0.58

Overall, the historic management of fisheries in Mexico has led to both ecological and economic waste of potentially valuable resources. On the other hand, fisheries have become an important source of direct and indirect employment along all coasts, making enforcement of regulations difficult both operationally and politically. Addressing sustainability issues will require full knowledge of the context in which fisheries and management have evolved in the country. Though developing, and particularly enforcing, new regulations will be difficult, there is an increasing number of people in Mexico, including within the fishing industry, who recognize the need for management reform, and may hopefully be willing to act or support it.

Indicator scores as derived here for Mexico are presented in Table (16).

Mozambique[14]

Mozambique is a country in Southeast Africa bordered by the Indian Ocean to the east, Tanzania to the north, Malawi and Zambia to the northwest, Zimbabwe to the west and Swaziland and South Africa to the southwest (Figure 17).

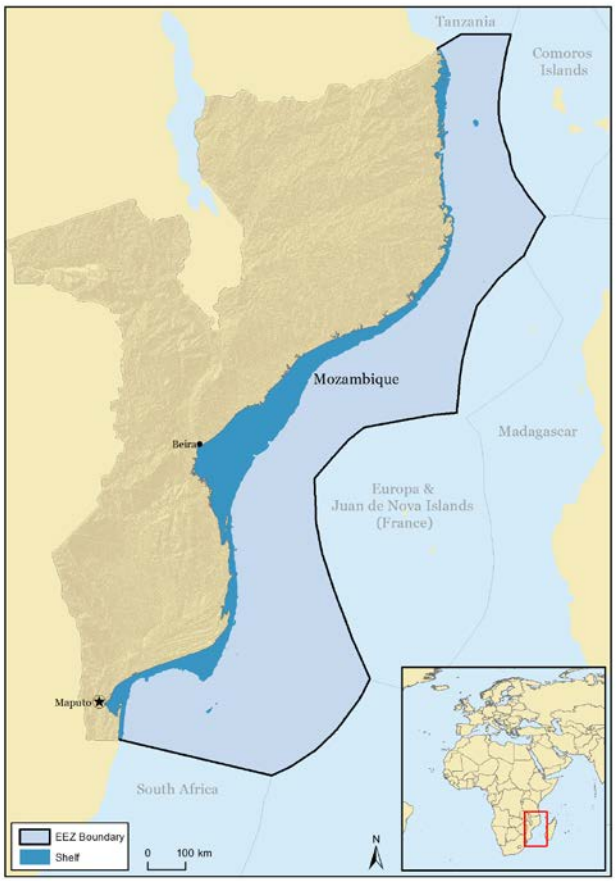

Figure 17. Extent of the EEZ and shelf waters (to 200 m depth) for Mozambique.

Mozambique gained independence from Portuguese colonial rule in 1975, becoming the People's Republic of Mozambique. After only two years of independence, the country descended into an intense and protracted civil war lasting from 1977 to 1992. In 1994, Mozambique held its first multiparty elections and has remained a relatively stable presidential republic since.

Mozambique is endowed with rich and extensive natural resources. The country's economy is based largely on agriculture, but with other industries are also growing, notably food and beverages, chemical manufacturing and aluminium and petroleum production. The country's tourism sector is also growing. South Africa is Mozambique's main trading partner and source of foreign direct investment. Portugal, Brazil, Spain and Belgium are also among the country's most important economic partners. Since 2001, Mozambique's annual average GDP growth has been among the world's highest. However, the country ranks among the lowest in GDP per capita, human development, measures of inequality, and average life expectancy.

Mozambique has an EEZ of around 572,000 km^2, and the Agulhas Current and associated eddies have a net southerly flow along Mozambique's coast, contributing to relatively high productivity and diversity of fish. Along the coast, mangroves, coral reefs, and sea grass beds provide food and habitat for marine life. Officially, marine capture fisheries account for more than 90% of Mozambique's total fish catch and millions of people living in coastal communities depend on the sea and its resources for survival. Small-scale fisheries play a significant role in the national economy, and are thought to account for about 80% of total marine catches. Industrial/semi-industrial fisheries are mostly export-oriented, targeting mainly penaeid shrimp, and represent an important source of foreign exchange income. On average, the industrial sector lands 15% of their catch as shrimp, while 85% is by-catch consisting of finfish, molluscs, and other crustaceans.

Of the 1,574 marine finfish species known to occur within Mozambique's Exclusive Economic Zone (EEZ), approximately 300 are of commercial importance (www.fishbase.org). At least 13 of the 22 identified species of shrimps occurring in the area are of commercial importance. Other valuable fisheries are conducted for species of deep-water shrimp, crayfish, lobsters, crabs, squid, octopus, sea cucumbers, bivalves and sharks for the Asian fin trade.

[14] Based on material in Jacquet and Zeller (2007a), Jacquet *et al.* (2010) and McBride *et al.* (2013).

Mozambique has one of the longest coastlines of any African nation and a long history of fishing. When the Portuguese arrived in the 16th century, an estimated 10,000 people were living around Sofala Bay and engaging primarily in trade, boat building, and fishing. Where raising cattle was difficult, coastal populations caught fish with traps and cages and collected intertidal resources, such as oysters. In addition to subsistence use, fish was dried and traded inland and shellfish were sold in local markets. Most of the finfish (primarily cod and canned sardines) eaten in urban centers during Portuguese colonial rule was, however, imported from Portugal and Angola.

Until the 1960s, there was no local industrial fishing fleet in Mozambique, and trawling was prohibited under colonial law. But, in the early 1960s, local Portuguese authorities recognized the export potential of a shrimp fishery and in 1965, the trawling ban was overturned. A small industrial fleet was established in Mozambique, but was owned and operated by fishers from Portugal.

By the mid-1960s, the fishing industry began to expand. Large processing and freezing plants for shrimp, crabmeat, and fish canning were established at various locations along the coast. Ten of Portugal's largest fishing enterprises formed a corporation aiming to invest in the expansion of Mozambique's fishing industry.

However, the small-scale sector is, for the most part, absent from the national fishing statistics presented by FAO. Yet, in the mid-1960s, there were more than 16,000 rural coastal fishers, and coastal people consumed many varieties of fish and shellfish. The small-scale fishing sector would become of even greater importance when thousands of refugees fled to the coast during the era of conflict that followed independence.

In 1962, an armed campaign began against Portuguese colonial rule, leading to eventual independence in 1975, at which time the new Mozambique leadership established a one-party state aligned with the former Soviet Union. At the time of independence, Mozambique was one of the world's poorest economies. Fishing infrastructure (including retailers) and the system of data collection were abandoned with the exodus of the Portuguese. The new government nationalized all industries, including the commercial fishing boats, of which there were fewer than 100.

The political instability after independence led to a civil war fuelled by South Africa and lasting from 1977-1992, which destroyed much of the country's infrastructure and caused extensive migrations of people. About 1.7 million refugees fled abroad. Four million people, about one-fourth of Mozambique's entire population, were internally displaced. The coastal cities of Angoche and Moma were attacked repeatedly but, generally, coastal areas experienced less fighting. Refugees migrated to the coast and islands and turned to fishing for survival. As the number of fishers increased, catch rates for coastal fishers declined.

By the early 1980s, 80-90% of the population was dependent on subsistence agriculture and fishing for a large part of their livelihood. As late as 1985, the artisanal fishing fleet was still operating within a subsistence, rather than a commercial, market-based economy. Trade of fish was made difficult due to the destruction of roads, landmines, and a shortage of salt, which prevented the preservation of fish for shipment inland.

To generate revenue, the government increased efforts to refurbish the industrial fishing sector. In 1976, the government passed legislation designed to protect its inshore fishing grounds and to bring unrestricted offshore fishing under control. The new law established a 12 nm zone along the coast, and fishing there required a government license. Eager for foreign exchange, the new Mozambique government formed joint enterprises with private fishing interests in Japan, Spain and Norway, and traded fishing rights for aid from the Soviet Union.

Through the 1980s, Norway supported most of the government-run industrial fishing activities. By 1984, Mozambique's fishing grounds had not been fully surveyed, yet, Norwegian advisors suggested increasing catches by 20,000 tonnes by 1985 through the development of bottom trawling.

Soviet fishing vessels overexploited many of Mozambique's fishing grounds, including the rich resources of Sofala bank. A joint Mozambique-Soviet fishing company was established in 1979

with the aim to supply fresh fish to the local domestic market and export shrimp for revenue. In the early 1980s, shrimp was, after cashews, the country's largest earner of foreign exchange.

In 1992, after 16 years of civil war, a cease-fire agreement was signed, and more than one million refugees who had fled abroad returned home to Mozambique. Though some refugees that fled to the coast of Mozambique during the war returned to their place of inland origin, many stayed.

Table 17. Indicator scores for Mozambique according to the five major criteria.

Criteria	Indicator	Score
Potential for impact on the marine ecosystem	BIO_{threat}	0.20
	COE_CMSY	0.52
	FIS_{FP}	0.74
	MPA_{area}	0.18
Potential impact on the lives of poor or vulnerable people	FIS_{jobs}	0.05
	2010 POP_{coast}	0.03
	$FAO_{consumption}$	0.09
	PRO_{animal}	0.16
	PRO_{total}	0.45
	GINI	0.38
	HDI	1.00
	SUB_{LV}	0.89
	MAR_{GDP}	0.54
Potential for market-based solutions to succeed	2012 BUS_{ease}	0.80
	$VALUE_{tonne}$	0.17
	$POT_{tourism}$	0.07
Governance and policy dynamism	FOR_{press}	0.68
	$SUB_{beneficial}$	0.11
	GOV_{va}	0.57
	GOV_{ps}	0.77
	GOV_{eff}	0.39
	GOV_{reg}	0.47
	GOV_{rol}	0.36
	GOV_{corr}	0.39
Strong existing body of knowledge/evidence base	REF_{FB_SLB}	0.47
	$REF_{literature}$	0.50
	TAX_{rep}	0.22

Trading fish to inland markets remained difficult due to transport difficulties. The lack of education and, therefore, alternatives to fishing, is severe in rural areas. Fishers span the seven coastal provinces and are some of the poorest people in Mozambique. Wooden, un-motorized canoes are the most common type of vessel, and beach seining for small pelagic species is the most widespread gear in the small-scale sector. Other traditional gears include hook and line, traps and cages. Some fishers have newer gear introduced in the 1980s, including gill nets, purse seines, longlines, and trolling equipment. Due to the lack of preservation technology, fishing effort is reduced during the rainy season (December to March), when sun drying is impossible.

In Mozambique, women also contribute to fisheries through processing and controlling retail. Women and children also collect intertidal organisms, such as mudcrab (*Syclla serrata*), blue swimming crab (*Portunus pelagicus*), and other shellfish. This catch is eaten while the fish caught by men is sold. The catch from women and children, as well as much of the small-scale finfish catch, has been absent from national statistics until recently.

However, the 2003 Marine Fisheries Regulation of Mozambique dedicated resources to improve monitoring of the small-scale fisheries sector. In 2004, for instance, the national fisheries division made great advances and reported a catch of 57,747 tonnes for the small-scale sector, an 800% increase from the landings reported in 2002. This clearly indicates how important the small-scale fisheries sectors and associated coastal marine livelihoods are for Mozambique.

Indicator scores as derived here for Mozambique are presented in Table (17).

Nicaragua[15]

Nicaragua lies in the heart of Central America, with Honduras to the north, Costa Rica to the south, the Caribbean Sea to its east, and the Pacific Ocean to its west (Figure 18). It is the largest country in Central America, with a land area of approximately 130,000 km^2, and an Exclusive Economic Zone (EEZ) of around 127,500 km^2. The name Nicaragua stems from *Nicarao*, the name of the chief of a group of indigenous peoples living near the Pacific coast in the 16th century, and *agua* which is Spanish for water.

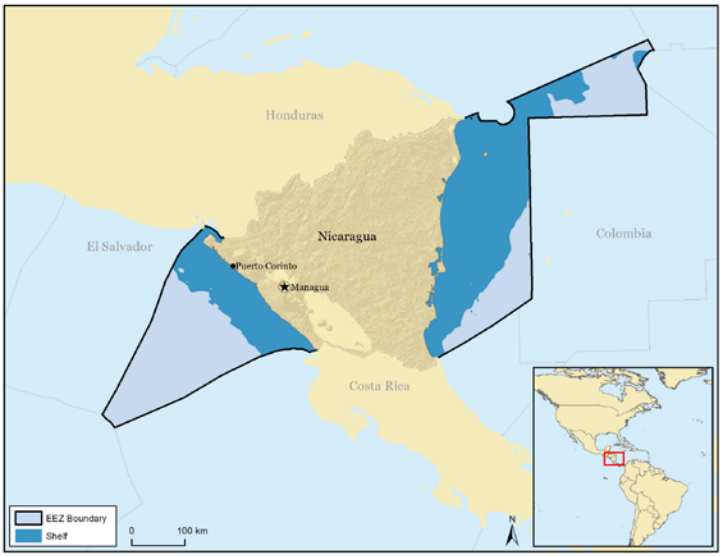

Figure 18. Extent of the EEZ and shelf waters (to 200 m depth) for Nicaragua.

Nicaragua contains three main geographic regions. The Pacific coastal region is the most economically developed (most of Nicaragua's population live there), and the coastal plains' volcanic soils support the country's commercial agricultural production of coffee, cotton and sugar. The Caribbean lowland region comprise more than half of the country's land area, but support less than 10% of the population; the high rainfall, tropical rainforests and swamps, and frequent flooding and storms have earned this region the name 'Mosquito Coast'. Finally, the central mountain region runs northwest to southeast, and is also an ideal location for much of the country's coffee production.

Nicaragua contains the two largest lakes in Central America, Lake Managua and Lake Nicaragua, the latter of which was originally considered for the site of the cross-isthmus canal prior to it being established in Panama. However, in June 2013, Nicaragua's National Assembly approved a bill to grant a 50-year concession to a newly formed Hong Kong company, the Hong Kong Nicaragua Canal Development Investment Co., to build the canal as a competitor to the Panama Canal. The concession can be extended for another 50 years once the canal is operational. The proposed Nicaragua Canal will be able to handle the world's largest ships, including the 10 percent of the world's merchant fleet that are already too large for even the new set of locks being constructed in Panama.

Lake Nicaragua is unique in Central America because some species of fish and euryhaline species of sharks such as *Carcharhinus leucas* journey almost 180 km up the San Juan River (Rio San Juan) from the Caribbean Sea to reach this lake. Nicaragua's population consists of roughly 69% mestizo (mixed Amerindian and white), 17% Caucasian, 9% black, and 5% Amerindian. The primary export markets for Nicaragua's fisheries products are the U.S. (over 80%), the European Union, and Japan.

Nicaragua has a long and tumultuous political history Nicaraguans declared their independence from Spanish colonial rule in 1821, and became an independent republic in 1838. By that time, the coffee boom in Nicaragua in the late 19th century and the expansion of many large coffee estates began tipping the balance of power towards wealthy coffee plantation owners aligned with president José Santos Zelaya López. In 1893, when president Zelaya was in office, he instituted

[15] Based on material in Haas *et al.* (in prep).

many policies which promoted the development of agricultural commodities which, along with coffee, were produced solely for export. This 'agro-export' model became widely used throughout the next century. Since its independence, Nicaragua has undergone periods of political unrest, dictatorship, and fiscal crisis—the most notable causes that led to the Nicaraguan Revolution of the 1960s and 1970s. Nicaragua is a representative democratic republic, and has experienced economic growth and political stability in recent years.

Table 18. Indicator scores for Nicaragua according to the five major criteria.

Criteria	Indicator	Score
Potential for impact on the marine ecosystem	BIO_{threat}	0.30
	COE_CMSY	0.23
	FIS_{FP}	0.88
	MPA_{area}	0.77
Potential impact on the lives of poor or vulnerable people	FIS_{jobs}	0.04
	2010 POP_{coast}	0.01
	$FAO_{consumption}$	0.05
	PRO_{animal}	0.08
	PRO_{total}	0.14
	GINI	0.35
	HDI	0.45
	SUB_{LV}	0.73
	MAR_{GDP}	0.44
Potential for market-based solutions to succeed	2012 BUS_{ease}	0.64
	$VALUE_{tonne}$	0.51
	$POT_{tourism}$	0.10
Governance and policy dynamism	FOR_{press}	0.96
	$SUB_{beneficial}$	0.53
	GOV_{va}	0.43
	GOV_{ps}	0.54
	GOV_{eff}	0.27
	GOV_{reg}	0.49
	GOV_{rol}	0.31
	GOV_{corr}	0.28
Strong existing body of knowledge/evidence base	REF_{FB_SLB}	0.61
	$REF_{literature}$	0.39
	TAX_{rep}	0.32

Due to its difficult political past, Nicaragua is the poorest country in Central America, and although the country's economy grew at approximately 4% in 2011, it still has prevalent poverty and underemployment. Nicaragua's economy has moved from agricultural products such as coffee, bananas, sugarcane, cotton, rice, corn, tobacco, soy, and livestock, to textiles and apparel, which now account for almost 60% of exports.

Several of Nicaragua's leaders were ardent supporters of the 'agro-export' economic model. This became the dominant model for commodities production throughout Nicaragua, and shrimp and lobsters in Nicaragua's fisheries sector were pursued in a similar fashion. Although landings data for fisheries have been reported since 1950, it is reasonable to assume that in the context of Nicaragua's political and economic past, fisheries data have not been reported accurately.

Indicator scores as derived here for Nicaragua are presented in Table (18).

Nigeria[16]

Nigeria, located in the Gulf of Guinea in West Africa, is bounded in the east, north, west and south by the Republics of Cameroun, Niger, Benin and the Atlantic Ocean, respectively (Figure 19). The total area of the Nigerian Exclusive Economic Zone (EEZ) is 192,000 km^2. The fisheries sector plays a salient role in Nigeria's overall agricultural and natural resource sector. In 2007, for example, there were about 8 million people (i.e., about 6%) employed in its primary sector (fishing, fish farming) and about 18 million (i.e., about 13%) in the secondary sector (processing, trading, boat-building, etc.). Given the estimated 140 million people in Nigeria, these figures are remarkable. Additionally, the fisheries sector contributes to about 4% of the agricultural GDP and in turn the entire agricultural sector contributes 40% of the country's total GDP. Domestic fish supply in Nigeria covers only 22% of the seafood demand. This demand-supply gap is bridged in part by seafood imports, which in 2007 stood at about 7.4 million tonnes valued at US$ 594.4 million. The reported per-capita consumption of fish in Nigeria is about 9.7 kg·person^{-1}·year^{-1}.

Figure 19. Extent of the EEZ and shelf waters (to 200 m depth) for Nigeria.

Fish assemblages and distribution in the Nigerian EEZ fall into the following broad categories: the demersal finfish species, the pelagic species including clupeid fishes such as the bonga (*Ethmalosa fimbriata*), shad (*Ilisha africana*), sardines (*Sardinella* species), exploited mostly by the coastal artisanal canoe fisheries, semi-abyssal groups and the brackish water groups in the delta of the Niger River and the estuaries of the many rivers, creeks, lagoons and intertidal mangrove swamps that provide a thriving fishery exploited essentially by artisanal canoe fishers. The greatest variety of fishing methods is found in the brackish waters. Catfishes (*Arius* spp. and *Chrysichthys* spp.), tilapia (*Oreochromis* spp.), mullet (*Mugil* spp.), shrimps (*Nematopalaemon* spp.) and crabs (*Callinectes* spp.) are some of the major species exploited.

Fishing activities in the marine fisheries sector may be classified into coastal small-scale (artisanal), inshore industrial and offshore (foreign, distant-water) industrial fisheries. The coastal small-scale fishery operates within 5 nm from the coastline and also in estuaries, creeks and lagoons. To reduce conflicts between the industrial and the artisanal sectors, the artisanal canoe fisheries have the exclusive right to exploit this area. The species exploited include pelagic and demersal fishes like clupeids, croakers, soles, threadfins, catfishes, sharks, peneid shrimps, crabs, etc. The artisanal fishery is labor intensive and employs small, traditional and sometimes un-motorized craft and simple hand-operated gears. Planked and dug-out canoes (3 to 13 m long) which are powered by outboard engines ranging from 15 to 25 hp are increasingly common. Generally, this fishery employs low capital outlay, simple technology and uses direct marketing channels for its catches,

[16] Based on material in Etim *et al.* (in prep).

which are sold mostly in nearby markets. According to official figures, this fishery contributes to more than 70% of the total fish catches in the country. Set gillnets and cast nets are the major fishing gears. The fishery is open access and unregulated.

The inshore industrial fishery operates from about 5 nm off the coast to the edge of the continental shelf. The industrial trawlers employ bottom or mid-water trawls to land a variety of species including croakers (*Pseudotolithus* spp.), soles (*Cynoglossus* spp.), groupers (*Epinephelus* spp.), snappers (*Lutjanus* spp.), bigeyes (*Brachydeuterus* spp.), threadfins (*Polydactilus* spp.), barracudas (*Sphyraena* spp.), jacks (*Carynx* spp.), horse mackerels (*Trachurus* spp.) and cutlass fishes (*Trichiurus* spp.). The industrial fisheries are capital intensive and utilize large fishing vessels with in-board engines and mechanically operated gears. They employ small- to medium-sized trawlers ranging in size from 9 to 25 m length. About 200 to 300 trawlers are registered in Nigeria, of which only around 65% are active due to maintenance problems. About 40 trawling companies, with an average fleet size of four vessels, operate in Nigeria and most are members of the Nigerian Trawlers Owners' Association. Companies with fleet size of more than four are likely to be in partnership with foreign investors. In 2001 for example, there were 244 fishing vessels in the country and only 179 were in operation. Out of the 179 vessels in operation 98 were foreign owned. During this period, 36 fishing companies operated in the country out of which 14 companies were foreign-owned.

Nigerian flag-registered vessels are allowed to operate in the waters of other African countries under the terms of the bilateral fishing right agreements existing between Nigeria and such countries, or under privately arranged agreements. All the fish catch must be landed at a Nigerian port. The fishing licence issued to such Nigerian-registered flag vessels is classified as Distant Water Fishing Licence (Category A). Category B license is for vessels which are foreign flag-registered but are chartered by Nigerian companies or individuals for fishing in the waters of foreign countries. Category C is Distant Water Fishing Licences usually issued to Reefer vessels bringing in frozen fish to Nigeria. Such vessels may be Nigerian or foreign-flag registered.

Table 19. Indicator scores for Nigeria according to the five major criteria.

Criteria	Indicator	Score
Potential for impact on the marine ecosystem	BIO_{threat}	0.58
	COE_CMSY	0.35
	FIS_{FP}	0.74
	MPA_{area}	0.00
Potential impact on the lives of poor or vulnerable people	FIS_{jobs}	0.08
	2010 POP_{coast}	0.08
	$FAO_{consumption}$	0.24
	PRO_{animal}	0.21
	PRO_{total}	0.54
	GINI	0.35
	HDI	0.71
	SUB_{LV}	0.97
	MAR_{GDP}	0.01
Potential for market-based solutions to succeed	2012 BUS_{ease}	0.71
	$VALUE_{tonne}$	0.10
	$POT_{tourism}$	0.04
Governance and policy dynamism	FOR_{press}	0.82
	$SUB_{beneficial}$	0.98
	GOV_{va}	0.37
	GOV_{ps}	0.00
	GOV_{eff}	0.18
	GOV_{reg}	0.39
	GOV_{rol}	0.13
	GOV_{corr}	0.17
Strong existing body of knowledge/evidence base	REF_{FB_SLB}	0.94
	$REF_{literature}$	0.09
	TAX_{rep}	0.41

In the late 2000s, the Nigerian Federal Department of Fisheries (FDF) made about US$ 250,000 annually from the registration of industrial trawlers and the sector contributes less than 5 % to the total marine fish catches in the country. A salient aspect of this subsector is that parts of its catch, notably shrimps, are for export, which brings in about US$ 20 million annually to the Nigerian economy.

Offshore marine fisheries exploit resources between the continental shelf area and the 200 nm EEZ boundary. Tuna and billfishes are the main target species. Vessels are generally more than 25 m in length. Vessels are wholly owned by Nigerians. The inability of Nigeria to attract foreign investors is due essentially to Nigeria's non-membership in the International Commission for the Conservation of Atlantic Tunas.

The history of systematic nation-wide fisheries data collection in Nigeria is rather short as it started in the early 1970s, and the accuracy and authenticity of data collated by FDF is usually doubted by other independent sources. Much of the inaccuracies and deficiencies in the Federal Department of Fisheries (FDF) data are the

consequence of inherent bureaucratic problems in government ministries, the fisheries sector and politics of the country. The various regional fisheries departments are grossly under-staffed with field officers who are not replaced by new employees upon their retirement. Thus, fewer field officers continue to collect data from increasingly larger numbers of non-contiguous landing beaches. Without funding, they are unable to cover all the landing sites assigned to them and they end up guessing part, or maybe even all, of their data. All the nine regional Directors of Fisheries noted that scarcity of funds constituted their greatest problem. The decline in government funding, as the only source of funds, to ministries implies that it is politically more expedient for government to direct scarce funds to community development projects and poverty alleviation programs than to reconcile fisheries data collection whose usefulness seems rather difficult to appreciate by the ordinary person. There are also inherent competitive tendencies among the states as they try to surpass or even outdo each other as the best producer of one commodity or the other. This explains the suspected or alleged tendencies by state ministries to inflate their production figures to the FDF. According to many state directors, often the final data published by FDF are higher than the ones they submit.

Furthermore, monitoring and surveillance by the FDF suffers from an utter lack of vessels and resources, hence they have to rely on other agencies (e.g. the Nigeria Navy) for their monitoring and surveillance activities.

Indicator scores as derived here for Nigeria are presented in Table (19).

Peru[17]

Peru is a developing country on the west coast of South America, with an EEZ of 900,000 km² (Figure 20), a high Human Development Index score, a population of around 30.4 million people, and a poverty level around 28.7 percent. Its main economic activities include agriculture, fishing, mining, and manufacturing of products such as textiles. The coastal waters of Peru along the west coast of South America are among the world's most productive, thanks to coastal upwelling processes. The immense planktonic production is consumed directly by species of low trophic levels like the Peruvian anchoveta (*Engraulis ringens*), which is a forage item of higher level consumers, including fishes, birds and marine mammals. The Peruvian industrial fishery development started in the 1950s, and today the fisheries sector is a key component of Peru's economy (after mining), mainly as a significant source of foreign currency. Particularly important is the marine fisheries sector, followed to a lesser degree by inland fisheries and aquaculture. Peru claims an exclusive economic zone of more than 906,000 km², some of it contested by Chile, its southern neighbor.

Figure 20. Extent of the EEZ and shelf waters (to 200 m depth) for Peru.

Much of the high marine productivity off Peru is shunted through immense schools of Peruvian anchoveta (*Engraulis ringens*), which, since the early 1950s, has been subjected to intense exploitation by the purse seine fishery. This peaked in the early 1970s with an annual (nominal) catch of 12 million tonnes, but which was most probably higher, in the vicinity of 16-18 million tonnes.

By present standards, this fishery, which overwhelmingly fed fishmeal plants, was not well managed. This, combined with successive El Niño events, led to spectacular crashes of the anchoveta population, with subsequent collapse of the anchoveta-dependent seabird and marine mammal populations.

The anchoveta fishery is now subjected to quota management, which foresees that it ought to be closed when the anchoveta biomass reaches 4-5 million tonnes. However, frenetic fishing for juvenile anchoveta, and their subsequent dumping to avoid fines is now affecting recruitment to the adult stock.

The other components of the Peruvian upwelling ecosystem, e.g., the pelagic bonito (*Sarda chiliensis*) and various coastal fishes, notably croakers (Family Sciaenidae), caught by the coastal artisanal fishery are not well studied, let alone managed, while the trawl fishery for hake (*Merlucius gayi peruanus*) has essentially collapsed.

[17] Based on material in Kleisner *et al.* (2012) and a currently unpublished fisheries report by Mendo and Wosnitza-Mendo (in prep).

Overall, it can be expected that the biomass of demersal nearshore fish would be enhanced by sound management, while re-establishing the abundance of anchoveta and associated pelagic resources (e.g., bonito) will require restraints on the fishery and favorable oceanographic conditions.

Table 20. Indicator scores for Peru according to the five major criteria.

Criteria	Indicator	Score
Potential for impact on the marine ecosystem	BIO_{threat}	0.88
	COE_CMSY	0.46
	FIS_{FP}	1.00
	MPA_{area}	0.08
Potential impact on the lives of poor or vulnerable people	FIS_{jobs}	0.04
	2010 POP_{coast}	0.05
	$FAO_{consumption}$	0.37
	PRO_{animal}	0.36
	PRO_{total}	0.42
	GINI	0.51
	HDI	0.16
	SUB_{LV}	0.99
	MAR_{GDP}	0.35
Potential for market-based solutions to succeed	2012 BUS_{ease}	0.18
	$VALUE_{tonne}$	0.00
	$POT_{tourism}$	0.04
Governance and policy dynamism	FOR_{press}	0.75
	$SUB_{beneficial}$	0.29
	GOV_{va}	0.64
	GOV_{ps}	0.43
	GOV_{eff}	0.53
	GOV_{reg}	0.72
	GOV_{rol}	0.34
	GOV_{corr}	0.45
Strong existing body of knowledge/evidence base	REF_{FB_SLB}	0.00
	$REF_{literature}$	0.57
	TAX_{rep}	0.55

It is known that the data collection systems for landings or catches by the state institution in charge have some deficiencies and hence do not correctly reflect either landings or actual catches. This is the case, most of all, for subsistence and sports (recreational) fisheries, and to a smaller extent also for artisanal fisheries. While their tonnage is admittedly low in comparison to pelagic commercial catches, such fisheries form an important socio-economic and food security function. Coastal artisanal fisheries in Peru are fundamental for local food security but also have social and cultural purposes.

Indicator scores as derived here for Peru are presented in Table (20).

Philippines[18]

The Philippines, with over 7,000 islands of various sizes, encompasses most of the Sulu-Celebes Sea Large Marine Ecosystem (LME), a world hotspot of marine biodiversity. These islands cover a land area of 300,000 km^2, while the Exclusive Economic Zone (EEZ) that is claimed by the Philippines covers an area of over 2 million km^2, including parts of the heavily contested Spratly Islands group, Scarborough Shoal, and Miangas Island (Figure 21). About 12% of this sea area consists of productive continental shelf (to 200 m depth) hosting coral reef (27,000 km^2, to depths of <30 m), mangrove and algal ecosystems. These ecosystems form the habitats of the large number of valuable species supporting coastal marine fisheries.

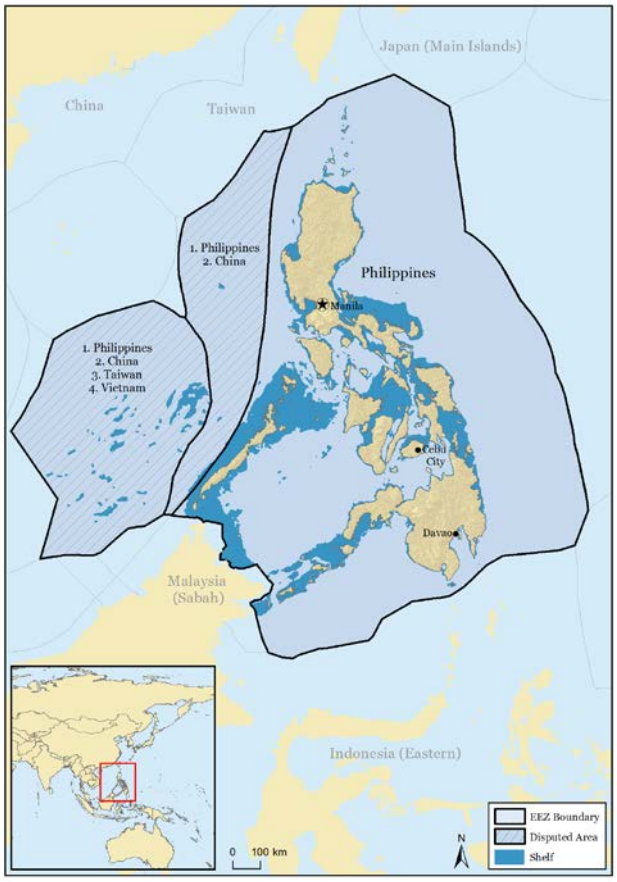

Figure 21. Extent of the EEZ and shelf waters (to 200 m depth) for the Philippines.

Fisheries play an important role in the Philippine economic and social fiber. The Philippine islands are divided into 15 administrative regions with 81 provinces, of which 80% are coastal, themselves composed of 1,514 municipalities, of which 65% are coastal. In 2009, the Philippines reported 4.1 million tonnes of total fish production (including aquaculture), about 59% of which were from marine fisheries. Of the 10 Southeast Asian countries, the Philippines ranked second largest fish producer of the region, next to Indonesia, accounting for 17% of the total production of the region. In 2003, the Philippines ranked 11th worldwide.

The proportion of the population living in coastal municipalities increased from 55% to 85% between 2001 and 2008. Averaging this rate, suggest that over 64 million people live in Philippine coastal areas in 2010. Though not all of these people are directly involved in fishing activities, such a high coastal population is undoubtedly the origin of relatively high exogenous impacts on the relatively shallow water area, and will generate enormous pressure on fish resources. Such impacts may be exacerbated by the high incidence of poverty among these mostly rural coastal populations, i.e., 34% of the about 77 million Filipinos in 2000 lived below the poverty line, and of this, over 72% are from rural areas. The high population growth in the Philippines (one of the highest in Asia) also implies a bleak future, both in terms of the economic standing of these rural populations, and in their use of coastal resources. Fishing and/or beach/reef gleaning are activities which can be performed without or with very little capital, and is often the easiest food provision option of poor coastal families. In the 1990s, over 66% of the Filipinos' animal protein consumption was based on fish, with an average per capita fish consumption of 36 kg·person^{-1}·year^{-1}. This reportedly increased to 53.4 kg·person^{-1}·year^{-1} in 2009.

[18] Material based on Kleisner *et al.* (2012) and a currenlty unpublished report by Palomares and Pauly (in prep).

The fisheries sector employed about 807,000 fishers in 1990, 46% of whom worked in the small-scale, 44% in the industrial, and 9% in the aquaculture sectors. Given the annual population growth rates of between 1.9% and 2.3%, we can estimate that about 1 million fishers[19] are currently employed in fisheries. This is almost 20% more than the number of fishers employed by these sectors in 1975, i.e., over 844,000 fishers, 68% of whom were employed by the small-scale sector. Note, however, that there is an almost 35% decrease in the number of small-scale fishers over these two decades, which may be indicative of an evolution that is directly tied to overexploitation of shallow coastal resources, resulting in a move towards industrial fisheries, targeting higher-value species like tuna and small pelagic fishes usually caught in offshore areas.

In addition, the government's attempts to cope with shifts in the fisheries sector brought about by socio-ecological factors has led to conflicting policies that may have contributed to inactivity and inefficiency with regards to managing the sector. Foreign aid via the United Nations (e.g., UNDP, FAO) and the regional body, SEAFDEC, assisted the government in implementing its expanded 'fish production' program. Government subsidies in terms of loans meant primarily for artisanal fishers to motorize their fishing operations ranged from 2.7 million pesos in 1987 to 10.6 million pesos in 1997[20]. The concerted effort to obtain self-sufficiency in fish since the 1970s conflicted with resource conservation advocated in national fisheries legislation. This has not helped alleviate the chronic problems that have beset the Philippine fisheries industry. In fact, the social conflicts which have developed between the small-scale fisheries and the commercial fisheries exacerbated excessive fishing efforts, particularly in municipal waters.

Table 21. Indicator scores for the Philippines according to the five major criteria.

Criteria	Indicator	Score
Potential for impact on the marine ecosystem	BIO_{threat}	0.72
	COE_CMSY	1.00
	FIS_{FP}	1.00
	MPA_{area}	0.14
Potential impact on the lives of poor or vulnerable people	FIS_{jobs}	0.31
	2010 POP_{coast}	0.24
	$FAO_{consumption}$	0.67
	PRO_{animal}	0.71
	PRO_{total}	0.52
	GINI	0.33
	HDI	0.34
	SUB_{LV}	0.63
	MAR_{GDP}	0.15
Potential for market-based solutions to succeed	2012 BUS_{ease}	0.75
	$VALUE_{tonne}$	0.14
	$POT_{tourism}$	0.06
Governance and policy dynamism	FOR_{press}	0.95
	$SUB_{beneficial}$	0.28
	GOV_{va}	0.62
	GOV_{ps}	0.19
	GOV_{eff}	0.58
	GOV_{reg}	0.51
	GOV_{rol}	0.37
	GOV_{corr}	0.28
Strong existing body of knowledge/evidence base	REF_{FB_SLB}	0.19
	$REF_{literature}$	0.84
	TAX_{rep}	0.54

The commercial large-scale fleet is directly under the jurisdiction of the national government, with management responsibility resting with the Bureau of Fisheries and Aquatic Resources (BFAR) under the Department of Agriculture. The national government decides on licenses, taxes and levies and the collection of fisheries data via monthly reports from registered (licensed) vessels. The Fisheries Code also redefined 'commercial' fisheries in three categories, i.e., small-scale (3.1-20 GT), medium-scale (20.1-150 GT), and large-scale 'commercial' vessels (>150 GT), respectively.

In contrast, the small-scale or artisanal fisheries, referred to as 'municipal fisheries' in Philippine parlance, is under the jurisdiction of the municipal governments, which have management jurisdiction over their municipal waters, that is within 15 kilometers of the shoreline, and share with the national government the responsibility in the management and maintenance of ecological balance within their territorial jurisdiction.

The development of scaled-down industrial operations (i.e., 'baby trawlers'), led to intensive fishing in inshore waters and in waters less than 12.8 m deep, traditionally

[19] This might be an underestimate as 1.5 million people have been reported with fisheries as their main livelihood in 2004. However, this figure included fishers also employed in the aquaculture sector.
[20] In 1987, 1USD=20.6PHP. In 1997, 1USD=29.5PHP.

reserved for artisanal fisheries. Thus, the highly heterogeneous municipal sector, which is clearly suffering from dwindling resources, as indicated by a minuscule and declining catch per unit effort of individual fishers, and an ever increasing number of fishers, is linked to the ever-increasing industrial fleet, which obtains an increasing share of their catches from (mostly illegal) fishing in the waters of their neighbors, especially in Malaysia (Sabah) and Eastern Indonesia.

The term 'subsistence' was recently redefined to categorize 'municipal' fishers whose livelihood is mainly fishing and whose earnings fall below the food threshold; who use the catch for a combination of purposes – family consumption, barter, and sale of surplus catch to regain capital spent on fishing operations.

Most fisheries are administered locally, i.e., by the municipal governments, a form of micro-management which renders implementation of fisheries rules and regulations rather difficult, and produces very variable results, although it allows flexibility. The Philippines produces, publishes, and distributes annually immense amounts of fisheries statistics that are readily cited by various non-government organizations (NGOs), but are lacking in accuracy. Thus, the *real* catch of the marine fisheries is essentially unknown. Lack of funds and repeated reorganisations of the government divisions handling fisheries statistics prevented the establishment of a comprehensive fisheries data collection system that treated to the same detail, the catch of industrial, small-scale and subsistence fisheries. Commercial landing statistics were collected since 1954 for ten fishery districts, based on monthly catch reports (by the operators of vessels >3 gross tonnes). It was determined that these landings were 'inadequate', and they were summarily 'corrected' by an expansion factor derived from monthly landings collected by enumerators from randomly sampled survey areas to estimate regional and national catches. Already then, underreporting of the catch and/or undervaluing of species caught by the few registered (and/or reporting) fishing vessels was a rampant form of tax evasion and as such, these statistics accounted for less than half of what was really caught. In some areas, underreporting may have been as much as 80% of the actual catch.

Numerous assessments of the status of fisheries in the Philippines have been conducted, especially in the 1980s, when the International Center for Living Aquatic Resources Management (ICLARM), then based in the Philippines, was very active. These analyses, in the aggregate, suggested that the majority of fishing grounds in the Philippines, which were extremely productive in the 1950s and 1960s, were overfished by the late 1970s and 1980s.

Indicator scores as derived here for the Philippines are presented in Table (21).

Senegal[21]

Senegal is located in north-west Africa, at the edge of two of the most productive fishing zones in the world, the Canary Current Large Marine Ecosystem and the Gulf of Guinea Large Marine Ecosystem (Figure 22). This, along with upwelling systems and a relatively wide continental shelf of 23,800 km^2, makes Senegal one of the most productive fisheries in West Africa and consequently in the world.

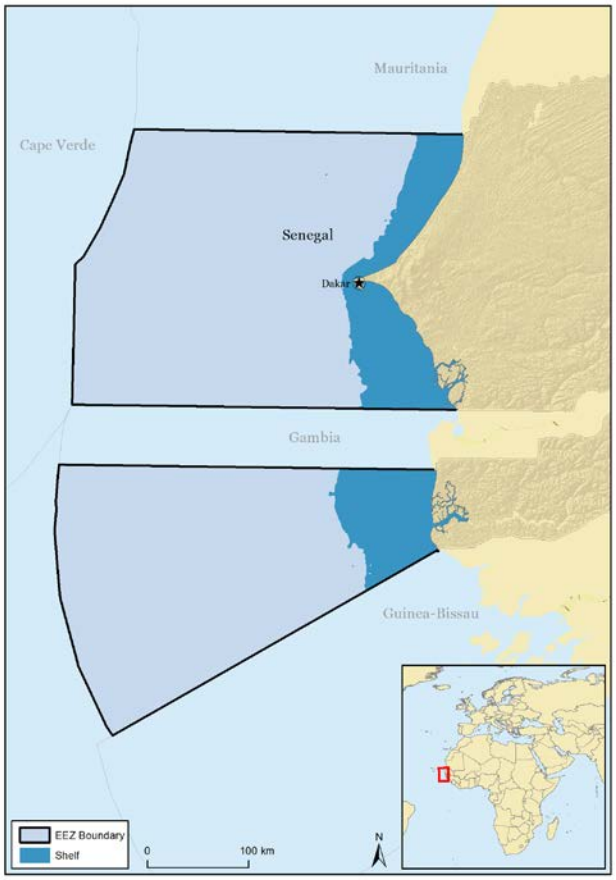

Figure 22. Extent of the EEZ and shelf waters (to 200 m depth) for Senegal.

Senegal's history was marked by major shifts: it was first occupied by important ethnic groups as part of the Empire of Ghana, after which the *Jolof* Empire was established in the 13th century. During this period, the slave trade was so important in the area that around one third of the population was captured and deported to the Americas by competing European powers, mostly the Netherlands, Portugal and Great Britain. This lasted until the area was handed over to France, which, from 1677 on, used what is now called the *Ile de Gorée* as a staging point for its slave trade. After almost three centuries of occupation, France granted independence to the 'Mali Federation', comprised of Senegal and the 'French Sudan' (i.e., Mali). This contract lasted only a few months, and both Mali and Senegal proclaimed their independence, with Senegal choosing its first president in September 1960. This historical path, and the interest of colonial powers in resource exploitation, made Senegal one of the few countries for which scientific data on its primary resources were available (e.g., though the 'Institut Fondamental de l'Afrique Noire', or IFAN), including basic data on its fisheries, in sharp contrast to, e.g., Liberia or other West African countries. Moreover, strong ethnic diversity and fishers migrations from different parts of West Africa – over centuries - contributed to giving Senegal a long marine resource tradition. Senegal is also the first African country to sign a fishing agreement with the EU, in 1979, to establish a domestic industrial fleet, and a powerful artisanal fleet of which a considerable segment is capable of long-distance operations. Indeed, this segment of the artisanal fleet should be viewed as distant-water fishery in its own right, rather than a classic artisanal fishery, characterized by exploiting the waters immediately adjacent to the community of which they are part.

Fisheries gained a key role in Senegal in rebalancing the economy after the decline of groundnut and phosphate exports. The sector employs over 600,000 people, about 1/5 of the working population of Senegal and provides over 75% of animal protein intake of the local population. With 36 kg·person^{-1}·year^{-1}, Senegal has the second highest per capita fish consumption in Africa.

[21] Based on material in Belhabib *et al.* (in press).

The importance of fisheries to the economy and food security in the region is no longer questionable. The industrialization of the small-scale artisanal sector, the uncontrolled issuance of fishing licenses, and market and fishing subsidies at first contributed to raising fish catches and trade. However, this business model is certainly directly related to the current decline of Senegalese fisheries, as over-capacity resulted in the over-exploitation of many fish stocks in Senegal and driven some high commercial value species, such as groupers and snappers to commercial extinction. The small pelagic species which now constitute the bulk of fish consumption of the local population are over-exploited, and demersal stocks have declined dangerously. Growing exports does not help in this situation, and indeed threatens the food security in Senegal and the neighboring countries.

Table 22. Indicator scores for Senegal according to the five major criteria.

Criteria	Indicator	Score
Potential for impact on the marine ecosystem	BIO_{threat}	0.44
	COE_CMSY	0.29
	FIS_{FP}	0.84
	MPA_{area}	0.17
Potential impact on the lives of poor or vulnerable people	FIS_{jobs}	0.88
	2010 POP_{coast}	0.02
	$FAO_{consumption}$	0.42
	PRO_{animal}	0.47
	PRO_{total}	0.60
	GINI	0.31
	HDI	0.71
	SUB_{LV}	0.92
	MAR_{GDP}	0.21
Potential for market-based solutions to succeed	2012 BUS_{ease}	0.92
	$VALUE_{tonne}$	0.04
	$POT_{tourism}$	0.04
Governance and policy dynamism	FOR_{press}	0.25
	$SUB_{beneficial}$	0.27
	GOV_{va}	0.53
	GOV_{ps}	0.57
	GOV_{eff}	0.43
	GOV_{reg}	0.52
	GOV_{rol}	0.39
	GOV_{corr}	0.33
Strong existing body of knowledge/evidence base	REF_{FB_SLB}	0.64
	$REF_{literature}$	0.46
	TAX_{rep}	0.67

Official data in Senegal refer to two main sectors, one being the small-scale artisanal fisheries operated by *pirogues*, large wooden canoes of 4 to 20 m of length, of which 90% are motorized, and which can carry up to 25 tonnes. The other, industrial sector consists of the large-scale fisheries, which include domestic and foreign semi-industrial and industrial trawling for demersal fish and crustaceans, especially shrimp (in both shallow and deeper waters), along with fisheries for large (e.g., tuna) and small pelagic fishes (e.g., sardinella).

Official data supplied to FAO show an annual catch of 400,000 tonnes, which is under the estimated Maximum Sustainable Yield of 600,000 tonnes. Assuming the latter number is correct, this would imply that either (*i*) fishing effort is not high enough to extract MSY, or (*ii*) fishing effort is excessive, and MSY can be reached by *reducing* fishing effort. However, the lack of accountability for sectors such as foreign fishing, the discarding of by-catch, and the non-consideration of subsectors such as recreational and subsistence fishing has led to a situation where catches are so mis-estimated that issues related to the sustainable exploitation of Senegalese marine resources cannot be addressed realistically using official data.

Indicator scores as derived here for Senegal are presented in Table (22).

Solomon Islands[22]

The Solomon Islands are situated in the south-western Pacific Ocean (Figure 23). The Main Group Archipelago (MGA) consists of a double chain of 6 large islands: Choiseul, Santa Isabel, New Georgia, Malaita, Guadalcanal and San Cristobal. The Solomon Islands includes the MGA in addition to hundreds of other small islands. The capital, Honiara, is located on the island of Guadalcanal.

The total land area of the Solomon Islands is over 27,500 km^2, with a 2009 population estimate of 523,000. The Exclusive Economic Zone (EEZ), declared in 1978, is 1.5 million km^2. These islands support some of the world's largest lagoons, and fringing and barrier coral reefs along an extensive coastline. Formerly a British Protectorate, the Solomon Islands achieved independence in 1977. The islands are high and volcanic, densely forested (though heavily logged), with large mangrove forests, coral reefs and lagoons. The fertile soil supports a growing agricultural sector. The majority of the population lives in small to medium sized coastal villages, although there are considerable inland populations on some major islands, and a growing migration to urban centers. Previously lucrative export commodities such as copra, palm oil, timber and minerals have declined in recent years, leaving fishery products as the remaining prospective export.

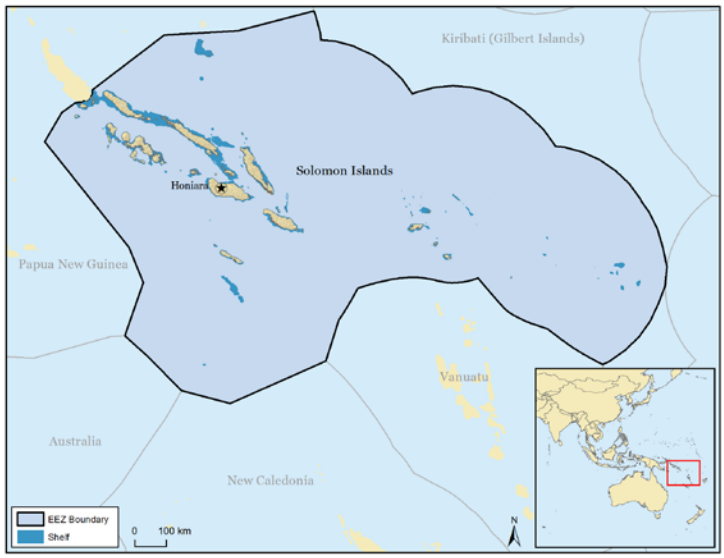

Figure 23. Extent of the EEZ and shelf waters (to 200 m depth) for the Solomon Islands.

Prior to the 1970s, the Solomon Islands have been largely a non-market economy, and local subsistence fisheries and agriculture dominated. The importance of this sector in fisheries is generally poorly reflected globally in statistics, as the available data are thought to be highly unreliable. National food security relies heavily on fisheries, as the local diet is largely based on marine protein and carbohydrates from root crops. Subsistence fishing gears include handline and dropline, troll, spear, gill nets (seasonally), and *buna* – a poison derived from a local vine. In some areas, religious groups (e.g., the Seventh Day Adventist Church) prohibit the consumption of shellfish or fish without scales.

A large portion of the artisanal fishery is carried out using dugout canoes. The finfish catch is primarily comprised of lutjanids (snappers), serranids (groupers), lethrinids (emperors), scombrids (mackerels), and carangids (trevallies). Small-scale tuna fishing does occur in the Solomon Islands, as tuna remains a culturally significant food source for coastal villages. Reporting of small-scale tuna fisheries is negligible, suggesting that tuna caught by this sector involves only a select number of villagers who possess the capacity to do so. Estimates of tuna catches by subsistence or artisanal fishers are not publically available, but are thought to be small relative to the large-scale commercial sector. There have been complaints from the islanders, however, that local tuna catches are declining as a result of the commercial fishing fleets and baitfish fishery.

[22] Based on material in Doyle *et al.* (2012).

Other commercially valuable marine exports (e.g., bêche-de-mer and trochus) are produced in a manner that resembles artisanal rather than large-scale commercial fisheries. Sea cucumbers are not part of the local subsistence diet and are largely exported to China and Southeast Asia in the form of dried bêche-de-mer. Trochus meat, however, is consumed by villagers before the shells are sold to foreign markets (Japan and Southeast Asia) or domestic button factories. Aquaculture is a growing practice in the Solomon Islands to farm oysters, prawns, clams, and seaweed.

Subsistence fisheries have existed in the Solomon Islands for centuries. Though managed according to customary traditions, subsistence fishing pressure is high enough to threaten local species, such as giant clams (*Tridacna* spp.) which have been extirpated from some areas. Coastal fisheries are increasingly under threat from a number of factors, such as agricultural development, mining and logging, which are jeopardizing the health of coastal reefs and lagoons. Coupled with the harvesting of mangrove trees and corals, this has a substantial impact on the coastal fisheries. The harvesting of mangrove wood to fuel the fires used in drying bêche-de-mer greatly increased in the late 1980s and early 1990s.

More recently, changes in social structure are also having an influence on fisheries. The shift from community-cooperation to cash markets threatens the status of village chiefs, although traditional authority remains strong today. Women's role in reef fishing is increasing, both in subsistence and artisanal sectors, further adding to fishing effort and pressure. Although growing urban consumption demands will be supplemented with alternative sources (e.g., imports), the increasing national population will inevitably maintain pressure on artisanal and subsistence fisheries.

The only large-scale commercial fishery in the Solomon Islands is for tuna. The large-scale commercial tuna fishery was virtually non-existent before a Japanese survey documented a large supply of tuna and associated baitfish in 1970. This survey marked the establishment of the Solomon Islands Fisheries Department. The Solomon Islands Government signed a joint venture agreement with the Japanese Taiyo Gyogyo Fishing Company in 1972. This venture produced the first domestic pole-and-line and purse seine fleet, Solomon Taiyo Ltd. (STL). STL was to progressively develop and expand the commercial fishery, and was granted the exclusive right, other than by fully local companies, to fish within the territorial waters.

In 1977, a joint venture was formed between the government and STL, establishing the second domestic commercial pole-and-line fishing company, National Fisheries Development Limited (NFD). The purpose of this venture was to develop a national fishing fleet employing Solomon Islanders as a way to stimulate local involvement in the commercial tuna industry and supply additional fish to STL. The initial joint venture agreement deemed STL responsible for receiving, processing and marketing all commercial tuna catches in the country, from both STL and NFD. Domestic purse seine operations began in 1980. NFD was later sold to the Canadian company, BC Packers, and again to Trimarine Corporation, based in Singapore.

There is little mention of a third joint venture agreement with the Philippines leading to the formation of the company Markirabelle. Both Trimarine (BC Packers) and Markirabelle catch and export tuna with no land-based processing. This type of agreement is referred to as transshipment, and is a widespread problem which complicates fisheries management, as catches are landed in countries other than where or by whom they were caught. The Solomon Islands Government allotted Markirabelle an annual allowable tuna catch of 35,000 t. In 1991, Markirabelle was reportedly catching only 1,000 tonnes per year. A total of 121 transshipments by foreign purse seine vessels occurred at the Honiara Port during 2005, with 65,616 tonnes of skipjack tuna (*Katsuwonus pelamis*) and 13,012 tonnes of yellowfin tuna (*Thunnus albacares*) being transshipped. Substantive revenues amounting to millions of SI dollars were collected by the government from these transshipments. Transhipment practises are likely continuing.

Japanese fleets were present in the Solomon Islands' waters as early as the 1930s, with no available quantitative records. Between 1980 and 2006, several foreign access agreements were negotiated with Japan, Republic of China, Republic of Korea, USA, Vanuatu, Fiji, the Federated States of Micronesia, Spain, France, and Portugal. In 2001, access fees account for 0.1% of the SI gross domestic product (GDP), while overall, fishing contributes 12.8% to the SI GDP. Japanese

longline and pole-and-line vessels, and US Multilateral Fishing Treaty vessels, appear to be the only fleets actively exercising foreign access in Solomon Islands' waters as documented in national reports.

The catch of the commercial tuna industry is largely composed of skipjack tuna (*Katsuwonus pelamis*), yellowfin tuna (*Thunnus albacares*) and bigeye tuna (*Thunnus obesus*). Associated with the tuna fishery is the capture of valuable non-target species including marlin, sailfish and shark. Tuna accounts for 90% of the marine exports of Solomon Islands, primarily frozen or canned. In 1999, 65% of STL's catch was canned, 20% exported frozen, 13% smoked, and 2% made into fish meal. The vast majority of tuna exports are destined for Japan, the UK, and Thailand.

Table 23. Indicator scores for the Solomon Islands according to the five major criteria.

Criteria	Indicator	Score
Potential for impact on the marine ecosystem	BIO_{threat}	0.26
	COE_CMSY	0.58
	FIS_{FP}	0.79
	MPA_{area}	0.00
Potential impact on the lives of poor or vulnerable people	FIS_{jobs}	0.45
	2010 POP_{coast}	<0.01
	$FAO_{consumption}$	0.58
	PRO_{animal}	0.97
	PRO_{total}	0.99
	GINI	--
	HDI	0.59
	SUB_{LV}	0.57
	MAR_{GDP}	0.62
Potential for market-based solutions to succeed	2012 BUS_{ease}	0.48
	$VALUE_{tonne}$	1.00
	$POT_{tourism}$	1.00
Governance and policy dynamism	FOR_{press}	0.09
	$SUB_{beneficial}$	0.71
	GOV_{va}	0.64
	GOV_{ps}	0.79
	GOV_{eff}	0.28
	GOV_{reg}	0.29
	GOV_{rol}	0.34
	GOV_{corr}	0.38
Strong existing body of knowledge/evidence base	REF_{FB_SLB}	0.80
	$REF_{literature}$	0.86
	TAX_{rep}	0.22

Civil war broke out in the late 1990s, culminating in the overthrow of the government in June of 2000 and the subsequent closure of all major industries, including fishing enterprises. The country remained dysfunctional until 2003, when the Australian police and military led the Regional Assistance Mission to Solomon Islands (RAMSI) to re-establish order. Tuna canneries were closed but have since re-opened under local management, though exports remain low.

The coastal areas were struck by a major earthquake and tsunami in 2007, further hindering the coastal commercial and subsistence fisheries. A decline is evident in reported commercial tuna landings after 2007, likely as a result of damaged boats and/or lack of fishery statistical collection following the tsunami. Commercial tuna catches remain well below those recorded before the year 2000.

In terms of governance, the Solomon Islands have been recognized as being corrupt in fisheries management and other governance issues in the Pacific Islands region. The Fisheries Department suffers from a lack of human and financial resources, in addition to problems of transparency and accountability. There are no published annual fisheries reports for the 1994-2004 time period, although Solomon Islands continued to collect data for the Secretariat of the Pacific Community (SPC) and Forum Fisheries Agency (FFA). A domestic audit of the Fisheries Department in 2003 revealed that millions of US dollars from distant water access fees could not be accounted for. Steps are being taken to improve accountability and build the capacity of the Fisheries Department.

Adding to the governance situation for commercial, subsistence and artisanal fisheries in the Solomon Islands is the presence of customary marine tenure. Most rural land and virtually all reefs are managed by a complex and dynamic system, whereby kinship-based groups exert control over designated areas and associated resources. The leaders of such kin groups are referred to as chiefs. Based on traditional knowledge, chiefs monitor the state of their resources and enforce necessary catch restrictions on reef areas or specific species. In Morovo Lagoon, for instance, tenure rights include limited entry to the fishing grounds, the complete prohibition of dynamite, and partial bans on gillnets, spearfishing, and fish poisons. There were also temporary closures of fishing grounds to allow for fish populations to rebuild.

All coastal resource development initiatives are assessed by local chiefs. Commercial fishing companies respect customary marine tenures by paying royalties to the chiefs who "own" the baitfish fishing grounds. Fisheries managers also work to integrate traditional values with fisheries development aspirations. The Provincial Government Act of 1981 specifies that provincial jurisdiction cannot override customary law.

Indicator scores as derived here for the Solomon Islands are presented in Table (23).

South Africa[23]

South Africa has a long coastline, an EEZ of over 1 million km^2, and spans two Large Marine Ecosystems, the Benguela Current LME and the Agulhas Current LME (Figure 24). The Benguela Current ecosystem in particular is one of the most productive ocean ecosystems in the world in terms of biomass production and fishery resources due to the upwelling of cold, nutrient rich water. A high endemism and unique group of fishes exist in the waters off South Africa due to distinct oceanographic conditions and the variety of habitats. Today, the fishing industry in South Africa provides employment and income for at least 27,000 people, contributing less than 1% of the country's GDP. South Africa has the highest reported catches in Africa, but only ranked 30th on a global scale in the 1990s. The overall value of fisheries for 2008 was estimated at approximately US$ 322 million and the overall value of the recreational and commercial fishery is estimated at US$ 400-500 million annually. The fisheries can be separated into three sectors: commercial/industrial, recreational, and subsistence/artisanal sectors, all targeting over 250 marine species.

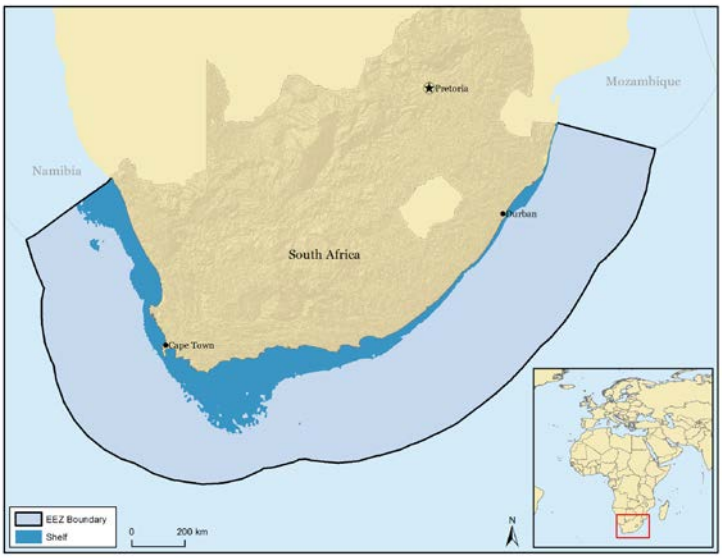

Figure 24. Extent of the EEZ and shelf waters (to 200 m depth) for South Africa.

Apartheid left South Africa with a horrible legacy of unemployment and an extremely unequal distribution of resources. Marine resources were also unequally distributed between small-scale and well-established large-scale operators. Furthermore, there was a regional imbalance in the fishing industry with most industry confined to the Western Cape.

The commercial fishing industry consists of several different fisheries. The most important fishery is the deep-sea trawl fishery and the smaller inshore trawl fishery mainly targeting hake stocks (*Merluccius paradoxus* and *M. capensis*), contributing approximately 50% of the overall value of fishery catches. There are also small fisheries for hake using demersal longlines and handlines. There is also a pelagic purse seine fishery targeting sardine (*Sardinops ocellatus*), anchovy (*Engraulis capensis*) and round herring (*Etrumeus whiteheadi*); producing fishmeal, oil and canned fish, which contributes 25% of the value of all fisheries. A midwater trawl fishery is targeting horse mackerel (*Trachurus capensis*) on the Agulhas Bank.

There are two important rock lobster fisheries in South Africa. On the West Coast, an inshore fishery is targeting West Coast rock lobster (*Jasus lalandii*), and on the South Coast, a deep-water fishery is targeting *Palinurus gilchristi*. Rock lobster contributes less than 1% by mass to the total fishery, but the contribution by value is approximately 9-10%. There is a very valuable, but politically highly disputed, abalone fishery (*Haliotis midae*). 'Poaching' (a politically fraught term) and resulting overexploitation led to the temporal closure of the industry in the late 2000s.

Other smaller fishing sectors include trawl fleets targeting shrimp off the coast of Kwa-Zulu Natal; a pelagic longline fishery targeting various tuna species, sharks and billfishes; and a tuna

[23] Based on material in Kleisner *et al.* (2012) and a currenlty unpublished fisheries report by Le Manach *et al.* (in prep-b)

bait and pole fishery. Additionally, there is a small squid jig fishery (targeting chokka squid *Loligo vulgaris reynaudi*) and a large linefish sector in terms of area fished and people employed, targeting a great diversity of fish species.

In general, catch data for the South African industrial fisheries appear to be well documented and catch statistics are readily available. However, there are no official catch statistics for the marginalized subsistence sector, as well as no comprehensive estimates for the recreational sector.

The South African marine recreational fishing industry is a large and important component of the South African fisheries in terms of economics, as well as in regards to the number of participants. An extensive coastline and a rich and diverse marine fauna offer thousands of recreational fishers the right conditions for their hobby. The major recreational fisheries are those targeting abalone (*Haliotis midae*), West Coast rock lobster (*Jasus lalandii*) and linefish, targeting 200 pelagic and demersal species, of which 31 contribute significantly to the overall total catch. The recreational component targeting linefish can be separated into various sectors, boat and shore-based estuarine fishers, including recreational fishers using cast nets; marine inshore rock and surf anglers; a boat-based offshore sector; and the spearfishing sector operating both from the shore and from boats. Additionally, there is a charter boat sector offering sport and big game fishing to paying customers, which has become increasingly popular in recent years, especially in the province of Kwa-Zulu Natal.

Table 24. Indicator scores for South Africa according to the five major criteria.

Criteria	Indicator	Score
Potential for impact on the marine ecosystem	BIO_{threat}	0.69
	COE_CMSY	0.45
	FIS_{FP}	0.63
	MPA_{area}	0.08
Potential impact on the lives of poor or vulnerable people	FIS_{jobs}	0.01
	2010 POP_{coast}	0.06
	$FAO_{consumption}$	0.11
	PRO_{animal}	0.11
	PRO_{total}	0.07
	GINI	0.78
	HDI	0.39
	SUB_{LV}	0.98
	MAR_{GDP}	0.07
Potential for market-based solutions to succeed	2012 BUS_{ease}	0.16
	$VALUE_{tonne}$	0.03
	$POT_{tourism}$	0.29
Governance and policy dynamism	FOR_{press}	0.85
	$SUB_{beneficial}$	0.49
	GOV_{va}	0.82
	GOV_{ps}	0.68
	GOV_{eff}	0.71
	GOV_{reg}	0.70
	GOV_{rol}	0.58
	GOV_{corr}	0.53
Strong existing body of knowledge/evidence base	REF_{FB_SLB}	0.16
	$REF_{literature}$	0.60
	TAX_{rep}	0.83

In contrast to subsistence fishing, which has existed in South Africa for thousands of years, and commercial fisheries which were initiated by Dutch colonists in the 17th century, recreational shore-based fisheries were introduced by British settlers in the early 19th century. It is acknowledged that recreational fishing is responsible for the decline of various fish stocks, crustaceans and other marine organisms in South Africa. Both boat and shore anglers have substantially contributed to the collapse of several stocks and perceived catch declines are reported in various scientific publications. In the early 2000s, the South African Government officially declared the marine linefish fishery as being in a state of emergency due to the collapsed or overexploited state of many linefish stocks.

In South Africa, despite its importance in terms of food security and poverty alleviation, the small-scale and subsistence sector has not been sufficiently integrated into management and policy systems. The reforms of the post-apartheid transformation process and the implementation of the new MLRA in 1998 have not yet fully reached the aims of sustainability, equity and stability. Many traditional fishers have been excluded from the new fisheries management framework and consequently are left without fishing rights and adequate support. Nevertheless, the MLRA comprised the initial legal recognition of subsistence fishers in South Africa and some progress has been made since then. In Kwa-Zulu Natal, a system of co-management has been implemented in some communities and a limited commercial sector for historically disadvantaged individuals (HDI) in South Africa was created in 2001.

Despite all remaining challenges in implementing legislation and further advancing management measures, much information and data about this fisheries sector is still to be derived. Various scientific studies have concentrated on political, socioeconomic and management-related issues concerning the subsistence sector in South Africa. Artisanal fishers are also poor fishers but have a historical, traditional and specific socio-cultural involvement with fishing and harvesting of marine resources. Artisanal fishers prefer to sell their catches, for example on small local markets, rather than using it for their own consumption. Many fishers in South Africa, defined as subsistence or artisanal fishers, actually intend to gain small-scale commercial rights in order to legally sell high value resources such as abalone (*Haliotis midae*) and rock lobster (*Panulirus homarus* and *Jasus lalandii*). The idea of creating a small-scale commercial fisheries sector was to enable subsistence fishers to generate revenues by allocating specific fishing rights. The process of implementing a management strategy for the small-scale sector by means of creating sufficient numbers of fishing rights and providing adequate support is still continuing.

Indicator scores as derived here for South Africa are presented in Table (24).

Sri Lanka[24]

The Democratic Socialist Republic of Sri Lanka is an island country southeast of India within the Bay of Bengal (Figure 25). The climate is tropical with seasonal monsoon and cyclones, but no upwelling. In 2009, the population was 20 million, with 32% living in coastal areas. The Sri Lankan Exclusivity Economic Zone (EEZ) covers 530,000 km^2.

The island was colonized by the Portuguese and the Dutch, but most influentially by the British. Sri Lanka, or "Ceylon" as it was known prior to 1972, was a strategic military and trade link between West Asia and Southeast Asia. It acquired independence from the British Empire as the Dominion of Ceylon in 1948, just after World War II. In 1972, Ceylon became a republic and the name was changed back to the pre-colonial name: Sri Lanka.

Figure 25. Extent of the EEZ and shelf waters (to 200 m depth) for Sri Lanka.

Attempts to record fisheries data in Sri Lanka may have begun during British rule; however, a rigorous island-wide attempt to estimate total landings did not start until after independence. Since 1910, general fisheries information was recorded by the resident marine biologist as part of an annual fisheries administration report. These reports included descriptions of traditional fisheries, destructive practices, fisheries regulations, results of test fisheries, policy changes, and financial record keeping; yet, information regarding landings on the island was incomplete. By the 1930s, the importance of quantifying total landings was recognized, and by the 1940s, efforts to quantify landings were well underway with the appointment of 12 fisheries inspectors (FIs) within 20 fisheries districts. In the early 1950s, the number of FIs was increased to 24. The first comprehensive annual report of total landings was published in 1952 by the Department of Fisheries (DOF); the reports were, from then on, published annually.

Records of landings in the 1950s focused mainly on the traditional practice of beach seining as it accounted for approximately 40% of total landings. The use of the large beach seine, *madella*, began in the mid to late 1800s and continued to be the most commonly used traditional fishing techniques throughout the twentieth century. Gillnetting began in the 195os, and eventually took over as the most widespread fishing method for small-scale fishers. Incidents of illegal dynamite fishing and fish poisoning were also reported. The DOF showed great interest at this time in test fisheries, with special attention to experimental dredging for pearl and windowpane oysters, as well as trawler surveys.

[24] Based on material in O'Meara *et al.* (2011).

In 1981, the National Aquatic Resources Research and Development Agency (NARA) was established with the mandate to improve research and development, with an emphasis to better understand tuna biology and catch statistics by way of a collaborative effort with the Indo-Pacific Tuna Programme (IPTP), the Bay of Bengal Programme (BOBP), the Food and Agriculture Organization (FAO) and the Asian Development Bank (ADB). Gillnetting, a practice that had become popular in the 1960s, continued as a favorite of Sri Lankan fishers and by the 1970s, was accountable for 60% of reported fisheries catches.

Shortly after the establishment of NARA, civil war broke out between the Liberation Tigers of Tamil Eelam (LITE) and the Government of Sri Lanka (GoSL). The effect of the war on fisheries was considerable, especially in the north where restrictions (e.g., a ban on outboard motors greater than 40 hp) on fishers were put in place to prevent fuel and weapons from being illegally brought from India by the LITE. Additionally, the conflict led to the destruction of boats, gear, and infrastructure which included ice making facilities and highways important for fish transport to distant markets. The northern fishing grounds, once responsible for generating over 40% of the country's reported landings, were the most productive and accessible fishing grounds in Sri Lanka due to the presence of a large continental shelf and a trawlable bottom.

Table 25. Indicator scores for Sri Lanka according to the five major criteria.

Criteria	Indicator	Score
Potential for impact on the marine ecosystem	BIO_{threat}	0.27
	COE_CMSY	0.25
	FIS_{FP}	0.62
	MPA_{area}	0.08
Potential impact on the lives of poor or vulnerable people	FIS_{jobs}	0.28
	2010 POP_{coast}	0.07
	$FAO_{consumption}$	0.37
	PRO_{animal}	0.57
	PRO_{total}	1.00
	GINI	0.15
	HDI	0.21
	SUB_{LV}	0.51
	MAR_{GDP}	0.13
Potential for market-based solutions to succeed	2012 BUS_{ease}	0.41
	$VALUE_{tonne}$	0.43
	$POT_{tourism}$	0.01
Governance and policy dynamism	FOR_{press}	0.92
	$SUB_{beneficial}$	0.57
	GOV_{va}	0.44
	GOV_{ps}	0.49
	GOV_{eff}	0.55
	GOV_{reg}	0.55
	GOV_{rol}	0.52
	GOV_{corr}	0.39
Strong existing body of knowledge/evidence base	REF_{FB_SLB}	0.34
	$REF_{literature}$	0.47
	TAX_{rep}	0.30

The 1990s saw an increase in reported landings due to improvements in the security situation in some areas of the north and the expansion of the fishing fleet offshore and internationally. By the 1990s, government officials recognized coastal resources were fully exploited, and efforts were shifted to expanding the potential of deep sea fisheries by providing boat and equipment subsidies.

The demand for marine fish has remained high, with a catch that was insufficient to meet demand. Despite the increase in multiday fishing vessels and other larger craft, a large component of the marine fishing fleet continues to consist of small artisanal boats with outboard motors as well as non-motorized traditional craft. The tsunami in December 2004 seriously affected 90% of the fishing community through losses of boats, fishing nets, housing, and lives. Eighty percent of fishing villages were destroyed, along with 12-14 fishing harbors. Post-tsunami efforts to rebuild fisheries have resulted in an overabundance of fishing boats in some areas, raising concerns for overfishing.

With the end of the civil war in 2010, efforts to increase fisheries catches in the north were a high priority for the DOF. Growing domestic demand for seafood and the potential for substantial earnings from seafood exports appear to be the driving force behind current fisheries policy, with plans to double marine fisheries catches in the future. Apart from increasing landings, offshore fisheries have been identified as a more viable source of high value export oriented species such as tuna. The lack of adequate offshore fishing capacity has been seen as a major obstacle to fisheries expansion, and there have been initiatives to allow commercial fishing by foreign vessels in exchange for access fees and prescribed landings in order to increase domestic fish supply.

Indicator scores as derived here for Sri Lanka are presented in Table (25).

Tanzania[25]

Tanzania, located in East Africa, with an EEZ of 241,000 km^2, has a mainland coast and three large offshore islands: Mafia, Pemba, and the island of Zanzibar, around which much inshore fishing is concentrated (Figure 26). Pemba and the island of Zanzibar form the region of Zanzibar. In the past, the mainland (called Tanganyika) and Zanzibar were separate entities. Both Tanganyika and Zanzibar fell under German colonial control in 1886 and then to the British in 1920, after WWI. Tanganyika gained independence in 1961 and Zanzibar followed two years later. In 1964, the two countries merged as the United Republic of Tanzania.

Figure 26. Extent of the EEZ and shelf waters (to 200 m depth) for Tanzania.

Lake Victoria has been the primary center of fishing, due partially to the fact that freshwater fishing is less capital intensive than marine fishing. Thus, most fisheries reports concentrate on freshwater catches. But subsistence marine fisheries have long provided protein for Tanzanian coastal and island communities, and thus play a significant food security and livelihood role for many coastal communities.

Prior to independence, fishers fished for small pelagic and demersal species using nets, traps, and hook and line. Women used a piece of sacking or a discarded *khanga* (printed cotton material worn as clothing) to catch prawns in the shallows. Women and children also collected invertebrates (i.e., reef and beach gleaning). The seafood trade in Tanzanian waters also has a long history. The export of fish and fisheries products from Zanzibar, for instance, dates back to the 13th century when Persians, Arabs and Indians traded dried salted fish (particularly kingfish), shells, shark fins, and later, sea cucumber.

During the colonial period (1880s-1960s), sportfishing became increasingly common in Tanzanian waters. At independence, commercial fishing began with the introduction of the purse seine in the Zanzibar channel for small pelagics, i.e., sardines, scads, mackerel, and anchovies. After independence, the new Tanzanian government practiced an African socialist policy and, under this regime, implemented a ban on the export of marine finfish to protect domestic food security, although the ban does not seem to apply to Zanzibar.

Despite its nominally socialist policies, Tanzania allowed a large amount of foreign investment, including the introduction of shrimp trawling—a practice that, given the amount of fish discarded by trawling, seems ironic in light of the export ban on marine finfish. However, the export of shrimp was allowed and began to grow. In the mid 1960s, a Japanese company and the Tanzanian government formed a shrimp company, although the Japanese left in 1975 and the fleet was

[25] Material based on Jacquet and Zeller (2007b) and Jacquet *et al.* (2010).

nationalized. With the rise of the shrimp fishery there was a great deal of by-catch, as much as 94% in the 1980s, though it is difficult to determine how much of this was retained and how much discarded. It was reported that, in the 1980s and 1990s, the dumping of finfish discards was so great that it was polluting inshore waters. This waste was later addressed by improved enforcement and much of the by-catch is now sold onshore to local markets or processing facilities.

A number of commercial cooperatives operated through the 1980s, including the Zanzibar Fishing Company (ZAFICO), the Bagamoyo Fishing Company (BAFICO), and the Tanzania Fishing Company (TAFICO). After trade liberalization began in 1985, a number of small-scale entrepreneurs as well as commercial and foreign trawlers became involved in the fishing sector and, in some cases, tripled fishing effort. In the early 1990s, Tanzania signed access agreements and allowed the EU to catch 7000 tonnes of tuna annually in its waters.

In the mid-1990s, tourism grew and so did demand for fresh fish and shellfish. On the mainland, the number of tourists increased from 82,000 in 1985 to 341,000 in 1996, which was reflected in the Tanzanian lobster fishery. In 1968, there were 22 permits issued for fishing crustaceans. By 1987, there were 415 boats fishing lobster, which far exceeded the upper limits of the effort recommended for the fishery. In 1988, the lobster catch in Tanzania peaked. Since then, the average size of lobster has decreased.

Table 26. Indicator scores for Tanzania according to the five major criteria.

Criteria	Indicator	Score
Potential for impact on the marine ecosystem	BIO_{threat}	0.28
	COE_CMSY	0.72
	FIS_{FP}	0.63
	MPA_{area}	0.24
Potential impact on the lives of poor or vulnerable people	FIS_{jobs}	0.01
	2010 POP_{coast}	0.02
	$FAO_{consumption}$	0.07
	PRO_{animal}	0.00
	PRO_{total}	0.02
	GINI	0.10
	HDI	0.70
	SUB_{LV}	0.95
	MAR_{GDP}	0.08
Potential for market-based solutions to succeed	2012 BUS_{ease}	0.73
	$VALUE_{tonne}$	0.07
	$POT_{tourism}$	0.14
Governance and policy dynamism	FOR_{press}	0.94
	$SUB_{beneficial}$	0.40
	GOV_{va}	0.59
	GOV_{ps}	0.67
	GOV_{eff}	0.39
	GOV_{reg}	0.46
	GOV_{rol}	0.37
	GOV_{corr}	0.36
Strong existing body of knowledge/evidence base	REF_{FB_SLB}	0.47
	$REF_{literature}$	0.19
	TAX_{rep}	0.26

In the 1990s, tourism also developed rapidly in Zanzibar. With the increase in tourism came an increase in demand for high-quality fresh fish. Tourist hotels offer good markets for fresh fish and prawns and hotel representatives now attend the fish auction in Kigomani, Zanzibar. Tourism also increased demand for marine curios, such as shark jaws, shark teeth, and shells. Roughly 150 species of shells are collected by fishers for food or sold as curios. The most sought after shells by tourists are horned helmut shell, triton trumpet shell, and Mauritian cowry. A shell survey done in the market in Dar es Salaam in 1998 found 112 species on sale with a total of 22,659 specimens. Seven years later, only 87 species were available on the market though there were 39,259 specimens. The number of red helmut shells in the market declined by 55% over the same time period.

Small-scale fishing takes place almost exclusively in the near-shore waters of 40 m depth or less by means of outrigger canoes and dhow-type planked boats, mostly propelled by sails. Dhows are still caulked with shark oil. Fishers use lines, traps, and nets to catch demersals, purse seines and scoop nets to catch small pelagics, and longlines, drift nets, gillnets, and shark nets to catch large pelagics. Like most small-scale fishing in the tropics, many species are caught and almost nothing is discarded. In Zanzibar, fishers from the villages exploit at least 61 families of fish.

Women and children still harvest shellfish, octopus, squid, crabs, sea cucumbers, and mollusks in the intertidal zone and mangrove areas using their hands, hooks, and natural and synthetic poisons. Women also beach seine for very small shrimp, which is quite profitable.

According to the 2005 fisheries frame survey, there are 29,754 fishers, 796 collectors, and 7190 boats on the Tanzanian mainland. No such survey has been conducted recently on Zanzibar, but it is estimated there are more than 23,000 fishers and collectors there. There are more than 400 landing sites for the mainland and Zanzibar combined. The majority of fish is eaten fresh, although some is dried, smoked, fried, and/or salted. Like other small-scale fisheries in East Africa, Tanzanian fisheries are subject to little management, and destructive (and illegal) fishing practices are common, such as use of herbicides, pesticides, beach seines and dynamite.

Indicator scores as derived here for Tanzania are presented in Table (26).

Thailand[26]

The Kingdom of Thailand is located at the centre of the Indochina peninsula in Southeast Asia (Figure 27). It is bordered to the north by Myanmar and Laos, to the east by Laos and Cambodia, to the south by the Gulf of Thailand and Malaysia, and to the west by the Andaman Sea and the southern extremity of Myanmar. Its maritime boundaries include Vietnam in the Gulf of Thailand to the southeast, and Indonesia, Myanmar and India in the Andaman Sea to the southwest. Thailand's EEZ (306,000 km^2) consists of the Gulf of Thailand (187,700 km^2) and the Andaman Sea (118,600 km^2).

Figure 27. Extent of the EEZ and shelf waters (to 200 m depth) for Thailand.

The country is a constitutional monarchy, headed by King Rama IX, and the world's 51st largest country in terms of total area, with an area of approximately 513,000 km^2, and the 20th most-populous country, with around 64 million people. About 75% of the population is ethnically Tai, 14% Thai Chinese, and 3% is ethnically Malay; the rest belong to minority groups.

Thailand experienced rapid economic growth between 1985 and 1996, and is presently a newly industrialized country and a major exporter. Tourism also contributes significantly to the Thai economy.

As is the case for many countries around the world, the fisheries of Thailand went through a period of boom and bust. From the early 1960s to the mid-1980s, catches from both marine and freshwater fisheries had grown at close to 8% per annum. The introduction of trawl technology and the expansion to new fishing grounds outside of the Thai EEZ contributed to the rapid increase in catches. The number of trawlers (otter board, pair, and beam) tripled within 10 years after their introduction in the early 1960s, and by 1989, the number of trawlers peaked at about 13,100 vessels. During this boom period, fisheries contributed about 10% to the Gross National Product (GNP) originating from the agricultural sector, or 3% of total GNP, and export values from fisheries went from about 235 million baht (about US$ 11.7 million) in 1966 to 5,019 million baht (US$ 250 million) in 1978. The growth rate in catches from 1976 onward, while still high, started to decline to less than 2% per annum, and was accompanied by a reduction in catch per unit effort from 300 kg·hour^{-1} in 1963 to 50 kg·hour^{-1} in the 1980s, and 30 kg·hour^{-1} in 1990 in the Gulf of Thailand, with a similar development along the Andaman Sea (i.e., Indian Ocean) coast of Thailand. Stock depletion and overfishing followed, with an increasing number of trawlers operating mostly in the Gulf of Thailand. The decline in the importance of the fisheries sector to the national economy was accentuated by the fast growing manufacturing and service sectors.

[26] Based on material in a currently unpublished fisheries report by Chuenpagdee *et al.* (in prep).

To overcome the problem of degraded fisheries resources, an exploitation of the then 'under-utilized' pelagic fishes, such as scads, sardines and tuna-like fishes, began along with the expansion of fishing areas for Thai trawlers to the South China Sea and Bay of Bengal in 1972. Joint-venture arrangements were also initiated to enable Thai vessels to fish in neighboring countries' waters. Reduction in catches continued, however, with the declaration of EEZs by neighboring countries beginning in 1977, and with prevailing shortage of fuel that escalated the cost of fishing. For these reasons, some trawlers returned to fish in the Thai EEZ, causing further declines in catches and intensifying conflicts with domestic small-scale fisheries. Several trawlers, however, entered into agreements (such as fishing concessions and joint ventures) with neighbouring countries, while some unofficial arrangements, as well as illegal fishing without any arrangements, also took place.

Table 27. Indicator scores for Thailand according to the five major criteria.

Criteria	Indicator	Score
Potential for impact on the marine ecosystem	BIO_{threat}	0.28
	COE_CMSY	0.51
	FIS_{FP}	1.00
	MPA_{area}	0.38
Potential impact on the lives of poor or vulnerable people	FIS_{jobs}	0.36
	2010 POP_{coast}	0.08
	$FAO_{consumption}$	0.44
	PRO_{animal}	0.41
	PRO_{total}	0.35
	GINI	0.30
	HDI	0.26
	SUB_{LV}	0.87
	MAR_{GDP}	0.47
Potential for market-based solutions to succeed	2012 BUS_{ease}	0.04
	$VALUE_{tonne}$	0.11
	$POT_{tourism}$	0.01
Governance and policy dynamism	FOR_{press}	0.99
	$SUB_{beneficial}$	0.00
	GOV_{va}	0.47
	GOV_{ps}	0.32
	GOV_{eff}	0.62
	GOV_{reg}	0.64
	GOV_{rol}	0.46
	GOV_{corr}	0.40
Strong existing body of knowledge/evidence base	REF_{FB_SLB}	0.41
	$REF_{literature}$	0.31
	TAX_{rep}	0.47

Fisheries in Thailand had historically been undertaken on a small scale, using bamboo stake traps and gillnet. Engines were introduced to the fisheries in the 1930s, and by 1953 the number of boats with engine had risen to 430. Still more than 80% of boats were small-scale and non-powered. This proportion of small-scale fishing boats in the fisheries remained until 1985, when the total number of boats increased to over 53,000. The development of commercial fisheries in Thailand has been at the peril of traditional, small-scale fishing sectors, despite the fact that about 90% of the 47,620 fishing households are small-scale.

Small-scale fisheries generally refer to fishing that involves family members, operate within 3-5 km from shore, and use gillnets, traps, set bag nets, push nets, lift nets, hooks and lines. Same as elsewhere around the world, the social, cultural and economic importance of small-scale fisheries and their contributions to food security and poverty alleviation are undermined and the sector has been marginalized. While some small-scale fishing methods can be very destructive, such as those involving the use of dynamite and cyanide, and are capable of destroying the resource base, the small-scale fisheries sector has overall been at a disadvantage, compared to its large-scale counterpart, with respect to financial support and policy attention from governments. Fisheries policies formulated to promote economic growth and development in fisheries, while contributing to increased income to fishing households, may result in displacing the small-scale fishing sector. The rising cost of fishing operations (due largely to high fuel prices) affect small-scale fisheries more so than large-scale sector since the former has little or no assets to fall back on.

The consequences of the rapid development and modernization of commercial fisheries have been resource depletion and overfishing, as well as functional change in trophic functioning of the ecosystem. Since the early 1970s, the degraded status of fisheries resources of Thailand, especially demersal species, was acutely noted as catches sharply declined, prompting the government to develop regulations to ban commercial trawling from within 3 km from shore. Yet, weak enforcement enables violations to occur, resulting in on-going destruction of nursery grounds, as well as conflicts with small-scale fisheries. This is despite the establishment of a Fisheries Patrolling Section within the Thai Department of Fisheries (DoF), equipped with patrol boats to

perform monitoring, control and surveillance (MCS) activities and suppress illegal fishing along the coasts.

Thai fisheries are managed under several official acts and decree, most of which aim to regulate fishing activities, mostly through gear, area and seasonal restrictions. Vessel and gear registrations and licensing programs are also in place. For instance, licenses for fishing, gears and leased areas are issued on annual basis with fees specified in the Fisheries Act. The Thai Vessel Act, enacted in 1938, stipulates that boat owners of powered vessels or those of 6 GT and beyond must register their vessels with the Harbor Department. Collaboration between this department and the DoF is necessary because gear licenses are controlled by the latter. One of the issues with the current vessel and gear registration and licensing systems, which contribute to problem caused by Illegal, Unreported and Unregulated (IUU) fishing, is the use of non-licensed fishing gears in registered vessels. In particular, since no new licenses are issued for trawlers, as part of the effort to control this fishing activity, some vessels apply for gillnet licenses, when in reality they operate trawls.

Concerns about IUU fishing are addressed through various initiatives. For instance, in 2009, a logbook information system was implemented to enable vessel operators to export their catches to European Union countries (EU). Of the 20,000 registered vessels with licenses (out of the total 54,000), 18% export their catches to the EU, which mean that their operators must strictly follow EU guidelines and regulations. Vessels that are not part of this system are encouraged to join, also as part of the regional cooperation in addressing IUU fishing issues in the Gulf of Thailand and Andaman Sea sub-region. For example, in 1996, the Foreign Ministry of Thailand estimated that only 28% of the total nearly 3,900 Thai fishing vessels operating in other countries' waters were doing so legally.

Indicator scores as derived here for Thailand are presented in Table (27).

Vietnam[27]

The Socialist Republic of Vietnam is located on the eastern coast of the Indochina peninsula and is bordered in the north by China and in the west by Laos and Cambodia (Figure 28). Fishing in Vietnam occurs in four main areas: the Gulf of Tonkin, shared with China, in the north, the South China Sea in the center and the southeast, and the Gulf of Thailand in the southwest. The total EEZ area of Vietnam is 1,396,000 km^2 and extends to 200 nautical miles off the coast.

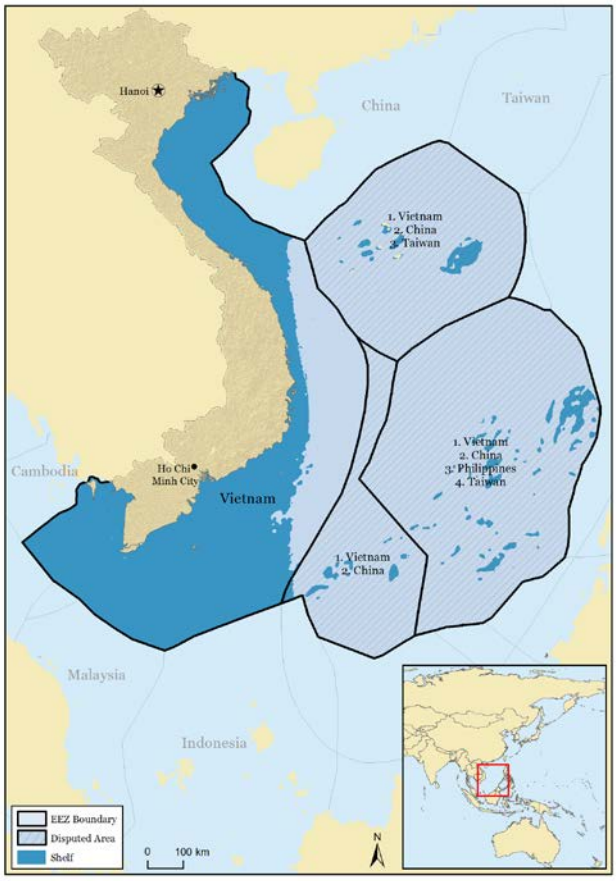

Figure 28. Extent of the EEZ and shelf waters (to 200 m depth) for Vietnam.

The majority of marine fishing in Vietnam is small-scale and occurs in shallow near-shore areas, which comprise roughly 11% of the EEZ. Inshore fishing, which comprises 84% of the fishing fleet is mandated by the government to be by vessels of less than 90 HP. In 2006, the fishery sector contributed 6% of the GDP. According to the World Bank, at least 20 million people depend on inshore fisheries for a portion if not all of their subsistence and income.

Women have a relatively small role in marine fisheries, with reports of only 1.4% of fish workers being women. However, due to fewer cultural constraints, women have a larger role in aquaculture. Efforts by the Ministry of Fisheries are underway to strengthen the role of women in fisheries; however, at present, women's roles are largely relegated to processing in the fisheries market chain.

There is a lack of systematic information for Vietnamese fisheries and this is impeding assessments of fisheries status. Under-reporting of catch has been identified as an issue.

Trawls, along with gill nets, purse seine, long lines, lift nets and gill nets are the major gear types used in Vietnamese marine fisheries. There is very little information on gear use in Vietnam, however. the major trawl types are known to be either single or pair trawls. There is an ongoing problem of larger trawlers illegally fishing in coastal waters due to poor enforcement of existing legislation. This issue of encroachment of offshore vessels into inshore waters is widespread throughout South East Asia, and contributes to the overfishing of coastal resources and habitat destruction.

Information regarding discards in Vietnam is not readily available. It is suspected that Vietnam has relatively low discards. The lack of data on discards may also be due to the high demand for fish of low economic value due for Vietnam's fishmeal and fish sauce industries. There have been estimates that 40-50% of trawl catch may be comprised of low value, inappropriately called 'trash' fish that supplies the fish sauce industry, which produced 160 million liters of fish sauce in 1998. However, some reports also suggest that trawlers that go on longer fishing trips of up to 20 days,

[27] Based on material in Kleisner *et al.* (2012).

typically discard a large portion of the catch. This is supported by the fact that a large portion of the Vietnamese fleet has neither adequate capacity nor the technology (i.e., freezer capacity) to maintain substantial by-catch on long fishing trips.

Indicator scores as derived here for Vietnam are presented in Table (28).

Table 28. Indicator scores for Vietnam according to the five major criteria.

Criteria	Indicator	Score
Potential for impact on the marine ecosystem	BIO_{threat}	0.30
	COE_CMSY	0.79
	FIS_{FP}	0.86
	MPA_{area}	0.05
Potential impact on the lives of poor or vulnerable people	FIS_{jobs}	0.63
	2010 POP_{coast}	0.21
	$FAO_{consumption}$	0.60
	PRO_{animal}	0.33
	PRO_{total}	0.26
	GINI	0.12
	HDI	0.41
	SUB_{LV}	0.00
	MAR_{GDP}	0.42
Potential for market-based solutions to succeed	2012 BUS_{ease}	0.52
	$VALUE_{tonne}$	0.16
	$POT_{tourism}$	0.04
Governance and policy dynamism	FOR_{press}	0.94
	$SUB_{beneficial}$	0.37
	GOV_{va}	0.13
	GOV_{ps}	0.73
	GOV_{eff}	0.48
	GOV_{reg}	0.41
	GOV_{rol}	0.39
	GOV_{corr}	0.34
Strong existing body of knowledge/evidence base	REF_{FB_SLB}	0.41
	$REF_{literature}$	0.40
	TAX_{rep}	0.07

Appendices

Presentation of indicator scores for all 45 countries

Table A1. Country scores for indicators under major criteria #1: Potential for impact on the marine ecosystem.

Country	BIO_{threat}	COE_CMSY	FIS_{FP}	MPA_{area}
Algeria	**0**	0.43	**1**	0.003
Argentina	0.73	0.55	0.62	0.22
Bangladesh	0.22	0.52	0.95	0.43
Benin	0.61	0.25	0.77	**0**
Brazil	0.56	0.22	**0**	0.54
Cambodia	0.66	0.46	0.96	0.22
Cameroon	0.61	0.53	0.83	**0**
Chile	**1**	0.45	0.26	0.01
China Main	0.45	0.80	**1**	0.31
Colombia	0.36	0.51	0.52	**1**
Costa Rica	0.65	0.27	0.72	0.51
Cote d'Ivoire	0.57	0.28	0.63	0.02
Ecuador	0.45	0.19	0.54	0.13
El Salvador	0.35	0.05	0.76	0.05
Fiji	0.40	0.61	0.56	0.14
Gabon	0.60	**0**	0.23	0.66
Gambia	0.61	0.16	0.81	0.08
Ghana	0.56	0.45	0.81	**0**
Guatemala	0.29	0.39	0.81	0.05
Honduras	0.29	0.53	0.92	0.20
India	0.21	0.64	0.66	0.10
Indonesia	0.26	0.66	**1**	0.67
Kenya	0.23	0.57	0.63	0.14
Madagascar	0.33	0.21	0.92	0.07
Malaysia	0.26	0.44	**1**	0.32
Mauritania	0.52	0.15	0.32	0.79
Mexico	0.74	0.63	0.56	0.36
Morocco	0.30	0.51	**1**	0.01
Mozambique	0.20	0.52	0.74	0.18
Myanmar	0.22	0.75	0.98	0.03
Namibia	0.82	0.13	0.38	0.32
Nicaragua	0.30	0.23	0.88	0.77
Nigeria	0.58	0.35	0.74	**0**
Panama	0.33	0.32	0.82	0.45
Peru	0.88	0.46	**1**	0.08
Philippines	0.72	**1**	**1**	0.14
Senegal	0.44	0.29	0.84	0.17
Solomon Is.	0.26	0.58	0.79	**0**
South Africa	0.69	0.45	0.63	0.08
Sri Lanka	0.27	0.25	0.62	0.08
Tanzania	0.28	0.72	0.63	0.24
Thailand	0.28	0.51	**1**	0.38
Uruguay	0.48	0.75	0.80	0.05
Venezuela	0.35	0.35	**1**	0.42
Viet Nam	0.30	0.79	0.86	0.05

Table A2. Country scores for indicators under major criteria #2: Potential impact on the lives of poor or vulnerable people.

Country	FIS_{jobs}	2010 POP_{coast}	$FAO_{consumption}$	PRO_{animal}	PRO_{total}	GINI	HDI	SUB_{LV}	MAR_{GDP}
Algeria	0.08	0.071	0.06	0.08	0.24	0.17	0.22	0.97	0.13
Argentina	0.00	0.058	0.07	0.07	**0**	0.46	0.02	0.90	0.31
Bangladesh	0.48	0.190	0.33	0.06	0.16	0.00	0.62	0.76	0.35
Benin	0.02	0.012	0.11	0.09	0.18	0.19	0.78	0.69	0.00
Brazil	0.10	0.273	0.12	0.05	0.00	0.73	0.18	0.81	0.05
Cambodia	**0**	0.007	0.62	0.03	0.02	0.22	0.56	0.87	0.04
Cameroon	0.03	0.009	0.22	0.19	0.40	0.23	0.66	0.89	0.11
Chile	0.09	0.040	0.38	0.55	0.34	0.61	**0**	**1**	0.14
China Main	0.07	**1**	0.57	0.22	0.19	0.20	0.24	0.79	0.13
Colombia	0.04	0.039	0.06	0.07	0.03	0.67	0.20	0.92	0.00
Costa Rica	0.09	0.012	0.15	0.09	0.05	0.43	0.09	0.72	0.15
Cote d'Ivoire	0.01	0.018	0.21	0.34	0.53		0.79	0.91	0.09
Ecuador	0.12	0.022	0.07	0.13	0.06	0.58	0.19	0.90	0.27
El Salvador	0.06	0.020	0.09	0.11	0.17	0.51	0.28	0.83	0.00
Fiji	**1**	0.002	0.63	0.66	0.55	0.35	0.24	0.54	**1**
Gabon	0.11	0.002	0.61	0.42	0.25	0.27	0.28	0.79	**0**
Gambia	0.61	0.002	0.49	0.52	0.88		0.77	0.43	
Ghana	0.46	0.026	0.51	0.66	0.79	0.19	0.53	0.98	0.06
Guatemala	0.09	0.024	**0**	0.02	0.02	0.66	0.48	0.57	0.13
Honduras	0.21	0.014	0.05	0.06	0.06	0.66	0.38	0.77	0.30
India	0.31	0.825	0.07	0.03	0.21	0.03	0.54	0.75	0.09
Indonesia	0.30	0.685	0.46	0.51	0.70	0.02	0.39	0.77	0.32
Kenya	0.32	0.007	0.03			0.42	0.61	0.82	0.04
Madagascar	0.12	0.024	0.09	0.14	0.25	0.34	0.68	0.90	0.13
Malaysia	0.05	0.068	**1**	**1**	0.61	0.38	0.10	0.87	0.70
Mauritania	0.09	0.002	0.34	0.32	0.37	0.27	0.72	0.87	0.29
Mexico	0.03	0.097	0.18	0.18	0.14	0.48	0.09	0.91	0.03
Morocco	0.36	0.064	0.18	0.18	0.30	0.23	0.46	0.91	0.30
Mozambique	0.05	0.030	0.09	0.16	0.45	0.38	**1**	0.89	0.54
Myanmar	0.80	0.074	0.95	0.37	0.34		0.65	0.87	0.19
Namibia	0.13	**0**	0.21	0.26	0.27	**1**	0.43	0.67	0.72
Nicaragua	0.04	0.011	0.05	0.08	0.14	0.35	0.45	0.73	0.44
Nigeria	0.08	0.082	0.24	0.21	0.54	0.35	0.71	0.97	0.01
Panama	0.72	0.009	0.23	0.31	0.19	0.65	0.08	0.90	0.43
Peru	0.04	0.050	0.37	0.36	0.42	0.51	0.16	0.99	0.35
Philippines	0.31	0.240	0.67	0.71	0.52	0.33	0.34	0.63	0.15
Senegal	0.88	0.024	0.42	0.47	0.60	0.31	0.71	0.92	0.21
Solomon Is.	0.45	0.001	0.58	0.97	0.99		0.59	0.57	0.62
South Africa	0.01	0.055	0.11	0.11	0.07	0.78	0.39	0.98	0.07
Sri Lanka	0.28	0.069	0.37	0.57	**1**	0.15	0.21	0.51	0.13
Tanzania	0.01	0.020	0.07	**0**	0.02	0.10	0.70	0.95	0.08
Thailand	0.36	0.082	0.44	0.41	0.35	0.30	0.26	0.87	0.47
Uruguay	0.02	0.009	0.14	0.13	0.11	0.36	0.05	0.98	0.03
Venezuela	0.49	0.057	0.33	0.30	0.17		0.14	0.95	0.00
Viet Nam	0.63	0.208	0.60	0.33	0.26	0.12	0.41	**0**	0.42

Table A3. Country scores for indicators under major criteria #3: Potential for market-based solutions to succeed.

Country	2012 BUS_{ease}	$VALUE_{tonne}$	POTtourism
Algeria	0.83	0.02	0.03
Argentina	0.67	0.11	0.29
Bangladesh	0.70	0.07	0
Benin	0.97	0.06	0.005
Brazil	0.70	0.37	0.26
Cambodia	0.72	0.27	0.19
Cameroon	0.89	0.15	0.03
Chile	0.15	0.03	0.03
China Main	0.47	0.23	0.06
Colombia	0.20	0.08	0.17
Costa Rica	0.58	0.31	0.19
Cote d'Ivoire	0.98	0.07	0.03
Ecuador	0.76	0.07	0.30
El Salvador	0.60	0.49	0.08
Fiji	0.29	0.57	0.83
Gabon	0.94	0.12	0.02
Gambia	0.80	0.13	0.32
Ghana	0.31	0.04	0.04
Guatemala	0.48	0.35	0.05
Honduras	0.67	0.42	0.10
India	0.71	0.13	0.13
Indonesia	0.69	0.07	0.03
Kenya	0.65	0.12	0.04
Madagascar	0.77	0.15	0.21
Malaysia	**0**	0.18	0.01
Mauritania	0.92	0.19	0.01
Mexico	0.21	0.17	0.06
Morocco	0.51	0.04	0.04
Mozambique	0.80	0.17	0.07
Myanmar		0.09	0.001
Namibia	0.45	0.08	0.23
Nicaragua	0.64	0.51	0.10
Nigeria	0.71	0.10	0.04
Panama	0.29	0.19	0.09
Peru	0.18	**0**	0.04
Philippines	0.75	0.14	0.06
Senegal	0.92	0.04	0.04
Solomon Is.	0.48	**1**	1
South Africa	0.16	0.03	0.29
Sri Lanka	0.41	0.43	0.01
Tanzania	0.73	0.07	0.14
Thailand	0.04	0.11	0.01
Uruguay	0.46	0.14	0.04
Venezuela	**1**	0.10	0.09
Viet Nam	0.52	0.16	0.04

Table A4. Country scores for indicators under major criteria #4: Governance and policy dynamism

Country	FOR_{press}	SUB_{bene}	GOV_{va}	GOV_{ps}	GOV_{eff}	GOV_{reg}	GOV_{rol}	GOV_{corr}
Algeria	0.93	0.45	0.28	0.20	0.35	0.26	0.27	0.34
Argentina	0.62	0.38	0.74	0.74	0.53	0.38	0.36	0.40
Bangladesh	0.99	0.56	0.52	0.15	0.28	0.36	0.30	0.21
Benin	0.91	0.13	0.69	0.77	0.42	0.49	0.30	0.31
Brazil	0.85	0.43	0.79	0.66	0.58	0.63	0.55	0.57
Cambodia	0.95	0.99	0.32	0.52	0.32	0.46	0.20	0.18
Cameroon	0.94	0.45	0.27	0.46	0.27	0.36	0.20	0.22
Chile	0.77	0.48	0.98	0.87	**1**	**1**	**1**	**1**
China Main	0.84	0.32	0.07	0.43	0.63	0.52	0.40	0.33
Colombia	0.88	0.84	0.57	0.24	0.67	0.68	0.46	0.43
Costa Rica	0.94	0.47	0.96	0.88	0.71	0.70	0.70	0.70
Cote d'Ivoire	0.86	0.37	0.24	0.18	0.16	0.35	0.12	0.18
Ecuador	0.95	0.66	0.52	0.42	0.39	0.30	0.16	0.27
El Salvador	0.97	0.91	0.64	0.71	0.55	0.71	0.30	0.45
Fiji	0.63	0.31	0.29	0.68	0.33	0.44	0.24	0.37
Gabon	0.85	0.38	0.31	0.80	0.27	0.42	0.38	0.28
Gambia	0.48	0.35	0.22	0.70	0.37	0.51	0.38	0.36
Ghana	0.94	0.31	0.79	0.72	0.57	0.62	0.52	0.57
Guatemala	**1**	0.75	0.51	0.42	0.33	0.55	0.20	0.36
Honduras	0.96	0.75	0.45	0.53	0.38	0.55	0.24	0.27
India	0.82	0.13	0.76	0.26	0.57	0.49	0.52	0.34
Indonesia	0.81	0.14	0.60	0.39	0.50	0.49	0.32	0.32
Kenya	0.97	0.14	0.55	0.22	0.39	0.54	0.21	0.25
Madagascar	0.84	0.75	0.34	0.37	0.27	0.43	0.26	0.43
Malaysia	0.84	0.05	0.48	0.73	0.94	0.76	0.72	0.52
Mauritania	**0**	0.36	0.30	0.26	0.85	0.37	0.25	0.34
Mexico	0.94	0.06	0.65	0.43	0.70	0.68	0.38	0.41
Morocco	0.68	0.31	0.39	0.51	0.51	0.55	0.47	0.44
Mozambique	0.68	0.11	0.57	0.77	0.39	0.47	0.36	0.39
Myanmar	0.90	0.75	**0**	0.27	**0**	**0**	0.07	**0**
Namibia	0.72	0.38	0.74	0.98	0.61	0.60	0.61	0.59
Nicaragua	0.96	0.53	0.43	0.54	0.27	0.49	0.31	0.28
Nigeria	0.82	0.98	0.37	**0**	0.18	0.39	0.13	0.17
Panama	0.97	0.47	0.79	0.63	0.62	0.69	0.52	0.41
Peru	0.75	0.29	0.64	0.43	0.53	0.72	0.34	0.45
Philippines	0.95	0.28	0.62	0.19	0.58	0.51	0.37	0.28
Senegal	0.25	0.27	0.53	0.57	0.43	0.52	0.39	0.33
Solomon Is.	0.09	0.71	0.64	0.79	0.28	0.29	0.34	0.38
South Africa	0.85	0.49	0.82	0.68	0.71	0.70	0.58	0.53
Sri Lanka	0.92	0.57	0.44	0.49	0.55	0.55	0.52	0.39
Tanzania	0.94	0.40	0.59	0.67	0.39	0.46	0.37	0.36
Thailand	0.99	**0**	0.47	0.32	0.62	0.64	0.46	0.40
Uruguay	0.98	**1**	**1**	**1**	0.79	0.69	0.78	0.91
Venezuela	0.90	0.50	0.31	0.22	0.19	0.17	**0**	0.14
Viet Nam	0.94	0.37	0.13	0.73	0.48	0.41	0.39	0.34

Table A5. Country scores for indicators under major criteria #5: Strong existing body of knowledge/evidence base

Country	REF_{FB_SLB}	$REF_{literature}$	TAX_{rep}
Algeria	0.51	0.39	0.39
Argentina	0.40	0.48	0.82
Bangladesh	0.55	0.44	0.07
Benin	**1**	0.04	0.51
Brazil	0.64	0.46	0.79
Cambodia	0.62	0.03	0.05
Cameroon	0.94	0.03	0.36
Chile	0.05	**0**	**1**
China Main	0.07	0.94	0.38
Colombia	0.90	0.33	0.53
Costa Rica	0.55	0.37	0.39
Cote d'Ivoire	0.90	0.57	0.53
Ecuador	0.13	0.36	0.70
El Salvador	0.23	0.51	0.26
Fiji	0.70	0.37	0.45
Gabon	0.92	0.92	0.41
Gambia	0.99	0.27	0.41
Ghana	0.97	0.12	0.52
Guatemala	0.58	0.10	0.27
Honduras	0.73	0.04	0.22
India	0.23	0.47	0.42
Indonesia	0.12	0.36	0.61
Kenya	0.45	0.63	0.28
Madagascar	0.55	0.18	0.15
Malaysia	0.39	0.41	0.50
Mauritania	0.77	0.41	0.43
Mexico	0.45	**1**	0.58
Morocco	0.67	0.85	0.47
Mozambique	0.47	0.50	0.22
Myanmar	0.59	0.61	**0**
Namibia	0.72	0.80	0.48
Nicaragua	0.61	0.39	0.32
Nigeria	0.94	0.09	0.41
Panama	0.49	0.75	0.31
Peru	**0**	0.57	0.55
Philippines	0.19	0.84	0.54
Senegal	0.64	0.46	0.67
Solomon Is.	0.80	0.86	0.22
South Africa	0.16	0.60	0.83
Sri Lanka	0.34	0.47	0.30
Tanzania	0.47	0.19	0.26
Thailand	0.41	0.31	0.47
Uruguay	0.83	0.61	0.66
Venezuela	0.91	0.46	0.56
Viet Nam	0.41	0.40	0.07

Table A6. Questions assessing compliance with the FAO Code of Conduct.

Field 1: Management objectives
1. Are formal reference points for fish stocks in fisheries identified using best science?
2. Is present fleet capacity calculated and are there plans to reduce it?
3. Are small-scale fishers considered in plan and are there institutional structures for ongoing consultation?
4. Impacts of fishery on biodiversity allowed for in plan and are mitigation measures in place?
5. Does the management plan aim to restore depleted stocks in this fishery?
6. Are human impacts (pollution, waste) on the fishery habitat identified and mitigated?
7. Is fishing gear mandated by the management plan to avoid by-catch of non-target species, environmental and habitat damage?
8. Are ecosystem linkages with this fishery made explicit in the management plan and are adverse effects minimized?
9. Are environmental influences on this fishery made explicit in the management plan and are adverse effects minimized?
Field 2: Framework (data and procedures)
1. Are total and complete removals from the stocks over the whole stock area and over whole life cycle accounted for in assessment?
2. Are management measures compatible with those of other jurisdictions concerned with the stocks?
3. Does the management plan have clearly stated long-term objectives?
4. Are all the stakeholders in this fishery resource identified and considered?
5. Are data, management processes and decision-making open and transparent, including any international aspects?
6. Are timely, complete and reliable statistics collected and verified?
7. Are social, economic and institutional factors related to sustainability evaluated with data?
Field 3: Precautionary approach
1. Is precaution explicitly enshrined in legislation, and is it applied to management of fishery stocks?
2. Is uncertainty, including lack of appropriate information, quantified and used to restrain fishing that might otherwise occur?
3. Are stock-specific target reference points estimated and employed?
4. Are stock-specific limit reference points estimated and employed?
5. Are there viable contingency plans to restrict fishing in the event of an environmental emergency?
6. Are there viable contingency plans to restrict fishing in the event of an unforeseen emergency caused by fishing?
7. Are management instruments under continuous review?
8. Are no-take areas of sufficient size to work, policed and monitored as insurance?
9. Are plans in place to restrict fishing if species linked through the ecosystem to the target(s) of this fishery become threatened?
Field 4: Stocks, fleets and gear
1. Is excess fleet capacity being reduced?
2. Are fishing methods known to be harmful to habitats, to create by-catch problems, or whose high fishing capacity is difficult to control, being phased out?
3. Is by-catch of non-target species minimized?
4. Are discards minimized?
5. Is gear designed to minimize ghost fishing if lost?
6. Is the fishing of juveniles and spawners restricted to safe levels?
7. Are depleted stocks being rebuild?
Field 5: Social and economic
1. Is the fishery managed so as to minimize conflict among different sectors?
2. Are Indigenous Peoples rights and needs in fisheries being met?
3. Are the needs of local fishing communities being met?
4. When a change to the management of a fishery is made, is its cost-effectiveness evaluated?
5. When a change to the management of the fishery is made, is its social impact evaluated?
6. Is funding for the research and the MCS programme obtained by cost recovery from the industry?
Field 6: Monitoring, control and surveillance (MCS)
1. On a ten-point scale, how effective is the observer scheme?
2. On a ten-point scale, how effective is the catch inspection scheme?
3. On a ten-point scale, how effective is the vessel monitoring scheme?
4. Are vessels fishing illegally in fisheries?
5. On a ten-point scale, how effective is control of access in stopping illegal fishing?
6. Are vessels that really derive from this jurisdiction reflagged in states of convenience, generally to avoid reporting or other fishery regulations?

REFERENCES

Belhabib D, Koutob V, Gueye N, Mbaye L, Nhiamadio I, Mathews C, Lazar N and Pauly D (in press) Lots of boats and fewer fishes: catch reconstruction for Senegal, 1950-2010. *In* Belhabib D and Pauly D (eds.), Marine fisheries catches in West Africa, 1950-2010, part II. Fisheries Centre Research Reports, Vancouver.

Belhabib D, Mendy AN and Pauly D (in prep) Caught in the "Smile of Africa": fisheries catch reconstruction for The Gambia. *In* Belhabib D and Pauly D (eds.), Marine fisheries catches in West Africa, 1950-2010, part III. Fisheries Centre Research Reports, Vancouver.

Bhathal B (2005) Historical reconstruction of Indian marine fisheries catches, 1950-2000, as a basis for testing the 'Marine Trophic Index'. Fisheries Centre Research Reports 13(5), Vancouver. 122 p.

Chuenpagdee R, Kongprakhon P, Dessane S, Juntarashote K and Teh L (in prep) Reconstruction of Thailand's fisheries catches: 1950-2010. Fisheries Research Centre Reports, Vancouver.

Cisneros-Montemayor AM, Barnes-Mauthe M, Al-Adulrazzak D, Navarro-Holm E and Sumaila UR (2013a) Global economic value of shark ecotourism: implications for conservation. Oryx 47(3): 381-388.

Cisneros-Montemayor AM, Cisneros-Mata MA, Harper S and Pauly D (2013b) Extent and implications of IUU catch in Mexico's marine fisheries. Marine Policy 39: 283-288.

Cisneros-Montemayor AM, Sumaila UR, Kaschner K and Pauly D (2010) The global potential for whale watching. Marine Policy 34: 1273-1278.

Costello C, Deschênes O, Larsen A and Gaines SD (2013) Removing biases in forecasts of fisheries status. Journal of Bioeconomics.

Doyle B, Harper S, Jacquet J and Zeller D (2012) Reconstructing marine fisheries catches in the Solomon Islands: 1950-2009. pp. 119-134 *In* Harper S, Zylich K, Boonzaier L, Le Manach F, Pauly D and Zeller D (eds.), Fisheries catch reconstructions: Islands, Part III. Fisheries Centre Research Reports 20(5), Fisheries Centre, University of British Columbia, Vancouver (Canada).

Dyck AJ and Sumaila R (2010) Economic impact of ocean fish populations in the global fishery. Journal of Bioeconomics 12: 227-243.

Etim L, Belhabib D and Pauly D (in prep) An overview of the Nigerian marine fisheries subsector and a re-evaluation of its catch data over the past 60 years. *In* Belhabib D and Pauly D (eds.), Marine fisheries catches in West Africa, 1950-2010, part III. Fisheries Centre Research Reports, Vancouver.

Haas A, Harper S and Zeller D (in prep) Reconstruction of Nicaragua's fisheries catches: 1950-2010. Fisheries Centre Research Reports, Vancouver.

Hornby C, Bhathal B and Zeller D (in prep) Reconstruction of India's marine fish catch from 1950-2010. Fisheries Centre Research Reports, Vancouver.

Jacquet JL, Fox H, Motta H, Ngusaru A and Zeller D (2010) Few data but many fish: Marine small-scale fisheries catches for Mozambique and Tanzania. African Journal of Marine Science 32(2): 197-206.

Jacquet JL and Zeller D (2007a) National conflict and fisheries: reconstructing marine fisheries catches for Mozambique. pp. 35-47 *In* Zeller D and Pauly D (eds.), Reconstruction of marine fisheries catches for key countries and regions (1950-2005). Fisheries Centre Research Reports 15(2). University of British Columbia Fisheries Centre, Vancouver.

Jacquet JL and Zeller D (2007b) Putting the 'United' in the United Republic of Tanzania: Reconstructing marine fisheries catches. pp. 49-60 *In* Zeller D and Pauly D (eds.), Reconstruction of marine fisheries catches for key countries and regions (1950-2005). Fisheries Centre Research Reports 15(2). University of British Columbia Fisheries Centre, Vancouver.

Khan A, Sumaila R, Watson R, Munro G and Pauly D (2006) The nature and magnitude of global non-fuel fisheries subsidies. pp. 5-37 *In* Sumaila R and Pauly D (eds.), Catching more bait: a bottom-up re-estimation of global fisheries subsidies. Fisheries Centre Research Reports 14(6). University of British Columbia, Vancouver, Canada.

Kleisner K, Coll M, Christensen V, Boonzaier L, McCrea-Strub A, Zeller D and Pauly D (2012) Towards increasing fisheries' contribution to food security. Part II: The potentials of 25 fishing countries. A report of the *Sea Around Us* Project to Oceana and the Bloomberg and Rockefeller Foundations, Vancouver. 148 p.

Le Manach F, Abunge CA, McClanahan TR and Pauly D (in prep-a) Reconstruction of total marine fisheries catches for Kenya (1950-2010). Fisheries Centre Research Reports, Vancouver.

Le Manach F, Baust S, Harper S, Zylich K and Zeller D (in prep-b) The reconstruction of total marine fisheries catches for South Africa (1950-2010). Fisheries Centre Research Reports, Vancouver.

Le Manach F, Gough C, Harris A, Humber F, Harper S and Zeller D (2012) Unreported fishing, hungry people and political turmoil: the recipe for a food security crisis in Madagascar? Marine Policy 36: 218-225.

Le Manach F, Gough C, Humber F, Harper S and Zeller D (2011) Reconstruction of total marine fisheries catches for Madagascar (1950-2008). pp. 21-37 *In* Harper S and Zeller D (eds.), Fisheries catch reconstructions: islands, part II. Fisheries Centre Research Reports 19 (4). Fisheries Centre, University of British Columbia, Vancouver.

Legendre P and Legendre L (1998) Numerical Ecology, 2nd edition. Developments in Environmental Modelling. Elsevier, Amsterdam. 853 p.

Link JS, Gaichas S, Miller TJ, Essington T, Bundy A, Boldt J, Drinkwater KF and Moksness E (2012) Synthesizing lessons learned from comparing fisheries production in 13 northern hemisphere ecosystems: emergent fundamental features. Marine Ecology-Progress Series 459: 293-302.

Martell SJ and Froese R (2012) A simple method for estimating MSY from catch and resilience. Fish and Fisheries.

McBride MM, Doherty B, Brito AJ, Le Manach F, Sousa L, Chauca I and Zeller D (2013) Taxonomic disaggregation and update to 2010 for marine fisheries catches in Mozambique. Fisheries Centre Working Papers 2013-02. Fisheries Centre, University of British Columbia, Vancouver. 26 p.

Mendo J and Wosnitza-Mendo C (in prep) Reconstruction of total marine fisheries catches for Peru: 1950-2010. Fisheries Centre Research Reports, Vancouver.

Mondoux S, Pitcher T and Pauly D (2008) Ranking maritime countries by the sustainability of their fisheries. *In* Alder J and Pauly D (eds.), A comparative assessment of biodiversity, fisheries, and aquaculture in 53 countries' Exclusive Economic Zones. Fisheries Centre Research Reports 16(7). University of British Columbia, Vancouver, Canada.

Nunoo FKE, Asiedu B, Amador K, Belhabib D and Pauly D (in prep) Reconstruction of marine fisheries catches for Ghana, 1950-2010. *In* Belhabib D and Pauly D (eds.), Marine fisheries catches in West Africa, 1950-2010, part III. Fisheries Centre Research Reports, Vancouver.

O'Connor S, Campbell R, Cortez H and Knowles T (2009) Whale Watching Worldwide: tourism numbers, expenditures and expanding economic benefits, a special report from the International Fund for Animal Welfare., Economists at Large, Yarmouth, MA.

O'Meara D, Harper S, Perera N and Zeller D (2011) Reconstruction of Sri Lanka's fisheries catches: 1950-2008. pp. 85-96 *In* Harper S and Zeller D (eds.), Fisheries catch reconstruction. Islands, Part II. Fisheries Centre Research Reports 19(4). Fisheries Centre, University of British Columbia, Vancouver.

Palomares MLD and Pauly D, editors (in prep) Philippine marine fisheries catches (1950-2010) and biodiversity. Fisheries Centre Research Reports, Vancouver.

Pauly D and Le Manach F (in prep) Tentative adjustments of China's marine fisheries catches (1950-2010). Fisheries Centre Research Reports, Vancouver.

Pauly D and Watson R (2008) Adjusting for context in evaluating national fisheries statistics reporting systems. pp. 57-61 *In* Alder J and Pauly D (eds.), A comparative assessment of biodiversity, fisheries and aquaculture in 53 countries' Exclusive Economic Zones. Fisheries Centre Research Reports 16(7). University of British Columbia, Vancouver, Canada.

Pitcher T (1999) Beverton and Holt equations: spreadsheet functions and uncertainty. Naga, the ICLARM Quarterly 22(1): 37-41.

Pitcher T, Kalikoski D and Ganapathiraju P, editors (2006) Evaluations of compliance with the UN Code of Conduct for Responsible Fisheries. Fisheries Centre Research Reports 14. University of British Columbia, Vancouver, Canada. 1192 p.

Pitcher T and Preikshot D (1999) A rapid appraisal technique to evaluate the sustainabilty status of fisheries. *In* Craig J (ed.) ICLARM Workshop on Lake Nasser's Fisheries.

Pitcher TJ, Kalikoski D, Short K, Varkey D and Ganapathiraju P (2009) An evaluation of progress in implementing ecosystem-based management of fisheries in 33 Countries. Marine Policy 33(2): 223-232.

Qiu W, Wang B, Jones PJS and Axmacher JC (2009) Challenges in developing China's marine protected area system. Marine Policy 33(4): 599-605.

Schaefer M (1954) Some aspects of the dynamics of populations important to the managemetn of commercial marine fisheries. Bulletin of the International Americal Tropical Tuna Commission 1(2): 26-56.

Srinivasan UT, Cheung W, Watson R and Sumaila UR (2010) Food security implications of global marine catch losses due to overfishing. Journal of Bioeconomics 12: 183-200.

Srinivasan UT, Cheung WWL, Watson R and Sumaila UR (2013) Response to removing biases in forecasts of fishery status. Journal of Bioeconomics.

Sumaila R, Khan A and Dyck AJ (2010) A bottom-up re-estimation of global fisheries subsidies. Journal of Bioeconomics 12(3): 201-225.

Sumaila R and Pauly D, editors (2006) Catching more bait: a bottom-up re-estimation of global fisheries subsidies. Fisheries Centre Research Report 14(6). University of British Columbia, Vancouver, Canada.

Teh L and Sumaila R (2011) Contribution of marine fisheries to worldwide employment. Fish and Fisheries.

Ullah H (in prep) Reconstruction of total marine fisheries catches for Bangladesh: 1950-2010. Fisheries Centre Research Reports, Vancouver.

van der Meer L, Arancibia H, Harper S and Zeller D (in prep) Reconstruction of total marine fisheries catches for Chile (1950-2010). Fisheries Centre Research Reports, Vancouver.

Walters CJ, Christensen V, Martell SJ and Kitchell JF (2005) Possible ecosystem impacts of applying MSY policies from single-species assessment. ICES Journal of Marine Science 62: 558-568.

Watson R, Kitchingman A, Gelchu A and Pauly D (2004) Mapping global fisheries: sharpening our focus. Fish and Fisheries 5: 168-177.

Wielgus J, Caicedo-Herrera D and Zeller D (2007) Reconstruction of Colombia's fisheries catches. pp. 69-79 *In* Zeller D and Pauly D (eds.), Reconstruction of marine fisheries catches for key countries and regions (1950-2005). Fisheries Centre Research Reports 15(2). University of British Columbia Fisheries Centre, Vancouver.

Wielgus J, Zeller D, Caicedo-Herrera D and Sumaila UR (2010) Estimation of fisheries removals and primary economic impact of the small-scale and industrial marine fisheries in Colombia. Marine Policy 34: 506-513.

Wood LJ, Fish L, Laughren J and Pauly D (2008) Assessing progress towards global marine protection targets: shortfalls in information and action. Oryx 42(3): 340-351.

Zylich K, O'Meara D, Jacquet J, Harper S and Zeller D (2012) Reconstruction of marine fisheries catches for the Republic of Fiji (1950-2009). pp. 25-36 *In* Harper S, Zylich K, Boonzaier L, Le Manach F, Pauly D and Zeller D (eds.), Fisheries catch reconstructions: Islands, Part III. Fisheries Centre Research Reports 20(5), Fisheries Centre, University of British Columbia, Vancouver (Canada).

www.seaaroundus.org

SEA AROUND US PROJECT
Fisheries Centre
The University of British Columbia
2202 Main Mall, 3rd Floor
Vancouver, B.C. V6T 1Z4

Phone 1-604-822-2731
Fax 1-604-822-8934

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