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Small is Beautiful? A Database Approach for Global Assessment of Small-Scale Fisheries: Preliminary Results and Hypotheses[1]

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Abstract.—Many aspects of small-scale fisheries hinder our efforts to understand their dynamics, as required for sustainable management. For example, there is no widely accepted definition of small-scale fisheries or global data on number of small-scale fishers and their catches. One reason for this is that most research on small-scale fisheries is done at community level and tends to focus on immediate problems, such as poverty reduction, maintaining traditional lifestyle, and conflict resolution with large-scale fisheries. Many national fisheries development plans claim, and in some cases do, favor the small-scale fisheries sector, though it is generally the larger scale fleets which benefit from such plans. Several studies suggest, moreover, that a "large" small-scale fisheries sector can be as detrimental to fisheries resources and marine ecosystems as large-scale fisheries. Undoubtedly, quantifying the impacts of the small-scale fisheries sector relative to that of the large-scale sector would help improve our ability to manage the fisheries. In this paper, we present global estimates of small-scale fisheries based on aggregation of available data on catch and number of fishers from national level statistics. The initial data were from FAO country profiles, which were used to interpolate for countries with missing data. We conclude with discussion about how to improve these estimates using field data from regional and national sources.

Introduction

"The most striking about modern industry is that it requires so much and accomplishes so little. Modern industry seems to be inefficient to a degree that surpasses one's ordinary powers of imagination. Its inefficiency therefore remains unnoticed."—E.F. Schumacher, Small is Beautiful, 1999.

For many countries worldwide, fisheries mean important sources of food, livelihood, employment, and income. However, their degree of importance in different countries varies, de-

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[1]Based on the presentation at the Fourth World Fisheries Congress, Vancouver, May 2004. Since this was originally presented, catch and effort estimates, which update the values presented herein, have been computed, using the methods described, applied to non-FAO, local data. These updated estimates are available at www.seaaroundus.org.

pending notably on the basic features of their economy. For countries with highly developed fisheries, operating as a large-scale industry, the focus is on income, particularly through export earnings. In developing countries, the contributions of fisheries also impact on food security, as fisheries products often represent the main source of animal protein. Small and large-scale fisheries generally co-exist in many parts of the world and the extent of their interactions and conflicts depend on the relative scale and intensity of their operations (Pauly 1997). The ecosystem impact of small and large-scale fisheries also differs, depending on the gear used (Chuenpagdee et al. 2003) and overall fishing effort. For example, industrial bottom trawling, covering a large fraction of a country's continental shelf, and extracting large catches, is likely to result in greater ecosystem impacts than small-scale inshore traps. It could be argued, however, that one large-scale fishing vessel may be less destructive than many small-scale fishing boats. Further, some small-scale fishing methods can be very destructive, such as dynamite and cyanide fishing, practiced illegally in many developing countries (e.g. of Southeast Asia [Saeger 1993] or Africa [Vakily 1993]). Thus, overfishing can occur with both large-scale and small-scale fisheries (World Bank et al. 1991). Indeed, a worldwide comparative analysis of these two sectors is urgently required to assess these and related issues.

Most of the research and systematic data collection efforts have been focused on industrial fishing in developed and developing countries. As a consequence, a large body of information and knowledge about large-scale sector exists, to the extent that the common complaint about lack of data as the reason for ineffective management measures leading to overfishing is now largely unjustified. The same cannot be said about small-scale fisheries. The Food and Agriculture Organization of the United Nations (FAO), for example, coordinates and publishes fisheries statistics, such as landings from capture fisheries by species groups, from member countries on an annual basis. However, it can be largely assumed that data reported by member countries to FAO fail to include catches from subsistence and artisanal fishing (both of these are components of small-scale fisheries; recreational fisheries may also be included in the small-scale category, although, along with freshwater fisheries, they won't be considered here).

Many studies of small-scale fisheries have been conducted, but these studies have tended to emphasize the anthropological, social, and cultural aspects of small-scale fishing and generally attempted to capture their unique situations at particular locations. Information about small-scale fisheries at a country level is rare; one important exception being the fisheries country profiles published by FAO (http://www.fao.org/fi/fcp/fcp.asp), which attempt to provide a description of the large and small fishing sectors of most maritime countries. Researchers and scientists working in small-scale fisheries, however, do not always appreciate such broad overviews, claiming that natural and social systems are too complex, and that each small-scale fishing community is distinctively different from others. Another common view is that small-scale fisheries are so different between countries that global, or even regional, definitions and comparisons are impossible, again implying uniqueness for each individual fishery.

The problem with these notions, which often appear convincing at first sight, is that in effect, they add further to the marginalization of small-scale fisheries, already disadvantaged by their physical, socio-economic, political and cultural remoteness from urban centers (Pauly 1997). Small-scale fishing communities in developing countries often operate in areas away

from the locations of political power, lacking landing facilities and other infrastructure, and direct access to markets. Compared with large-scale industrialized fishery sector, small-scale sector usually receives far less support (e.g., subsidies) from the governments. Also the lower economic status, on a per caput basis, of small-scale fishers, marginalizes them further and undermines the political power, that, at least in what are formally democracies, their numbers would imply.

At the onset, an attempt to counter this marginalization of small-scale fisheries would include an amount of research and a data collection effort comparable to those devoted to large-scale fisheries with aggregate catches of similar magnitude. This would help not only to provide a quantitative framework for the sociological and anthropological work performed so far, but also to allow for comparative analysis of social and economic contributions of the two sectors, as well as their relative impacts to marine and coastal ecosystems.

This contribution illustrates the reframing of research on small-scale fisheries suggested above by presenting a quantitative approach for deriving regionally stratified, global estimates of their catches and number of fishers and vessels based on data in the FAO country profiles. The following sections describe the iterative approach we have developed to achieve this, and preliminary results, followed by a discussion which emphasizes the next iterations, where the locale-specific knowledge embedded in the primary and gray literature will be used to improve our database, and the results based thereon.

Methods

Small-scale fisheries are sometimes described as subsistence and artisanal, with fishers using traditional and simple gears, some without a boat and some with boats lacking engines. These fisheries normally contribute food for household consumption, with small amount of catches used for barter or trade. In other instances, small-scale fisheries involve use of modern gears and boats with outboard or inboard motor. They are considered commercial fisheries, as catches are landed and sold either by fishers or their family members at the market or through marketing systems involving "middlemen" (often women). Concerns regarding the definition of small-scale fisheries are related to the wide range of fishing and marketing practices, framed in a great variety of cultural and political settings. Thus, the first in our effort to derive global estimates was to review the definitions of small-scale fisheries in the FAO country profiles. We used FAO data as for the initial estimates because it is the only data set that provides coverage of small-scale fisheries in a consistent format across countries.

Of 137 countries that provide report of marine fisheries to FAO, 50 offer definitions of their small-scale fisheries, in terms of boat type and size, engine size, gross boat tonnage (GRT), number of crew, gear used, and various combinations of these statistics. Table 1 illustrates the overall consistency of what is considered small-scale fisheries in developing and developing countries. It is this overall consistency which made possible the use of the database approach we present below.

The database was given the following features. First, it contains all countries with marine fisheries, grouped into two main categories, based on the UNEP human development index (HDI) (UNEP 2000) (i.e., high [H-HDI] and medium–low [ML-HDI]. Human development index measures a country's status in terms of life expectancy, educational attainment of its citizen, and adjusted real income, and is considered more appropriate than gross

Table 1. Characteristics of small-scale fisheries provided in FAO country profiles

Characteristics	General range
Boat size	between 5 and 8 m; less than 12 or 15 m; up to 21 m
Boat type	no boat canoe, sail, un-powered, outboard engine, open boat, no deck
Boat GRT	between 10 and 20 GRT; less than 20 GRT
Size of engine	15–40 hp; less than 60 hp
Number of crew	2–3; 5–6
Gear type	handline, longline, dive, traps, nets, gill nets, push nets, small trawlers
Combination	less than 10 m or 20 GRT, 5–6 m with 2–3 crew

domestic product (GDP), often used for ranking and grouping countries and their national fisheries. The grouping of the countries is done to allow for statistically improved estimates of global catches, as available data are averaged within groups of countries ("strata") and computation for missing values (i.e., their replacement by within-stata averages) is performed for countries within the same categories. Medium and low HDI countries are grouped together since their estimates are similar and they are very different from H-HDI countries. The grouping results in 40 H-HDI and 97 ML-HDI countries.

Then, for each country with data, the number of small-scale fishers, vessels, and catches were entered as reported in the FAO country profiles, along with other reported features of the small-scale fishery of each country. These data largely cover the late 1990s and 2000. As well, we entered for each country an estimate of its small-scale fishing area, defined as the area of its shelf ranging from the shoreline to 50 km offshore or 200 m depth—whichever comes first providing the limit. These limits were selected on the assumptions that small-scale fishers usually a) perform day trips (a few hours sailing, a few hours fishing, and a few hours sailing back) and, hence, the limit in terms of distance from shore and b) do not fish in very deep waters, except in areas where the shelf is very narrow (e.g., around oceanic islands) and, hence, are restricted to on-shelf (neritic) waters and resources.

Global estimates (e.g., of number of fishers) were then obtained by
1) Using available estimates by countries to compute within-strata estimates of mean number of fishers per square kilometer of small-scale fishing area;
2) Multiplying these means by the country-specific values of small-scale fishing area to obtain preliminary estimates of fishers in countries without such number;
3) Adding fisher numbers across countries, by strata. Note that this approach, which was applied in similar fashion to number of vessels and catch per fisher (and hence to absolute catches by small-scale fisheries), implies that per stratum and global estimates obtained thereby emerge from summing a reasonably high number of largely independent products.

Consequently, we can assume that underestimates in certain countries will compensate for overestimates in others (Sokal and Rohlf 1995). Technically, this approach also allows for estimating formal confidence intervals for the global estimates, although we have abstained here from dealing with issues of precision, given the dubious accuracy of some of our source estimates.

Preliminary Results and Discussion

The current database includes existing information from eight H-HDI and 27 ML-HDI countries, or 20% and 28% of the total countries, respectively. Our preliminary estimates of the number of small-scale fishers and vessels are given in Table 2 and the global catches in Table 3. The estimates show that there are five times more small-scale fishers per area in ML-HDI countries than in H-HDI countries and that they use twice the number of boats. Conversely, individual small-scale fishers in H-HDI catch five times more per year than those in ML-HDI. These ratios can be taken to reflect the level of dependency on resources and the social well-being of small-scale fishers in these countries. Different estimates can be made using reported data within strata, to differentiate between geographical regions, as shown in Table 4 for ML-HDI countries. Table 4 suggests that these estimates vary only slightly from the estimates obtained in the first procedures (see Tables 2 and 3). Yet, regional differences found within the ML-HDI statum can be informative, particularly for discussion about fisheries sustainability at the regional level. In the Asia-Pacific region, for example, there are more small-scale fishers and more boats, resulting in relatively less catch per fisher and smaller total catches, compared to other regions. Curbing of small-scale fisheries in Asia-Pacific countries may be an issue that needs further exploration.

These preliminary estimates provide information about small-scale fisheries that can be used to compare with large-scale sector, similar to the broad comparisons performed by D. Thompson (in Pauly 1997). For example, the number of crew on large-scale fishing vessels reported therein is about half a million, while our estimates suggest that there are over 10 million small-scale fishers in the world. The contribution of small scale fisheries to global fisheries catches is, at 31 million metric tons (mt, Table 3), roughly half that of the large-scale sector, which ranges from 50 million to 80 million mt, depending on the proportion of commercial small-scale fisheries reported by FAO member countries as part of their national landings (see below). Also important about small-scale fisheries is the fact that income generated from this sector is likely

Table 2. Global estimates of small-scale (SS) fishers and boats

Countries	SS fishers per km^2	SS boats per km^2	Total SS fishers ('000)	Total SS boats ('000)
H-HDI	0.19	0.15	1,380	397
ML-HDI	0.97	0.31	9,100	2,050
Total			10,480	2,447

Table 3. Estimates of global landings by small-scale fisheries

Countries	Catch per SS fisher (mt/fisher/year)	Total SSF catch (1,000 mt/year)
H-HDI	10	13,467
ML-HDI	2	17,962
Total		31,429

to stay at the local level and contribute to local well-being (Sen 1999).

When considering fishing activity in terms of food efficiency, almost all small-scale fisheries catches are used for human consumption, as opposed to only 57% in the case of large-scale fishing (Pauly 1997). The contribution of small-scale fisheries to human food security is therefore greater than that of the large-scale sector; similar analyses can be made for fuel efficiency or return on investment. Thus, the catch per metric ton of fuel consumed in small-scale fishing is 4–5 times higher than for large-scale fishing and the number of fishers employed per $1 million investment in fishing vessels is at least 100 times higher in small-scale than in large-scale fisheries (Pauly 1997).

The estimates reported in this paper are very preliminary and will require continuing update and improvement. First, efforts must be made to replace the data from FAO country profiles by data from local studies documented in the primary or report literature. Our database provides an appropriate framework for the systematic data collection required here both at local and national levels. Global estimates will be improved with the increase in data quality and quantity. Indeed, explicit consideration of uncertainty (through estimated confidence intervals, or more crudely through

Table 4. Regional breakdown of key statistics on small-scale fisheries in ML-HDI countries

Region (*n*)	Fishers/ km^2	Total fishers ('000)	Boats/ km^2	Total boats ('000)	Catch/fishers (mt/year)	Total catches (1,000 mt/year)
American/ Caribbean (25)	0.85	1,220	0.36	242	0.43	547
Africa (36)	0.93	980	0.21	187	2.21	2,040
Asia/Pacific (18)	1.35	6,060	0.57	1,490	0.72	4,360
Europe/Near East (18)	0.86	1,810	0.23	438	2.60	4,710
Total (mean)	(0.97)	10,070	(0.31)	2,357	(1.88)	11,657

ranges for the different inputs, or through a Monte-Carlo approach) will allow evaluation of the uncertainty in all estimated outputs (Figure 1).

Next, the database must be expanded to include explicitly the catches taken by women and children, which are hardly ever included in national statistics, another expression of the marginalization alluded to above. Contrary to a widespread belief, women and children in many countries do take active roles in catching fish and coastal invertebrates, rather than only in processing and marketing. Examples are reef gleaning, widespread in Southeast Asia and the Pacific (Chapman 1987), or gathering of estuarine bivalves and other invertebrates in West and East Africa (Williams 2002) and in El Savaldor (Gammage 2004). Consideration of these catches will not only add to the reported amounts, but also highlight an income source so far largely neglected in accounts of the coastal economies.

Some published social science (anthropology, sociology, economics) studies of small- scale fisheries report information on their catch composition. These data, if available for several time periods, will be useful to determine the extent of small-scale fisheries on their supporting ecosystems (e.g. by computing the mean trophic level of their catch) (Pauly et al. 1998), thus providing a basis for discussions on whether, in such cases, small is beautiful. Moreover, catch composition data can be used to infer whether the small-scale fisheries catches of a given country are included in the catch statistics it submits to FAO. Presently, many island countries with substantial small-scale fisheries exploiting near shore reefs report only tuna and or lobster catches (i.e., exported commodities), a sign that they do

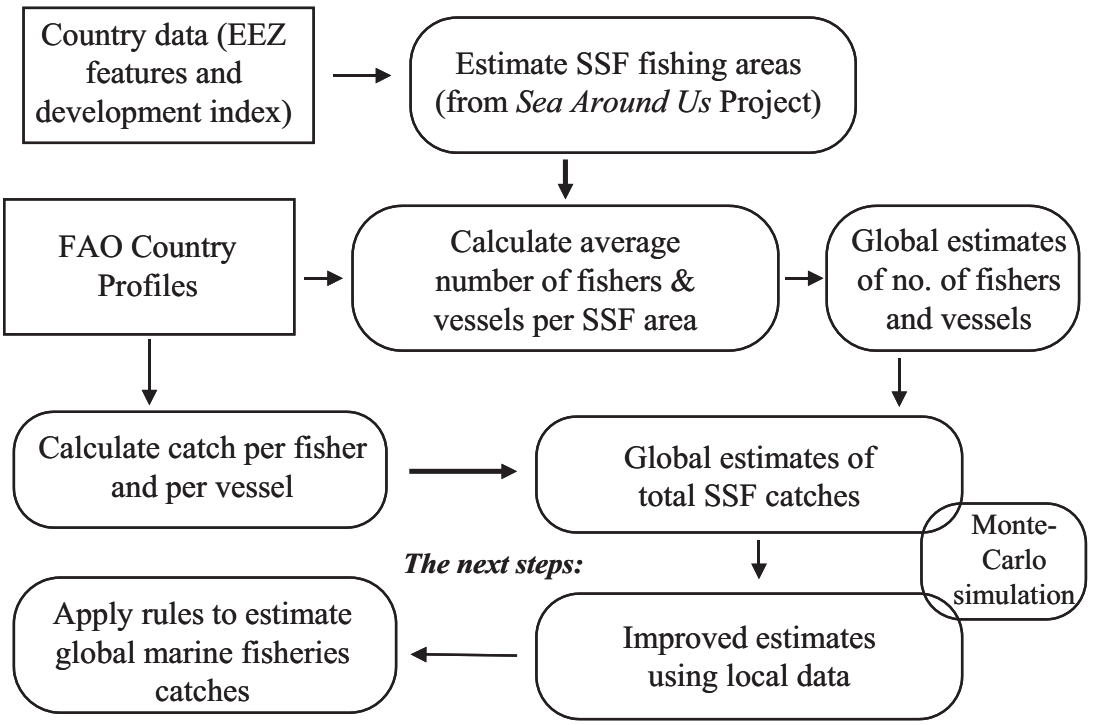

Figure 1. Schematic diagram for global estimation of small-scale fisheries.

not consider their small-scale fisheries worth attention, though it is they which feed the local populations.

Additional rules can be devised to infer whether small-scale fisheries catches are included in the FAO catches of different countries. For countries reporting "zero catches" in small-scale fisheries, our estimates should be added to FAO catches since small scale fishing occurs in all maritime countries, whether or not government officials went to the beaches to record their catches. On the other hand, in cases where small-scale fisheries catches are roughly equal to the nonidentified catches (e.g., the frequent "miscellaneous" or "other species"), then they might have been included in the FAO statistics. Further, some countries do not report catches of boats below a certain tonnage. In most cases, the entire estimate of the small-scale catch of these countries will have to be added to the FAO-based global catch estimates for marine fisheries.

Finally, estimates of value of fisheries catch should be made to suggest economic and social importance of small-scale fisheries to local communities. One possibility is to apply global average price for fish species (available at www.seaaroundus.org) to small-scale catch composition data. Alternatively, for commercial small-scale fisheries, price data can be obtained directly from field studies or inferred from prices of corresponding species in other, similar fisheries. Interviews and surveys will be required, however, to assess other values of fish, such as for household consumption and cultural and spiritual uses (e.g. in aboriginal communities).

Conclusion

The database approach presented here to obtain global estimates of sall-scale fisheries, and thus to document, rather than assert their importance, is an initiative to construct a new "mental map" for small-scale fisheries, where they are put at the front and center of research and management interests, instead of remaining at the margin. Similar to the large-scale fisheries, small-scale fisheries share features across broad regions, which render them amenable to comparative quantitative studies, and to global inferences. As the global small-scale fisheries database presented here is structurally similar to the global (large-scale) fisheries, ecosystem and biodiversity database assembled by the *Sea Around Us* Project (see www.seaaroundus.org), global comparative analyses will therefore be possible. In addition to comparing directly the contribution of small- and large-scale fisheries to the economy and food security of various countries, it will be possible to assess impacts of small-scale fishing on ecosystems and biodiversity, especially when trends can be observed. This will allow us to tell, in rigorous fashion, whether, in fisheries, small is beautiful.

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