



Reconstructing global marine fishing gear use: Catches and landed values by gear type and sector

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ABSTRACT

The interaction between fishing gears and the marine environment define ‘fisheries,’ and the effect of gears on marine ecosystems and fish stocks has been the source of much debate. Here, we present the first summary of globally reconstructed fisheries catches by major gear categories for 1950–2014. We used the *Sea Around Us* reconstructed global catch database that accounts for reported and unreported fisheries catches, and associated all catches to a fishing gear category. We assigned all industrial (i.e., large-scale) fisheries catches to industrial gear categories by fishing country, taxon, year and the area of fishing. Additionally, we derived catches by individual small-scale gear types for the most-important small-scale fishing countries in each of nine regions around the world, and applied their gear use to similar countries in each of the regions, to serve as a preliminary small-scale catch-by-gear assignment that can be improved upon over time. The combination of these account for gear use for all marine fisheries globally. We found that two industrial gear types, bottom trawling and purse seining, jointly account for over 53% of all catches, while bottom trawling alone dominated discarded catches. In the small-scale sector, over 60% of catches were caught by gillnets, various line gear, and encircling nets. Small-scale fisheries contributed most to the value of landed catches, while industrial bottom trawlers were responsible for discarding large amounts of potentially valuable catches. Catches by purse seines fluctuated over time, mainly due to variability of the underlying species, e.g., anchovies and sardines. The distribution and scale of use of different fishing gears, combined with knowledge of their divergent environmental impacts should allow a new wave of research into the global impacts of fisheries.

1. Introduction

Fishing gears enable fishers to interact with finfishes and marine invertebrates (hereafter ‘fish’) in the marine environment; this interaction between gears and fish is the fundamental definition of ‘fisheries’. There is a wide diversity of fishing gears that have been employed by fishers around the world over the last 60+ years, from simple small-scale gears operated with one’s hands like spears, traps, handlines or a variety of beach seines and gillnets, to industrial-scale

bottom- and midwater-trawls the size of large aircrafts, and mechanically powered seine nets that can match the size of several Olympic swimming pools (Gabriel et al., 2005). There are major concerns regarding the use of fishing gears including by-catch of non-target organisms (Alverson et al., 1994), often leading to substantial discarding (Zeller et al., 2018), habitat alterations and destruction (Turner et al., 1999; Watling and Norse, 1998), and associated high fuel use (Parker and Tyedmers, 2015).

While many detailed, local studies exist on fishing gears used in

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fisheries, little research exists on a global scale on the total patterns and trends in their use. An exception is the earlier work of the *Sea Around Us* research initiative (Pauly and Zeller, 2015), which produced an assignment of fishing gears associated with officially reported landings data, largely as assembled and reported by the Food and Agriculture Organization of the United Nations (FAO) on behalf of its member countries (Watson et al. 2006a, 2006b). This approach did not account for unreported catches, nor could it allocate catches to different fishing sectors such as small-scale commercial (i.e., artisanal) as compared to large-scale commercial (i.e., industrial).

However, recently the *Sea Around Us* completed their global reconstructions of marine catch data for all countries in the world (Pauly and Zeller, 2016a, 2016b), which augmented the officially reported landings data with complete time-series estimates of unreported catches over the last 60+ years, including commonly un- or under-reported small-scale sectors (e.g., Zeller et al., 2015), recreational fisheries (e.g., Smith and Zeller, 2016), as well as major discards (Zeller et al., 2018). These country-level reconstructions were further complemented with a global reconstruction and harmonization of catches by the industrial large pelagic fisheries in each ocean basin that are administered by Regional Fisheries Management Organizations (RFMOs), mainly for tuna, billfishes and pelagic sharks (Le Manach et al., 2016). In addition to comprehensively reconstructing total reported and unreported catch data, all catches are spatially allocated to a global half degree ocean grid system across the world's marine waters, taking into account biological probability distributions for each taxon in the data (Palomares et al., 2016) as well as known and derived foreign fishing access information to national EEZ waters in each country (Zeller et al., 2016).

The species-gear associations derived earlier by the *Sea Around Us* (Watson et al., 2006a, 2006b) can now be replaced with a new, detailed and improved catch-by-fishing gear dataset that accounts for country, species and annual changes in gear use by fishing sector. We synthesized the global findings of this new and comprehensive global fishing gear database that harmonizes with and links directly to the globally reconstructed catch data of the *Sea Around Us*. We are now able to examine all catches (whether reported or unreported) by gear types, by fishing sector, and by country, in space and time back to 1950. These freely available data will allow all users to evaluate and analyze a variety of policy questions around marine fisheries and gear use over the last 65+ years, and will hopefully assist in better understanding trends in global fisheries and gear use.

2. Materials and methods

We used the reconstructed *Sea Around Us* catch data (Pauly and Zeller, 2016a, 2016b), available at www.seaaroundus.org, by fishing sector, taxon and fishing country to assign fishing gear types to the catch data. All gear types and categories assigned here are listed in Tables 1A and 1B. The catch reconstructions for each country or territory used country- or region-specific definitions to assign catches to either large-scale (i.e., industrial) or small-scale sectors (i.e., artisanal, subsistence, recreational). However, all fishing gears that are moved through the water or across the seafloor using engine power were defined as industrial (Martín, 2012), irrespective of vessel size. Thus,

some trawl or purse seine operations defined as 'small-scale' by a given country due to vessel length were re-assigned as industrial sector fisheries in the *Sea Around Us* database (Zeller et al., 2016).

The *Sea Around Us* reconstructed catch data are composed of millions of catch records, each consisting of a catch tonnage for a particular taxon, particular fishing country and year, caught in a particular area (e.g., a certain EEZ, FAO or RFMO area), by a particular fishing sector, and which is either landed or discarded catch, and either deemed reported or unreported. The *Sea Around Us* catch data are structured into three distinct data layers: domestic fisheries, foreign fisheries, and industrial tuna and other large pelagic species fisheries. The distinction between these layers, and thus generally where fisheries operate (i.e., in a country's home EEZ, or other countries' EEZs, or High Seas areas), was used in part to inform potential gear types for different countries. All gear assignments were made while considering temporal and geographical changes for the respective fishing country and taxon. We addressed the gear use in three different segments: industrial non-tuna gears (i.e., excluding industrial tuna and large pelagic fisheries), industrial tuna and large pelagic gears, and artisanal (i.e., small-scale) gears.

2.1. Industrial non-tuna gears

For all industrial catch data records, we first determined the likely gear types or gear categories that an industrial catch record could be assigned to, based on the definitions of fishing gears in Gabriel et al. (2005). Second, we assigned all data rows that have gear information already included (e.g., from catch data reconstructions) to the appropriate gear categories, while confirming and validating this choice based on additional information in the reconstruction and its source material. Examples where this was done include the domestic fisheries in the EEZs of countries around the Red Sea (Tefamichael and Pauly, 2016) where gears were assigned that readily allowed standardized gear categories to be associated. Third, we assigned all taxa that are caught by a single gear by a fishing country in a geographic region in a given year. Examples of this include taxa that are only caught by one industrial gear type by a country, such as the use of purse seines for anchoveta (*Engraulis ringens*, Engraulidae) in Peru (Mendo and Wosnitza-Mendo, 2014). Fourth, we assigned gear types to all taxa that are caught by multiple gears by the same fishing country in the same geographic area. This required assigning proportions of the different gear types to the mixed gear category for each unique fishing country, year, taxon and geographic region. In this way, catches of Atlantic cod (*Gadus morhua*, Gadidae) by the United Kingdom could be separated into Danish seines, bottom trawls, gillnets, and line gear.

These identified major gear types were assigned to one of the major gear categories defined here (Tables 1A and 1B). The details of the gear-to-catch matching results for each country and region (e.g., national EEZ, territory, high seas area) can be found in the Supplemental methods (S1).

2.2. Tuna and large pelagic gears

The industrial tuna, billfish and other large pelagic fisheries that are

Table 1A

Large scale. Gear categories and gear types with descriptions (adapted from Gabriel et al., 2005).

Gear category	Gear types	Description (Gear type)
Bottom trawl	Bottom trawl, Shrimp trawl, Beam trawl, Otter trawl	Nets dragged by vessels in contact with the seabed
Pelagic trawl	Pelagic trawl	Nets dragged by vessels not in seabed contact and targeting pelagic or semi-pelagic taxa
Longline	Lines, Pole and line, Longline, Hand line	Includes all gears where lines of any kind are the primary fishing gear
Purse seine	Encircling nets, Purse seine	All net-based gears that encircle their catch rather than entangle it
Gillnets	Gillnet, Trammel net	All net-based gears that entangle their catch rather than encircle it
Other	Dredge, Other, Pots or traps, Other nets, Other lines, Dragged gear, Mixed gear, Unknown class	Other gears which are not major contributors to global industrial catches and do not fit into the major gear categories

Table 1B

Small-scale (SS). Gear categories and gear types with descriptions (adapted from Gabriel and others 2005).

Gear category	Gear types	Description (Gear type)
Bag nets	Bag nets	Nets used by individuals to lift or scoop fish from the water
Cast nets	Cast nets, Lampara nets	Nets thrown atop the intended catch from shore or boats
Hand/tools	Hand collection, Diving, Harpoons	Fishing by hand, skin diving, harpoons, or other methods not involving nets or lines
Encircling nets	Encircling nets, Purse seine	Nets in small-scale fisheries that surround fish from the sides and beneath
Gillnets	Set net, Driftnet, Trammel net	Nets that entangle catch, deployed from a boat and/or suspended in the water column
Lines	Hand line, Trolling line, Longline, Pole and line, Squid jigging	Gear composed of fishing lines with baited or unbaited hooks
Pots or traps	Fyke nets, Traps	Manufactured structures that trap fish, including net weirs and pots
Seines	Beach seine, Boat seine	Weighted, surrounding nets that encircle fish
Other nets	Small-scale other nets	Nets not belonging to other net categories
Artisanal fishing gear	Dynamite chemical, Mixed gear, Unknown	Other fishing gear not belonging to any of the above categories, or used in a mixed gear fishery or is unknown

administered and managed by various RFMOs are addressed separately in the *Sea Around Us* data (Le Manach et al., 2016; Zeller et al., 2016). They are spatially assigned with their gears based on reported data from each tuna RFMO, and these gears were ascribed to the gear types and categories described in Tables 1A and 1B. The industrial gears make up the greatest proportion of reported catches by RFMOs and largely belong to purse seines and longlines, with smaller amounts of catch from industrial pole and line and gillnet fisheries. Many of the gear types reported by RFMOs are originally more descriptive of the various types and even sub-types of longlines, pole and line or net gears used, but these details were re-assigned here into their more general major gear types. The reconstructed discards of these fisheries correspond to the gears used in the respective fishery.

2.3. Artisanal gears

To derive catch-to-gear assignments for the highly diverse small-scale fisheries of the world (Chuenpagdee, 2011), we developed a country-to-region-substitution approach. The three countries with the largest artisanal catches in each region were identified (Table 2) and their catches assigned to small-scale gear types (Tables 1A and 1B) for each taxon for each year (for additional information on how this assignment was done, see the Supplementary methods). Annual breakdowns of artisanal catch of each taxon by gear were pooled for regions (Africa, Asia, Europe, South America) and these breakdown were used to assign artisanal gear use for all other countries within each region. Taxa that did not occur in these regional gear breakdowns based on the sample countries, but were present elsewhere within the region were assigned a gear breakdown based on a similar taxon on the basis of similar taxonomic lineage, habitat, or functional group. Overall breakdowns for broader taxonomic categories (families, orders, classes,

etc.) were pooled with data for all taxa that fell within the category in order to best reflect the various gears used for catching broad categories of taxa.

For regions with particularly stark differences in economic development or climate and thus gears used, the top three sample countries (Table 2) were not pooled, but instead a breakdown was assigned based on the countries or areas most similar in fisheries development and taxa caught. For example, for the North American region artisanal gear breakdowns from Mexico were assumed to be most similar for countries in Central America, while Cuba was assumed to best represent small-scale gear use in the wider Caribbean island countries. Gear information from the Alaskan Arctic EEZ and the Canadian Arctic were used for Greenland and data from the Canadian Atlantic EEZ was used for St Pierre and Miquelon. For the Oceania region, New Zealand data were assumed to most closely resemble the situation in Australia where artisanal gear information was not available, while all other EEZs within the region were assumed to be represented most closely by a pooled breakdown from Papua New Guinea and Tonga. For further details on the small-scale catch-by-gear assignments within these regions, see Supplemental methods (S1).

2.4. Landed values

While the catch data used for fishing gear assignment in the present study were based on the global reconstructed catch database of the *Sea Around Us* (Pauly and Zeller, 2016b), we expanded our synthesis of gear type use to incorporate the landed value of these catches by gear type. To derive landed values, we relied on the global dataset of ex-vessel prices first developed by Sumaila et al. (2007) and updated by Swartz et al. (2013) and Tai et al. (2017). This dataset includes prices for each country, year and taxon present in the *Sea Around Us* catch database

Table 2

Regionally representative fishing countries used for small-scale fishing gear assignment.

Region	Countries	Artisanal catch in region (%)	Key references ^b
Africa	Ghana, Nigeria, Senegal	38.5	Camara (2008); FAO (2007); Heddon (2006); Nunoo et al. (2014)
Asia	Japan, South Korea, Thailand	28.4	Ministry of Agriculture (2016); Anon (2014a); SEAFDEC (2018)
Europe	Denmark, Norway, UK	38.2	Anon (2004); Anon (2005); Anon (2006); Anon (2014b); ICES (2011); ICES (2017)
North America – North/Central	Canada ^a , USA ^a	96.3	Divovich et al. (2015); Doherty et al. (2015); NOAA (2016); Fisheries and Oceans Canada (2018); Pooley (1993)
North America – South Caribbean	Mexico	90.4	Cisneros-Montemayor et al. (2015)
	Cuba	29.4	Joyce (1996)
South America	Brazil, Chile, Venezuela	45.1	Cárdenas et al. (2009); Freire et al. (2015); Subsecretaría de Pesca y Acuicultura (2016)
Oceania – Australia	New Zealand	66.4	King (1986)
Oceania – Others	Papua New Guinea, Tonga	24.2	Tu'avao et al. (1996); Dalzell et al. (1996)

^a Data for North American arctic and subarctic EEZs and the Atlantic coast of Canada were used to assign artisanal gear breakdowns to Greenland and St. Pierre and Miquelon, respectively.

^b Full references for artisanal gears can be found in the Supplementary methods.

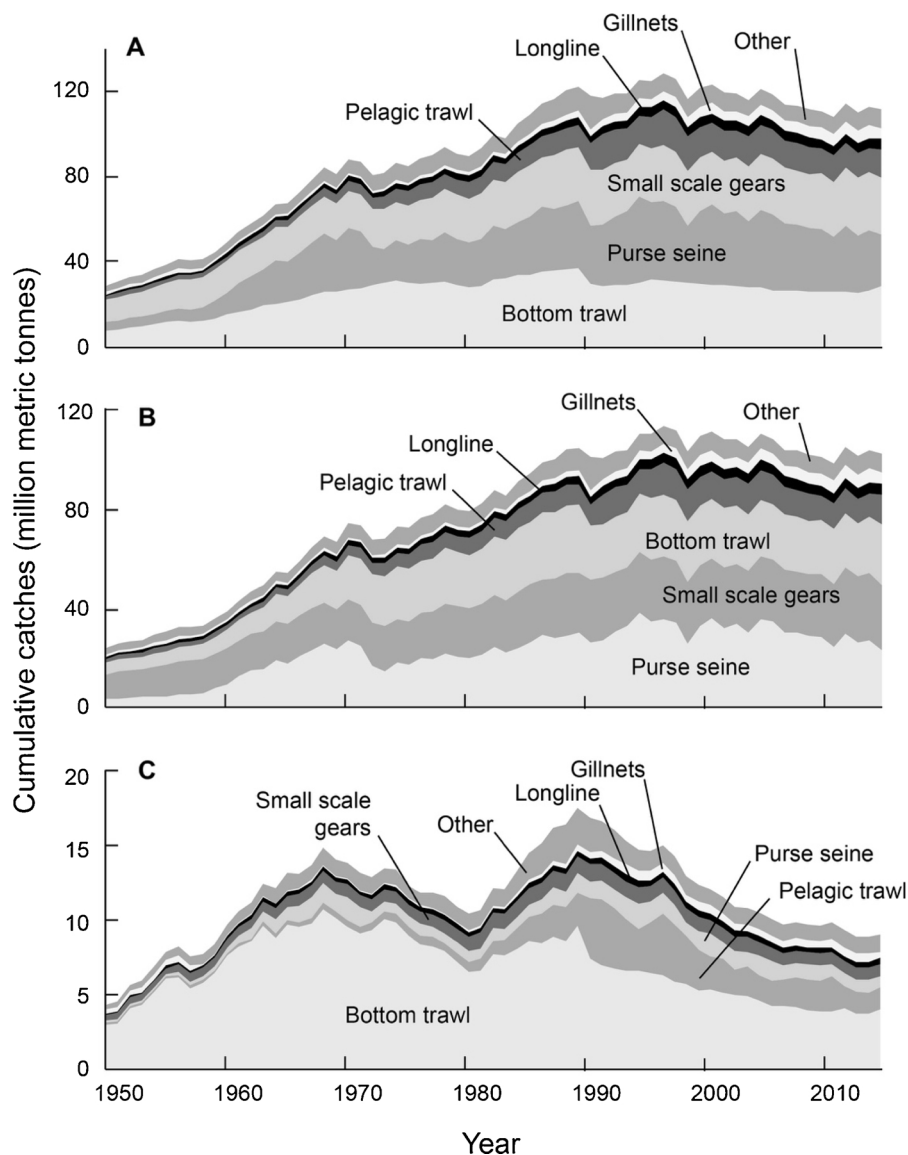


Fig. 1. Cumulative stacked reconstructed global marine fisheries catches by major fishing gear types, for (A) total catches (landings plus discards); (B) landings only; and (C) discards only.

that have been normalized to 2010 real USD through market exchange rates and purchasing power parity between countries. These prices represent the average ex-vessel price for a taxon in a country in a year, and were assumed to be representative of the value of discarded catches in the absence of other ‘shadow prices’ for these ‘goods’ without a market (Cisneros-Montemayor et al., 2018; Drèze and Stern, 1990).

3. Results

Based on the assignment of globally reconstructed fisheries catches to the gear types considered here, industrial bottom trawl and purse seine gears, jointly with small-scale gears accounted for over 75% of total global catch from 1950 to 2014 (Fig. 1A). Most general gear categories maintained their relative share of total fisheries catches over time when the 1950s were compared to the last 5 years (2010–2014). However, the relative distribution of gear types differed when considering landed catches only (i.e., excluding discards), as landings were dominated by purse seine gears (28%), followed by small-scale gears (25%), with bottom trawling accounting for less, with 23% (Fig. 1B). While accounting for only around 23% of fisheries landings, bottom trawls (including shrimp trawls) accounted for nearly 60% of fisheries

discards (Fig. 1C). Thus, bottom trawling disproportionately contributes to discarding. Purse seines, on the other hand, displayed the opposite, being responsible for nearly 29% of landings but only 8% of discards (Fig. 1B, C).

Changes in observed gear use over time are driven by the expansion of fisheries and fluctuating landings. For instance, single species fisheries that dominate with high tonnages, such as the *Peruvian anchoveta* fisheries, may drive the global pattern in single gear use (here purse seine, Fig. 1B), due to their high inter-annual variation in catches.

Discrepancies between gear types in terms of landings versus discards become even more distinct when one considers the landed value of the catch (Fig. 2). While purse seines account for 29% of global landings (Fig. 1B), they only account for 15% of global landed value (Fig. 2A, B). Bottom trawls on the other hand dominate total catch in terms of value (Fig. 2A), but small-scale gears clearly provide higher landed value of the actual landed catch (Fig. 2B). Thus, the unrealized high value of discarded catch by bottom trawls (Fig. 2C) demonstrates formerly unquantified losses associated with this gear type. Pelagic trawls, which often catch lower-value species, now account for nearly 12% of global catches (Fig. 1A), but less than 6% of total value of catches in 2014 (Fig. 2A).

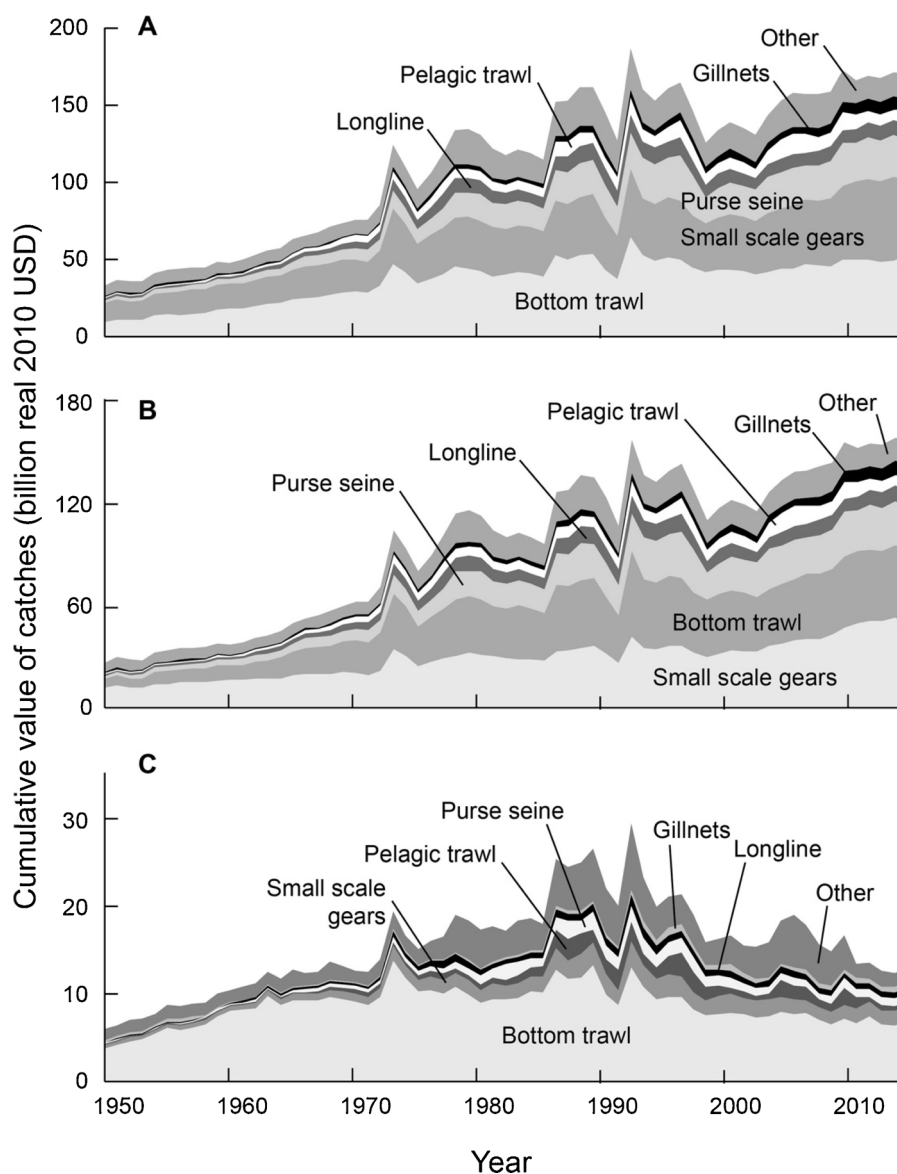


Fig. 2. Cumulative stacked landed value of reconstructed global marine fisheries catches by major fishing gear types, for (A) total catches (landings plus discards); (B) landings only; and (C) discards only.

The small-scale fisheries sector, which accounts for nearly 23% of total catch (landings plus discards, Fig. 1A) and 27% of total landed value (Fig. 2A) over the 1950–2014 period, displayed a more diverse spread of major gear types being used. Gillnets, line gear, encircling nets, and pots and traps make up the majority of catches, accounting for over 70% of global total small-scale catches in 2014 (Fig. 3A). Of interest is a noticeable change in gear use over time in small-scale fisheries, with encircling nets having been a major contributor in the 1980s and early 1990s, but declined in importance thereafter, while more recently various pots and traps accounted for a larger share of small-scale catches (Fig. 3A). With regards to the landed value of small-scale catches, three gear types account for the majority (64%) of landed value from small-scale fisheries (Fig. 3B), i.e., gillnets, various line gears and pots and traps. Interestingly, ‘hand and tools’ also account for a substantial portion of landed value (11% in 2014). Likely the importance of pots/traps and ‘hand and tools’ in landed value is due to high-value invertebrates (especially crustaceans) being targeted using such gears.

4. Discussion

Previous studies have alluded to the contribution of different gear types to catches and discards (e.g., Kelleher, 2005). In addition, many studies have pointed to the various indirect impacts associated with different fishing gears, ranging from the effects of bottom trawling on the seafloor (Jones, 1992; Watling and Norse, 1998), to the incidental catch (i.e., by-catch) in longlines and gillnets of non-target fish, sea-birds, and marine mammals (Hall et al., 2000), and to the general considerations of discarding (Zeller et al., 2018). With the completion of the harmonized catch-by-gear type assignment undertaken here for the global reconstructed catch data of the *Sea Around Us* (Pauly and Zeller, 2016a, 2016b), we can now provide a global overview and synthesis of the use of different fishing gears over time and by fisheries sectors to examine the extent of such impacts.

We have clearly illustrated the differing contributions of various gear types in terms of landings, discards, and landed value. While bottom trawling contributes most to total catches, this is partially attributed to the substantial amounts of discards they account for, which is also reflected in the high landed value of discarded bottom trawl

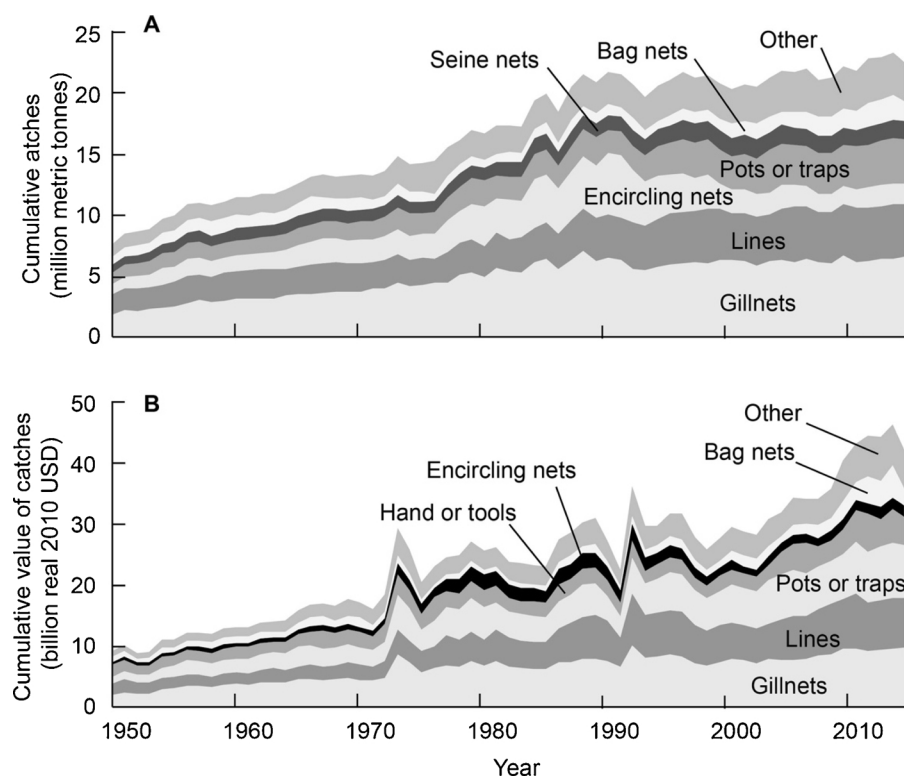


Fig. 3. Cumulative stacked reconstructed global marine fisheries catches major fishing gear types for the small-scale sector, for (A) total catches; and (B) landed value.

catches, a wasteful practice that represent a massive unrealized value (see also Zeller et al., 2018) and production forgone for both fish stocks and fishing fleets (Jensen et al., 1988). Purse seine fisheries on the other hand, while also contributing massively to global landings, have considerably fewer discards. Pelagic trawls and purse seines often catch lower value species, including substantial catches for non-human consumption (Cashion et al., 2017), and this is reflected here in the higher proportions of catches as measured in tonnage compared to their contribution to the value of catches. Conversely, certain gear types contribute disproportionately more to landed value than they do to catches. For example, in the small-scale sector, high-value species (mainly crustaceans and other invertebrates) are often targeted by pots/traps and hand/tools.

The discards generated by these fisheries were likely less economically valuable than the landed catch due to species, size, or quality of the fish. Part of a fisher's catch is discarded, as it is economically beneficial to the individual fisher in the short term to discard: i) less valuable catch, or ii) catch for which they do not have a quota (Turner, 1997). These discards provide energy for opportunistic feeders in pelagic and demersal ecosystems passing this energy to higher trophic levels. However, such artificial ecosystem feed supplements are likely to benefit only a few groups of species, such as gulls (family Laridae), which are one of the few seabird families not showing declining population patterns (Paleczny et al., 2015; Washburn et al., 2016). In general, the costs and benefits of discarding are borne by different actors (i.e., the discarded species versus their consumers and fishers; see chapter 4 of Kelleher (2005) for a discussion of costs and benefits to different actors).

Fishing gear is often used to differentiate and manage fisheries at the national level. Industrial fisheries, and more specifically, those gears believed to be most harmful are often banned in protected areas (Chuenpagdee et al., 2003), such as bottom trawls being banned in Belize's waters (Ramos, 2010). While these gear bans can occur at a very fine resolution spatial scale, the catches and value produced at a national level can be used to analyze and inform policies that affect the

fisheries sector. The data presented herein is an improvement over previously available data and can be used evaluate the costs and benefits of fisheries at national and global scales.

To a casual reader, the results presented here do not seem to greatly differ from the earlier catch-by-gear data derived by the *Sea Around Us* (Watson et al., 2006b). However, the data presented here differ fundamentally from the earlier work in two substantial ways: we now account in great details for (1) country-by-country specific unreported landings and discards (Pauly and Zeller, 2016a, 2016b), i.e., we account for total removals from marine ecosystems by gear over time; and (2) the four major fishing sectors (industrial, artisanal, subsistence and recreational; Zeller et al., 2016) that differentiate global fisheries. This allows us, for the first time to describe and examine gear-use by the various fisheries sectors across time, taxon, fishing country and space.

Using complementary work of the *Sea Around Us* on ex-vessel prices (Sumaila et al., 2007; Swartz et al., 2013; Tai et al., 2017), we can also estimate the unrealized shadow value (Cisneros-Montemayor et al., 2018; Drèze and Stern, 1990) of discarding for global fisheries by gear categories and fishing sector. Through this, we are able to not only document the amount of fish discarded by different gear types, but the potential lost economic value of these discards by gear type. Notably, the unrealized economic value of discards from bottom trawling from 1950 to 2014 exceeds the value of all catches from longline fisheries (\$560 billion and \$432 billion, respectively). Such global-level analyses of fisheries catches and landed values by gear-type improves the resolution of lost value from fisheries discards, and enhances our understanding of the contribution of different gear types.

The small-scale fisheries sectors, although highly diverse, widespread and of crucial food security importance (Chuenpagdee 2011; Golden et al., 2016), are generally more poorly understood in terms of catch-by-gear and gear-type use over time and space than the industrial sector, despite contributing to nearly a quarter of total fisheries catches worldwide (Pauly and Zeller, 2016a). Particularly, it is challenging to create a comprehensive quantitative picture of the use of gears by these fisheries, especially in developing countries where such information

may be sparse or nonexistent. We were able to assign all globally reconstructed small-scale catches to a large (although not complete or exhaustive) list of small-scale gears used around the world, by country and taxon over time. We achieved this through a country-to-region-substitution approach in which we derived small-scale gear information and catch-by-gear breakdown for representative countries (selected for their high contribution to total small-scale catches in each region) within each of nine geographic regions around the world. While there are obvious limitations in using such a substitution approach, as patterns of gear use in small-scale fisheries can vary between neighboring countries, it permitted a first-order differentiation of catch-by-gear for all small-scale fisheries around the world for the first time based on the comprehensive, reconstructed small-scale fisheries catches (Pauly and Zeller, 2016a). We hope and anticipate that further research and studies will deepen and expand the coverage of catch-by-gear for small-scale fisheries in various countries, which will allow us to improve these gear assignments in the future.

The large-scale and small-scale data presented herein were assembled from a large diversity of sources and attempts to best reflect the gears used in different fisheries over time. However, the results are limited by the available information initially recorded which means there is still a great diversity of data quality between countries. These data can and will continue to be improved over time through periodic reviews, and through further collaborations from these countries.

Finally, improving the *Sea Around Us* gear data presented here can lead to improvements in the spatial allocation of catch data (Palomares et al., 2016; Zeller et al., 2016), as some fishing gears are only used in certain areas based on depth, area and gear restrictions. This is already being put into practice for the *Sea Around Us* large pelagic data by restricting countries fishing areas to where the gear is used by any other country using the same gear. Through progressive refinement this can be integrated into the spatial allocation process of the *Sea Around Us* to refine the spatial representation of global fisheries catches.

5. Conclusion

We assigned fishing gear categories to all reconstructed catches (by fishing sector) of the *Sea Around Us*, thereby revising and correcting earlier catch-by-gear data approaches of the *Sea Around Us*. Bottom trawl gears account for a large portion of discard catch and value over these 65 years, whereas purse seine gears deliver a large portion of global landings with relatively little discards. Small-scale gears as a group account for a large portion of landings and generate substantial value. This catch-by-gear database explicitly matches reconstructed catches to gears by fishing sector, and improves our understanding of which particular fishing gears are responsible for the benefits and costs associated with global fisheries. This improved database can be used for future studies of fishing gear impacts at the global level.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <https://doi.org/10.1016/j.fishres.2018.04.010>.

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