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Section 2

Reconstructing catches of large pelagic fishes[2]

Frédéric Le Manach, Andrés M. Cisneros-Montemayor, Dirk Zeller and Daniel Pauly

Despite tuna fisheries being among the most valuable in the world (FAO 2012), as well as the considerable interest by civil society in the management of large pelagics, there are, to date, no global and comprehensive spatial datasets presenting the historical industrial catches of these species.

Here, we present the methods used to produce a first comprehensive spatial set of large pelagics fisheries catch data.[3] To achieve this, we assembled various existing tuna datasets (Table 1), and harmonized them using a rule-based approach.

[2] Adapted from: Le Manach, F, Chavance, P, Cisneros-Montemayor, AM, Lindop, A, Padilla, A, Zeller, D, Schiller, L and Pauly, D. 2015. Global catches of large pelagic fishes, with emphasis on the High Seas, *In:* Pauly D and Zeller D (eds.) *Global Atlas of Marine Fisheries: Ecosystem Impacts and Analysis*. Island Press, Washington, D.C.

For each ocean, the nominal catch data were spatialized according to reported proportions in the spatial data. For example, if France reported 100 tonnes of yellowfin tuna in 1983 using longlines in the nominal dataset, but there were 85 tonnes of yellowfin tuna reported spatially in 1983 by France using longlines, in four separate statistical cells (potentially of varying spatial size), the nominal 100 tonnes for France were split up into those four spatial cells according to their reported proportion of total catch in the spatial dataset. This matching of the nominal and spatial records was done over a series of successive refinements, with the first being the best-case scenario, in which there were matching records for year, country, gear and species. The last refinement was the worst-case scenario, in which there were no matching records except for the year of catch. For example, if France reported 100 tonnes of yellowfin tuna caught in 1983 using longlines, but there were no spatial records for any country catching yellowfin tuna in 1983, the nominal 100 tonnes for France were split up into spatial cells according to their reported proportion of total catch of any species and gear in 1983. After each successive refinement, the matched and non-matched records were stored separately, so that at each new refinement, only the previous step's non-matched records were used. The matched database was added to at the end of each step. The end result was a catch baseline database containing all matched and spatialized catch records, which sum up to the original nominal catch.

Table 1. Overview of the various data sources used for the creation of global catch maps of industrially caught tuna and other large pelagic fishes.

Ocean	RFMO	Sources		Spatial resolution	Countries/gear /species
		Nominal catch	Spatialized catch		
Atlantic	ICCAT	ICCAT website	ICCAT website	1°x1°, 5°x5°, 5°x10°, 10°x10°, 10°x20°, 20°x20°	114/48/142
Indian	IOTC	IOTC website	IOTC website	1°x1°, 5°x5°, 10°x10°, 10°x20°, 20°x20°	57/35/45
Eastern Pacific.	IATTC	IATTC website	FAO Atlas of Tuna and Billfishes	5°x5° [c]	28/11/19
Western Pacific	WCPFC	WCPFC website	WCPFC website	5°x5°	41/9/9
Southern	CCSBT	Via CCSBT staff	CCSBT website	5°x5°	11/8/1

The catches thus assigned to the various sized tuna-cells (1° x 1° to 20° x 20°; Table 1) were then spatially allocated to the standard 0.5° x 0.5° degree cells used by the *Sea Around Us* following the procedure described in Section #4. All artisanal catches (i.e., any gear other than industrial scale longlines, purse-seines, and pole-and-lines,[4] as well as 'offshore gillnets') were reallocated to the EEZs of origin of the fleet, as the *Sea Around Us* defines artisanal fleets as being restricted to domestic areas (Section #1). Here, only the industrial catches are presented.

Finally, a review of the literature was performed for each ocean to collect estimates of discards. Due to the limited amount of country- and fleet-specific data that this search yielded, it was

[3] The Food and Agriculture Organization of the United Nations (FAO) has published a global, harmonized atlas, but it includes only the catch of 12 species of tuna and billfishes (i.e., albacore, Atlantic bluefin tuna, Atlantic white marlin, bigeye tuna, black marlin, blue marlin, Pacific bluefin tuna, skipjack tuna, southern bluefin tuna, striped marlin, swordfish, and yellowfin tuna; FAO 2013). This atlas is available at: www.fao.org/figis/geoserver/tunaatlas. For reasons of confidentiality of commercial interests, this dataset entirely lacks longline data for the eastern Pacific area after 1962, managed by the IATTC, although some data for the earlier time-period have been published in aggregated form (Fonteneau 1997). A recent resolution on confidentiality rules may however mean that these spatialized data may become publicly available at some point (IATTC 2013). Fonteneau (1997) has also published a global atlas, but did not estimate discards, nor scaled the spatialized data up to 100% of the nominal catch. Updates were published later, but at regional scales and without the Pacific Ocean (Fonteneau 2009, 2010).

[4] Except when labeled 'non-mechanized', 'coastal', 'small' or such that non-industrial fishing can be inferred.

decided that discard percentages should be averaged across the entire time-period and applied to the region of origin of the fleet (e.g., East Asia or Western Europe), rather than the actual country of origin of the fleet. Similarly to the spatialization step described above, successive refinements were then performed to add discards to all reported catch.

Our approach introduces the first harmonized and spatially complete database of global large pelagic fisheries catches, including an estimate of discards. Until now, only regional (RFMO) or globally incomplete (e.g., the FAO Atlas of Tuna and Billfish Catches) databases existed, thus providing a truncated picture of these highly interconnected and global fisheries. The approach sued here, while preliminary in nature, represents the concept and rationale of catch reconstruction as applied to the global large tuna and billfish fisheries. Here, we mention several points that can be improved upon in future iterations:

- The IATTC (Inter-American Tropical Tuna Commission) posed some data problems by not yet releasing the spatialized catches for all gears. We hope that spatialized IATTC data will become available in the future, which will then improve mapping of tuna catches in the northeast Pacific;
- The ICCAT nominal catch database contains some qualitative geographic information (i.e., 'sub-areas'), which are apparently not geographically defined. Thus, we could not use them to refine our coarse spatialization. If these sub-areas were to become geographically defined, it would allow for improved spatial assignment of catches;
- Discard rates used here only account for a subset of the literature, and difficulties exist in harmonizing them. Feedback from worldwide experts could allow us to refine these rates, by integrating a rule-based approach by gear and country to our discard estimation; and
- Finally, other global databases such as www.fishbase.org can be used to refine our spatial distribution of the catch by, e.g., restricting species to certain areas of high and consistent occurrence.

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Section 3