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AN UPDATED CATCH RECONSTRUCTION OF THE MARINE FISHERIES OF TAIWAN FROM 1950-2010

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ABSTRACT

The present paper is both an update and revision of the catch reconstruction by Kuo and Booth (2011) for the marine fisheries of Taiwan. Total reconstructed catch within FAO Area 61 by Taiwan (excluding large pelagics) was 55% higher than the 23.2 million tonnes of catch FAO reported on behalf of Taiwan from 1950-2010. The difference of 12.8 million t between the two time series is predominantly composed of unreported commercial landings (63.8%), followed by discards (26.5%), subsistence catch (9.5%), and recreational catch (0.2%). A similar relationship is evident between Taiwanese reconstructed catch within the EEZ, which is 65% of the total FAO Area 61 catch, and approximately 57% higher than the portion of catch reported by the FAO on behalf of Taiwan which was deemed to be taken within the EEZ.

INTRODUCTION

Taiwan, Republic of China (ROC), is located in the South China Sea, with neighboring countries of China, Japan, and the Philippines to the west, east, and south, respectively (Figure 1). After WWII, the ROC faced food shortages, a growing population, and simultaneously exploitation in the coastal fisheries within 12 nm from shore, leading the Taiwanese government to heavily fund and subsidize the growth of distant water fishing fleets (Kuo and Booth 2011). This trend is captured in the catch reconstruction of marine fisheries by Kuo and Booth (2011) which estimates total marine fishery removals by Taiwan from its Exclusive Economic Zone (EEZ), i.e., waters 200 nm from shore, and outside its EEZ by distant water fisheries (DWF). The present paper is both an update and revision of the catch reconstruction by Kuo and Booth (2011) for the marine fisheries of Taiwan. The primary work includes catch estimates from 1950-2007, while the present paper adds data for the years 2008-2010. Furthermore, the present paper makes revisions and updates in the methodology of its predecessor, most notably adding estimates of recreational and subsistence fisheries to the study, although revisions in other sectors are also presented.

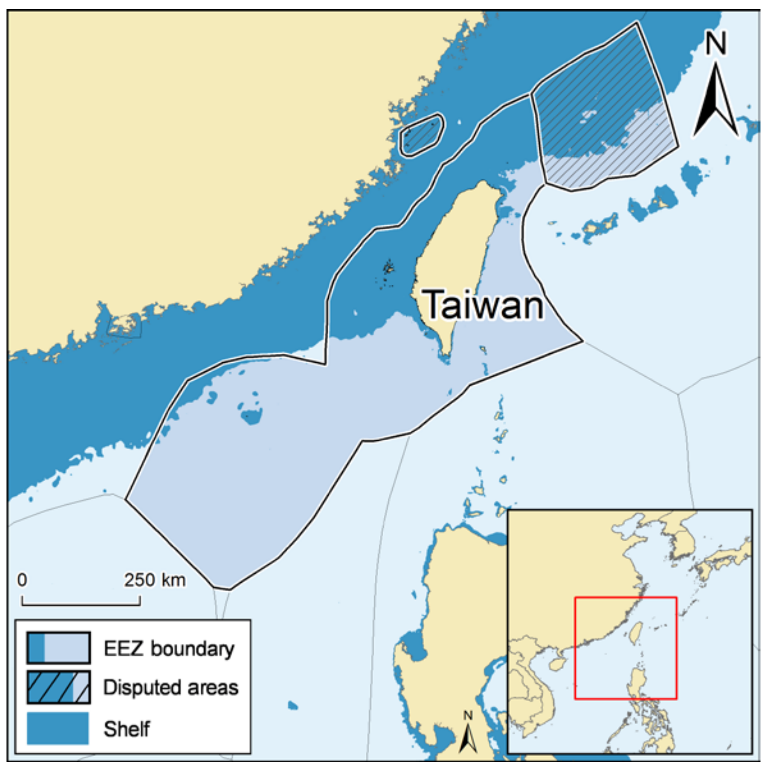

Figure 1: Map of Taiwan with its Exclusive Economic Zone (EEZ).

METHODS

Kuo and Booth (2011) utilized national landing statistics by area and gear from 1959 to 2007, accessible through Taiwan's Fisheries Agency (FA; www.fa.gov.tw). These data were composed of catches from three different fisheries: 'coastal', artisanal fisheries which operate up to 12 nm from shore; 'offshore', industrial fisheries operating within Taiwan's EEZ; and 'far seas' fisheries, also known as the industrial DWF operating outside the EEZ of Taiwan.

For the present paper, our aim was to extend the reported catch up to 2010, as well as reconcile national data with the annual landings statistics of the Food and Agriculture Organization of the United Nations (FAO), which reports, on behalf of Taiwan, marine capture data by FAO Area from 1950-present. Taiwan is primarily located in FAO Area 61, although a small portion of its southern waters are located in FAO Area 71. The latter is also a region with a high occurrence of maritime boundary disputes between many of the East Asian countries of the region (i.e., South China Sea). Hence, this report aims to reconstruct catch only within FAO Area 61, as well as differentiate between catch inside and outside the EEZ of Taiwan.

The three fisheries presented in national data, i.e., coastal, offshore, and far seas, were instrumental in fulfilling this aim. Coastal and offshore fisheries are both within the EEZ of Taiwan as well as considered to be within FAO Area 61. The far seas fisheries, by contrast, are active outside the EEZ of Taiwan in various regions of the world. Thus, the following simple formula enabled us to determine which portion of the 'far seas' data for Taiwanese fleets was within FAO Area 61:

$$'Far\ seas'\ catch_{FAO\ Area\ 61} = Total\ catch_{FAO\ Area\ 61} - \ 'Coastal'\ catch_{FAO\ Area\ 61} - 'Offshore'\ catch_{FAO\ Area\ 61}$$

The above formula was applied for all years where there were national data available (1959–2010). For the time period 1950-1958, we accepted the magnitude of FAO landings as the reported baseline and split the catch into coastal, offshore, and far seas catch using the proportions of national data from 1959. Lastly, we excluded industrial catches of tuna and tuna-like species from the analysis, as these fisheries were reconstructed separately (Le Manach *et al.*, in prep).

Unreported landings

Unreported catches within the commercial fisheries of Taiwan were calculated as in Kuo and Booth (2011), which utilized a second national data source on the Taiwanese food balance to indicate discrepancies between the food balance data and catch data of both the FAO and national data. These discrepancies were assumed to represent unreported commercial catches, a summary of which can be found in Figure 4 of Kuo and Booth (2011). We assumed that the unreported catch rate in 2007 remained constant until 2010. The unreported rates were applied to the reported landings of the three fleets in FAO Area 61 (coastal, offshore, far seas). Kuo and Booth (2011) assumed that "the unreported catches are proportional to the spatially reported landings," except for a species category of 'sharks, rays, skate, etc., nei', where adjustments were made. The present report did not make the adjustments for this taxonomic category as our predecessor had, due to lack of tangible evidence that it was improperly distributed.

Kuo and Booth (2011) indicated that there are additional unreported catches of whale sharks, as this offshore (industrial) fishery is unregulated and its catch are not sold through the common market, rather the black market. As in the original paper, we added an additional 279 $t \cdot year^{-1}$ of whale shark catches from 1990 to 2000 and 126 $t \cdot year^{-1}$ from 2001 onward, extending this estimate to include all years up to 2010.

Discards

Discards of the Taiwanese commercial fleets were calculated with similar discard rates as in Kuo and Booth (2011), except for a few alterations. First, longline discard rates for pelagic species were excluded, as the present paper does not consider this fishery. Second, in addition to presenting discard rates as a percentage of total catch, we also presented discard rates as a percentage of landings so that we could multiply the appropriate base landings by the discard rate:

$$Discard\ rate\ (\%\ landings) = \frac{Discard\ rate\ (\%\ catch)}{1 - Discard\ rate\ (\%\ catch)}$$

Regarding the original data, the discard rates for the purse seine, demersal trawl, and 'other nets' was identical to the original reconstruction, while the discard rates for shrimp trawl and squid jig were revised due to notably discrepancies. The 97% discard rate for the shrimp trawl cited in Kuo and Booth (2011) was in fact an estimate of the percentage of by-catch discarded for the southwest Pacific region (Clucas 1997), and hence was not an appropriate discard rate. Instead, we utilized data from Lin (1999), who cites the percentage of bycatch caught in 10 fishing harbours of Guangdong province in China, averaging 46.02% of total catch. The Guangdong province is located southwest from Taiwan across the China Sea, and while in a different country, we assumed discard rates of shrimp trawl could be comparable in these regions. Nonetheless, in order to remain conservative, we halved the by-catch rate. Mathematically speaking, it is more accurate to first convert this by-catch rate into a percentage of landings, resulting in a by-catch rate of 85.25% of landings. We halved this rate to obtain a by-catch rate of 42.63% of landings, and then applied the percentage of by-catch discarded (97%) from Clucas (1997) to obtain a total discard rate of 41.35% of landings.

There was also an issue for the squid jig, where the discard rate was cited as 50%, while in the source data the discard date was in fact 0.5% (Kelleher 2005), likely the result of a simple error. The result of these changes can be seen below in a revised summary table of discard rates (Table 1).

Table 1. Summary table of discard rates (both as a proportion of total catch and landings) for various gear types of the Taiwan fisheries fleets.

Year	Gear	Discard rate (of catch)	Discard rate (of landings)	Source
1950-2010	purse seine	0.0400	0.0417	Amande *et al*. (2008) and Anonymous (2003)
1950-2010	shrimp trawl	0.2925	0.4135	Lin (1999) and Clucas (1997)
1950-2010	demersal trawl	0.1230	0.1403	Kelleher (2005)
1950-2010	squid jig	0.0050	0.0050	Kelleher (2005)
1950-2010	other nets	0.0140	0.0142	Kelleher (2005)

We applied these derived discard rates to the targeted species in fishing operations, e.g. small pelagic species by purse seine, shrimp by shrimp trawl, demersal species for the demersal trawl, squid for the squid jig, and other species by other nets (excluding any catch of whale sharks). Furthermore, while all of these gears were used in the industrial sector, only the squid jig and other nets were appropriate for the artisanal sector. Thus, the discard rates were applied to the sum of the reported and unreported landings for each group of target species, resulting in discard amounts.

Regarding the species composition of discards, national data on the species composition of discards exists by sector from 1999 – 2010. The relative percentages were extracted for top species and used from 1999 – 2010. From 1950 – 1998, the species composition from 1999 was utilized. Specifically, for artisanal fisheries, all gears and fisheries were included except 'sport fishing,' which is not commercial in nature. For the offshore fishery we included all gears except discards from the coral fishery and the tuna long line fishery (as fisheries targeting tuna and corals are excluded from this analysis). Finally, we also calculated discards for the far seas fishery operating in FAO Area 61, including all gears except the purse seine for tuna and tuna longline for the reasons previously described.

Subsistence fisheries

Subsistence catch was estimated by calculating the population of Taiwan residing 10 km from the coast (CIESIN 2012), and assuming a per capita catch rate for subsistence fishing. Specifically, we assumed a subsistence catch rate of 1.0 kg·week^{-1} in 1950 and 0.5 kg·week^{-1} in 2010, interpolating between these two values. Furthermore, we assumed that 20% of the catch was 'marine fishes nei', and the remaining catch was composed equally of Bivalvia, Sparidae and Mugilidae.

Recreational fisheries

To estimate catch from recreational fisheries, we utilized data by Cisneros-Montemayor and Sumaila (2010) who estimate a participation rate in recreational fishing of 0.3067% of the population for Eastern Asia. We assumed that the recreational fishery in Taiwan began in 1985, with the participation rate growing from 0% in 1984 to 0.3067% by 1990 and thereafter remaining constant. We applied the participation rate to a time series of Taiwanese population. For the per capita catch rate in the recreational fishery, we made a similar assumption as in Pauly and Le Manach (2014) that each recreational fisher catches 1 kg·month^{-1}, equivalent to 12 kg·year^{-1}.

This per capita catch rate was multiplied by the population time series of recreational fishers to obtain a time series of recreational catch. We assumed 'marine fishes nei' accounted for 50% of the catch, and the remaining 50% were equally split between 10 commonly targeted species in recreational fishing: large yellow croaker (*Larimichthys crocea*), small yellow croaker (*Pseudoscianea polyactis*), yellow drum (*Nibea albiflora*), red seabream (*Pagrosmus major*), red porgy (*Pagrus pagrus*), blackhead seabream (*Acanthopagrus schlegelii*), Japanese seaperch (*Lateolabrax japonicus*), Korean rockfish (*Sebastes schlegelii*), highfin grouper (*Epinephelus maculatus*), and other groupers (Serranidae).

Results and discussion

Total reconstructed catch within FAO Area 61 by Taiwan was 55% higher than the 23.2 million tonnes of catch FAO reported on behalf of Taiwan from 1950-2010. The difference of 12.8 million t between the two time series is predominantly composed of unreported commercial catches (63.8%), followed by discards (26.5%), subsistence catch (9.5%), and recreational catch (0.2%). A similar relationship is seen between Taiwanese reconstructed catch within the EEZ, which is 65% of FAO Area 61 catch, and approximately 57% higher than the portion of catch reported by the FAO on behalf of Taiwan that was deemed to be caught within the EEZ.

Total reconstructed catch for FAO Area 61 began at 107,000 t in 1950, grew to approximately 822,000 t·year^{-1} during the 1970s and 1980s, and then declined in the 2000s averaging 619,000 t·year^{-1} (Figure 2a). Total reconstructed catch within the EEZ depicts a similar trend for the early period with catches increasing from 81,300 t in 1950 to a peak of 637,000 t in 1980; however the decline in catches for the later time period is more marked, with catches declining on average 12,000 t·year^{-1} (Appendix 1). This trend depicts the over-exploitation within Taiwan's EEZ, as well as compensation for low catch rates by fishing outside its EEZ. Total reconstructed catch was predominantly composed of species in the following families (or higher taxonomic classification): Scombridae (mackerels, tunas, and bonitos), Carangidae (jacks and pompanos), shrimps and prawns, Ommastrephidae (arrow squids), Scomberesocidae (sauries), Elasmobranchii (sharks and rays), Sparidae (porgies), Sciaenidae (drums or croakers), and 'others' which represents 67 other families or higher aggregated groups (Figure 2b). Lower catch rates in the later time period are the result of both overexploitation in the world's oceans as well as government initiatives to reduce Taiwan's fishing overcapacity through various programs, including buybacks (Huang and Chuang 2010). Such initiatives have been growing worldwide as governments recognize the environmental repercussions of unbridled expansion.

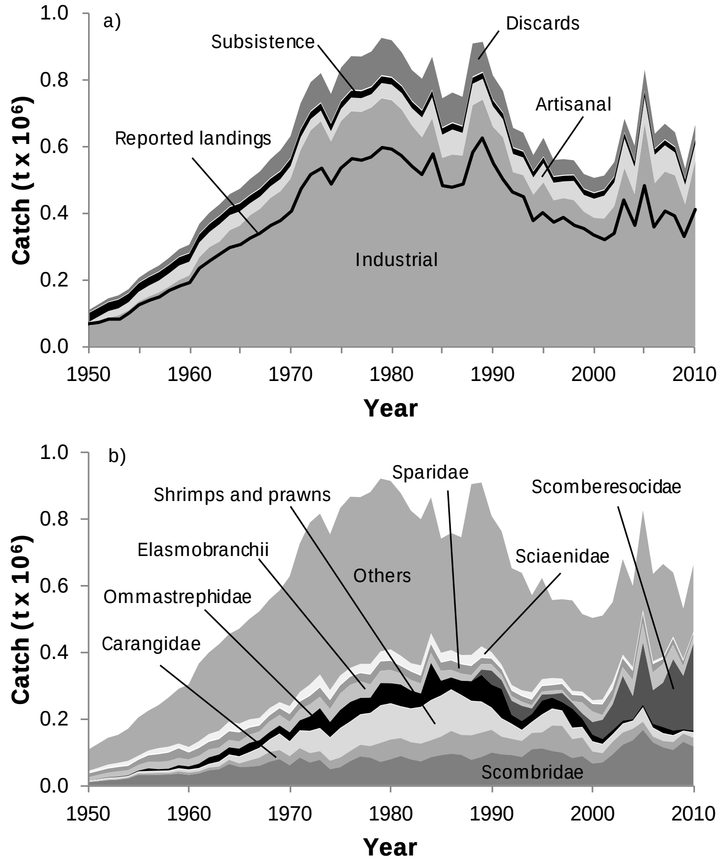

Figure 2. Total reconstructed catch for Taiwan in FAO Area 61 a) by sector, with reported landings for that region overlaid as a line graph (note that recreational catches are too small to be visible), and b) by taxa. 'Others' consists of 67 additional families or higher taxonomic groupings.

ACKNOWLEDGEMENTS

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REFERENCES

CIESIN (2012) National Aggregates of Geospatial Data Collection: Population, Landscape, And Climate Estimates, Version 3 (PLACE III). NASA Socioeconomic Data and Applications Center (SEDAC), Center for International Earth Science Information Network (CIESIN)/Columbia University, Palisades, NY. Available at: http://sedac.ciesin.columbia.edu/data/set/nagdc-population-landscape-climate-estimates-v3 [Accessed: August 2014].

Cisneros-Montemayor AM and Sumaila UR (2010) A global estimate of benefits from ecosystem-based marine recreation: potential impacts and implications for management. Journal of Bioeconomics 12(3): 245-268.

Clucas I (1997) A study of the options for utilization of bycatch and discards from marine capture fisheries. FAO Fisheries Circular No. 928, Food and Agriculture Organization (FAO) of the United Nations, Rome. 59 p.

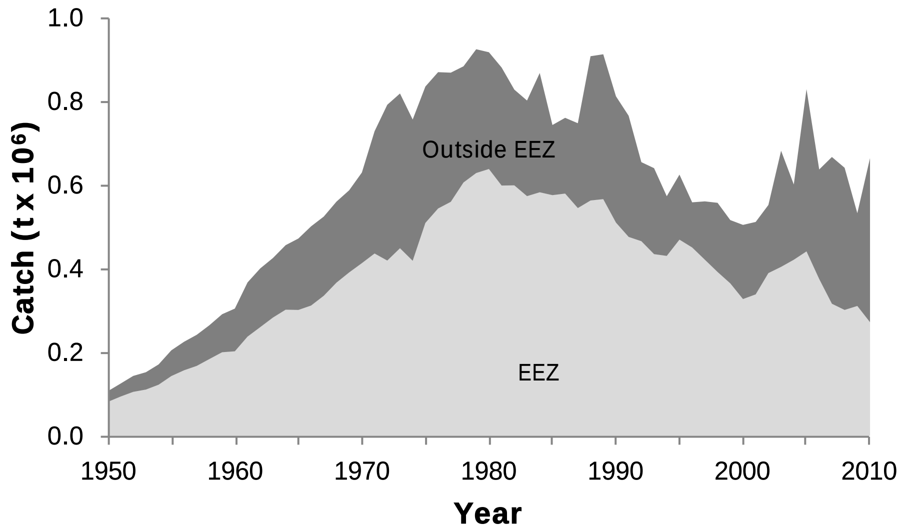
Huang H-W and Chuang C-T (2010) Fishing capacity management in Taiwan: Experiences and prospects. Marine Policy 34(1): 70-76.

Kelleher K (2005) Discards in the world's marine fisheries: an update. FAO Fisheries Technical Paper 470, Food and Agriculture Organization (FAO) of the United Nations, Rome. xix + 131 p.

Kuo D and Booth S (2011) From local to global: A catch reconstruction of Taiwan's fisheries from 1950-2007. pp. 97-106 *In* Harper S and Zeller D (eds.), Fisheries catch reconstructions: Islands, part II. Fisheries Centre Research Reports 19 (4). University of British Columbia, Vancouver (Canada).

Lin Y (1999) A review of the bycatch and its utilization for capture fisheries in the South China Sea. pp. 139-146 *In* Clucas I and Teutscher F (eds.), Report and proceedings of FAO/DFID expert consultation on bycatch utilization in tropical fisheries, Beijing, China, 21-28 September 1998. Natural Resources Institute, Chatham, Uk.

Pauly D and Le Manach F (2014) Tentative adjustments of China’s marine fisheries catch (1950-2010). Fisheries Centre Research Reports, Fisheries Centre, University of British Columbia, Vancouver, Canada.



Appendix Figure A1. Taiwanese catch within FAO Area 61, inside and outside its Exclusive Economic Zone, 1950 – 2010.