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Review

Comment on "Fisheries catch misreporting and its implications: The case of Senegal"

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As scientists involved in fisheries production statistics in Senegal recent decades, we have read the paper "Catch misreporting in Senegal" by D. Belhabib et al., published in Fisheries Research (2014, vol .151 pages 1–11). We agree on the need for good fisheries statistics, but show below that this contribution does not provide an acceptable alternative to the statistics already provided by Senegalese institutions. The initial purpose of the paper was to "present realistic catches by sub-sectors and taxonomic groups" but we show that the methodology used to "reconstruct" catches from 1950 to 2010 does not take into account significant published information on survey design and results, leading to huge overestimates. The catch estimates proposed affect the credibility of both the national Senegalese research institute and the Directorate of Fisheries and, possibly more dangerous, may have negative consequences for fisheries management.

The paper should be considered alongside the 2013 working paper by Belhabib et al. in which the data and assumptions leading to the computation of a large part of the catch estimates are shown. The analysis presented here thus considers both papers (Belhabib et al., 2013,2014).

Several fisheries sectors are considered. The results for the most important ones—small scale fisheries and industrial fisheries—are not coherent for the reasons set out below.

1. Small scale fisheries

Reconstructed estimates given by Belhabib et al. are erroneous because they are based on several false assumptions and

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methodological choices as regards the way in which past estimates were calculated.

Landings estimates by the CRODT are not based on monthly catch effort surveys but on daily surveys at eight landing sites (and not five as said in the paper), even if the results may be published monthly (or fortnightly). Fishing trip samples are selected every working day to provide the mean catch per trip per species and gear. Fishing effort (numbers of trips per gear) is recorded daily to obtain an extrapolation base per fortnight and gear in each of the eight landing sites. This survey design was clearly described in several papers (e.g. Pechart, 1982a,b) that are not fully used or that are not quoted by Belhabib et al. They miss the essential characteristic of the survey design which is stratified (by gear) to enable the results for the main types of gear (purse seines and gill-nets, for example) to be considered separately.

Belhabib et al. reconstruct catches by applying their own extrapolation factors to published data. These extrapolations are supposed to correct effort values published by the CRODT that were considered by the authors to be grossly underestimated ("*The results showed substantial under-reporting, ranging from 4 times higher than the official data in the past to about 1.6 times recently*"). They thus consider that fishing effort was equivalent to the number of pirogues registered. This is not correct as the efforts estimates by the CRODT for each region are in fact based on the number of daily trips per gear at monitored landing sites. Census data on operational pirogues are then used to estimate catches in the remaining (secondary) landing sites in each region, assuming that the fishing units in the secondary sites and in the monitored sites have similar results. Depending on gear and region, the numbers of fishing units in monitored sites represent 80–100% of the total small-scale fleet. Finally, the catches in the remaining non-monitored regions (Louga, Saloum and Casamance) were taken into account using estimates provided by the Direction des Pêches Maritimes (see below).

The extrapolation factors proposed by Belhabib et al. are thus constructed from different fishing effort definitions and estimates to those used in the estimation procedure by the CRODT! Furthermore, they are based on four (4) census data for 2005 and 2010 combined with certain erroneous considerations with regard to the procedures applied since 1950:

> "Thereafter, to re-assess artisanal catches, we calculated the average gap between the effort used for extrapolation and the surveyed effort for 2010 (8,672 pirogues compared to 17,500) and 2005 (9,509 pirogues compared to 12,619), i.e., 67%. We assumed catches were under-reported by 67% in the 2000s, and by doubling this estimate for 1982 (to 134%), before the extension of CRODT coverage. For the 1950-1972 time period, we again doubled the previous estimate (to 269%), before the DPM extended its coverage. This approach assumes that before the DPM extended its coverage in 1972, catch data were heavily under-estimated, the under-estimation declined with the increasing coverage by first DPM (1972-1982) and then by CRODT (1982-2000). We interpolated these percentages (correction factors) to fill in the gaps, and then applied the completed time series of correction factors to the reported artisanal landings" (Belhabib et al., 2013).

Belhabib et al. affirm that CRODT data are available until 1999 only. In fact these data are up to date in the CRODT database and statistics are published in the "Archives Scientifiques" available at the CRODT library and at certain other public institutions (CRODT, 2011; Thiao et al., 2012).

Belhabib et al. are also not correct when presenting the data collection methodology of the Direction des Pêches Maritimes (DPM). Data on small scale fisheries are not collected from the distribution of fuel purchase vouchers but are based on administrative registration of fish dispatches by fishmongers from landing centers ("certificats d'origine et de salubrité"). Even if this method may have some flaws, it should be described correctly by the authors.

It is also inaccurate to write that the "Cellule d'Etude et Planification (CEP)" gathers the data from the other institutions, corrects its and sends it to FAO. The CEP compiles some basic data provided by the other institutions in order to publish a local quarterly bulletin (entitled "Note de conjoncture") on certain named species.

2. Industrial fisheries

2.1. Tuna fisheries

Senegalese industrial tuna fisheries are not specifically discussed in Belhabib et al. (2014) but their estimated catches are included in the industrial catches in the Senegal area. These estimated catches are presented in the 2013 paper (Table 5, Belhabib et al., 2013). They are based on an estimate of the number of Senegalese seiners, mean CPUE and activity level in the Senegal area. According to these estimates, an average of 13 Senegalese seiners operated from 1961 to 2010 with an average catch of 30,000 tons. In fact, efforts and catches of Senegalese tuna vessels (seiners but also tuna bait boats that are never mentioned by Belhabib et al.) have been monitored in detail by scientists since the first year of activity (i.e. in 1969 and not 1961 as indicated by Belhabib et al., 2013, Table 5). These data have been sent to ICCAT each year since 1969. Belhabib et al. (2013,2014) did not use these data and thus provide highly overestimated volumes of catches: the average number of Senegalese tuna seiners during the period 1960–2010 was 2.5 (and not 13) and mean catch per year of Senegalese tuna vessels (all gears, all areas, often outside the Senegalese ZEE) was only 3000 tons per year, that is about a tenth of the figure (29,000 tons) given by Belhabib et al. in their papers.

2.2. Demersal fisheries

2.2.1. Industrial national fishery

Here again, the data and estimates provided (Table 5 of Belhabib et al., 2013) are not coherent with existing data in terms of the number of vessels. This could have been avoided with at least some reference to available national databases and documents. There is also a methodological error regarding the use of the classic formula (number of vessels × GRT × number of days × CPUE) to estimate total catches. This method may be used for homogenous fleets of similar vessels (in terms of targeted species and fishing gear). But here the authors use the same CPUE (catch per GRT and per day) for all vessels belonging to different fleets (demersal trawlers, small pelagic seiners, tuna seiners). Neglecting such differences between the CPUE of the different fleets leads to unreliable estimates with huge estimation variances. Here again, the authors did not use the work done at the CRODT on taking into account these differences between the various fleets operating in Senegal. Hence, the results given by Belhabib et al. cannot make any improvement here and the final estimate of a 5-million ton catch from 1950 to 2010 is totally unrealistic.

2.2.2. Legal foreign fishery

The same methodological error is made here (except for Russian pelagic trawlers from 1992 to 1999) as Belhabib et al. do not make a distinction between fish trawlers, shrimp trawlers and tuna seiners and apply the same estimated catch per unit of effort to all types of industrial boats. This is not logical. The data presented in Table 6 of the Working Paper (Belhabib et al., 2013) do not show the huge catch volumes (several hundred thousand tons) announced in paragraph 3.1.4 of the article (2014) published in Fisheries Research.

2.2.3. Illegal fisheries

Illegal catches are particularly difficult to estimate and any attempt has to be carefully considered. In these papers illegal catches are estimated from a *linebase illegal catch* whose estimation method is not clearly explained and extrapolation is performed by using the number of infractions proposed by Kelleher (2002) and Johnstone (1996). An implicit, undiscussed assumption of proportionality between illegal catches and the number of infractions was used.

2.3. Regarding discards

Regarding discards, most of the references used by Belhabib et al. concern the shrimp trawl fishery whose discards are always much greater than for trawlers targeting finfish. But in Senegal the number of finfish trawlers has always been larger than the number of shrimp trawlers. The proposed discards estimate is thus highly overestimated. The observed decrease in discards is explained mainly by the development of new markets for species formerly discarded (*Trichiurus* sp., *Cymbium* sp., etc.).

The authors highlight a correlation between a decrease in foreign legal landings and an increase in illegal catches. The decrease in the legal foreign catch is real and explained (1) by the choice of national authorities to give preferential access to the national fleet and (2) by the decreasing attractiveness of Senegalese waters for foreign fleets due to the diminishing trend in demersal species yields.

Most of the legal foreign fishery consists of bottom trawlers with limited catch volumes, but high market value targeted species (cephalopods, shrimps). Illegal fishery targets mainly offshore small pelagics with high catch volumes and limited market value. Then even if contrasting trends are observed for legal and illegal foreign fisheries, there is absolutely no clear correlation between them because they do not target the same resources.

In conclusion, we confirm that the reconstruction proposed by Belhabib et al. suffers from the insufficient use of available information. As a result, the conclusions deduced from the reconstruction are based on the wrong premises and do not hold. This raises a question of a deontological nature because such an analysis brings discredit to available studies, causes a worsening of information and decision support capacity and may lead to inadequate management advice.

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