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SOME PRELIMINARY RESULTS ON TUNA DISCARDS AND BYCATCH IN THE FRENCH PURSE SEINE FISHERY OF THE EASTERN ATLANTIC OCEAN

by

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SUMMARY

Estimates of discards and bycatch in the French purse seine fishery of the eastern Atlantic Ocean were derived from observer trips conducted during 2005-2008 within the framework of the European 'Data Collection Regulation' (CE 1639/2001). Results showed that there was almost no tuna discard observed on free schools during this period and that skipjack (*Katsuwonus pelamis*) described by a median size of 37 cm and little tunny (*Euthynnus alleteratus*) composed the bulk of the tuna discards that were essentially made under fishing aggregating devices (FADs). In 2007, the average discard rates of skipjack and yellowfin tunas under FAD were estimated at 42.9 kg and 1.3 kg per ton landed, respectively. Small skipjacks have dominated the “faux poisson” tuna landings in Abidjan since the early 1980s while small yellowfin have contributed to a smaller extent. The importance of the French purse seine fishing fleet on the “faux poisson” market has strongly varied since the 1980s and has decreased from about 30-40% of total “faux poisson” landings in the early 2000s to less than 10% in the recent years. The average rate of “faux poisson” for skipjack and yellowfin landed by the French purse seine fleet was estimated about 150 kg and 15 kg per ton of fish destined to the canneries during 2004-2007, respectively. Data samples on size of “faux poisson” collected at the fishing port of Abidjan showed that there was no significant difference between discard and “faux poisson” size distributions for skipjack, yellowfin, and bigeye tunas. Quantities of juvenile tunas sold as “faux poisson” could then largely exceed observed discard rates, emphasizing the need to improve sampling of “faux poisson” that is currently absent from official statistics and not included in stock assessment models. Besides, a large diversity of marine species was also taken as bycatch in the purse seine fishery, including billfishes, rays, sharks, and a few turtles listed as endangered that were all released alive at sea. The importance of bycatch in weight was generally low but some species such as wahoo (*Acanthocybium solandri*), rainbow runner (*Elagatis bipinnulata*), common dolphinfish (*Coryphaena hippurus*), and silky sharks (*Carcharhinus falciformis*) were often caught under FADs, with an average occurrence per fishing set higher than 30%. For free schools, Atlantic sailfish (*Istiophorus albicans*) was the most frequent species taken as bycatch, with an average rate per fishing set higher than 20%. Only about 3.3% of the bycatch of associated fauna was discarded at sea while the remaining was sold as “faux poisson” in Abidjan. Further work should be conducted to better understand the factors involved in selecting between discarding at sea and retaining fish aboard for local markets.

1. INTRODUCTION

Purse seine fisheries in the Atlantic Ocean mainly target yellowfin (*Thunnus albacares*), skipjack (*Katsuwonus pelamis*), bigeye (*Thunnus obesus*), and albacore (*Thunnus alalunga*) tunas. Several other marine species can be taken as incidental bycatch in tuna purse seine fisheries, i.e. minor tuna species, billfish, other fish, sharks, rays, and turtles. Bycatch as well as major tunas of too small size, damaged or badly preserved can be discarded at sea because they have no commercial value, retained aboard fishing vessels for consumption by the fishing crew, or sold on local fish markets because they are not processed by tuna canneries. In the eastern Atlantic Ocean, a major local fish market has developed in the last decades at the fishing port of Abidjan, Ivory Coast, where bycatch and low value commercial tunas are sold under the category “faux thon” or “faux poisson” for local consumption (Romagny et al. 2000).

Incidental bycatch and associated discarding are difficult to estimate on the basis of log-book information because they are poorly reported by fishing masters and their importance varies according to several interrelated factors (Rochet and Trenkel 2005). The issues raised by bycatch and discarding are however of increasing concern because such practices are responsible for economic loss, juvenile mortality, ecological effects on key species which are relevant to the overall ecosystem structure and functioning, and added threat to endangered or high ethical value species (Pascoe 1997, Garcia et al. 2003). In addition, catches of juvenile tunas that are discarded or sold on local fish markets are generally absent of official statistics whereas they should be included in the ICCAT tasks 1 and 2 and in the catch-at-size database used as inputs of stock assessment models.

The European Union (EU) has recently implemented a multi-year regional sampling program 'Data Collection Regulation' (DCR; CE 1639/2001) for “collecting, managing and using data in the fisheries sector and giving support for scientific advice”. In this framework, the French National Program for tropical tuna includes an observer program for acquiring data on effort strategy, species composition and quantities of bycatch and discard in the purse seine fisheries of the Indian and Atlantic Oceans. Based on observer data available since autumn 2005 through the DCR program, an initial attempt was made here to give estimates of tuna discard and bycatch for the French purse seine tuna fishery of the eastern Atlantic Ocean. The analysis mainly aimed to (i) describe the species composition of catch, bycatch, and discard of major tunas, minor tunas, and associated fauna, (ii) compare size composition between tuna landings for the cannery, “faux poisson” sold on the local market fish, and discards to better understand some of the factors involved in discarding, and (iii) give preliminary estimates of yellowfin and skipjack sold as “faux poisson” in Abidjan to be included in the stock assessments performed for these 2 species at the ICCAT working group of July 2008.

2. MATERIALS AND METHODS

2.1 Data

Observer data. A total of 7 observer trips were conducted between January 2005 and January 2008 aboard French purse seiners, corresponding to a total of 287 fishing days, with 180 observed sets. Although observers generally board large vessels for logistical reasons, the distribution of fishing trips observed was assumed random because vessel size has not been shown as a factor affecting species composition and size of tuna catches (Pallares and Hallier 1997). Through the observer program, about 3,700 t of major tuna catch was retained aboard: 2,030 t being caught using fishing aggregating devices (FAD) that include here both natural and artificial aggregating devices, and 1,670 t made on free schools (FSC). During this period, 156.6 t were discarded at sea, i.e. 152.7 t

and 3.9 t for tuna species and associated fauna, respectively. In 2006, the sampling program covered 3.2% of the total fishing trips made by the French purse seine fishery, representing 5.5% of the French landings of the major tunas. The sampling rate increased to 9.1% of total French purse seine tuna landings in 2007 and should reach the target rate of 10% coverage in 2008.

"Faux poisson" data. Quantities of "faux poisson" landed in Abidjan have been tentatively estimated since the early 1980s based on surveys and counts of pick-up cars conveying fish from the fishing port (Amon Kothias et al. 1994, 1996). There is large uncertainty in estimates of "faux poisson" due the informal character of the market and the difficulties associated with sampling (Romagny et al. 2000, N'Da et al. 2007). Species composition was estimated visually by observers posted at the port of Abidjan at night and day time periods during 1998-1999 and assumed constant in time for extrapolation to the whole time series.

Size data. Datasets on size composition for the period 2006-2007 were available for each major tuna species caught by the European purse seine fishery based on large samples (> 50,000 individuals) of fish measured at landing fishing ports and collected within the DCR framework as part of the ICCAT Task 2 size statistics database (Pianet et al. 2008). Samples of discards and bycatch species were collected aboard fishing vessels during observer trips and measured with a caliper to the nearest cm. The sample size in number of individuals for the discards of skipjack, yellowfin, and bigeye tunas was 5,948, 2,525, and 639 respectively. Since April 2007, a sampling protocol has been implemented at the Abidjan fishing port to measure with a caliper the size of samples of "faux poisson" to the nearest cm. Sample size for skipjack, yellowfin, and bigeye tunas landed as "faux poisson" was 41,736, 7,544, and 3,214, respectively.

2.2 Analyses

Only a stratification based on the fishing mode (FAD vs. FSC) was considered. Seamounts were not considered in the stratification because tuna species composition of the catch under seamounts has been shown to be very similar to sets made under FAD in the Atlantic Ocean (Pallares and Hallier 1997). Fonteneau (1991) has however described the particularity of tuna schools associated with seamounts and some authors have considered seamounts as a specific fishing mode for extrapolation (Gaertner et al. 2002). Regarding the number of fishing sets observed (180), no spatial or temporal stratification was made in the present analysis. The period 2006-2007 was considered to estimate catch, discard and bycatch both for tuna and associated fauna species.

3. RESULTS

3.1 Major and minor tuna species

The geographical distribution of fishing sets observed greatly differed between FADs and FSCs, with high catches of skipjack observed around the equator between 0° and 10°W for sets made under FAD (Fig. 1). Catches on free schools were generally smaller and mainly observed along the equator between 0° and 10°E, with yellowfin composing the bulk of the catch (Fig. 1).

There was no tuna bycatch in 2005-2006 for the 66 fishing sets observed and only about 120 t of tuna was discarded at sea in 2007, corresponding to 3.5% of the total tuna catch landed observed during this year. More than 97% of discards was made after fishing sets performed under FADs and little tunny (*Euthynnus alleteratus*) and skipjack represented 50% and 46% of total tuna discarded, respectively (Table 1). In 2007, the average discard rates of skipjack and yellowfin tunas under FAD were then estimated at 42.9 kg and 1.3 kg per ton landed, respectively. Discarding on free schools

was very low and only observed for frigate tuna (*Auxis thazard*) (Table 1).

3.2 “Faux poisson”

Landings of “faux poisson” showed an increasing trend through time despite high interannual variations (Fig. 2). The flag/country origin of fishing vessels landing “faux poisson” in Abidjan included France, Spain, Ghana, Guinea Conakry, Cape Verde, Dutch Antilles, Guatemala, Panama, Morocco, Venezuela, Belize, El Salvador, and Saint Vincent. Skipjack was the major species landed as “faux poisson” with an annual average of more than 9,500 kg landed by all fishing flags on the local market during 2004-2007 while the total landings in Abidjan for the canneries were about 40,000 t each year during the same period. Landings of “faux poisson” by French purse seiners represented about 30% of total “faux poisson” in the late 1990s, increased to about 40% in the early 2000s and decreased thereafter to about 10-11% in 2005-2006 and to 4.5% in 2007. Hence, the average rate of “faux poisson” in the recent years for the French purse seine fleet was estimated about 154 kg per ton of skipjack landed, i.e. more than 3.5 times the discard rate estimated for FADs from observer trips in 2007. The average rate of “faux poisson” considering all fishing fleets landing “faux poisson” in Abidjan was about 239 kg per ton of skipjack processed in the canneries. For yellowfin, the annual average weight of total “faux poisson” landed was about 1,900 t during 2004-2007 compared to a yearly average of 37,000 t of commercial landings destined to the canneries of Abidjan. The average rates of “faux poisson” were then of about 50 kg and 15 kg per ton of yellowfin landed for the canneries for all fishing fleets and the French fleet, respectively.

3.3 Associated fauna

More than 50 t of associated fauna (excluding minor tunas) was observed through the observer program, including 2 whale sharks (*Rhincodon typus*) of about 10 t each that were released alive from the purse seine. Of the remaining 34 t, about 30 t were retained aboard fishing vessels (mainly for “faux poisson”) and less than 4 t were discarded at sea including turtles and rays. Based on the observed trips, bycatch seemed mainly associated with FAD fishing while fishing on free schools appeared more selective and restricted to a smaller geographical area (Fig. 3).

A large diversity of marine species was taken as bycatch during 2006-2007, i.e. more than 15 fish species, 3 billfish species, 7 species of sharks and rays, and 3 turtle species (Table 2). The major species included wahoo (*Acanthocybium solandri*), rainbow runner (*Elagatis bipinnulata*), common dolphinfish (*Coryphaena hippurus*), Atlantic sailfish (*Istiophorus albicans*), Atlantic blue marlin (*Makaira nigricans*), silky shark (*Carcharhinus falciformis*), smooth hammerhead (*Sphyrna zygaena*), olive ridley (*Lepidochelys olivacea*), and Kemp's ridley sea turtle (*Lepidochelys kempii*) (Fig. 4). Although the weight of these species was generally low, their occurrence in the fishing sets could be high, particularly for wahoo, rainbow runner, and common dolphinfish on FADs with an average occurrence per fishing set larger than 30%, and Atlantic sailfish with an average occurrence higher than 20% of fishing sets made on free schools. In addition, species such as *Carcharhinus falciformis* were often observed in the bycatch. Finally, the 2 species of turtles *Lepidochelys kempii* and *Lepidochelys olivacea* did represent a very low weight in the bycatch but have been listed as endangered on the IUCN red list of threatened species for several years. All turtles caught during observer trips were released alive at sea.

3.4 Comparison in size structure

Discard and “faux poisson” for the 3 major tuna species corresponded to fish generally smaller than observed in the commercial landings (Figs. 5-7). The 90% quantile of size observed for “faux-

poisson" corresponding to fish weighting 1.42 kg, 1.36 kg, and 1.63 kg for skipjack, yellowfin, and bigeye, respectively, i.e. close or lower than the 1.5 kg limit generally considered for processing by the canneries. Kolmogorov-Smirnov tests performed for yellowfin, skipjack, and bigeye tunas showed that there was no significant difference between the size-frequency histograms of discard and "faux poisson" for the 3 species ($p > 0.05$). Size 25%-, 50%- and 75%-quantiles in the discards and "faux poisson" landings of yellowfin were very close (Fig. 5). The median length in the "faux poisson" was 36 cm, corresponding to a weight of about 920 g.

For skipjack, size 25%-, 50%- and 75%-quantiles in the discards and "faux poisson" landings were exactly equal, the median length of skipjack being 37 cm corresponding to a median weight of about 940 g (Fig. 6).

For bigeye, size 25%-, 50%- and 75%-quantiles in the discards and "faux poisson" landings were also very close and the median length in "faux poisson" and discard was 38 cm, corresponding to a body weight of 1 kg (Fig. 7).

4. DISCUSSION

The observer trip data used in the present study have been available from the end of 2005 within the DCR program. The number of fishing sets observed until now remains low to extrapolate discard and bycatch rates at the scale of the fishery therefore our results must be seen as an attempt to give an overview of available data and describe the major features of discard and bycatch in the French purse seine fishery of the eastern Atlantic. Our findings show that there was almost no discard observed on free schools during 2006-2007 while skipjack and little tunny composed the bulk of the discards essentially made under FAD. Quantities of juvenile tunas sold as "faux poisson" in Abidjan were shown to be very important, largely exceeding fish discarded at sea in the case of skipjack. Bycatch of associated fauna excluding minor tunas was low in terms of biomass but showed a large diversity of marine species characterized by a high frequency of occurrence of several fishes such as wahoo and rainbow runner under FAD, and Atlantic sailfish on free schools.

4.1 Tuna discarding and "faux poisson"

The total tuna and associated species discard to landings ratio (in weight) was estimated to be about 3.5% in 2007, indicative of the selective character of tuna purse seine fisheries compared to many other world fisheries (Alverson et al. 1994, Harrington et al. 2005, Kelleher 2005). Based on about 2,000 fishing sets observed during 2001-2005 a very similar discard rate of 3.4% was estimated for the Spanish tropical tuna purse seine fleet of the Atlantic Ocean (Sarralde et al. 2006). Observations made aboard U.S. tuna purse seiners fishing in the central-western Pacific Ocean in 1998 indicated a lower total discard to landing ratio of 1.8% (Coan et al. 1999), while discard rates tentatively estimated in the early 1990s for the western Pacific purse seine fisheries based on a literature review were comprised between 0.35% and 0.77% and 3.0% and 7.3% for unassociated schools and log schools, respectively (Bailey et al. 1996).

Tuna discarding was mainly observed for skipjack and little tunny caught under FADs, and small yellowfin to a lesser extent. Almost no discard was observed for fish caught on free schools except a few tons of frigate tuna. The discarding rate of 43 kg of skipjack per ton landed under FAD was in excellent agreement with estimates for the Spanish purse seine fishery during 2001-2005 based on a larger dataset of observer trips (Sarralde et al. 2006). By contrast, estimate of yellowfin discards under FAD of 1.3 kg per ton landed was lower than estimates of about 24 kg per ton landed for the Spanish fishing fleet. This discrepancy could be due to the low number of observations of fishing

sets with yellowfin discards in our dataset, to a different species composition of catch between French and Spanish fishing fleets, and to a different strategy between fishing crews regarding discarding vs. retaining fish aboard vessels for local fish markets. Further investigation based on an extended dataset combining Spanish and French observer trips would allow separating the effects associated with each of these factors.

Estimates of "faux poisson" landings have shown an increasing trend marked by important variations since the early 1980s with a major increase until the mid-1990s followed by a decrease in 1993-1998, and a new increase since the 2000s. The high interannual variability in "faux poisson" can be explained by several factors such as the changes in quality of available information, the variations in relative importance of fishing mode in the fishery through time, and the strategies of fishing vessels and crews regarding the specific target of some bycatch species (Romagny et al. 2000). In Ghana for instance, the increase in small tuna landings sold as "faux poisson" has mainly been attributed to the increasing use of FADs since the 1990s in conjunction with a decline in *Sardinella aurita* catches (Bannerman and Bard 2001). A large uncertainty is still associated with the method used to estimate quantities of "faux poisson" landed at the fishing port of Abidjan. In particular, quantities might be underestimated due to landings made at late hours or fish directly transhipped to other vessels for tuna canneries based in Spain (Romagny et al. 2000). Regarding the increasing importance of local fish markets and the complementarity between information derived from observers aboard fishing vessels and present at the fishing port, it is of major importance to continue and improve the sampling process in Abidjan to better quantify tuna and associated species catches in the eastern Atlantic.

4.2 Including "faux poisson" data into stock assessment models

The time series of "faux poisson" landings for major and minor tuna species were included in the total catch to be accounted for in surplus production models during the 2008 ICCAT joint yellowfin and skipjack stocks assessments that was held in Florianopolis, Brazil, July 21-29. The size range of discard and "faux poisson" was shown to be very similar for the 3 major tuna species, indicating that the choice between discarding at sea and retaining fish aboard for local fish markets is not driven by the size of the fish but other factors such as vessel flag or carrying capacity and this requires further investigation. Assuming the size structure of "faux poisson" has not been modified in the last years and considering the quantities of skipjack landed at Abidjan based on estimates of the "faux poisson" species composition, "faux poisson" landings-at-age data were included into the MULTIFAN-CL model to assess the status of the stock of eastern Atlantic skipjack.

4.3 Quantifying bycatch of associated fauna

The analysis of associated fauna bycatch showed that a large diversity of species was caught by purse seine fisheries, including fishes, billfishes, rays, sharks, and turtles. The number of distinct bycatch species (about 35) was logically lower than observed for the Spanish purse seine fleet (more than 70) due to the difference in sampling effort: 180 fishing sets observed in the present study compared to 1,927 sets in the analysis of Sarralde et al. (2006). Nevertheless, the frequency of occurrence was close for the species commonly taken as bycatch under FADs, i.e. common dolphinfish *Coryphaena hippurus* (about 35%), rainbow runner *Elagatis bipinnulata* (about 54%), silky shark *Carcharinus falciformis* (about 12%), and wahoo *Acanthocybium solandri* (about 55%). The major species taken as bycatch in free schools was the Atlantic sailfish *Istiophorus albicans*, a feature also observed for the Spanish fishing fleet (Sarralde et al. 2006) and consistent with the 62 observer trips conducted in 1997-1999 during the European Union bigeye tuna program (Gaertner et al. 2002). Further analyses are now required to better understand the factors involved in bycatch and

eventually give estimates of total bycatch by the European purse seine fisheries at the scale of the Atlantic Ocean for some selected species.

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Figure captions

Fig. 1. Location of the French tuna catch observed during 2006-2007 within the European observer program in the purse seine fishery of the eastern Atlantic Ocean. 'Others' includes minor tuna species, i.e. *Euthynnus alleteratus* and *Auxis thazard*. FAD = fishing aggregating device; FSC = free school

Fig. 2. Updates of “faux poisson” landings for total fish species and major commercial tuna species at the fishing port of Abidjan during 1981-2007. SKJ = skipjack; YFT = yellowfin; BET = bigeye

Fig. 3. Location of the bycatch of associated fauna observed during 2006-2007 within the European observer program in the French purse seine fishery of the eastern Atlantic Ocean

Fig. 4. Percentage of occurrence per fishing set of the main trophic groups and species taken as bycatch during 2006-2007. WAH = wahoo; ELP = rainbow runner; COH = common dolphinfish; SAI = Atlantic sailfish; BUM = Atlantic blue marlin; CFA = silky shark; SZY = smooth hammerhead; LOL = olive ridley; LKE = Kemp's ridley sea turtle. FAD = fishing aggregating device; FSC = free school

Fig. 5. Size-frequency histograms (expressed in density) for yellowfin tuna in the total catches during 2006-2007 made on free schools and FADs (size data from all countries included), in the discards of the French purse seine fishery in 2007 (derived from the French observer program), and in the “faux poisson” landings at the fishing port of Abidjan in 2007. FSC = free school; FAD = fishing aggregating device

Fig. 6. Size-frequency histograms (expressed in density) for skipjack tuna in the total catches during 2006-2007 made on free schools and FADs (size data from all countries included), in the discards of the French purse seine fishery in 2007 (derived from the French observer program), and in the “faux poisson” landings at the fishing port of Abidjan in 2007. FSC = free school; FAD = fishing aggregating device

Fig. 7. Size-frequency histograms (expressed in density) for bigeye tuna in the total catches during 2006-2007 made on free schools and FADs (size data from all countries included), in the discards of the French purse seine fishery in 2007 (derived from the French observer program), and in the “faux poisson” landings at the fishing port of Abidjan in 2007. FSC = free school; FAD = fishing aggregating device

Table captions

Table 1. Tuna catches landed and discarded at sea derived from observer trips made in 2007. FAD = fishing aggregating device; FSC = free school; D/L = discard to landings ratio (%)

Table 2. Occurrence per set (%) and weight (t) of associated fauna taken as bycatch during the observer trips of 2006-2007. FSC = free school; FAD = fishing aggregating device