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Note on yellowfin and bigeye catches collected during fishing and research cruises onboard pelagic longliners of the La Reunion fleet in 2008 and 2009

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Abstract : The pelagic longline fleet based in La Reunion started modification of its fishing strategy in 2005. Largest longliners of the fleet (LOA ranged between 20 m and 25 m) moved towards the west of La Reunion to exploit waters of the Madagascar EEZ. Such modification of the fishing strategy was driven both by the reduction of the swordfish CPUE in the EEZ of La Reunion and the difficulties to obtain satisfying sale prices for swordfish at the EU market. Then, currently the local longline fishery is split into two parts, one part composed by mini-longliners (mainly less than 17 m LOA) fishing inside EEZ of La Reunion, mostly off west side of the Island. The second part of the fleet composed of largest longliners and several mid-sized vessel fishing in the eastern and south eastern parts of the Madagascar EEZ. Though fishing strategy did not exhibit drastic modifications in terms of gear, bait, fishing time, fishing depth, the change of fishing grounds led to variation in the species composition of catches. Common target species caught using current fishing strategy (swordfish) was gradually displaced by tuna, mostly yellowfin and bigeye. In this note we present and discuss data collected (i) by observers placed onboard fishing vessels in the frame of the EU project "Data Collection Framework" and (ii) during scientific surveys carried out in the frame of several research projects: SWIOFP (South West Indian Ocean Fisheries Project), IOSSS (Indian Ocean Swordfish Stock Structure) and MADE (Mitigation of Adverse Ecological Impact of the open ocean fisheries).

Keywords : European Union data collection regulation, observer program, scientific cruise, onboard sampling, pelagic longline, target species, swordfish, tuna.

Introduction

The pelagic longline fishery of the Reunion Island started its activity in 1991 with single vessel involved in the fishing operations (Bourjea et al., 2009). Fleet is growing fast till 2000 reaching 38 active longliners participated in the fishery (Figure 1). Nowadays the number of active longliners is about 36. The length (LOA) of boats is ranged between 10 m and 25 m and the fleet is dominated by small to medium vessels from 10 to 20 m long, which represents 75% of the total. Since the launch of this fishing activity, both fishing gears and the fishing strategy did not exhibit major modifications. All fishing boats are equipped with a monofilament mainline (3.2−3.8 mm in diameter) stored on a hydraulically powered spool of a capacity ranged from about 20 to 60 miles. The longline is deployed around the sunset (from 4 p.m. to 8 p.m. local time). The mainline is maintained at the surface by buoys attached at the extremity of monofilament floatlines with a length ranged from 2 fathoms (~4 m) to 25 fathoms (~45 m). At the start of the fishery all fishermen used J-hooks (size 8/0 or 9/0), (Poisson et al., 2010) but currently several longliners switched to mixed hooks strategy using J-hooks, tuna hooks and circle hooks. Some boats deployed 100% of circle hooks (size 14/0) even recognizing that circle hooks usually considered as less efficient than J hooks for swordfish. In general the number of hooks deployed between floats (HBF) is between 6 and 7. Traditionally squid (*Illex* spp.) is used as bait and lighsticks are attached on every 2, 3 or 4 branchlines. The number of days at sea varied depends on vessel size. The smallest longliners concentrate their activity close to Reunion island with cruise of 1 to 3 days at sea, medium-size vessels stayed from 5 to 11 days at sea. Large longliners are mostly active in the south of Reunion (below the latitude 24°S), along the east coast and off the south of Madagascar between latitudes 20°S to 30°S. Latter vessels stay at sea at up to 21 days and deploy about 15 fishing sets every cruise.

Traditionally, the La Reunion pelagic longline fishery targets swordfish *Xiphias gladius*. Currently, fleet is suffering from the decrease of the swordfish CPUE. Initial decline of CPUE was observed in few years after the beginning of the fishery due to the well-known local depletion effect. Recent decline started after 2001 despite the expansion of the fishing grounds. Potential origin of the current downward CPUE trend is could be depletion of the swordfish stock in the heavy exploited by international longline fishery south west basin of the Indian Ocean (Figure 2). Declined CPUE urged largest longliners of the fleet to move towards the east coast of Madagascar since 2005. This spatial shift of fishing grounds implied a modification of the species composition of capture even if the fishing strategy did not introduce any changes in terms of fishing time, soaking time, bait and maximum fishing depth. As a major consequence of that, yellowfin (*Thunnus albacares*) and bigeye (*T. obesus*) became not dominant but important component in the commercial catches (Figure 3).

In this work, we present data collected by observers and scientists embarked during commercial longline fishing operations in the frame of projects carried out from Reunion

Island (EU "Data Collection Framework" dedicated to the onboard observer's monitoring of the bycatch of the local pelagic longline fishery (Bach et al., 2009), IOSSS : Indian Ocean Swordfish Stock Structure, MADE: Mitigation of adverse ecological impacts of the open ocean fisheries and SWIOFP: South West Indian Ocean Fisheries Project). These data are focused on yellowin and bigeye catches. First we compare geographical variations of the ratio between swordfish catches and yellowfin and bigeye catches. Second, length frequency distributions of individuals kept on board for the two species are presented and discussed.

Material and methods

Data considered in the present work come from the database SEALOR dedicated for the archival of information of pelagic longline activities and capture collected during both commercial pelagic longline fishing cruises (Bach et al., 2008; 2009a) and scientific surveys carried out with an instrumented longline (Bach et al., 2009b).

The average coverage rate of the fishing activity in 2008 was at the level of 1.5%. The value depends on the parameter considered for the estimation. Thus, the coverage rate is 1.92% in terms of cruises, 1.55% for sets and 1.26% for the number of hooks deployed to hooks sampled (Table 1). Compared to 2009, both the number of sets and hooks sampled by observers at sea increased to 72 and 95657, respectively by 2009 (Table 1).

		Fleet	Observer	Covering (%)
2008	Hook	2525407	32006	1,27
	Set	2127	33	1,55
	Cruise	313	6	1,92
2009	Hook	NA	95657	NA
	Set	NA	72	NA
	Cruise	NA	6	NA

Table 1 – La Reunion pelagic longline activity covered by observers embarked in the frame of the EU "Data Collection Framework" program.

The geographical area covered by observer activities is located in a "window" delimited by latitudes 14° S and 29° S and by longitudes 40° E to 70° E (Figure 4). The pelagic fishing sets considered in the study were pooled into 4 geographical strata (Figure 4, Table 2).

Geographical strata	Latitude	Longitude
1	Lat < 25° S	45° E < Long < 60° E
2	Lat >25° S	Long < 45° E
3	Lat >25° S	45° E < Long < 60° E
4	Lat >25° S	Long > 60° E

Table 2 – Limits of geographical area considered in the study for data aggregating purposes.

Results

Swordfish catches versus Bigeye and Yellowfin

The ratio between the capture of a target species (i.e. the swordfish in the present study) and capture of other major commercial species can be considered as an indicator of the efficiency of the targeting of a fishing strategy.
In this context our observer data displays that the targeting was less efficient in 2008 than in 2009 (ratio equals 0.49 and 1.57, respectively) while the CPUE of swordfish was stable with an average of 0.62 fish and 0.66 fish for 100 hooks (Table 3, Figures 5 and 6). Then, the variation of ratio depends only on tuna catchability. Between 2008 and 2009, tuna CPUE (yellowfin and bigeye capture) expressed in number showed a sharp decline from 1.25 to 0.42 fish/100 hooks. If we consider the spatial variation of the CPUE, we observe that this trend is mainly a consequence of the CPUE decrease in the geographic strata 1 (latitude < 25°S; 45° E < longitude < 60° E) from 2.48 fish/100 hooks in 2008 to 0.39 fish/100 hooks in 2009.
CPUE for swordfish shows rather stable values according to both year and geographical strata, except for strata 2 in 2008, where observed swordfish CPUE corresponds to experimental cruise with modified fishing strategy (fishing during daytime), (Table 3, Figure 6). On the contrary, tuna CPUE varied in wide range both by years and by geographic strata. The CPUE variation between 2008 and 2009 for the strata 1 could be a consequence of the longline positions according to the distance of the coast. Indeed, we observe that longline sets considered in 2008 were operated closer to the south coast of Madagascar compared to those sampled in 2009 (Figure 4). This suggests that an analysis of tuna CPUE variations should consider additional criteria of data stratification, which is not taken into account here: such as proximity to topographic features, season and species.

Year	Geographical strata	Effort (hook)	SWO/(YFT+BET)	CPUE SWO	CPUE tuna
2008	1	13036	0.27	0.67	2.48
	2	4242	0.2	0.17	0.83
	3	14728	2.51	0.7	0.28
	4				
	TOTAL	32006	0.49	0.62	1.25
2009	1	37280	1.11	0.44	0.39
	2				
	3	31857	1.19	0.82	0.69
	4	26520	5.94	0.78	0.13
	TOTAL	95657	1.57	0.66	0.42

Table 3 – Variations of the ratio between capture of swordfish and tuna (yellowfin and bigeye) in number and CPUE (number/100 hooks) for swordfish and tuna according to both the year and geographic strata.

Length frequency distributions of yellowfin and bigeye

Yellowifin tuna

Size composition of yellowfin for 2008 and 2009 is presented in the Fig. 7. Abrupt shift toward smaller fish (mean FL is 150.7 and 120.1 in 2008 and 2009 respectively) and tri-modal length frequency distribution is visible for the catch of 2009. Changes in size composition apparently related with redistribution of sampled fishing effort toward southern tip of Madagascar and increased catch around seamounts located in the area.

Size frequency distribution aggregated by four fishing sectors (south of Madagascar, Mozambique Channel, east of Madagascar-Reunion Island, and east of Reunion) shows that small individuals (FL<90 cm) constitute about 30% of the catch in the southern area (Fig. 8). Catch of small fish is less important issue for other sectors, where big yellowfin is predominate (Figs. 8).

In comparison to global size frequency composition of all longline fleets in the Indian Ocean taken during recent years (Fig. 7) catch of Reunion-based longliners consist higher percentage both large (FL>160 cm) and small fish (FL<90cm). Individuals of such size almost absent during recent years in the international longline fisheries, while they constitute significant part of catch in the LL fisheries of Reunion Island.

Bigeye tuna

Size frequency of the bigeye tuna demonstrates similar temporal and spatial variability as for yellowfin. Figs. 9 shows shift from uni-modal to tri-modal distribution and increased percentage of small fish (FL<90 cm). However mean size of bigeye was relatively stable in 2008-2009 (119. 5 and 118.7 cm respectively). Simultaneous increase of catch of large individuals in 2009 (FL>140 cm) contribute to relatively stable observed mean length.

Size frequencies by sectors also demonstrate that small bigeye is often caught around seamounts at the southern tip of Madagascar (Fig.10). However small individuals are also present in the catches in two other sectors: east coast of Madagascar to Reunion Island and eastward of Reunion (Fig. 10).

Size of the bigeye tuna caught in 2008 is similar with size of bigeye in the international catches (Fig. 9). Wider size range of fish caught in 2009 and higher percentage of both small and big individuals (same as for yellowfin tuna) are principal difference of the catches of Reunion-based fleet from recent catches reported by other fleets to IOTC.

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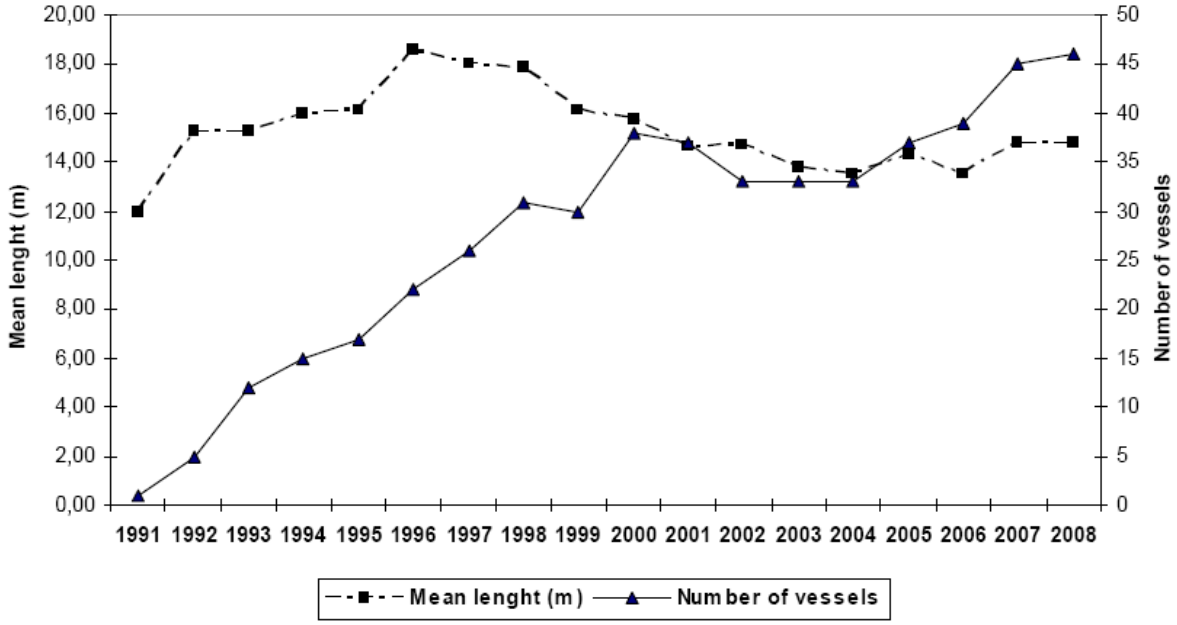

Figure 1 – Temporal variation of both the number the mean LOA of pelagic longliners of the La Reunion fleet from 1991 to 2008 (from Bourjea *et al.*, 2009).

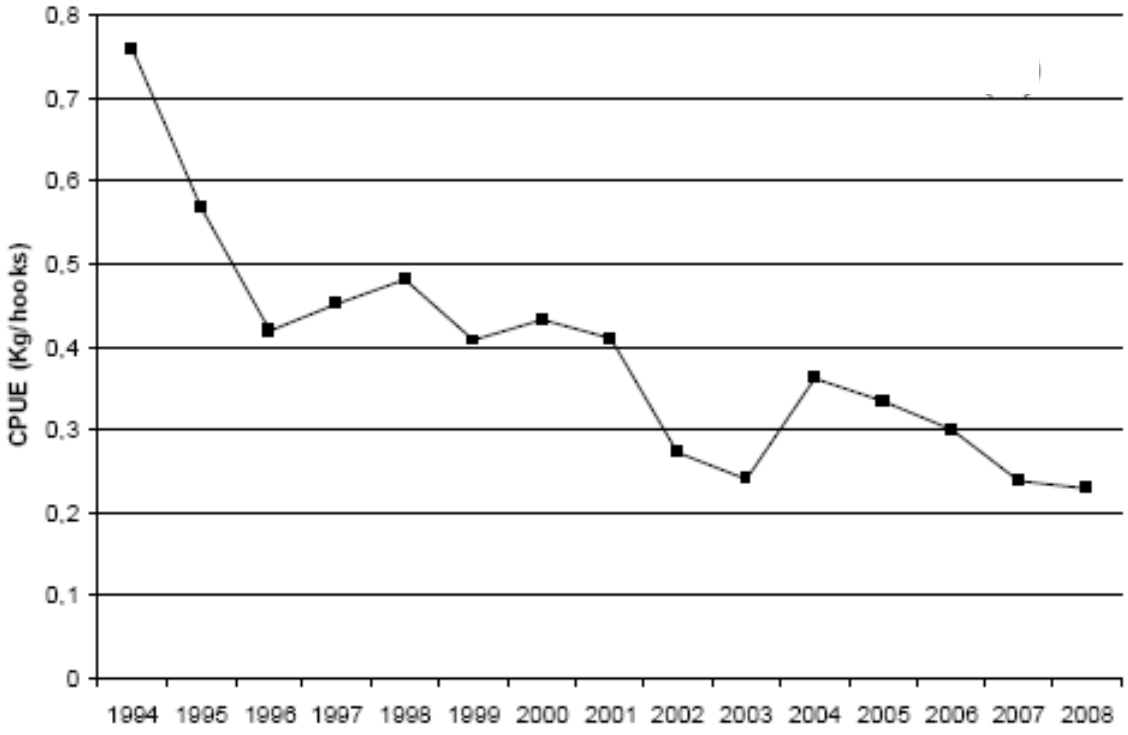

Figure 2 – Temporal trend of the swordfish CPUE (kg/hook) for the La Reunion pelagic longline fishery (from Bourjea *et al.*, 2009).

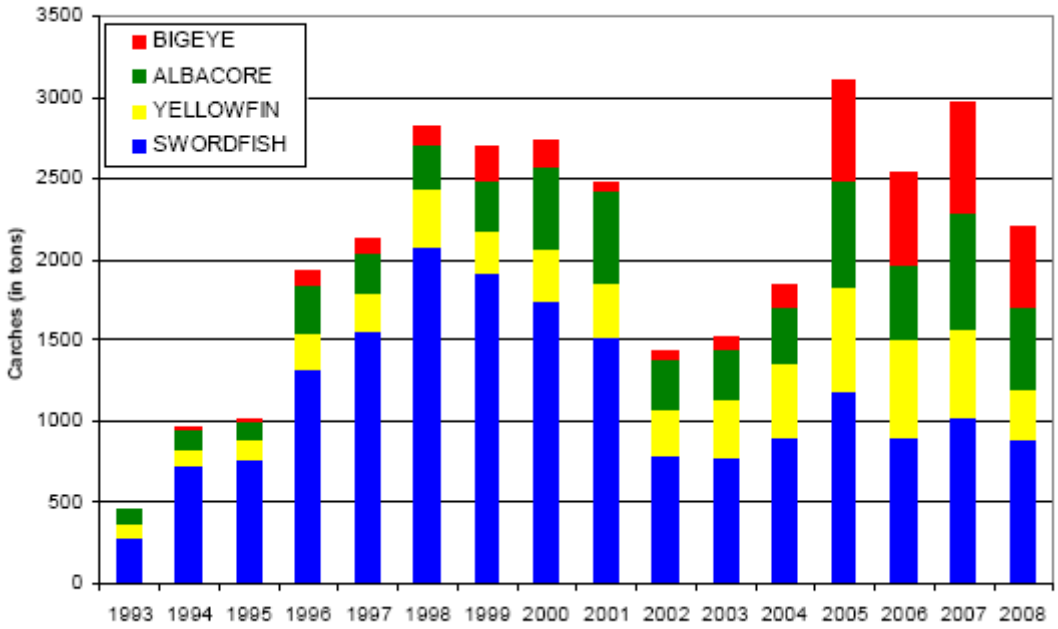

Figure 3: Temporal variations of catches of four major commercial species (swordfish, yellowfin, albacore and bigeye) of the Reunion Island pelagic longline fishery (from Bourjea *et al.*, 2009).

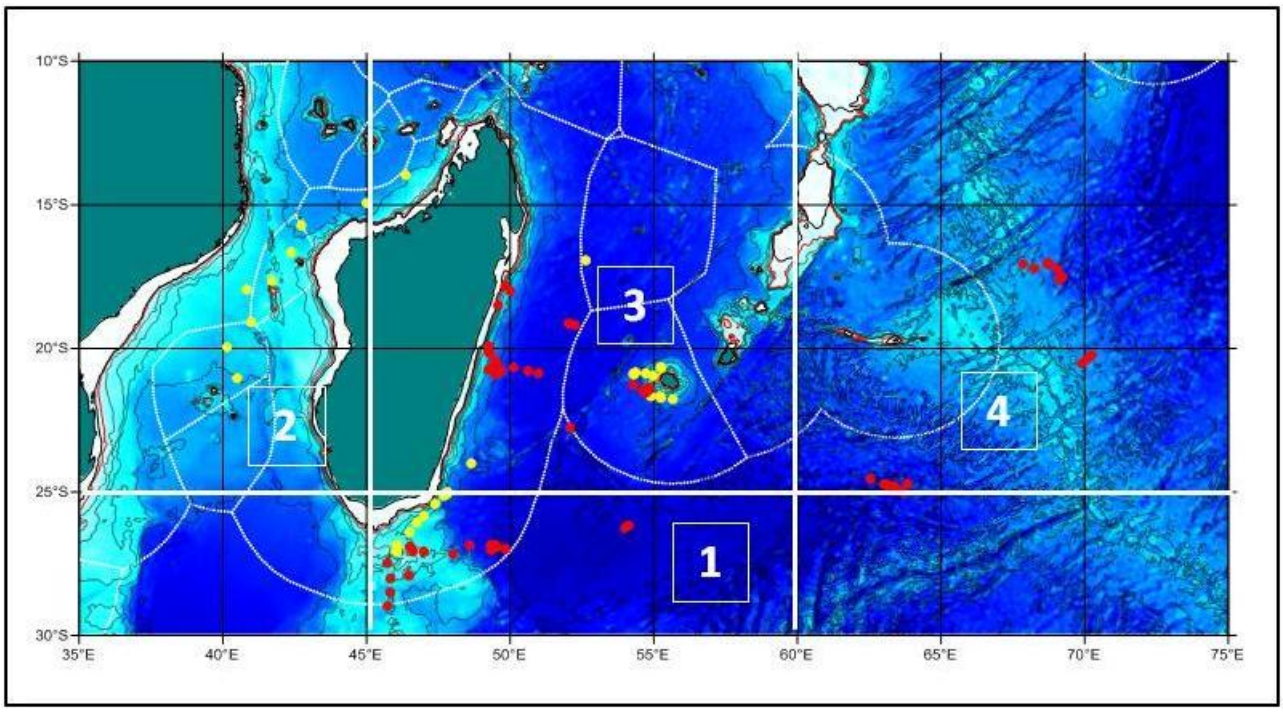

Figure 4 –Geographical positions of fishing sets sampled by observer embarked in 2008 (yellow dot) and in 2009 (red dot).

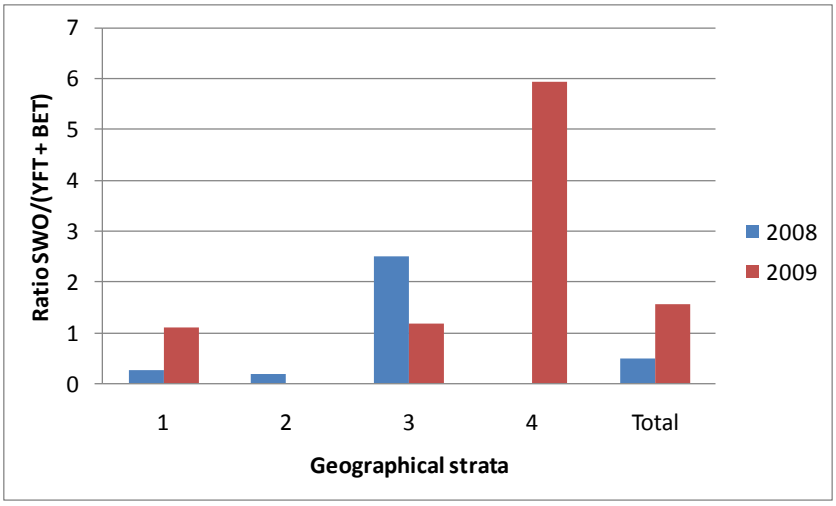

Figure 5 – Geographical variation of the ratio swordfish (SWO) : tuna (yellowfin, YFT and bigeye, BET) catch (in numbers of individuals) in 2008 and 2009 (ratio of 1 indicates equal number of swordfish and tuna)

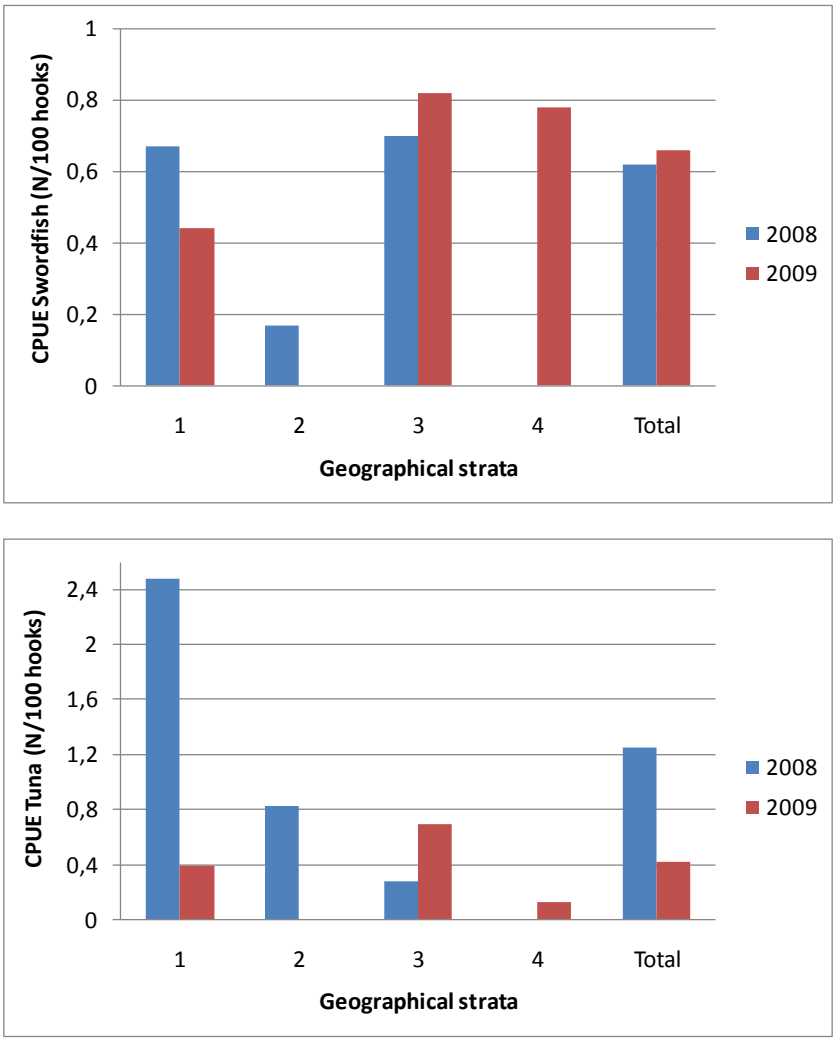

Figure 6 - Geographical variation of the CPUE (N/100 hooks) for swordfish (top) and tuna (yellowfin and bigeye, bottom) in 2008 and 2009.

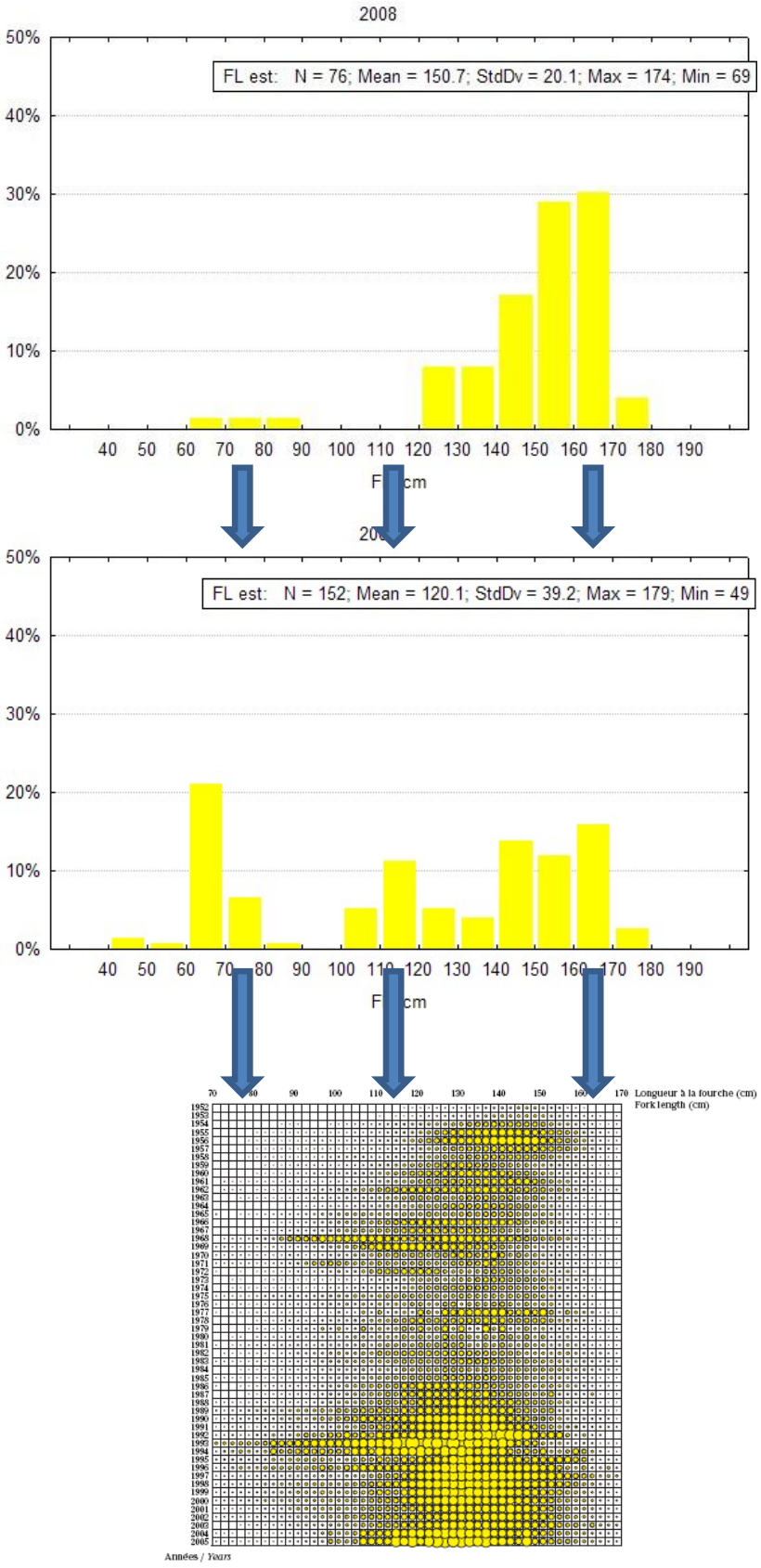

Figure 7. Size frequency distribution of the yellowfin tuna *Thunnus albacares* in the Reunion-based French pelagic longline fishery.

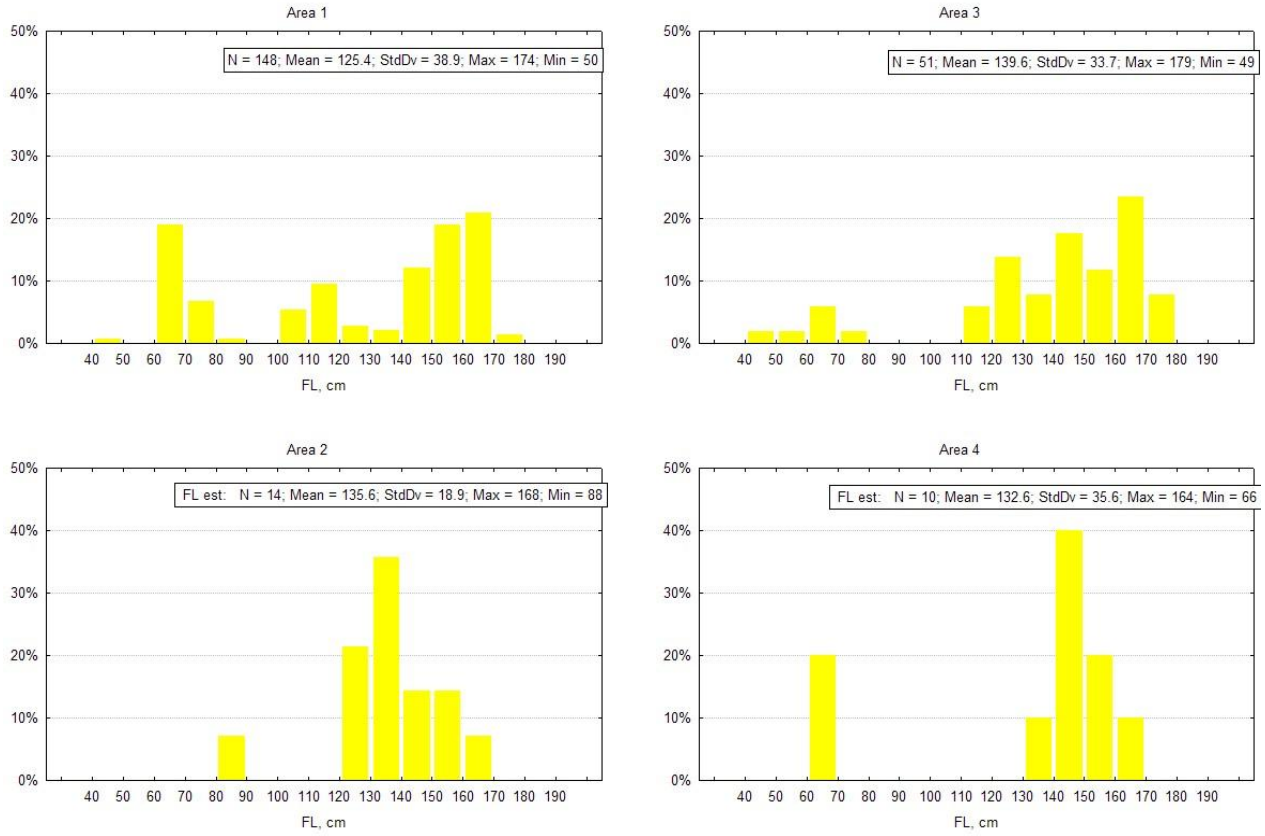

Figure 8 - Size frequency distribution of the yellowfin tuna *Thunnus albacares* by geographic strata in the Reunion-based French pelagic longline fishery.

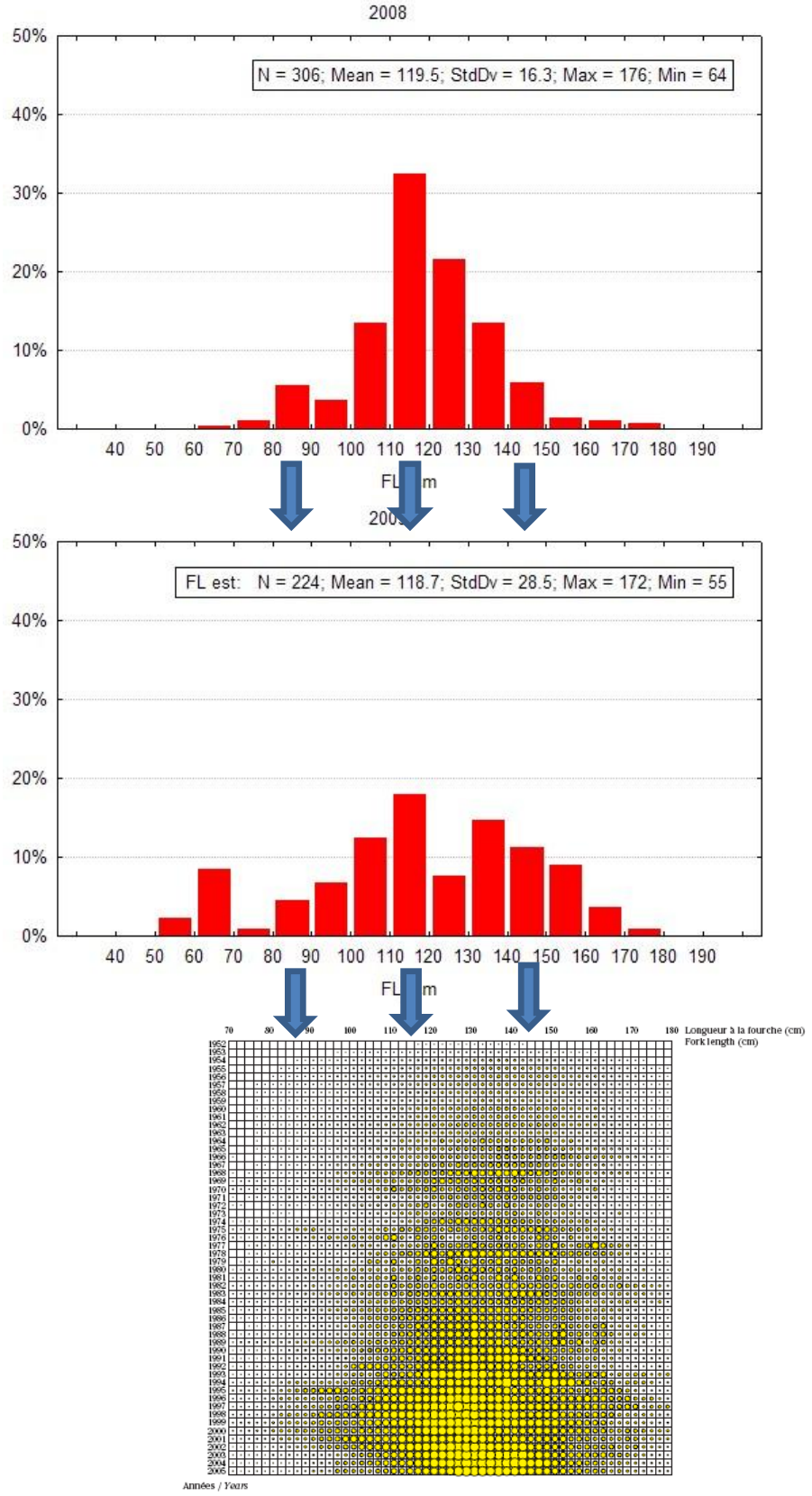

Figure 9 - Size frequency distribution of the bigeye tuna *Thunnus obesus* in the Reunion-based French pelagic longline fishery.

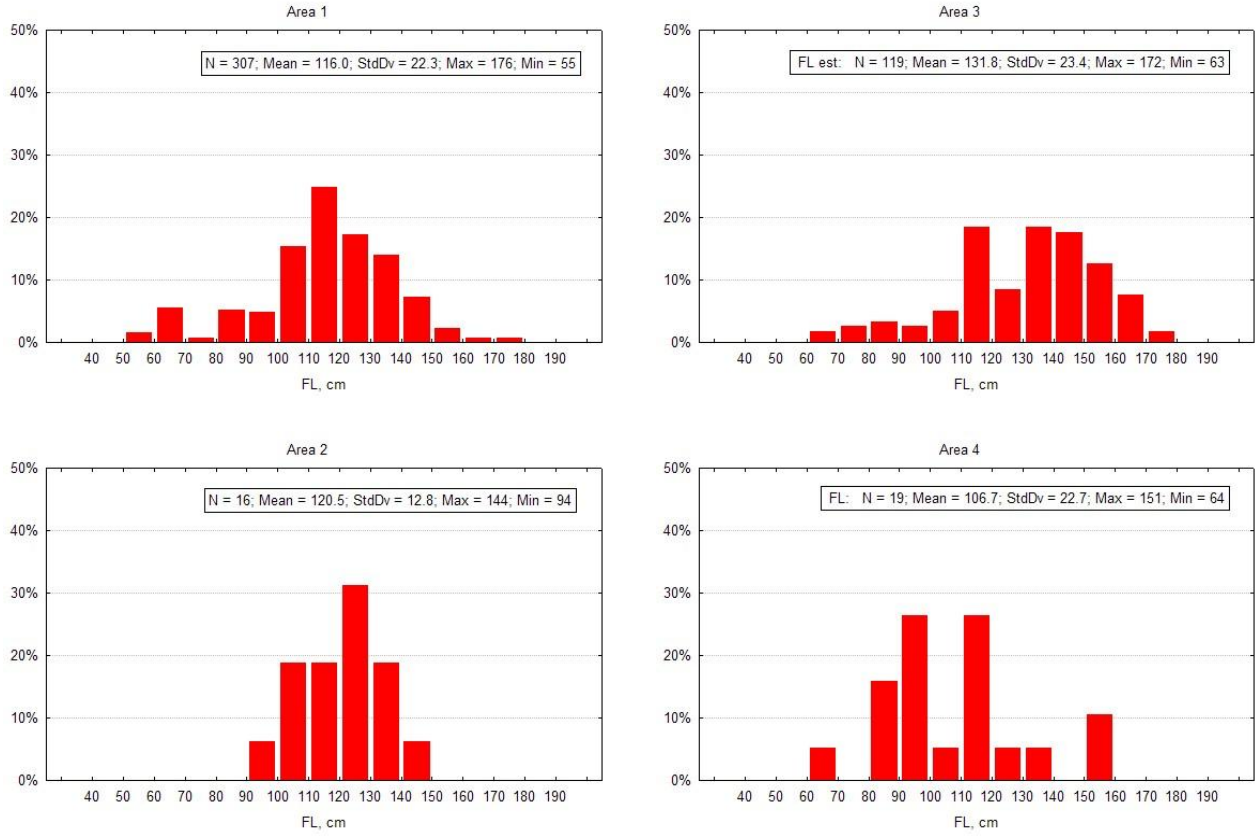

Figure 10 - Size frequency distribution of the bigeye tuna *Thunnus obesus* by geographic strata in the Reunion-based French pelagic longline fishery.