Commercial catch and discards of pelagic longline fishery of Reunion Island based on the self-reporting data collection program

Philippe S. Sabarros[1], Evgeny Romanov[2], Loic Le Foulgoc[2], Emilie Richard[2], Jean-Pierre Lamoureux[1], Pascal Bach[3]

[1]IRD, UMR 212 EME, 97420 Le Port, La Réunion
[2]CAP RUN, ARDA, 97420 Le Port, La Réunion
[3]IRD, UMR 212 EME, CRHMT, 34203 Sète, France

* Corresponding author, email: philippe.sabarros@ird.fr, tel: +262(0)693509062

Keywords

Pelagic longline | CPUE | Swordfish | Albacore | Bycatch | Discards | Reunion Island | Southwest Indian Ocean

Abstract

Pelagic longline fishery activities of Reunion Island are monitored since 2011 by the self-reporting data collection program (SRP) that covered 12% of the total fishing effort in 2011-2012. Fishermen report in SRP various informations on fishing locations, gear used, catch, discards and depredation. We used these data to assess the levels and distribution of commercial catch and discards between mid-2011 and mid-2013. We found that the catch per unit of effort (CPUE) of swordfish (target species) has decreased since 2011 as long as the overall profitability of this fishery including other commercial species and taxa: yellowfin tuna, bigeye tuna, albacore tuna, dolphinfish and billfish. Discards were mostly blue sharks (38%), pelagic stingrays (24%) and a generic group of very long fish usually called snooks by fishermen (20%). In this context of overall decrease of fishery profitability, fishing on the east coast of Madagascar between July and September still remains a profitable strategy while byctach rate of discards is reasonably low. Albacore tuna season occurring the last quarter of the year also remains profitable with high albacore CPUE levels near Reunion Island and below average rate of discarded bycatch.

Introduction

Worldwide, fishing pressure has increased in the recent decades suggesting that the impact on target and bycatch species, and ecosystems effects have evolved in the same direction (Kelleher, 2005; Pauly et al., 2005).

The pelagic longline fishery operating from Reunion Island uses horizontal drifting longlines that are set at night with 300 to 1600 baited hooks to primarily target swordfish. Longlines are hauled in the morning just after sunrise to catch – in addition to swordfish – other commercial species such as tuna species, marlins and dolphinfish. Reunion's longliners operate in the southwest Indian Ocean between Reunion Island and the east coast of Madagascar. This fishery started in 1991 with a single vessel operating off the coast of Reunion Island. The fishing fleet grew fast until 2000 with 38 active longliners at that time (Bourjea et al., 2009). By 2012, the number of active longliners decreased to 29 because of more difficult operational conditions and marginal profit due to higher fuel and bait prices, decreased catch per unit of effort (CPUE), impact of depredation by sharks and toothed whales, and low off-board prices for swordfish.

A fishery monitoring program that consists in data reported by captains of commercial longliners is now fully operational in Reunion Island since 2011. This self-reporting data collection program (SRP) was developed by IRD and CAP RUN in the framework of EU Data Collection Framework (DCF) as a complementary information system of the observer program (Bach et al., 2008). Fishermen from Reunion Island are compensated for collecting data on their fishing operations, commercial catch, discards and depredation (Bach et al., 2013).

The purpose here is to give a first glance at SRP data and show the potential of these data to assess CPUE commercial species and discards. We present the cover rate of SRP over the total fishing effort, the quarterly distribution of the main commercial species catch per unit of effort (CPUE), an index of profitability based on catch weight declarations and off-board prices for commercial species, and the distribution of discards including fish, sharks, turtles and cetaceans, also provided quarterly. Depredation data from SRP will be presented by Romanov et al. (2013). Results are discussed in the light of profitability and ecosystem impact, and we eventually provide guidance for reducing bycatch rate of discards or at least post-release mortality for some bycatch species, e.g., sharks.

1. Self-reporting data

The self-reporting data collection program (SRP) consists in data collected by a group of cooperative fishermen in the framework of EU Data Collection Framework (DCF) dedicated to monitoring of captures, bycatch and depredation in the local pelagic longline fishery (Bach et al., 2009). SRP was developed by IRD and CAP RUN and is administrated by IRD. Fishermen collect data using forms based on the observer program (OP; Bach et al., 2009) related to the boat location, fishing gear and setup used, captures, depredation, bycatch and physical environment using temperature-depth recorders (Bach et al., 2013). The OP started in 2008 while the SRP was fully operational in May 2011. A total of 711 fishing operations (=sets) has been monitored between May 2011 and June 2013 (Tab. 1). The exact position of setting and hauling are collected so that fishing polygons that include longline drift can be defined as well as their center of gravity (Appendix 1).

The monitoring potential of SRP is 400 sets per year which depends on the deal with EU DCF program. Even though SRP monitoring effort has been temporally heterogeneous since it started (Tab. 1), it is now intended to be more homogeneous throughout the year (e.g. 2013).

Yearly total fishing effort for vessels >12m – number of hooks deployed – was provided by Ifremer (source: DPMA). Therefore, mini longliners (<12m) fishing effort was removed to calculate SRP coverage over the total fishing effort. SRP has been effective since May 2011 with 4% of the total fishing effort monitored that year (Tab. 2). Twenty-three percent of the total fishing effort was monitored in 2012. The overall 2011-2012 was 12% of the total fishing effort (Tab. 2)

Quarterly distribution of SRP-monitored fishing effort between mid-2011 and mid-2013 is presented in Figure 1. During the 3rd quarter of 2011 and 2012 most of the fishing effort was located off the east coast of Madagascar, especially within a few 1°-squares with 30 to 50 K hooks deployed in each square in 2012. Fishing effort was limited to the French EEZ during the 4th quarter of the year.

Table 1. Number of sets and fishing effort monitored by the self-reporting program including all fishing vessels

Table 2. Self-reporting program (SRP) coverage over total fishing effort. Fishing effort is the number of hooks that were deployed
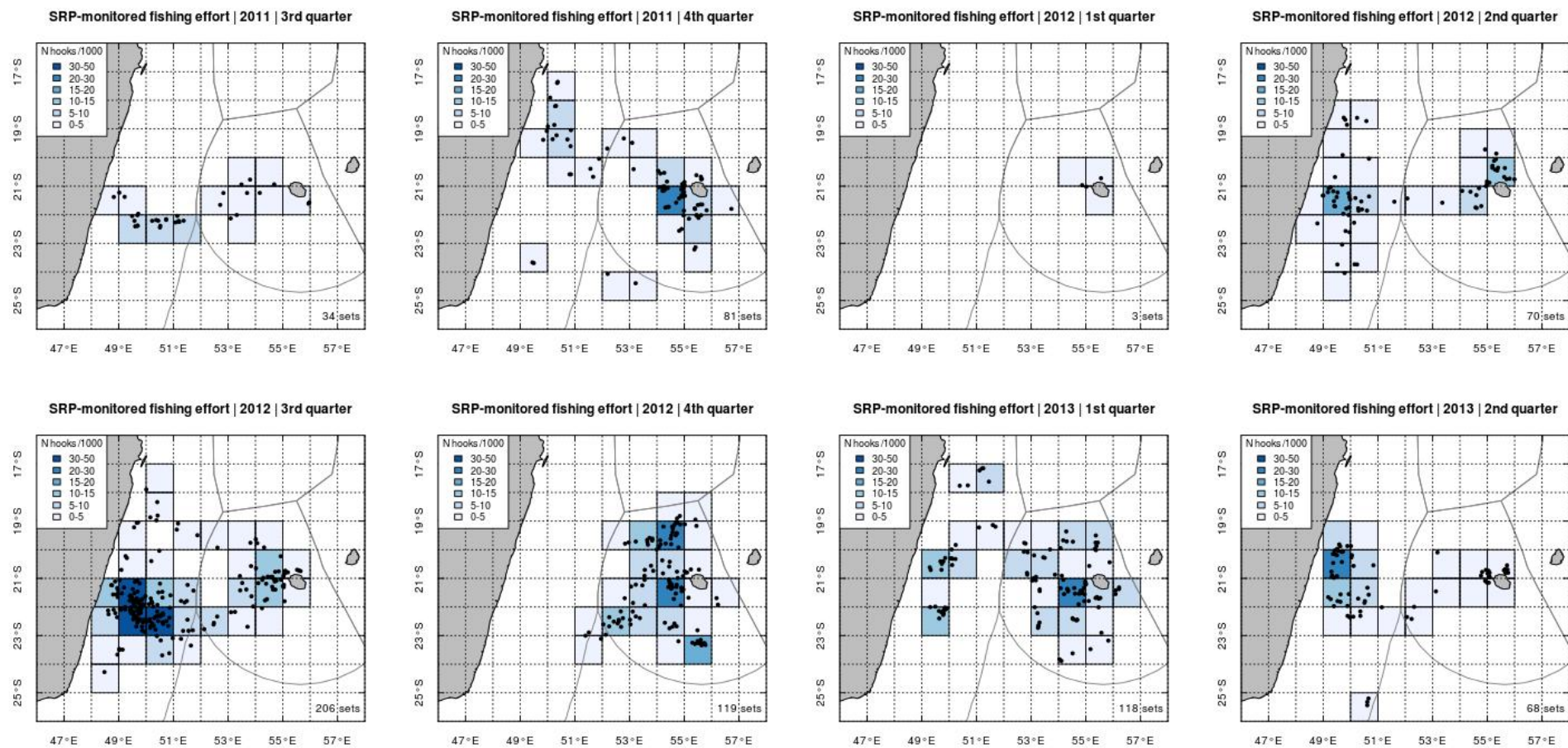
Figure 1. Fishing effort monitored by self-reporting program in 2011-2013

2. Commercial catch and profit

Reunion's longline fishery primarily targets swordfish (SWO *Xiphias gladius*) with night settings, squid baits and light sticks. Longlines are hauled just after sunrise to catch additional yellowfin tuna (YFT *Thunnus albacares*), bigeye tuna (BET *Thunnus obesus*), albacore tuna (ALB *Thunnus alalunga*), dolphinfish (DOX *Coryphaena spp*) and billfish including blue marlin (BLM *Makaira mazara*), black marlin (BUM *Makaira indica*), stripped marlin (MLS *Tetrapturus audax*), shortbill spearfish (SSP *Tetrapturus angustirostris*) and sailfish (SFA *Istiophorus platypterus*) that have a commercial value.

Total catch data include commercial catch as well as undersize and depredated catch. Depredated fish can be discarded but they are often kept onboard for non-commercial consumption. Catch per unit of effort (CPUE) was calculated using total catch data. Here we present the quarterly CPUE of SWO, YFT, BET, ALB, DOX and BIL between mid-2011 and mid-2013 (Fig. 2) as well as their respective distributions (Figs. 3-7). The purpose of using CPUE distributions is to identify spatial and seasonal patterns.

Swordfish nominal CPUE decreased from over 5 fish/1000 hooks in 2011, down to 5 in 2012 and below 5 in 2013 (Fig. 2). Swordfish CPUE rarely reached 10 fish/1000 hooks locally (Fig. 3), which is rather low considering the local longline fishery primarily targets this species (1/100 success rate). Yellowfin tuna CPUE does not show strong spatial or seasonal pattern and seems to be proportional to the fishing effort. Occasionally longliners did not catch any yellowfin tuna and when they did, CPUE rarely raised above 4 fish/1000 hooks locally (Fig. 4). Bigeye tuna CPUE followed the same (absence of) pattern as yellowfin tuna (Fig. 5). Albacore nominal CPUE around Reunion Island raised during the 4th quarter of the year for both 2011 and 2012 (Fig. 2) which is known as the albacore season. These high CPUE were found near Reunion Island in the French EEZ (Fig. 6). Dolphinfish CPUE gradually decreased between 2011 where average CPUE was over 10 fish/1000 hooks and 2013 where the average CPUE is now below 7 (Figure 7). Marlins and sailfish CPUE was the lowest among commercial species (Fig. 2) and never raised above 1-4 fish/1000 hooks (Fig. 8).

The profitability index (PI) is an estimation of the profit per hook made by fishermen based on weight declarations of the commercialized catch including SWO, YFT, BET, ALB, DOX and BIL, and their respective off-board prices per kg at the fish factory provided in Table 3. The quarterly distribution of PI is presented in Figure 9.

The overall PI decreased between 2011 and 2013. PI locally reached >3€/hook in 2011 while it was mostly 1-2€/hook in 2013 (Fig. 9). The zone near Madagascar with the most fishing effort during the 3rd quarter of 2012 (cf. Fig. 1) appeared to be reasonably profitable with 1-2 €/hook compared to other locations all around (Fig. 9). Profitability during the 4th quarter of 2012 in

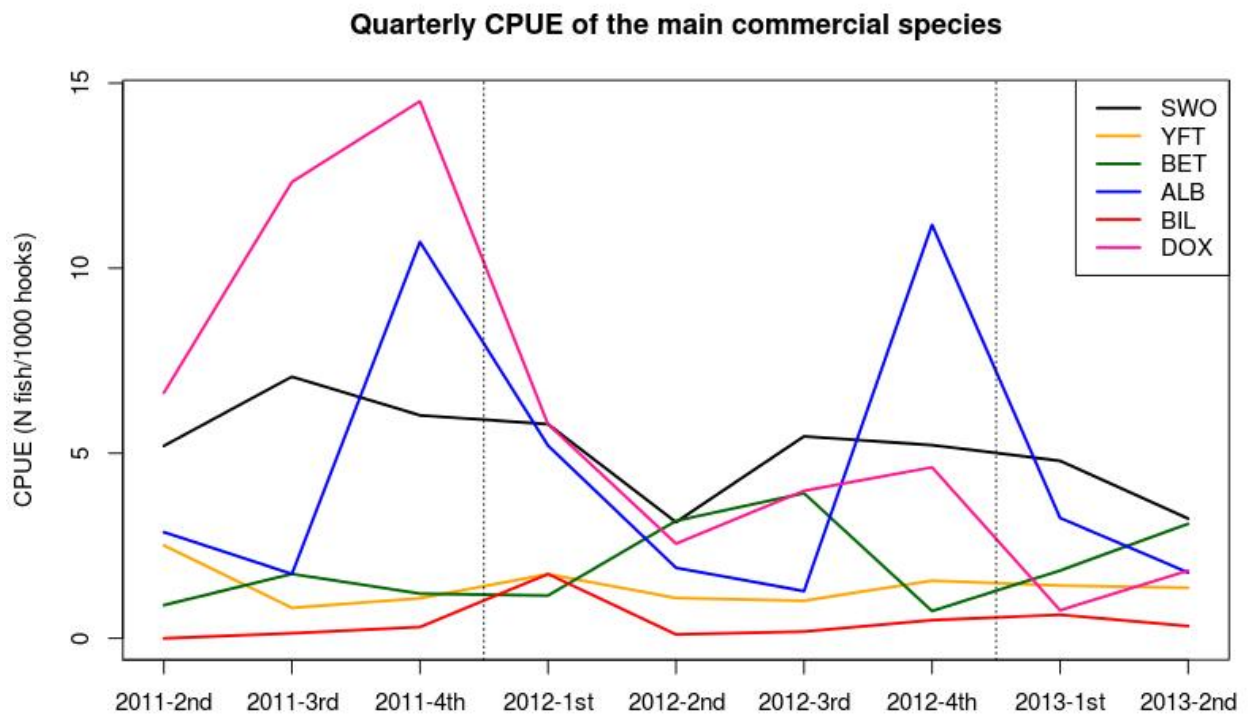French EEZ was on average higher than the rest of year (Fig. 9).

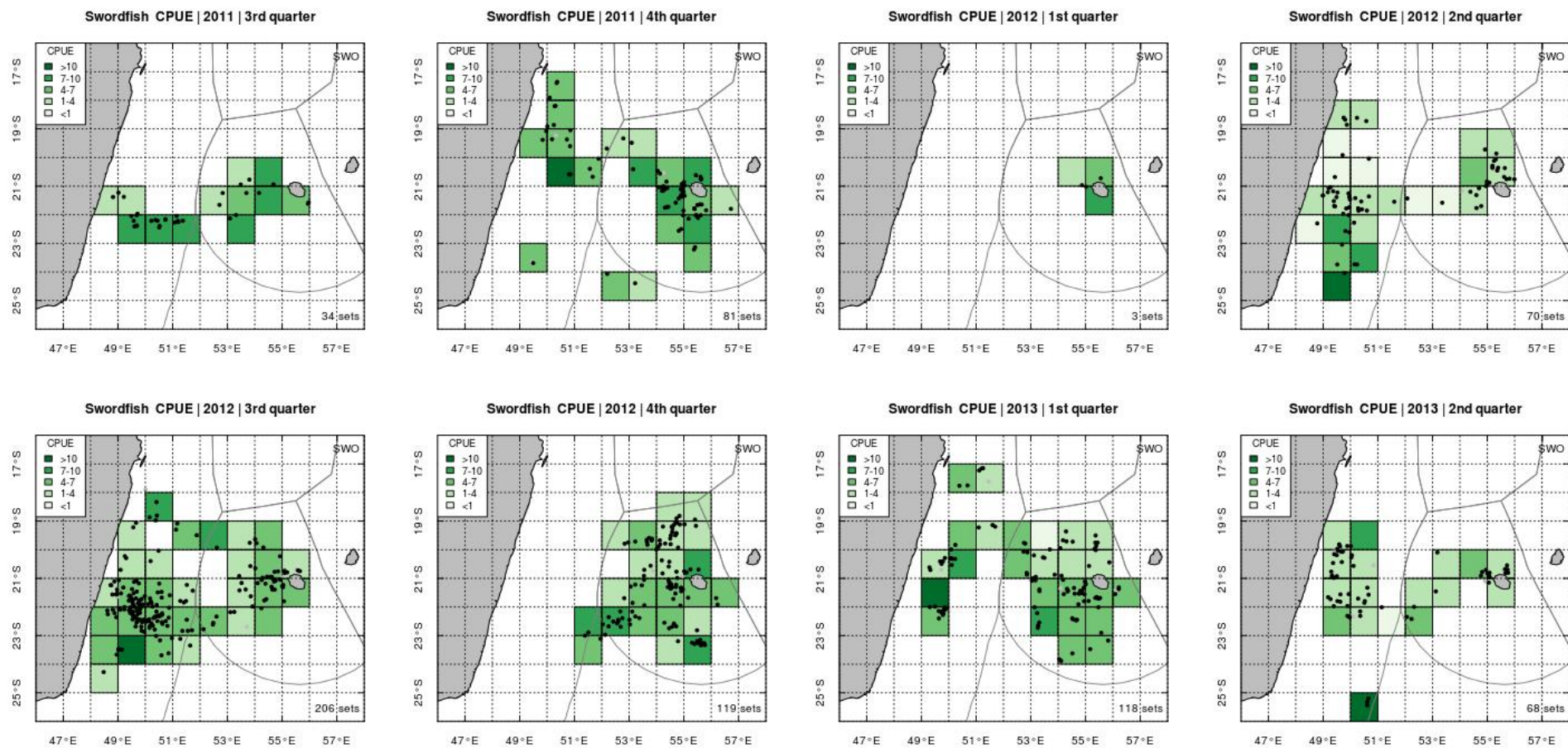Figure 2. Quarterly CPUE of the main commercial species between 2011 and 2013

Figure 3. Quarterly swordfish CPUE distribution in 2011-2013
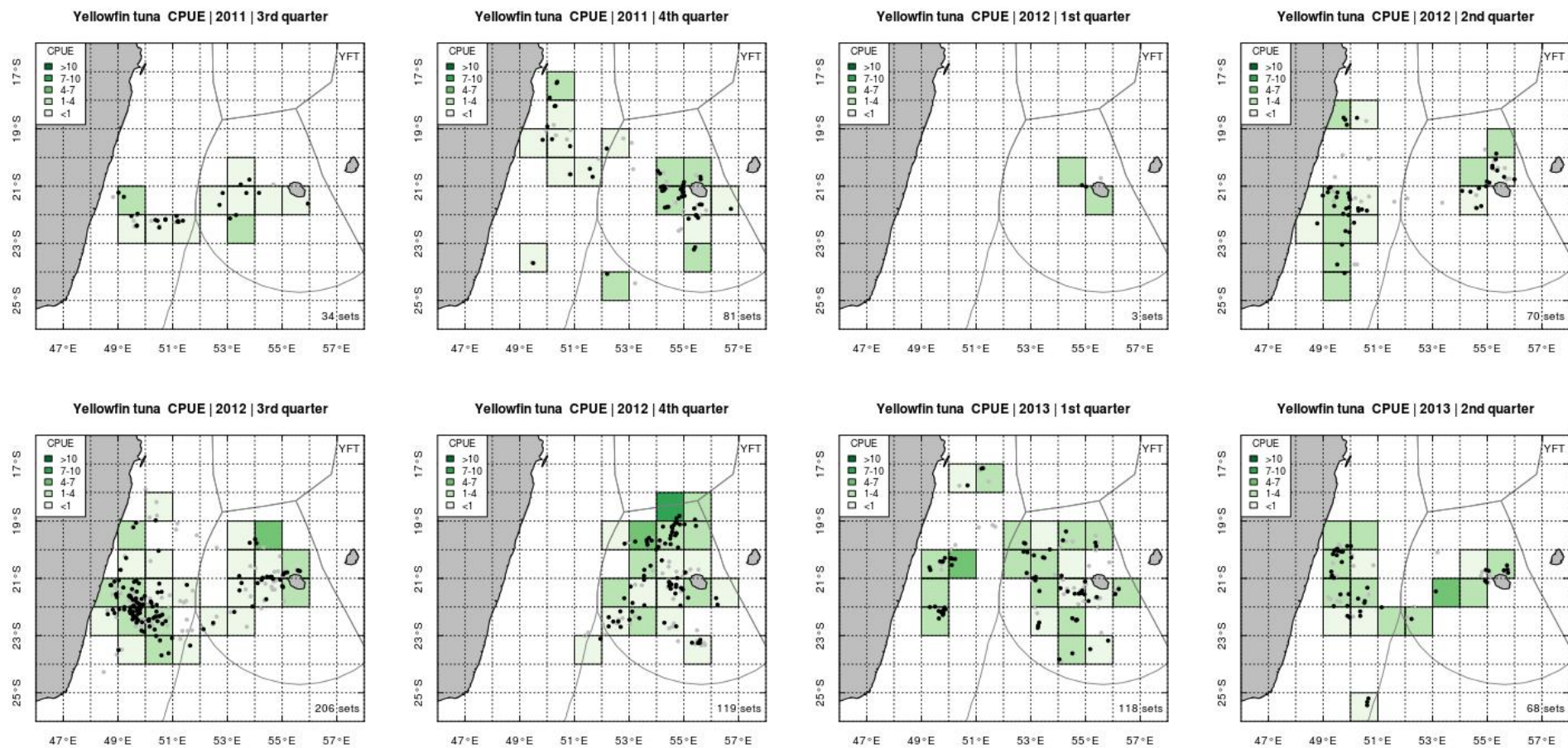
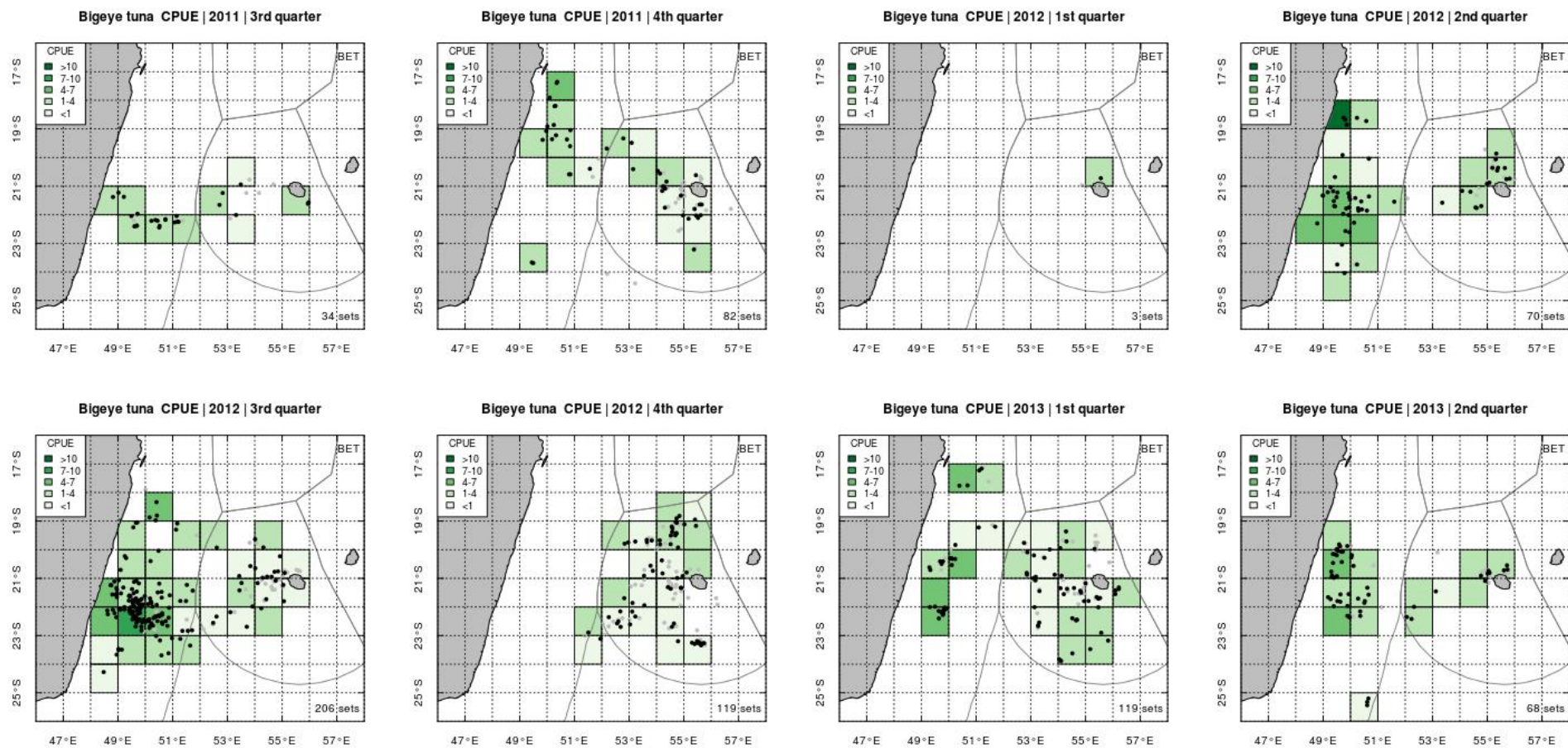Figure 4. Quarterly yellowfin tuna CPUE distribution in 2011-2013

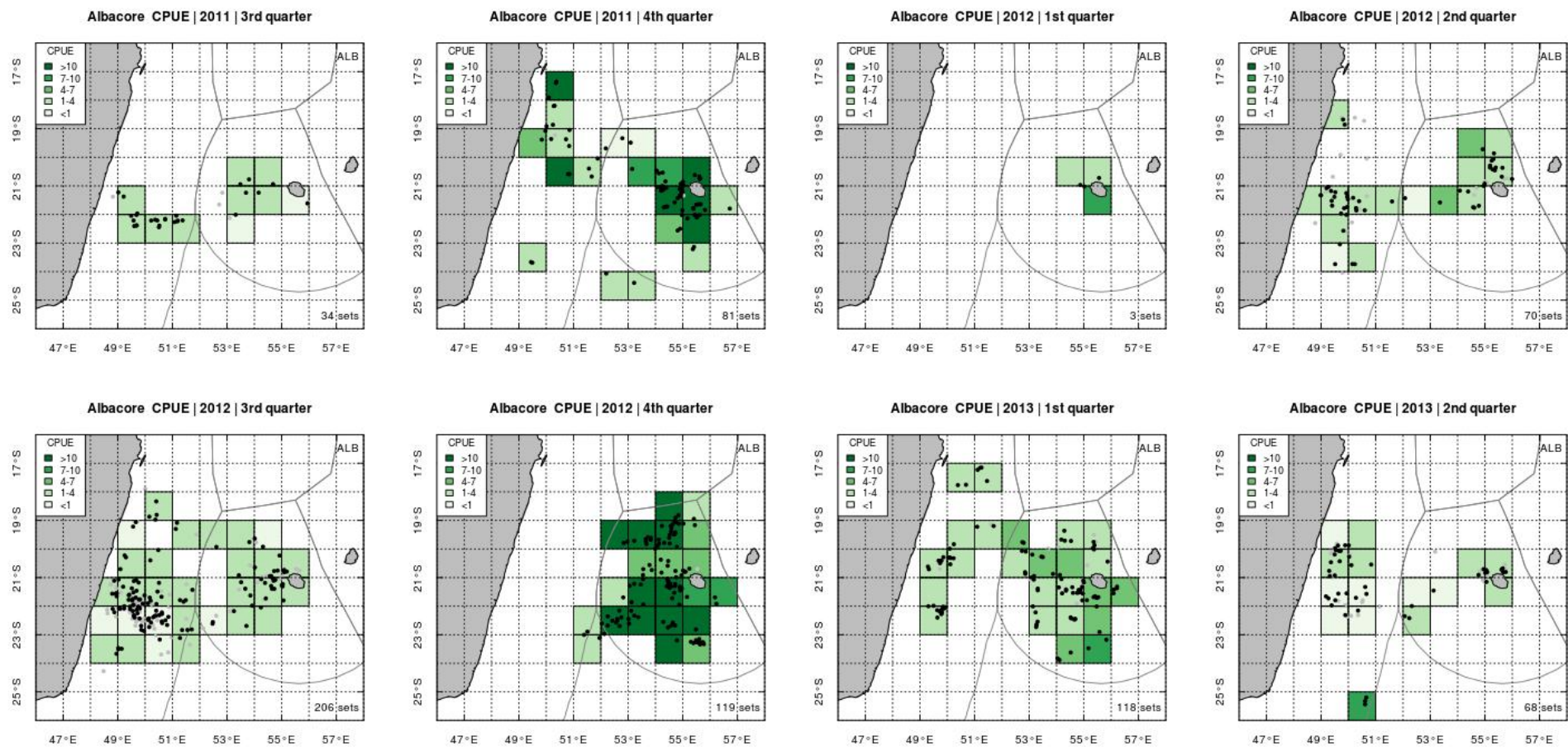Figure 5. Quarterly bigeye tuna CPUE distribution in 2011-2013

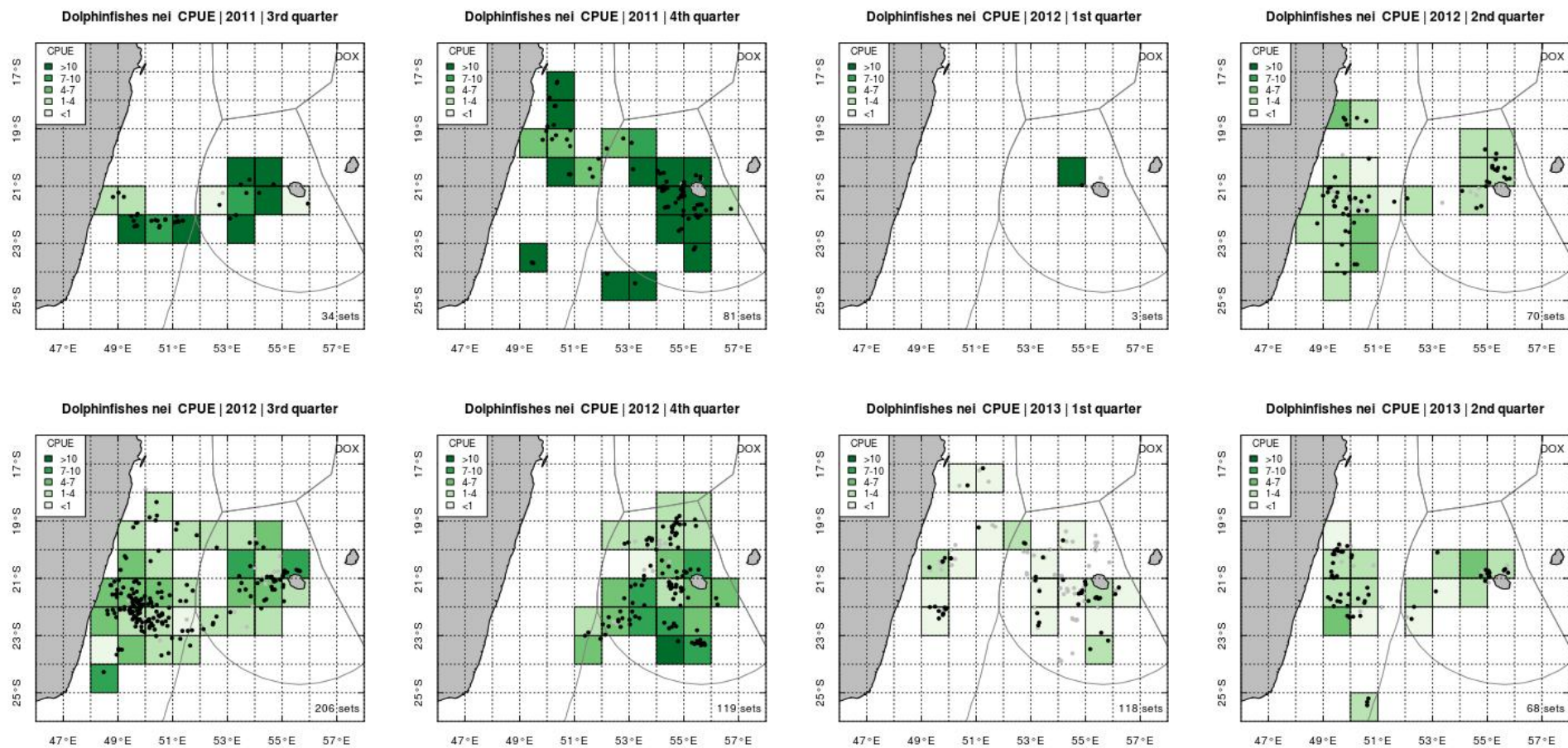Figure 6. Quarterly albacore CPUE distribution in 2011-2013

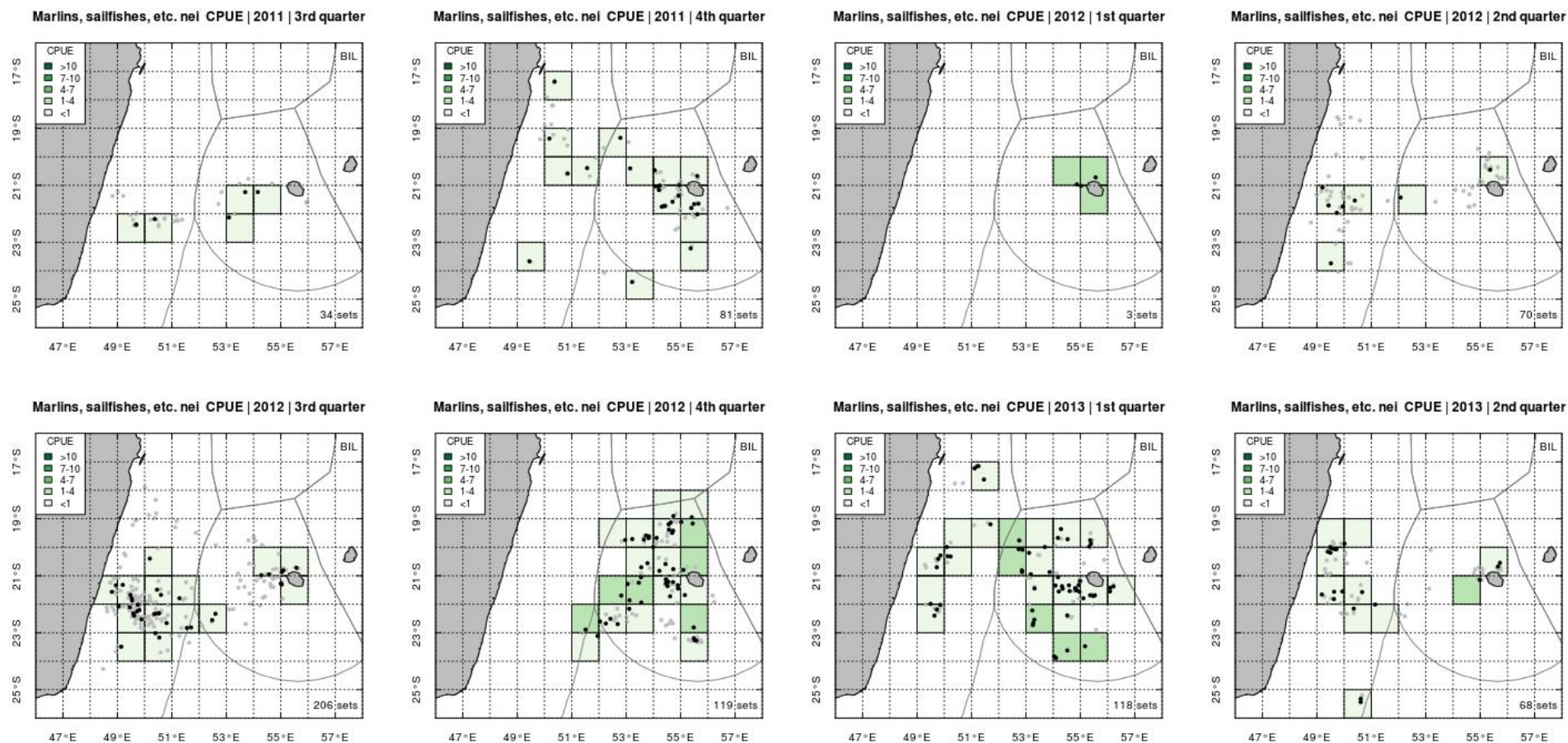Figure 7. Quarterly dolphinfish CPUE distribution in 2011-2013

Figure 8. Quarterly billfish CPUE distribution in 2011-2013

Table 3. Off-board prices per kilogram for the main commercial species (July 2013)
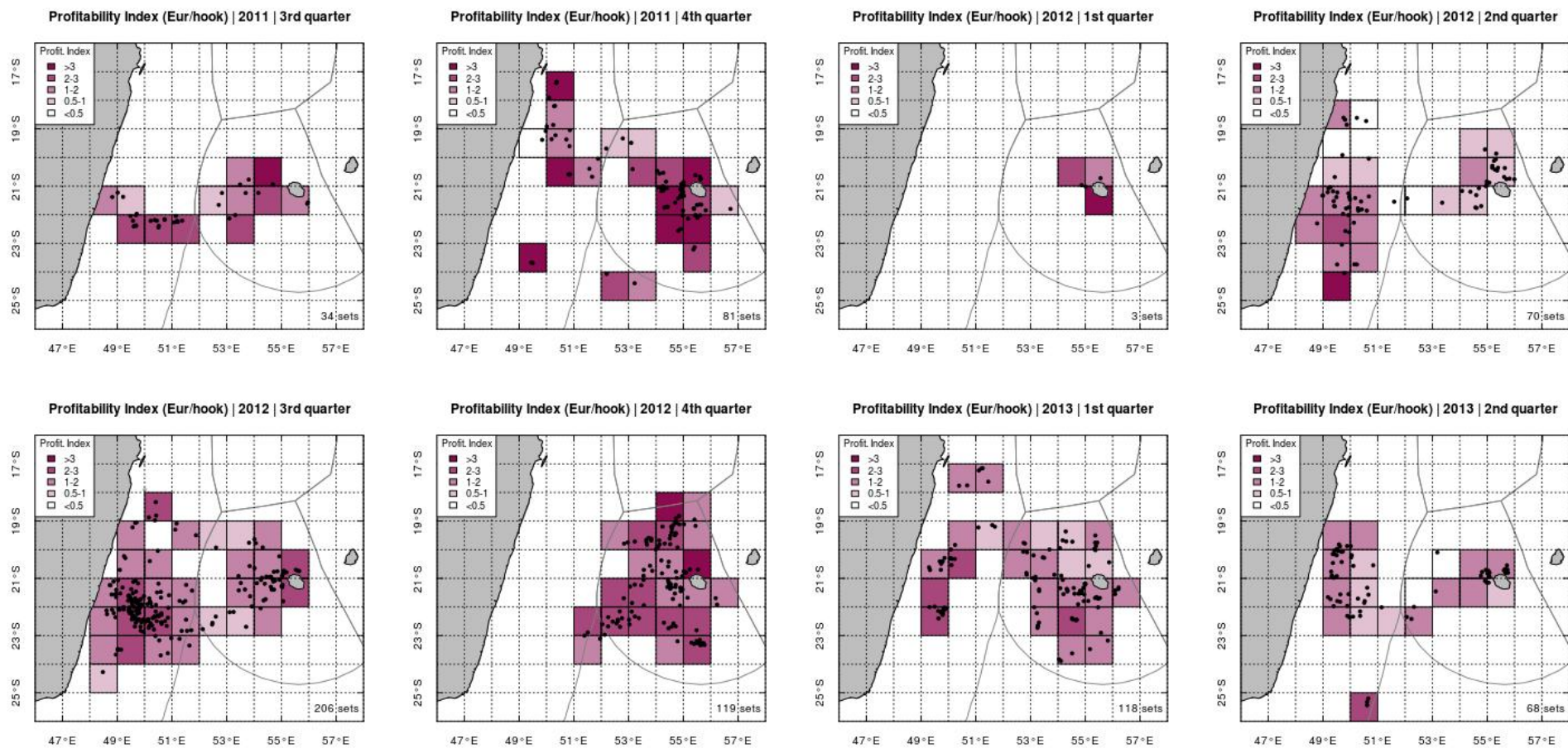
Figure 9. Quarterly profitability index distribution in 2011-2013. Profitability index is the profit in euros made by fishermen from selling the fish to the factory per hook (€/hook)

3. Discards in bycatch

Discard levels in pelagic longline are highly variable. The bycatch rate of discarded species was calculated as the ratio between the number of individuals of non-commercial bycatch species that are mostly discarded at sea, and the total number of fish including targeted/commercial species. The distribution of bycatch rate of discarded species is provided quarterly (Fig. 10). Also we present the distribution of bycatch of discarded species per unit effort (BPUE) for fish excluding sharks (Fig. 11), sharks only (Fig. 12), a focus on blue shark (*Prionace glauca*, Fig. 13), and finally sea turtles (Fig. 14) and cetaceans (Fig. 15). BPUE is the number of discards per 1000 hooks.

Discarded species and taxa caught by longliners operating from Reunion Island were diverse including various pelagic fish species with a significant number of elasmobranchs, and occasionally sea turtles and cetaceans. Forty discarded species or taxa were caught between mid-2011 and mid-2013 (Tab. 4). Blue sharks represent the most of the total bycatch (38%), followed by pelagic stingray (*Pteroplatytrygon violacea*; 24%) and a generic group of non-identified very long fish (20%; Tab. 4). Very long fish (VLF) – often considered as "snooks" by fishermen – include non-identified lancetfish (*Alepisaurus spp.*), gempylids (snake mackerel *Gempylus serpens*, oilfish *Ruvettus pretiosus*, escolars *Lepidocybium flavobrunneum, Promethichthys prometheus, Rexea* spp., and snoeks *Thyrsitoides marleyi, Nesiarchus nasutus*). Training programs should be developed for fishermen to improve their ability at identifying those species.

Bycatch rate of discards did not show strong spatio-temporal patterns expect for the 3rd quarter of 2012 where bycatch rate was 1-60% in Madagascar's exclusive economic zone (EEZ) – excluding the northernmost set that stands alone in its 1°-square – while it ranged between 40 and 80% in Reunion's EEZ. Fish discards (excluding sharks) – 55% of the total bycatch – ranged between 0 and 7 ind./1000 hooks in 2011 while it raised locally above 10 ind./1000 hooks in 2012 and 2013 (Fig. 11). Discarded fish BPUE was higher in French EEZ compared to Madagascar's in a similar fashion as the total bycatch rate of discarded species.

Most sharks (81%), turtles (68%) and cetaceans (91%) were released alive (Tab. 5). Fishing mortality (at haulback) on discarded species concerned 13% of sharks, turtles and cetaceans bycatch (Fig. 5). Sharks were usually released by cutting off the leader while the hook remained in the shark's jaw, gills or stomach (pers. comm.). Mortality could not be estimated for discarded fish species or taxa (expect sharks) because this information was not available. Makos (*Isurus* spp.) and oceanic whitetip sharks (*Carcharhinus longimanus*) were often kept onboard, respectively 75% and 51% of them. The oceanic whitetip shark is now on IUCN Red List of threatened (Vulnerable) species since May 2013 banning fishing and commerce of oceanic whitetip sharks. The spatio-temporal distribution of sharks bycatch that represent 44% of the total bycatch of discarded species (Tab. 5) did not show strong patterns expect higher BPUE in French EEZ in the 3rd quarter of the

year (Fig. 12), similarly to the overall bycatch rate. Idem for blue sharks that make most of the bycatch of discards with 38% (Tab. 5, Fig. 13).

Incidental captures of turtles were seldom (0.83%) and most turtles were released alive (68%). The hook was removed from the turtle's jaw when possible (pers. comm.). A hook extraction kit would be useful to fishermen at these occasions. A few turtles (14%) were brought back to a rehabilitation center for sea turtles on the island: Kelonia. Cetaceans were also rarely caught (0.47%) and 9% of these encounters were deadly for dolphins (Risso's dolphins *Grampus griseus*, pers. comm.). One humpback whale swam across the longline and successfully managed to free itself from it (pers. comm.). The distribution of sea turtles and cetaceans Their respective BPUE did not show any spatial patterns or seasonality (Figs. 14-15).

Table 4. Number of discarded species or taxa in 2011-2013. * indicates custom made groups. VLF includes non-identified lancetfish (*Alepisaurus spp.*), gempylids (snake mackerel *Gempylus serpens*, oilfish *Ruvettus pretiosus*, escolars *Lepidocybium flavobrunneum, Promethichthys prometheus, Rexea* spp., and snoeks *Thyrsitoides marleyi, Nesiarchus nasutus*). VVL includes non-identified trachypteridae, lophotidae, regalecidae and radiicephalidae species

Table 5. Sharks, sea turtles and cetaceans bycatch between mid-2011 and mid-2013. "nei" stands for "not enough information"
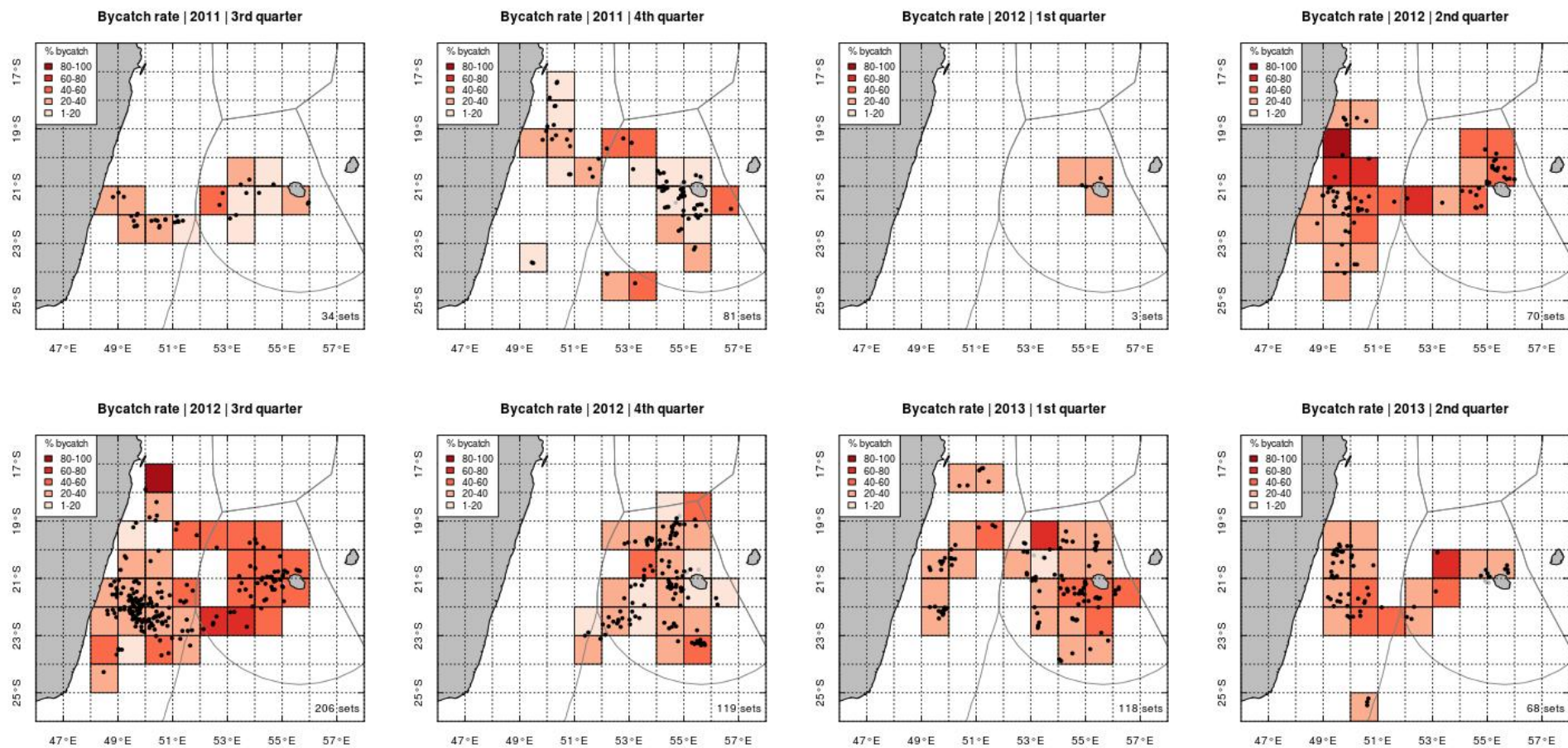
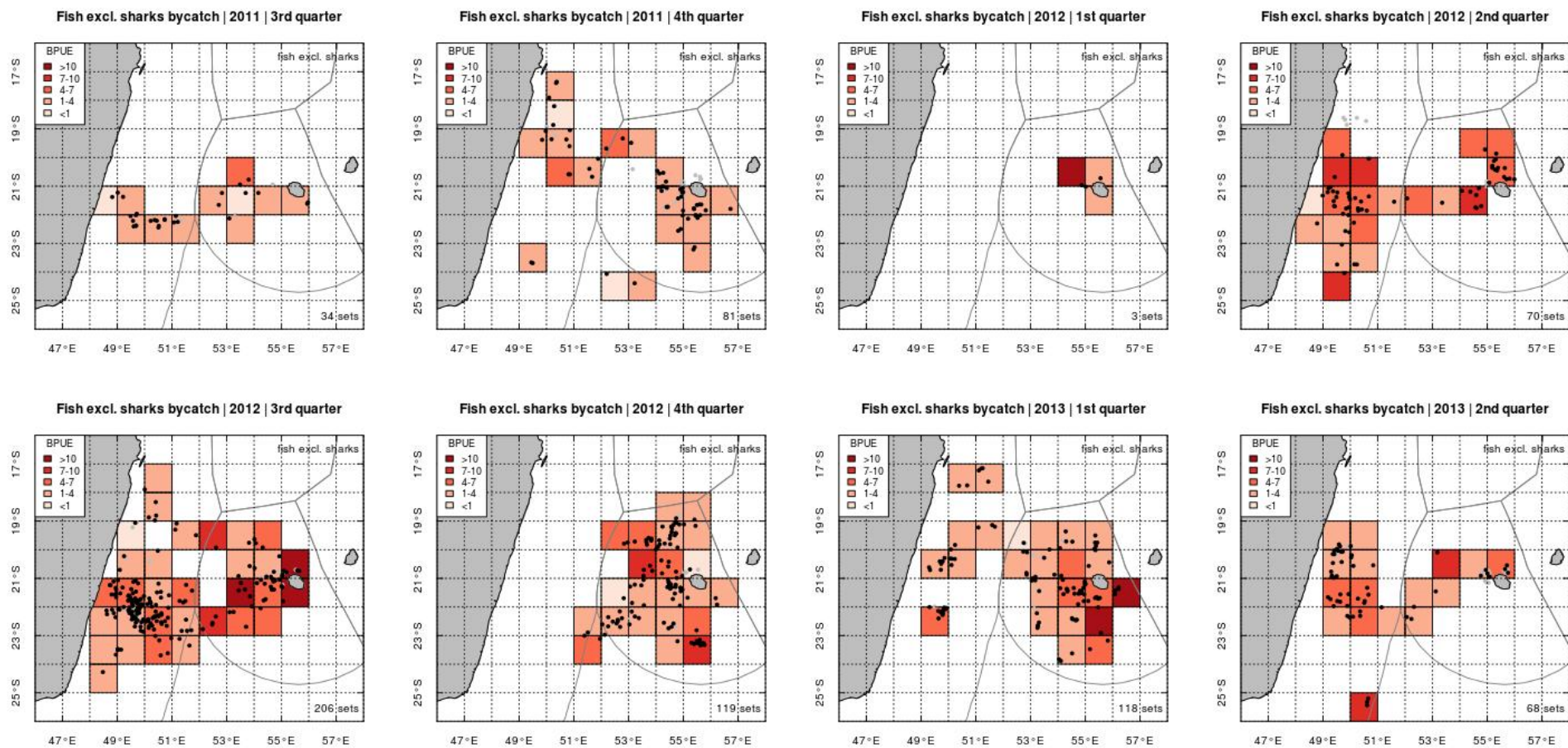Figure 10. Bycatch rate of discarded species in 2011-2013

Figure 11. Discarded fish distribution excluding sharks in 2011-2013. BPUE is the number of captures per 10000 hooks
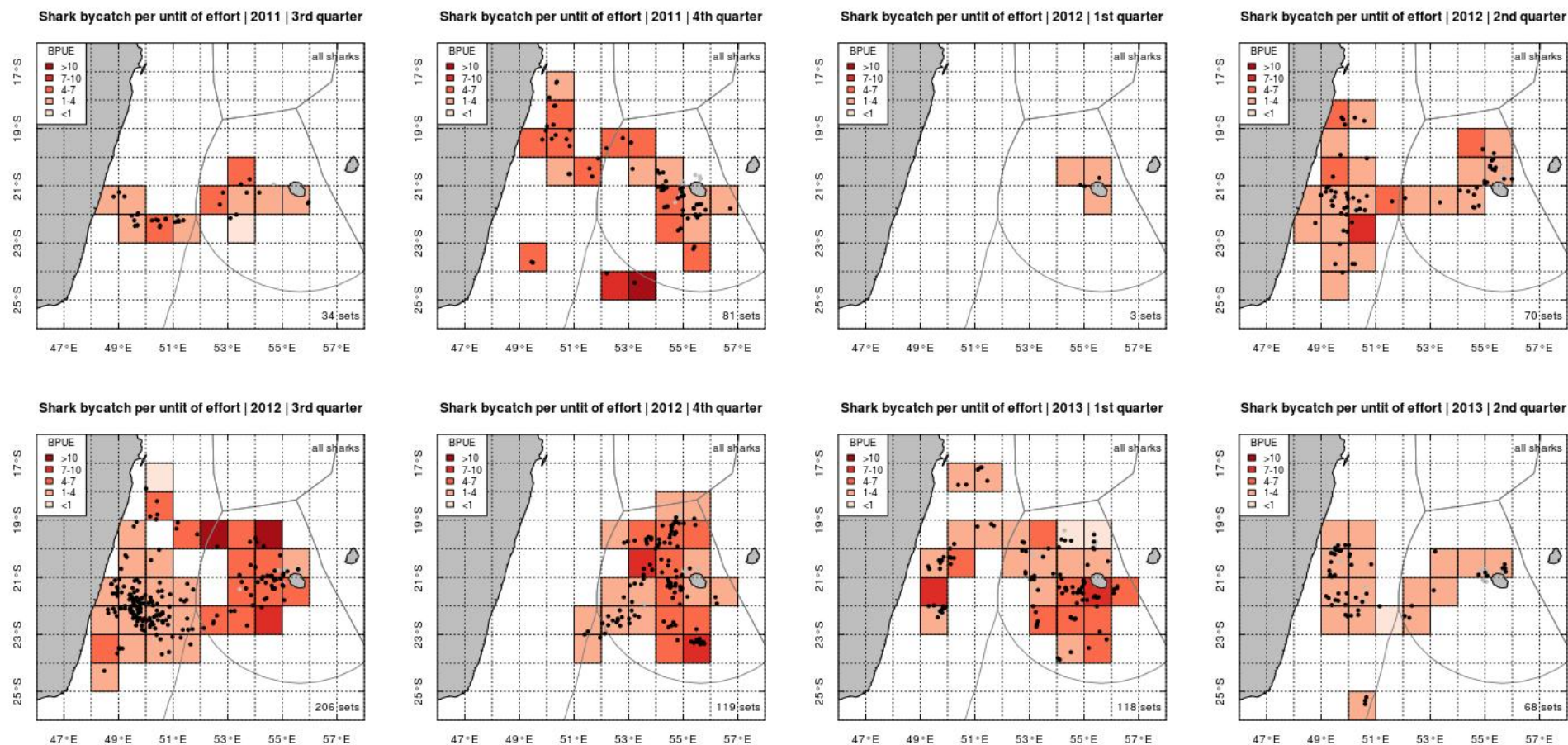
Figure 12. Shark bycatch distribution in 2011-2013. BPUE is the number of captures per 10000 hooks
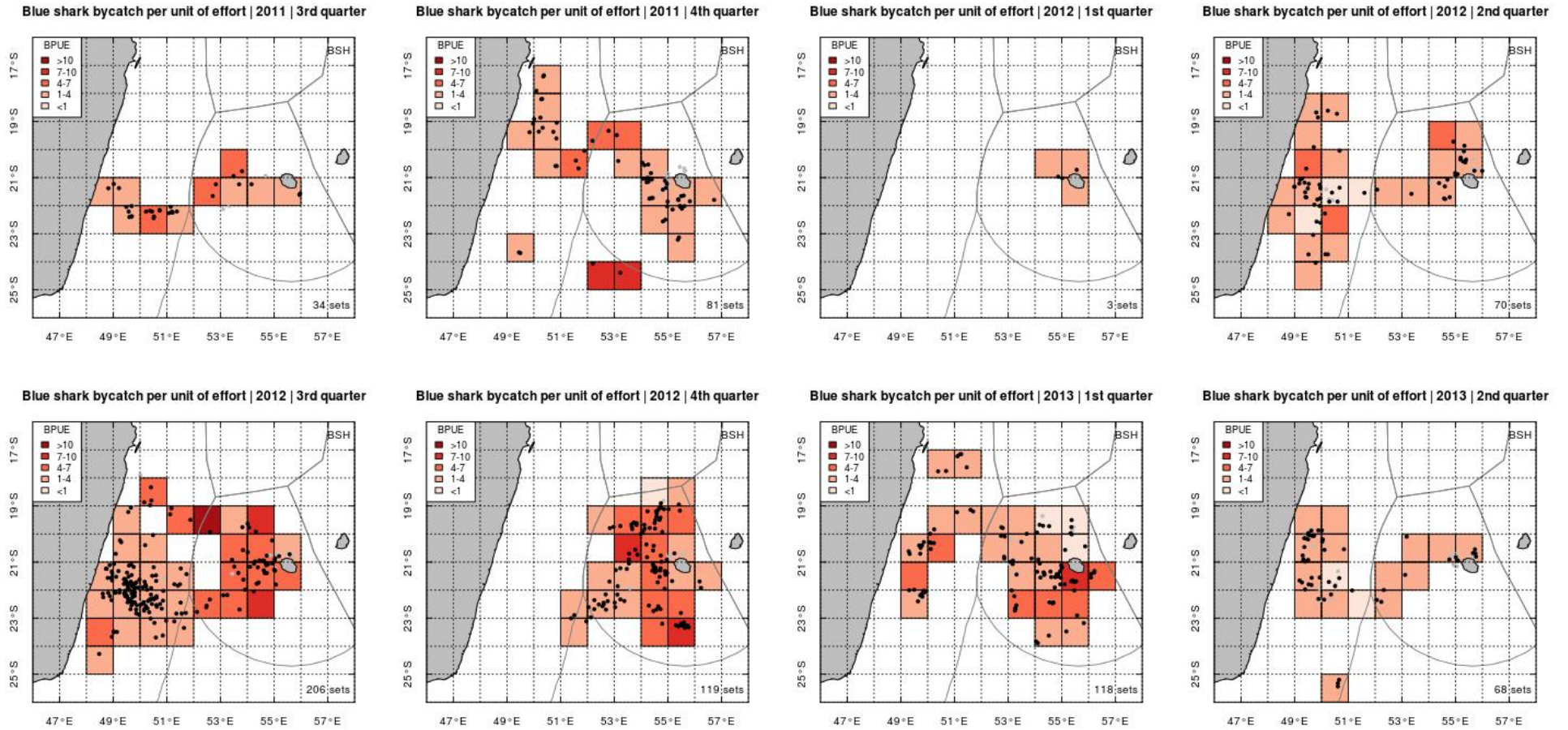
Figure 13. Blue shark (BSH *Prionace glauca*) bycatch distribution in 2011-2013. BPUE is the number of captures per 10000 hooks
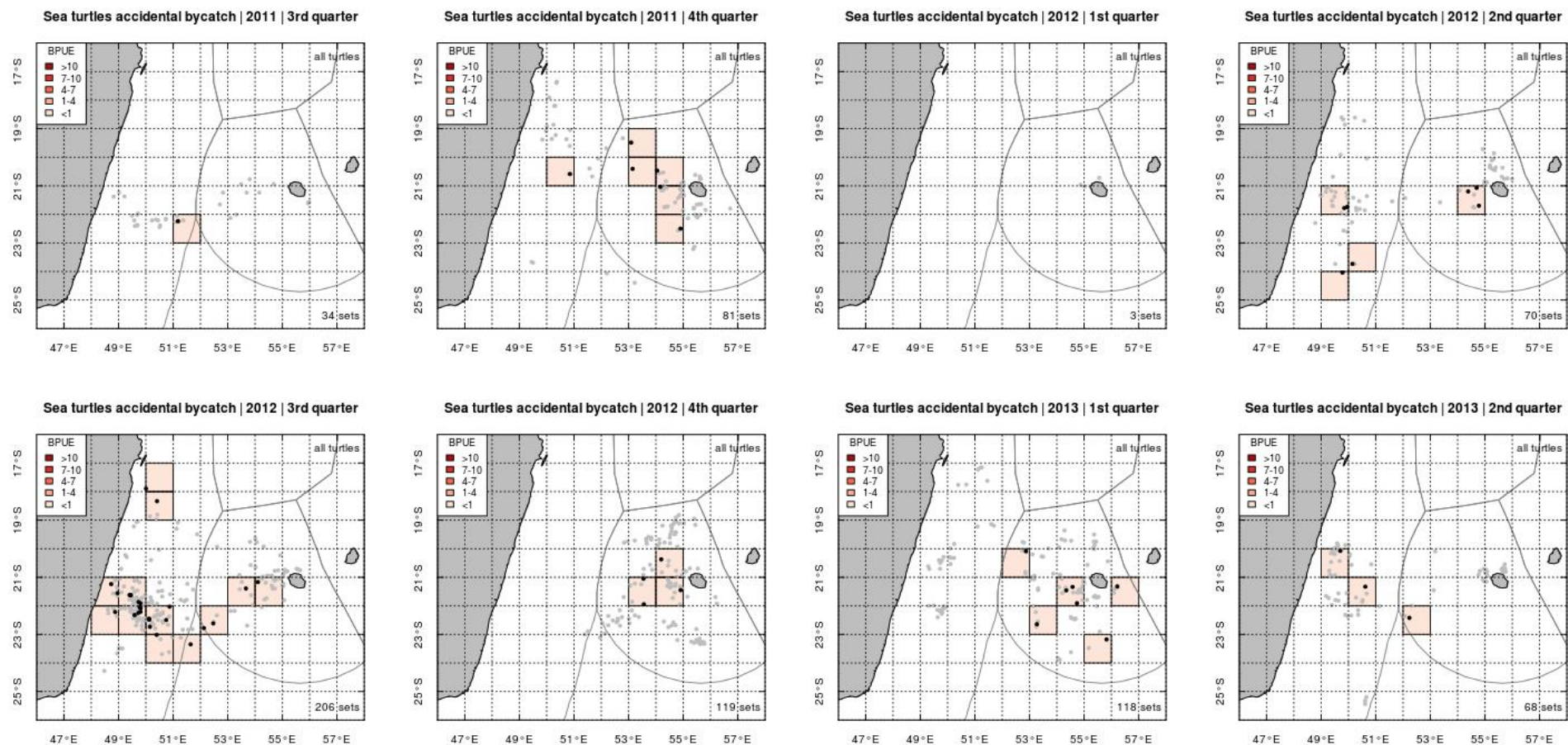
Figure 14. Accidental sea turtles bycatch distribution in 2011-2013
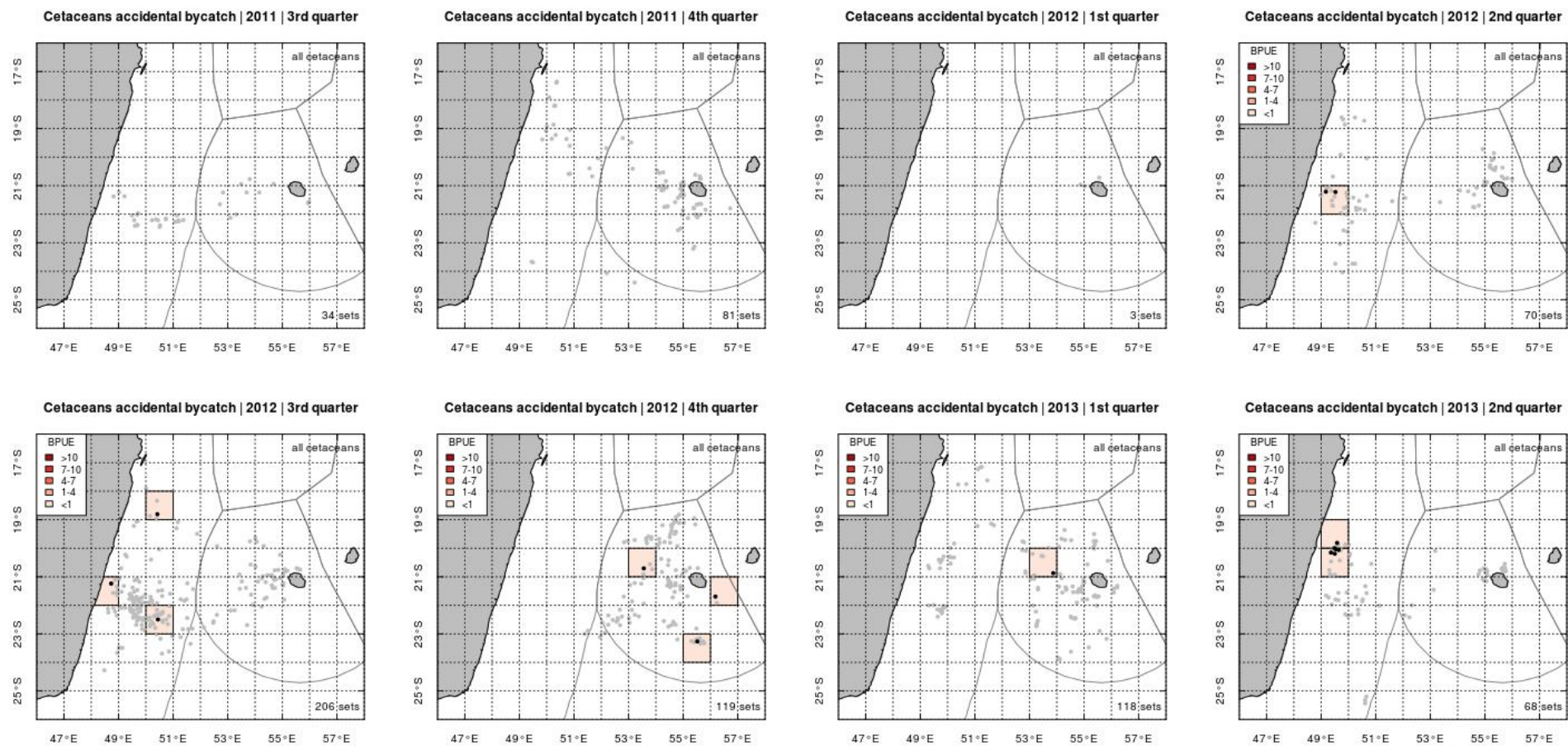
Figure 15. Accidental cetaceans bycatch distribution in 2011-2013

Discussion and conclusion

Self-reported data provide a very useful set informations to assess various aspects of Reunion's pelagic longline fishery including commercial catch, bycatch of discarded species and depredation.

Profitability of Reunion's pelagic longline fishery has clearly decreased since 2011 along with the CPUE of targeted swordfish.

Fishing in the EEZ of Madagascar during the 3rd quarter of the year instead of the French EEZ could be a recommendation made to fishermen because profitability raises above average and bycatch rate of discarded species is reduced. It is less profitable to go fishing in French EEZ at this period and ecological impact of higher bycatch rate is increased.

Albacore season (4th quarter of the year) can be reasonably profitable to fishermen even if albacore off-board price is low. Albacore price varies and usually decreases at that period as the offer raises (pers. comm.). High albacore CPUE are found near Reunion Island in the French EEZ. Fishermen may then reduce fuel costs by remaining in the French EEZ instead of going to Madagascar's EEZ at this period. Bycatch of discarded species is also reasonably low (mostly below 40%) during this period.

Discards from bycatch is a serious concern for fisheries worldwide, especially in the context ecosystem-based management to fisheries (Pikitch et al., 2004). Accidental captures of sea turtles are very seldom but sometimes deadly. Mortality at hauling on the main bycatch group, sharks, was rather low (19%) but it certainly underestimated non-quantifiable post-release mortality due for instance to hooks that remained in sharks gills and stomach. More detailed analysis on the actual impact of bycatch on non-commercial species is needed.

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Appendix 1. Fishing polygons between mid-2011 and mid-2013. Total number of sets monitored by the self-reporting program is 711

Fishing polygons