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Comparing the biological characteristics, length structure and capture

status of bycatch in the Chinese longline fishery targeting different species

in the Indian Ocean

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Summary

From October 2013 to January 2018, twelve Chinese tuna longline observer trips were operated in the Indian Ocean, seven targeting Bigeye tuna (N10°14′ - S22°47′, E23°12′ - E89°54′) and the other six targeting Albacore (N0°11′ - S34°37′, E25°19′ - E89°54′) including one trip changing the targeting species. Regarding observer trips targeting Bigeye tuna (*Thunnus obesus*), a total of 11,293 individuals among 49 bycatch species were observed from 2,178,636 hooks, including tunas (42.36%), billfishes (17.29%), sharks (12.26%), rays(3.19%) , dolphins and turtles (0.13%) ,and other species (24.77%). Major bycatch species (above 4% of total individuals) were as follows: Yellowfin tuna (*Thunnus albacares*), Longnose lancetfish (*Alepisaurus ferox*), Swordfish (*Xiphias gladius*), and the Blue shark (*Prionace glauca*). Regarding observer trips targeting Albacore (*Thunnus alalunga*), 7,860 individuals among 40 bycatch species were observed from 1,454,153 hooks, including tunas (40.01%), billfishes (5.22%), sharks(5.52%), rays (2.23%) , turtles (0.03%) ,and other species (47.00%). Major bycatch species were as follows: Bigeye tuna, Longnose lancetfish, Opah (*Lampris guttatus*), Escolar (*Lepidocybium flavobrunneum*), Dolphinfish (*Coryphaena hippurus*), Skipjack tuna (*Katsuwonus pelamis*), Yellowfin tuna and the Blue shark. The fate and condition of the capture status for bycatch were also analyzed. This report also compared the length frequency of major bycatch species between longline fishing vessels targeting bigeye tuna and albacore with Chinese scientific observer data.

Introduction

Bycatch species play an important role in maintaining stability and diversity of ecosystem, and especially some of them live at the top of trophic level but with slow growth rate, late maturity, and low fecundity. Generally, bycatch defined as non-targeted or/and non-retained species(Alverson, 1994) ,and it also has two more detailed definitions. The one definition based on a taxonomic approach defined the targeted species as a total of the 64 tuna and tuna-like species including mackerels, Spanish mackerels, bonitos, tunas and billfishes(Clarke et al, 2014). Another definition means any landed or/and non-retained species without regular is bycatch ,and even include high value species such as tuna (Davies,2009). According the last definition, all over the world bycatch was in approximately 40% of the commercial product(Davies,2009; Oliver,2015). Dealing with the definition in this case, we followed the last one, the bycatch species thus were defined as all recording catch(including discard) based on observer data only except targeted fish(bigeye tuna or albacore) during the trips.

Regarding the significant influence on marine fishery management from bycatch issues(such as discard mortality and catch reconstruction), and at the same time basic information from the observe data play a both essential and problematic role in solving these problems(Davis,2002). Therefore, China made a brief report to describe the national tuna longline bycatch information with observe data during the 12th WPEB meeting in 2016. In this study, we updated the bycatch information from 2013 to 2018 ,and additionally given an comparison of bycatch data among the trips targeting different species.

Material and method

In this case ,data collected by Chinese longline fisheries scientific observers program. Twelve Chinese tuna longline observer trips operated in the Indian Ocean from October 2013 to January 2018, seven targeting Bigeye tuna(BET) with 2,178,636 hooks (N10°14′ - S22°47′, E23°12′ - E89°54′) and the other six targeting Albacore(ALB) with 1,454,153 hooks (N0°11′ - S34°37′, E25°19′ - E89°54′) including one trips changing the targeting species(Table 1). The observer data includes fishing position (Figure 1 a&b), date, hooks, catch number by species and various types of biological information (such as sex, maturity ,length(cm) and capture status). We compared the length frequency, sex ratio and maturity of major bycatch species between longline fishing vessels targeting bigeye tuna and albacore.

Result

Bycatch species composition

The bycatch species were classified into different categories, i.e. tunas, billfishes, sharks, rays, turtles, dolphins and other species. Figure 2 revealed the composition of bycatch species for each trip. The tuna was the most component of the bycatch in all trips, but the others play the different role when trips have different target species. For the trips targeted BET, the sharks and billfishes had the relative large fraction ,both accounted for 5% to 20 % each trip. For the trips targeted ALB, both proportion were lower than 3% each trip.

The composition of bycatch was listed in Table 2 and 3. For the trips targeted BET, 11,293 bycatch individuals were observed, belonging to 3 tuna species(42.63%), 6 billfish species(17.29%), 16 shark species(12.26%), 2 ray species(3.19%), 3 turtle species (0.1%) ,2 dolphin species(0.03%) and 17 other species(24.77%). For the trips targeted ALB, 7,860 bycatch individuals were observed, belonging to 4 tuna species(40.01%), 7 shark species(5.52%), 6 billfish species(5.22%), 1 ray species(2.23%), 2 turtle species (0.03%) and 20 other species(47.00%).

Regarding we include tuna species in the bycatch species, we selected4% as a standard to record the major species. For the trips targeted BET, major bycatch species (above 4% of total individuals) were as follows: Yellowfin tuna (28.31%), Longnose lancetfish(7.47%), Swordfish (6.18%), and the Blue shark (4.9%). For the trips targeted ALB, Major bycatch species were as follows: Bigeye tuna (27.29%), Longnose lancetfish (10.99%), Opah (10.09%), Escolar (8.63%), Dolphinfish (8.18%), Skipjack tuna (6.49%), Yellowfin tuna (5.87%) and Blue shark (4.8%).

Capture fate of bycatch species

The capture status   record as A1(alive and healthy), A2(alive and injured), A3(alive but dying) and   D(dead). The fate conditions were record as D(discard), PD(part discard) and R(retain). Capture statuses were recorded for a total of 10,963 and 7,628 individuals including tunas, sharks, billfishes, rays ,turtles ,dolphins and other species from observe trips targeted BET and ALB respectively(Figure 3 and 4). For the BET vessels, 11 sea turtles (8 healthy, 1 dying and 2dead) and 3 dolphins were observed, all of them were discarded. For the ALB vessels, only two sea turtles(1 healthy and 1 dead) were observed and all were discarded. Due to the economic value, tunas were all retained or part discard and rays were almost discard in all observer trips. The discarded rate of billfishes(10.18%), sharks(60.49%) and other species(72.62%) from BET trips were all higher than that(billfishes 0.49% ,sharks 17.33% and other species 22.55%) form ALB trips. The proportion of alive and healthy of sharks and rays were both more than half in trips target ALB or BET(except that healthy sharks accounted for 40.98% in trips target ALB). Most of billfishes were dead or dying in both BET trips or ALB trips, and healthy tuna bycatch accounted for 40.64% and 32.87% when trips targeted BET and ALB respectively.

For BET trips, a total of 366, 1859, 361 individuals of Blue shark(BSH), Yellowfin tuna(YFT) and Escolar(LEC) has been recorded fork length respectively. And for ALB trips, the number of that

three bycatch species whose size were recorded is 358, 461 and 671(Figure 5). The mean of BSH were 207.6 cm and 158.7 cm(FL), suggesting the size of blue shark from BET trips is larger than that form ALB trips. About YFT and LEC ,there is no significant different between trips targeted ALB or BET.

Considering there are significant different in bycatch composition and size frequency when tuna longline vessels targeted different species. Spatial distribution could be one reason, but the selectivity or catchability of vessel may change when the captain change the fishing technology to target other species. Thus we may give different selectivity or catchability to vessels targeted different species ,although they were all tuna longline vessel.

Reference

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Davies R W D, Cripps S J, Nickson A, et al. Dening and estimating global marine sheries bycatch[J]. Marine Policy, 2009, 33(4):661-672.

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Tab.1 Summary of longline observer trips conducted in the Indian Ocean

Trips	Data	Operations/days	Hooks	Target species
1	2013/10/7 - 2014/2/22	129	211,640	Bigeye tuna
2	2014/8/3 - 2014/8/15	3	7,446	Bigeye tuna
2	2014/8/16 - 2014/9/26	30	95,649	Albacore tuna
3	2014/8/3 - 2014/9/26	28	75,318	Albacore tuna
4	2015/12/15 - 2016/2/17	59	104,448	Bigeye tuna
5	2016/10/9 - 2016/11/29	40	151,534	Albacore tuna
6	2016/10/17 - 2017/4/14	145	456,896	Bigeye tuna
7	2016/10/21 - 2017/4/10	155	414,103	Bigeye tuna
8	2016/10/18 - 2017/4/10	149	421,080	Bigeye tuna
9	2017/6/17 - 2017/12/22	142	486,687	Albacore tuna
10	2017/8/28 - 2017/12/16	90	328,090	Albacore tuna
11	2017/9/8 - 2017/12/22	87	316,875	Albacore tuna
12	2017/4/28 - 2018/1/2	213	563,023	Bigeye tuna

Tab.2 The list of bycatch species composition (trips targeted BET)

Category	English Name	Scientific Name	Catch	
			Number	**%**
Tunas	Yellowfin tuna	*Thunnus albacares*	4589	40.64%
	Skipjack tuna	*Katsuwonus pelamis*	126	1.12%
	Albacore	*Thunnus alalunga*	69	0.61%
Other Species	Longnose lancetfish	*Alepisaurus ferox*	1211	10.72%
	Escolar	*Lepidocybium flavobrunneum*	511	4.52%
	Sickle pomfret	*Taractichthys steindachneri*	301	2.67%
	Dolphinfish	*Coryphaena hippurus*	247	2.19%
	Great barracuda	*Sphyraena barracuda*	170	1.51%
	Wahoo	*Acanthocybium solandri*	95	0.84%
	Opah	*Lampris guttatus*	89	0.79%
	Snake mackerel	*Gempylus serpens*	72	0.64%
	Dagger pomfret	*Taractes rubescens*	47	0.42%
	Oilfish	*Ruvettus pretiosus*	17	0.15%
	ocean sunfish	*Mola mola*	17	0.15%
	Bigscale pomfret	*Taractichthys longipinnus*	8	0.07%
	Sharptail sunfish	*Masturus lanceolatus*	7	0.06%
	Dealfish	*Desmodema polystictum*	2	0.02%
	Rainbowrunner	*Elagatis bipinnulata*	1	0.01%
	Rabbit puffer	*Lagocephalus lagocephalus*	1	0.01%
	Atlantic tripleail	*Lobotes surinamensis*	1	0.01%
Billfish	Swordfish	*Xiphias gladius*	1002	8.87%
	Indo-Pacific blue marlin	*Makaira nigricans*	483	4.28%
	Striped marlin	*Tetrapturus audax*	284	2.51%
	Indo-Pacific sailfish	*Istiophorus platypterus*	142	1.26%
	Black marlin	*makaira indica*	27	0.24%
	Shortbill spearfish	*Tetrapturus angustirostris*	15	0.13%
Sharks	Blue shark	*Prionace glauca*	795	7.04%
	Pelagic thresher	*Alopias pelagicus*	137	1.21%
	Oceanic whitetip shark	*Carcharhinus longimanus*	117	1.04%
	Silky shark	*Carcharhinus falciformis*	105	0.93%
	Bigeye thresher	*Alopias superciliosus*	78	0.69%
	Shortfin mako	*Isurus oxyrinchus*	49	0.43%
	Crocodile shark	*Pseudocarcharias kamoharai*	43	0.38%
	Velvet dogfish	*Zameus squamulosus*	27	0.24%
	longfin mako	*Isurus paucus*	12	0.11%
	Bigeye sand tiger	*Odontaspis noronhai*	6	0.05%
	Great hammerhead	*Sphyrna mokarran*	4	0.04%
	Blacktip shark	*carcharhinus limbatus*	4	0.04%
	Smooth hammerhead	*Sphyrna zygaena*	3	0.03%

	Scalloped Hammerhead	*Sphyrna lewini*	3	0.03%
	Bignose shark	*Carcharhinus altimus*	1	0.01%
	Silvertip shark	*Carcharhiuns albimarginatus*	1	0.01%
Rays	Pelagic stingray	*Dasyatis violacea*	352	3.12%
	spinetail mobula	*Mobula japonica*	8	0.07%
Turtles	Leatherback turtle	*Dermochelys coriacea*	7	0.06%
	Olive Ridley turtle	*Lepidochelys olivacea*	3	0.03%
	Green turtle	*Chelonia mydas*	1	0.01%
Dolphins	Common bottlenose dolphin	*Tursiops truncatus*	2	0.02%
	Dolphin	*Delphinidae*	1	0.01%

Tab.3 The list of bycatch species composition (trips targeted ALB)

| Category	English Name	Scientific Name	Catch	
			Number	%
Tunas	Bigeye tuna	*Thunnus obesus*	2145	27.29%
	Skipjack tuna	*Katsuwonus pelamis*	510	6.49%
	yellowfin tuna	*Thunnus albacares*	461	5.87%
	Southern Bluefin tuna	*Thunnus maccoyii*	29	0.37%
Shark	blue shark	*Prionace glauca*	377	4.80%
	Shortfin mako	*Isurus oxyrinchus*	51	0.65%
	Oceanic whitetip shark	*Carcharhinus longimanus*	2	0.03%
	Bignose shark	*Carcharhinus altimus*	1	0.01%
	silky shark	*Carcharhinus falciformis*	1	0.01%
	Bigeye thresher	*Alopias superciliosus*	1	0.01%
	Kitefin shark	*Dalatias licha*	1	0.01%
Billfishes	Striped Marlin	*Tetrapturus audax*	116	1.48%
	Indo-Pacific sailfish	*Istiophorus platypterus*	103	1.31%
	swordfish	*Xiphias gladius*	68	0.87%
	Shortbill spearfish	*Tetrapturus angustirostris*	61	0.78%
	blue marlin	*Makaira nigricans*	40	0.51%
	Black marlin	*Makaira indica*	22	0.28%
Rays	Pelagic Stingray	*Dasyatis Violacea*	175	2.23%
Turtles	Olive ridley sea turtle	*Lepidochelys olivacea*	1	0.01%
	loggerhead turtle	*Caretta caretta*	1	0.01%
Other Species	Longnose lancetfish	*Alepisaurus ferox*	864	10.99%
	Opah	*Lampris guttatus*	793	10.09%
	Escolar	*Lepidocybium flavobrunneum*	678	8.63%
	Dolphinfish	*Coryphaena hippurus*	643	8.18%
	wahoo	*Acanthocybium solandri*	222	2.82%
	Great barracuda	*Sphyraena barracuda*	174	2.21%
	sickle pomfret	*Taractichthys steindachneri*	143	1.82%
	dagger pomfret	*Taractes rubescens*	79	1.01%
	Slender mola	*Ranzania leavis*	40	0.51%
	Oilfish	*Ruvettus pretiosus*	22	0.28%
	Crestfish	*Lophotus capellei*	10	0.13%
	Snake mackerel	*Gempylus serpens*	7	0.09%
	Lustrous pomfret	*Eumegistus illustris*	6	0.08%
	Atlantic pomfret	*Brama brama*	5	0.06%
	Black gemfish	*Nesiarchus nasutus Johnson*	2	0.03%
	Pacific fanfish	*Pteraclis aesticola*	2	0.03%
	Dealfish	*Desmodema polystictum*	1	0.01%
	Sharptail sunfish	*Masturus lanceolatus*	1	0.01%
	Razorback scabbardfish	*Assurger anzac*	1	0.01%
	ocean sunfish	*Mola mola*	1	0.01%
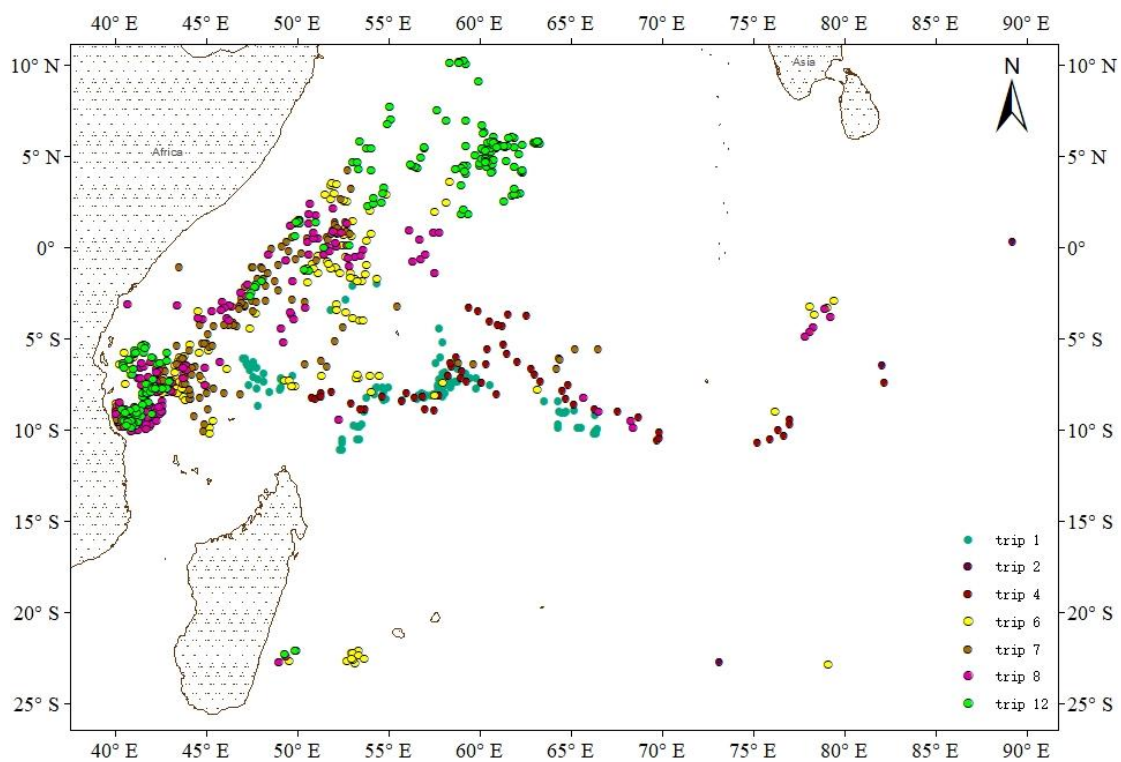
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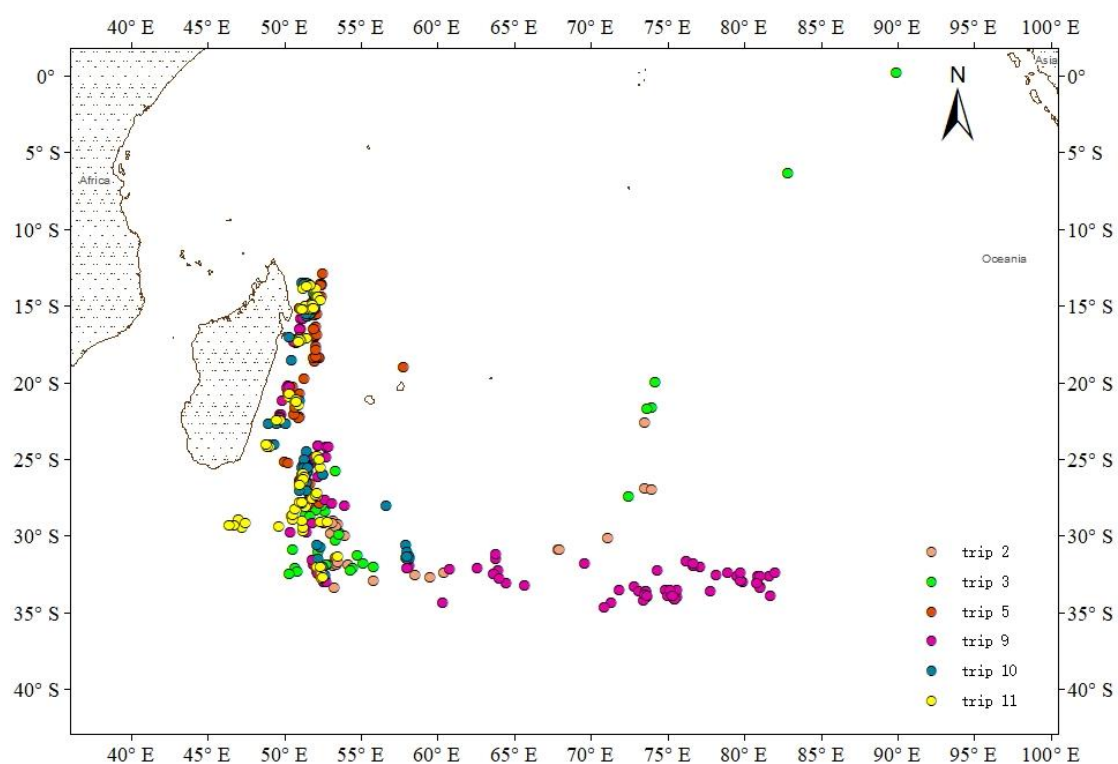
b

Fig.1 Spatial distribution of Chinese longline observer trips in the Indian Ocean(a, trips targeted BET; b, trips targeted ALB)
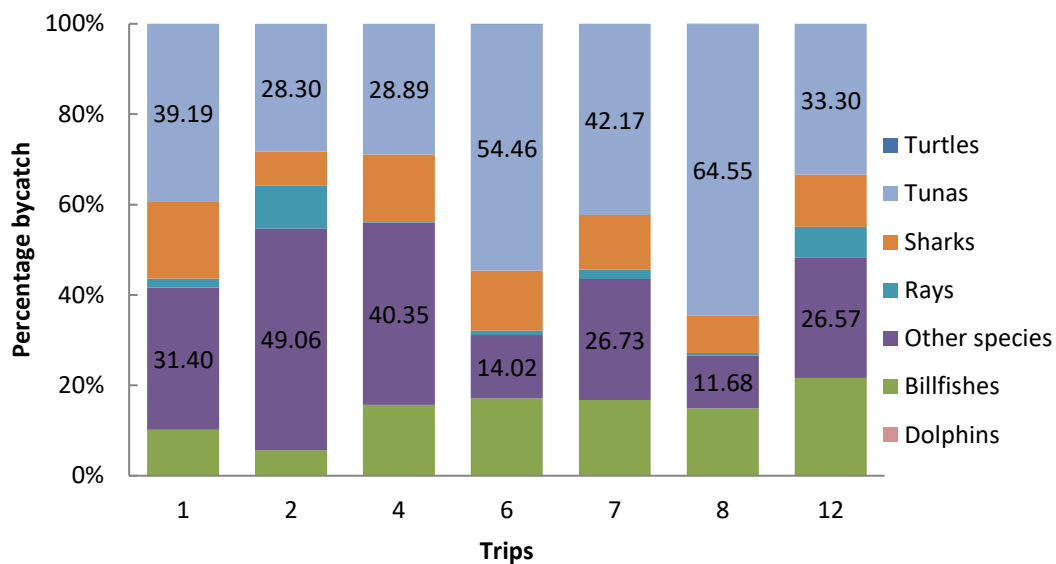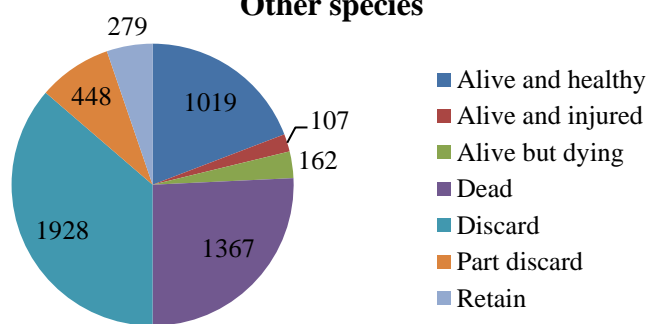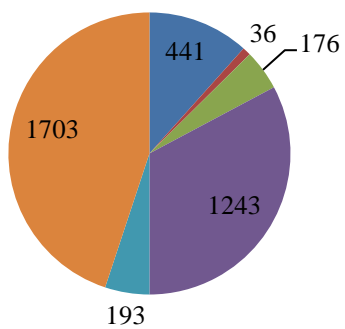
a
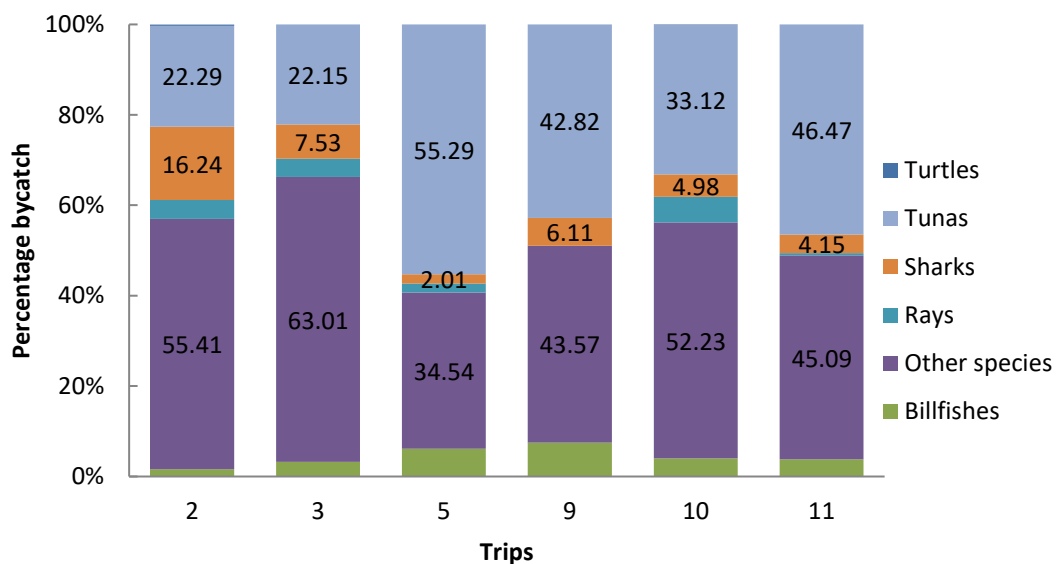
b

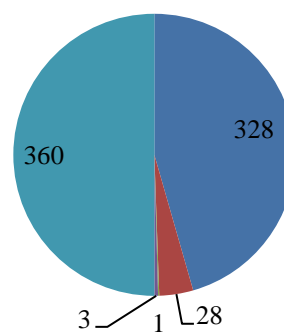Fig.2 Proportion of catch in number of by-catch species groups(a, trips targeted BET; b, trips targeted ALB)

Other species

1019 — Alive and healthy
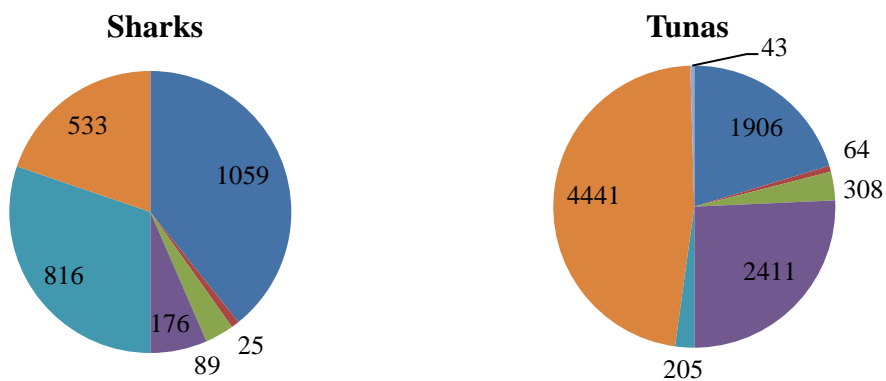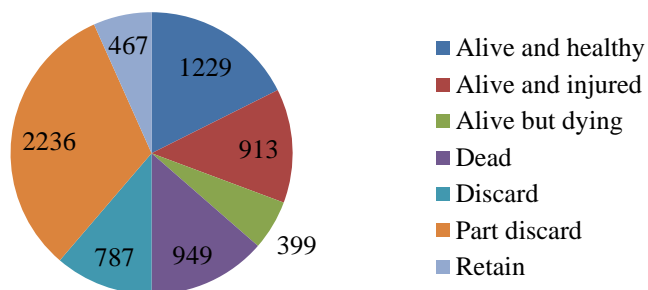107 — Alive and injured
162 — Alive but dying
1367 — Dead
1928 — Discard
448 — Part discard
279 — Retain

Legend:
- Alive and healthy
- Alive and injured
- Alive but dying
- Dead
- Discard
- Part discard
- Retain

Billfishes

441
36
176
1243
193
1703

Rays

328
28
1
3
360

Sharks

Tunas

Fig.3 The composition of capture fate of bycatches (trips targeting BET)

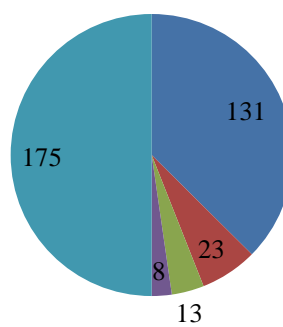**Other species**

- Alive and healthy
- Alive and injured
- Alive but dying
- Dead
- Discard
- Part discard
- Retain

Billfishes
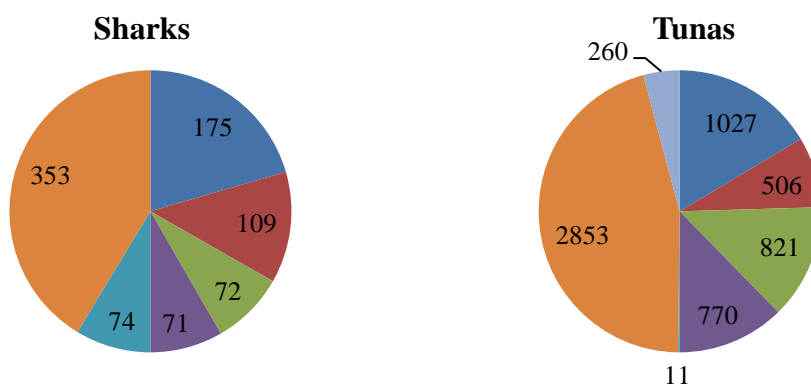

Rays

Sharks
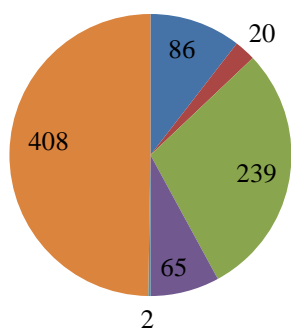
Tunas

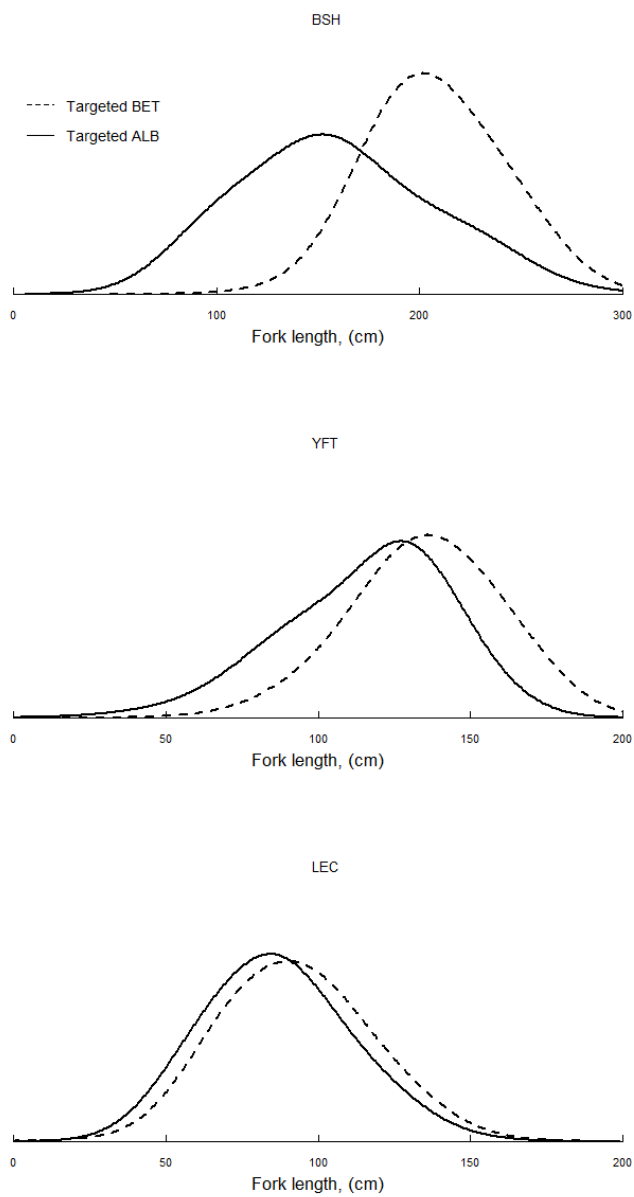Fig.4 The composition of capture fate of bycatches (trips targeting ALB)

Fig.5 Size frequency for three major bycatch species