(IOTC-WPTT-2005-)

Report of the predation* survey by the Japanese commercial tuna longline fisheries

(September, 2000 – December, 2004)

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Abstract

This report summarizes the results of the predation survey conducted by the Japanese commercial tuna longline fisheries for 4 years and 4 months from September, 2000-December, 2004. We conducted the descriptive data analyses to present results. Definition of the predation rates are changed from those used in the past.

Contents

Submitted to the Seventh Working Party on the Tropical Tuna meeting (WPTT) (July 18-22, 2005), Phuket, Thai, organized by Indian Ocean Tuna Commission (IOTC).

Note (*): It is noted that "depredation" is the correct term as we survey the catch (dead tuna) being predated again. But we use "predation" in this report as we have been using it as a common term in the past.

1. Introduction

Predation problems by killer whales (*Orcinus orca)* and false killer whales (*Pseudorca crassidens*) on Japanese tuna longline fisheries have been continued to the present in three Oceans since the start of its fisheries in 1952. The first report was from the Palau water in 1952. In the earlier years, only some catch of the longliners where the predators had passed, were damaged. But, predation had become expanding to the whole catch of the longliners for some cases. In serious case, predators approach to the broadsides of the boats and attack the catch.

To investigate this predation problem and to find out possible mitigation methods, Fisheries Agency of Japan had conducted a number of surveys and research in the Pacific Ocean and the Indian Ocean, using public longline vessels (high school longline training vessels and prefecture fisheries stations' longline vessels) for 18 years in 1954, 1958 and 1965-81. Summary of these survey results were reported by Nishida and Tanio (IOTC-WPTT-2001-17, 2001).

In recent years, predation problems in the western Indian Ocean became also serious, thus the IOTC Scientific Committee and Commissioner's meetings in 1998 and 1999 recommended to start investigating the situation of the predation problems. Upon this recommendation, Japan started the predation survey from September, 2000 for all the longliners belonging to Japan Tuna Federation and nationwide Fishers' Union called as the JF (Japan Fisheries Cooperatives or Zengyoren in Japanese) in three Oceans. Currently about 450 longliners from Japan Tuna and 30 from the JF are cooperating to this survey. This report summarizes the results of the surveys for 4 years and 4 months from September, 2000 to December, 2004.

2. Materials and methods

We have collected predation survey data for 4.5 years from September, 2000 to March, 2005. Map 1 show the world-wide location of the survey report by year and Table 1 and 2 show numbers of boats and operations reported by Ocean respectively. However, in this paper, we used the data for 4 years and 4 months (September, 2000- December, 2004) because only small part of the recent data in 2005 has been recovered. And even for the 2004 data, data are not fully recovered yet. We conducted descriptive data analyses for the Indian Ocean using different presentations , i.e., summary tables, Figures and maps using by Marine Explorer version 4.2 (*http://www.esl.co.jp/index.htm*) (Marine GIS software).

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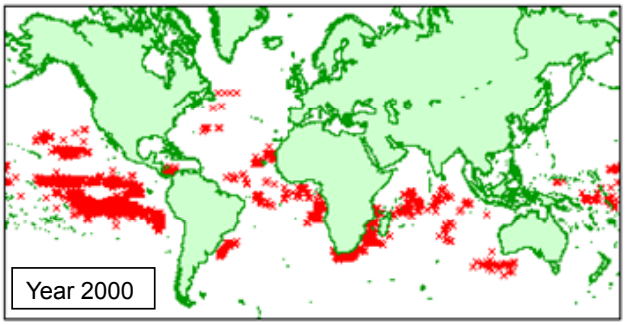

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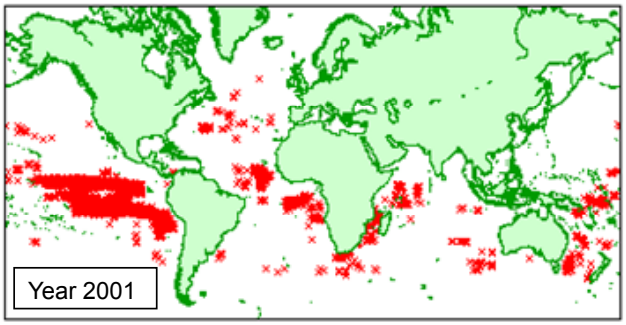

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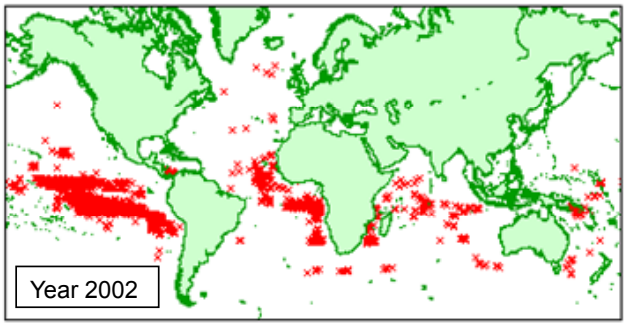

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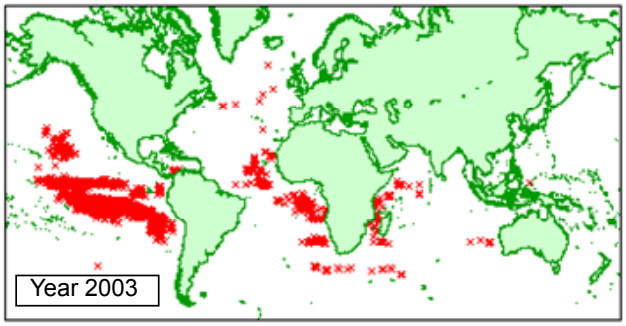

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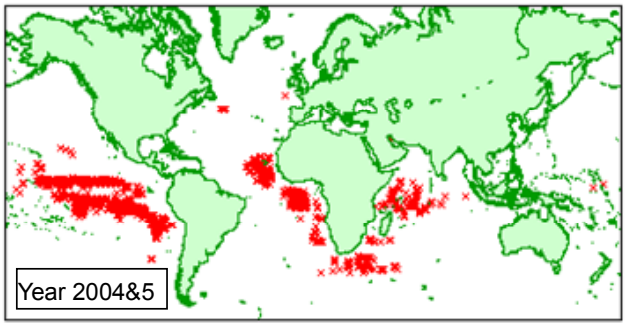


Map 1 Locations of predations reported by Japanese longliners (as of June, 2005, total n=17,100)

Table 1. Total number of Japanese tuna LL vessels reporting damages by predators

Year	Q	Pacific	Indian	Atlantic	TOTAL
2000	Q3(7-9)	67	24	27	118
	Q4(10-12)	75	25	28	128
	TOTAL	142	49	55	246
2001	Q1(1-3)	39	5	14	58
	Q2(4-6)	47	6	14	67
	Q3(7-9)	50	11	4	65
	Q4(10-12)	52	11	10	73
	TOTAL	188	33	42	263
2002	Q1(1-3)	48	5	9	62
	Q2(4-6)	49	5	6	60
	Q3(7-9)	43	7	7	57
	Q4(10-12)	43	10	8	61
	TOTAL	183	27	30	240
2003	Q1(1-3)	39	5	8	52
	Q2(4-6)	39	3	9	51
	Q3(7-9)	37	2	10	49
	Q4(10-12)	32	1	13	46
	TOTAL	147	11	40	198
2004	Q1(1-3)	29	2	14	45
	Q2(4-6)	23	9	9	41
	Q3(7-9)	15	8	8	31
	Q4(10-12)	3	3	4	10
	TOTAL	70	22	35	127
2005	Q1(1-3)	0	0	1	1
	TOTAL	0	0	1	1
TOTAL		730	142	203	1,075

Table 2 Reported number of Japanese tuna LL operations damaged by predators

Year	Q	Pacific	Indian	Atlantic	TOTAL
2000	Q3(7-9)	811	174	182	1,167
	Q4(10-12)	1,852	305	197	2,354
	TOTAL	2,663	479	379	3,521
2001	Q1(1-3)	1,126	94	287	1,507
	Q2(4-6)	1,002	113	134	1,249
	Q3(7-9)	1,043	110	10	1,163
	Q4(10-12)	949	66	92	1,107
	TOTAL	4120	383	523	5,026
2002	Q1(1-3)	821	72	136	1,029
	Q2(4-6)	624	44	58	726
	Q3(7-9)	847	124	69	1,040
	Q4(10-12)	629	82	152	863
	TOTAL	2,921	322	415	3,658
2003	Q1(1-3)	547	66	129	742
	Q2(4-6)	605	28	94	727
	Q3(7-9)	795	13	94	902
	Q4(10-12)	613	5	98	716
	TOTAL	2,560	112	415	3,087
2004	Q1(1-3)	445	23	196	664
	Q2(4-6)	337	92	47	476
	Q3(7-9)	424	105	90	619
	Q4(10-12)	7	29	11	47
	TOTAL	1,213	249	344	1,806
2005	Q1(1-3)	0	0	2	2
	TOTAL	0	0	2	2
TOTAL		13,477	1,545	2,078	17,100

In the predation survey, when at least one fish in each operation was damaged, number of the damaged fish by species is reported by the LL boats, while when there are no predations, they don't report. In addition, they don't record catch data in the predation survey form, although they are necessary information to compute the predation rates. This is because we can get the catch data through the logbooks, so that extra works can be avoided for LL fishers to re-write (duplicate) Catch data from the logbook and 0 predation data into the predation survey forms during their busy fishing operations. Thus, the predation rates (%) by species in each operation are computed by:

Predation rate (PR) (%) = a*100/ (total catch: A+B)

, where, *A: number of damaged fish from the predation survey*
B: number of catch from the logbook (no. of damaged fish are excluded)

Important note:

(1) This PR in our survey is the figure for the situation when at least one fish in each operation was damaged.
*(2) Previously (until the last report), we used Predation rate (%) = A*100/B, which apparently provided overestimated figures.*

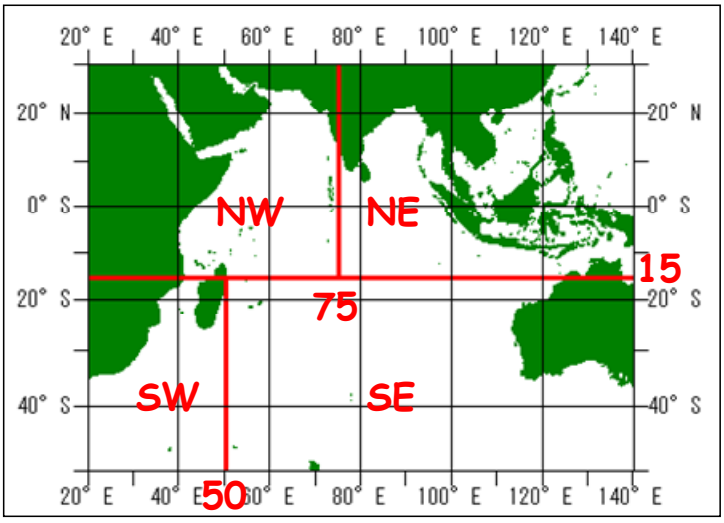
For annual or quarterly average PR, it is computed by simple arithmetic mean by month, quarter, 1x1 areas,

3. Results (Indian Ocean)

Results are summarized by different presentations as shown in Table 3.

Table 3 Results of the predation survey in the Indian Ocean (September, 2000 – December, 2002)

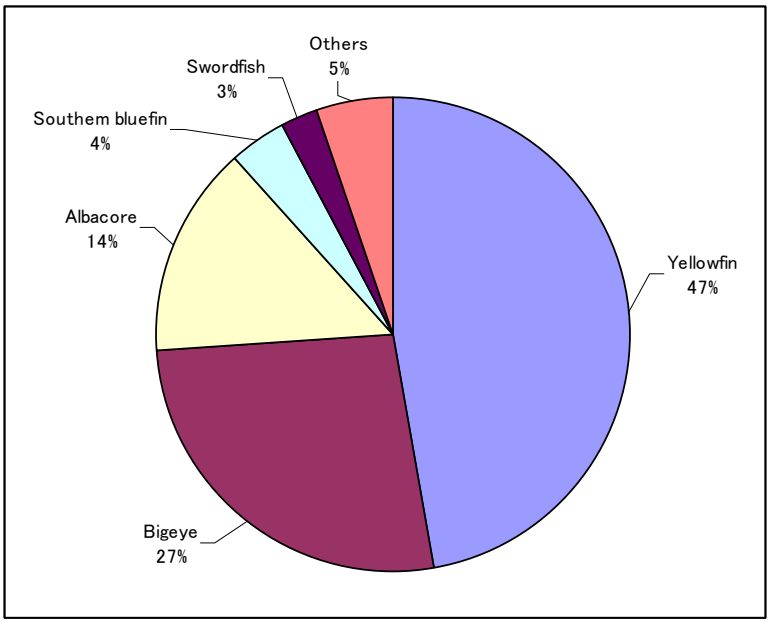
Type	No.	Page	Contents
Table	1	4	Total number of Japanese tuna LL vessels reporting damages by predators
	2	4	Reported number of Japanese tuna LL operations damaged by predators
	3	6	(this table)
	4	7	Reported number of fish attacked by year and species
	5	8	Reported number of predators by year and species
	6	9	Reported number of attacked fish & umber of attacked fish per operation by quarter and sub-area
	7		Reported number of predators & number of predators recorded per operation by quarter and sub-area
Fig.	1	7	Species compositions of attacked fish (2002-2004)
	2	8	Species compositions of predators (2002-2004)
Map	2	6	Four sub-areas
	3	10	Species compositions of attacked fish per operation by quarter and sub-area (2002-2004)
	4	11	Species compositions of predators per operation by quarter and sub-area (2002-2004)
	5	12	Distribution of attacked fish by year (all species combined)
	6	13	(Yellowfin tuna)
	7	14	(Bigeye tuna)
	8	15	(Albacore tuna)
	9	16	(Swordfish)
	10	17	Distribution of attacked fish by quarter (all species combined)
	11	18	(Yellowfin tuna)
	12	19	(Bigeye tuna)
	13	20	(Albacore tuna)
	14	21	(Swordfish)



Map 2 Four sub-areas

Table 4 Reported number of fish attacked by year and species in the predation survey in the Indian Ocean

	2000	2001	2002	2003	2004
Southern bluefin	30	154	36	18	85
Albacore	306	348	342	32	167
Bigeye	818	806	337	80	172
Yellowfin	1,048	1,583	454	490	346
Swordfish	100	66	24	12	13
Striped marlin	1	1	4	4	0
Blue marlin	22	3	3	5	5
Black Marlin	1	1	0	0	0
Sailfish	5	15	9	5	12
Skipjack	0	0	2	0	0
Sharks	3	0	0	0	2
unidentified	8	0	0	0	0
Others	17	197	76	7	9
Butterfly fish	3	0	9	0	0
TOTAL	2,362	3,174	1,296	653	811



(Others: black marlin, sailfish, skipjack, sharks. butterfly fish, unidentified species and other species)

Fig. 1 Species compositions of attached fish (2002-2004) (n=8,296)

Note: These figures are based on the reported data when at least one fish is attacked in each operation, thus operations without any predation are not included.

Table 5 Reported number of predators by year and species in the predation survey in the Indian Ocean

	2000	2001	2002	2003	2004	TOTAL
Sharks	283	237	215	33	141	909
False killer*	187	139	107	79	111	623
Others	10	8	0	0	14	32
TOTAL	480	384	322	112	266	1,564

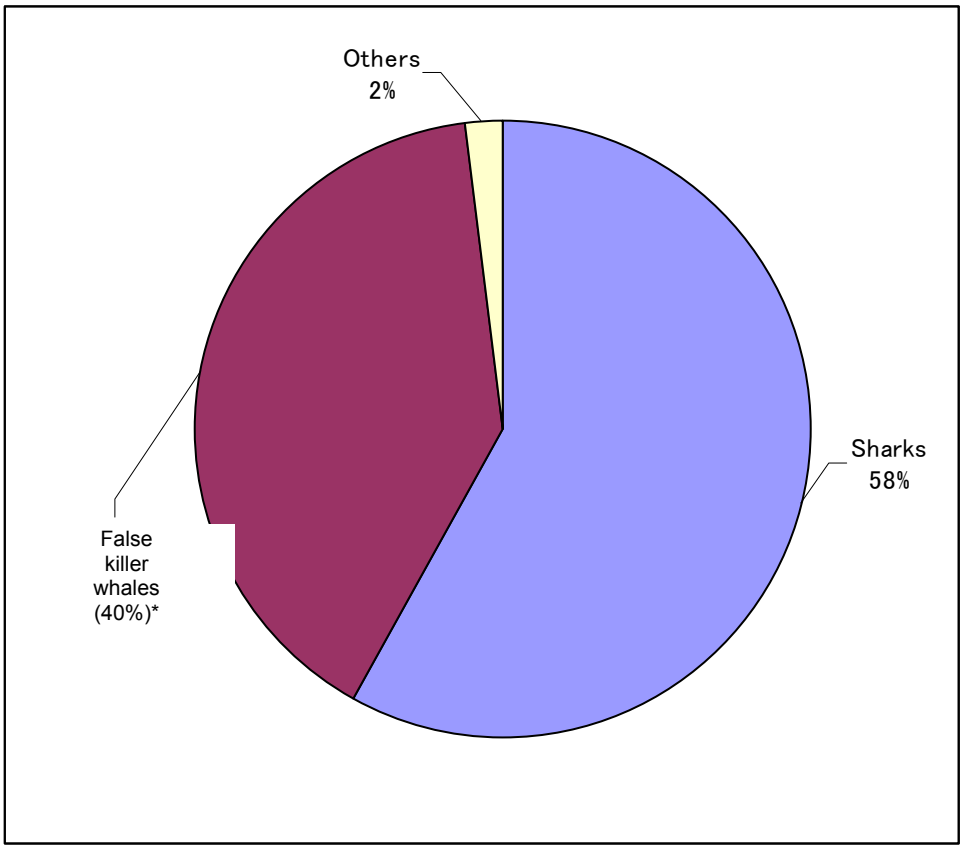


Fig. 2 Species compositions of predators (2002-2004) (n=1,564)

Note (*) killer whales are included.
Others: other whales, unidentified species, squids and fur seals)

Note: These figures are based on the reported data when at least one fish is attacked in each operation, thus operations without any predation are not included.

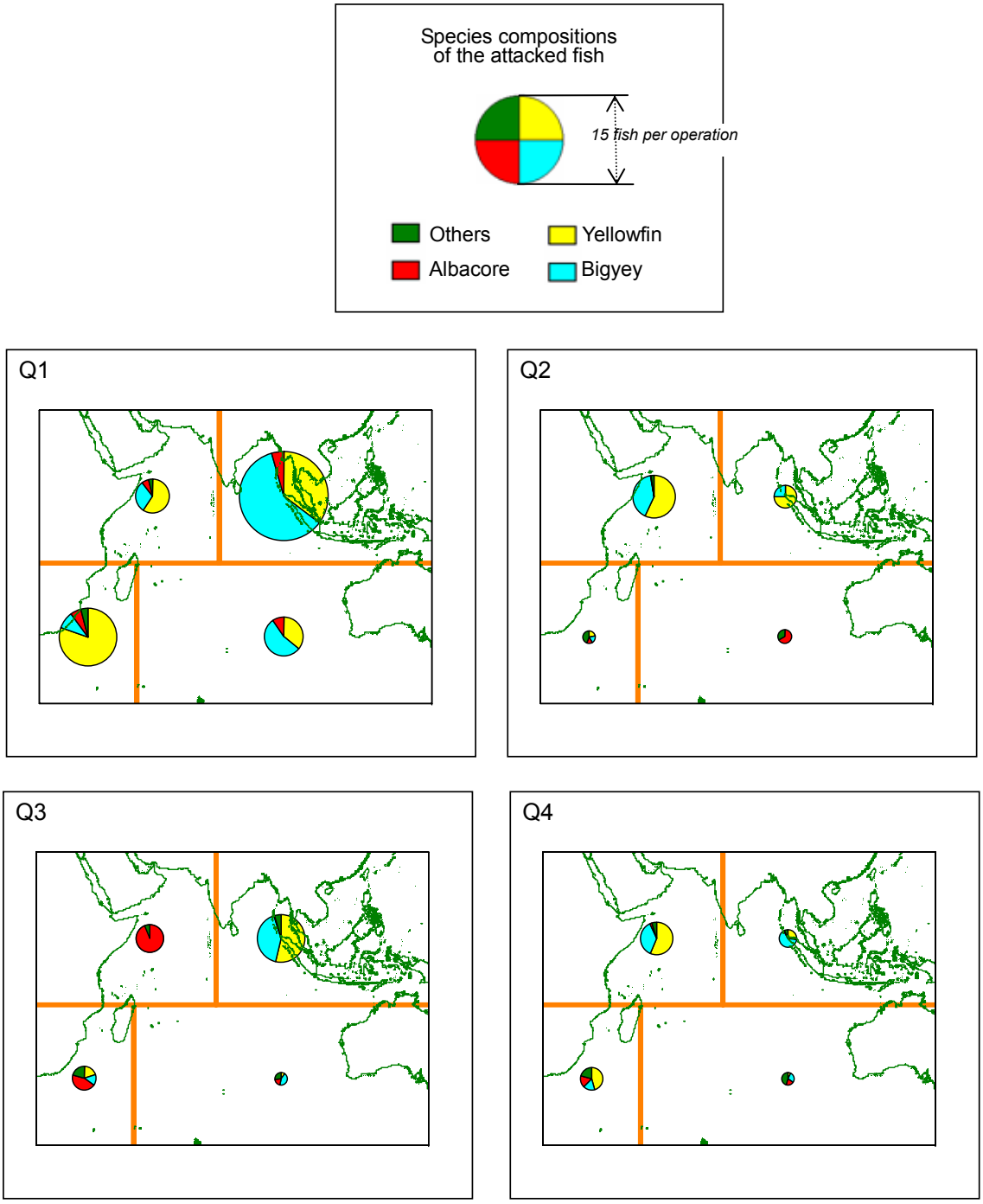
Table 6 (A) Reported number of attacked fish and (B) number of attacked fish per operation by quarter and sub-area

Q	Sub-area	Yellowfin		Bigeye		Albacore		Others		Number of operation	total	
		A	B	A	B	A	B	A	B		A	B
1	NW	557	3.87	289	2.01	62	0.43	31	0.22	144	939	6.52
	NE	62	5.64	106	9.64	7	0.64	0	0.00	11	175	15.91
	SW	839	8.47	102	1.03	65	0.66	38	0.38	99	1,044	10.55
	SE	8	2.67	12	4.00	2	0.67	0	0.00	3	22	7.33
2	NW	586	4.34	415	3.07	11	0.08	13	0.10	135	1,025	7.59
	NE	12	3.00	4	1.00	0	0.00	0	0.00	4	16	4.00
	SW	73	0.58	60	0.48	47	0.38	141	1.13	125	321	2.57
	SE	0	0.00	0	0.00	40	1.82	20	0.91	22	60	2.73
3	NW	312	2.84	196	1.78	4	0.04	28	0.25	110	540	4.91
	NE	73	4.56	57	3.56	1	0.06	5	0.31	16	136	8.50
	SW	329	0.93	242	0.69	731	2.08	335	0.95	352	1,637	4.65
	SE	21	0.24	90	1.02	45	0.51	55	0.63	88	211	2.40
4	NW	782	3.23	521	2.15	33	0.14	56	0.23	242	1,392	5.75
	NE	40	1.00	91	2.28	2	0.05	8	0.20	40	141	3.53
	SW	595	2.00	224	0.75	221	0.74	271	0.91	298	1,311	4.40
	SE	15	0.19	56	0.70	37	0.46	90	1.13	80	198	2.48

Table 7 (A) Reported number of predators and (B) number of predators recorded per operation by quarter and sub-area

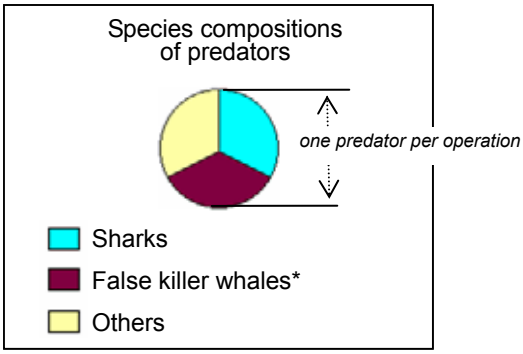
Q	Sub-area	Sharks		False killer whales		Others		Number of operation	total	
		A	B	A	B	A	B		A	B
1	NW	83	0.58	59	0.41	2	0.01	144	144	1.00
	NE	5	0.45	2	0.18	4	0.36	11	11	1.00
	SW	53	0.54	41	0.41	4	0.04	99	99	1.00
	SE	2	0.67	1	0.33	0	0.00	3	3	1.00
2	NW	83	0.61	52	0.39	0	0.00	135	135	1.00
	NE	0	0.00	4	1.00	0	0.00	4	4	1.00
	SW	67	0.54	56	0.45	2	0.02	125	125	1.00
	SE	14	0.64	7	0.32	1	0.05	22	22	1.00
3	NW	79	0.72	30	0.27	1	0.01	110	110	1.00
	NE	9	0.56	7	0.44	0	0.00	16	16	1.00
	SW	248	0.70	90	0.26	14	0.04	352	352	1.00
	SE	63	0.72	22	0.25	3	0.03	88	88	1.00
4	NW	136	0.56	104	0.43	2	0.01	242	242	1.00
	NE	10	0.25	30	0.75	0	0.00	40	40	1.00
	SW	139	0.47	154	0.52	5	0.02	298	298	1.00
	SE	45	0.56	32	0.40	3	0.04	80	80	1.00

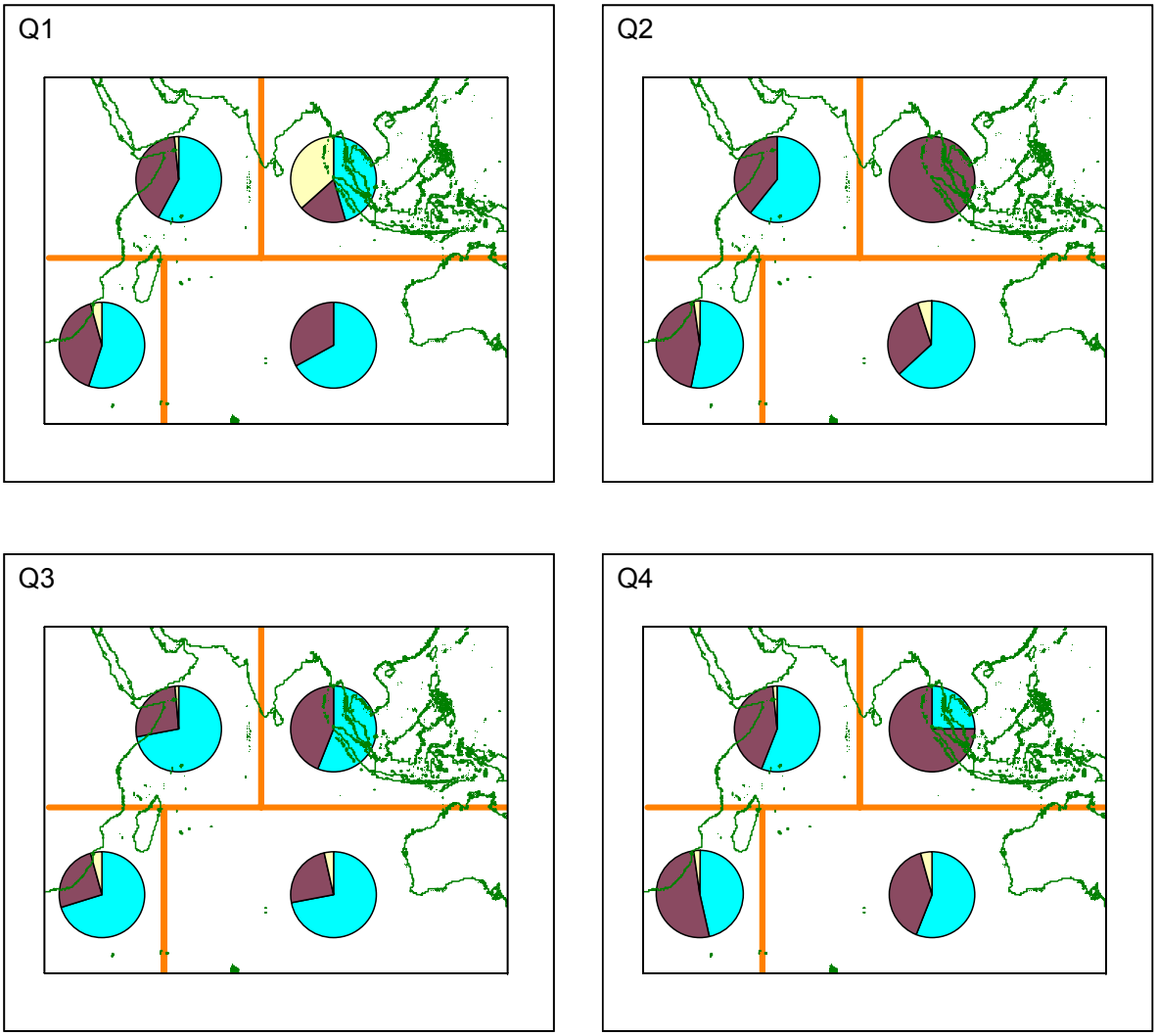
Note: Above figures are based on the reported data when at least one fish is attacked in each operation, thus operations without predation is not included.



Map 3 Species compositions of attacked fish per operation by quarter and sub-area (2000-2004).

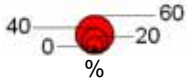
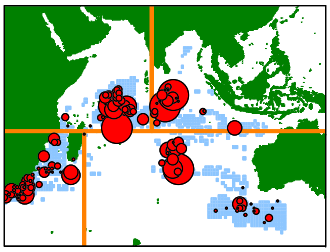
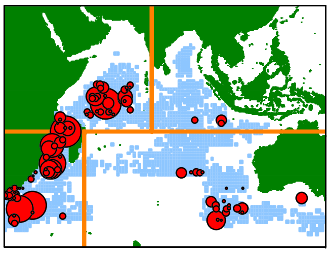
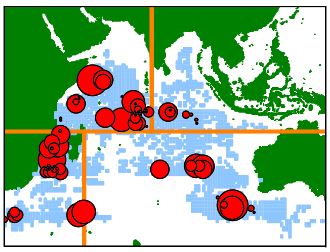
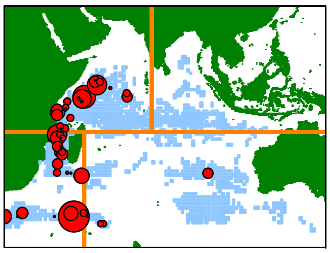
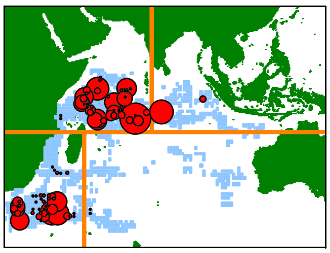
Note: Above figures are based on the reported data when at least one fish is attacked in each operation, thus operations without predation is not included.



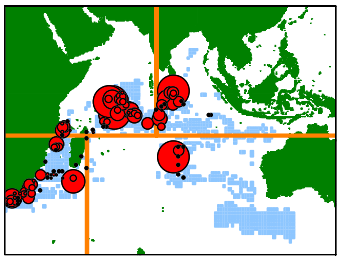
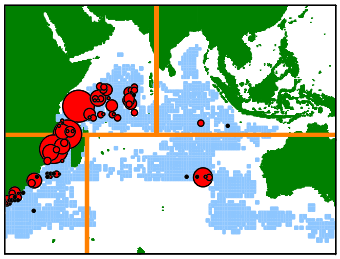
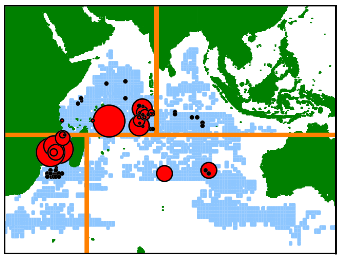
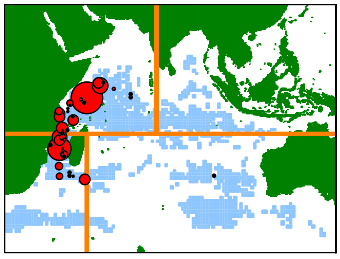
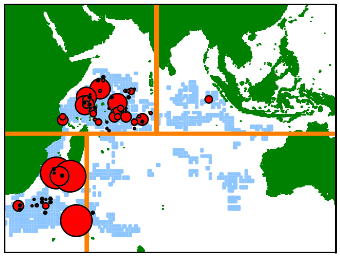


Map 4 Species compositions of predators per operation by quarter and sub-area (2000-2004).

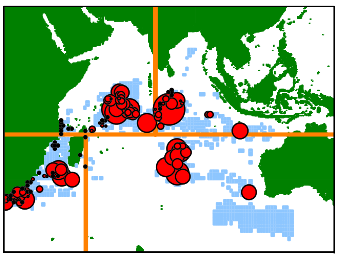
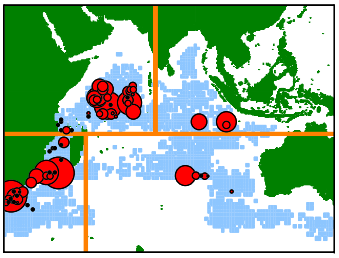
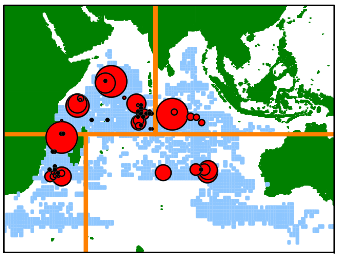
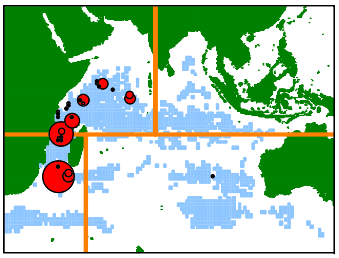
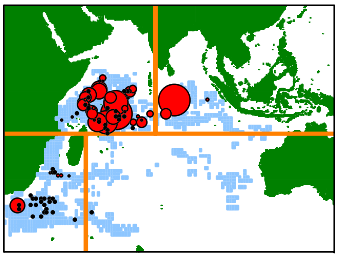
Note: *(1) * killer whales are included*
(2) Above figures are based on the reported data when at least one fish is attacked in each operation, thus operations without predation are not included.

(ALL spp.) Legend	Predation rates(%) = (no. of attacked fish)/(no. of catch)  Blue zone : fishing grounds
2000	
2001	
2002	
2003	
2004	

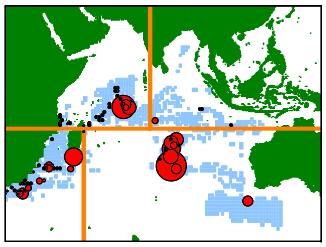
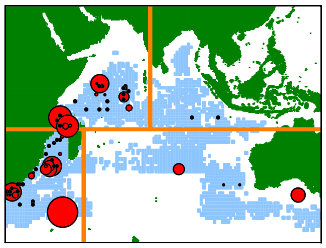
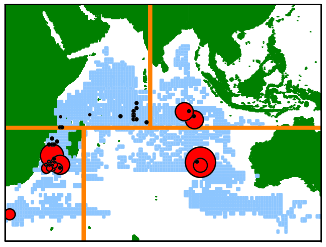
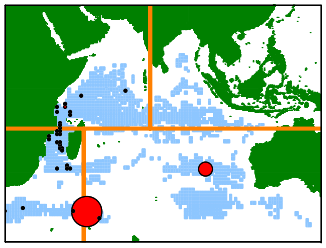
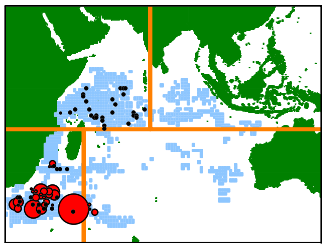
Map 5 Distribution of attacked fish (all species combined) by year (2000-2004)
Note: Size of red circle is proportional to the predation rates.

(YFT) Legend	Predation rates(%) = (no. of attacked fish)/(no. of catch) 40 0 60 20 % Blue zone : fishing grounds
2000	
2001	
2002	
2003	
2004	

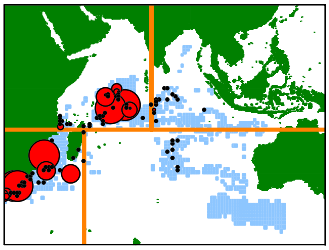
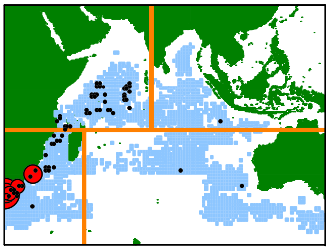
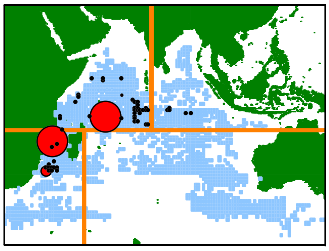
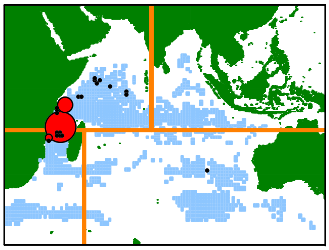
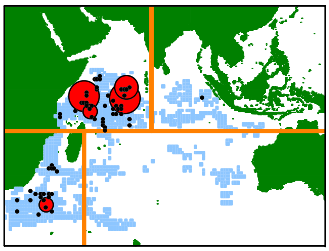
Map 6 Distribution of attacked fish (yellowfin) by year (2000-2004)
Note: Size of red circle is proportional to the predation rates.

(BET) Legend	Predation rates(%) = (no. of attacked fish)/(no. of catch) 40 60 0 20 % Blue zone : fishing grounds
2000	
2001	
2002	
2003	
2004	

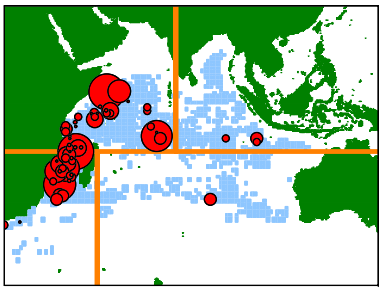
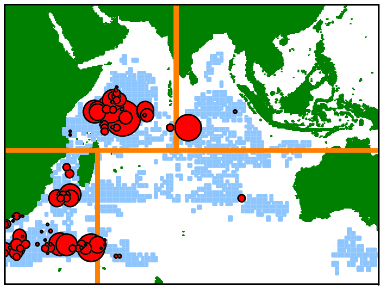
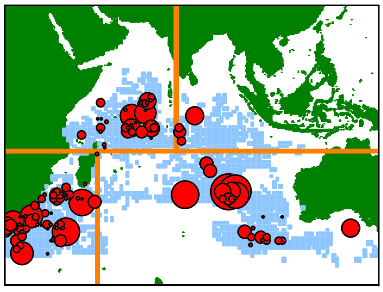
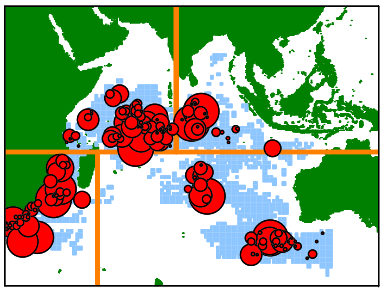
Map 7 Distribution of attacked fish (bigeye) by year (2000-2004)
Note: Size of red circle is proportional to the predation rates.

(ALB) Legend	Predation rates(%) = (no. of attacked fish)/(no. of catch) 40 0 60 20 % Blue zone : fishing grounds
2000	
2001	
2002	
2003	
2004	

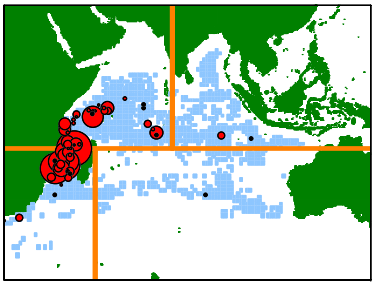
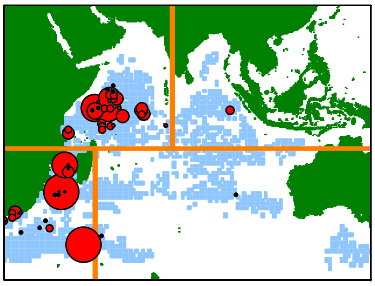
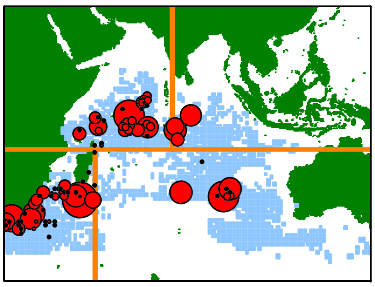
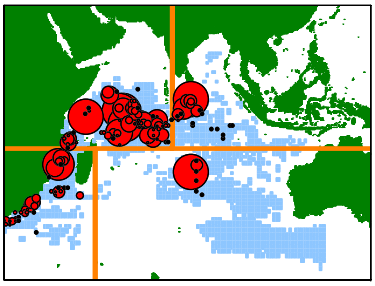
Map 8 Distribution of attacked fish (albacore) by year (2000-2004)
Note: Size of red circle is proportional to the predation rates.

(SWO) Legend	Predation rates(%) = (no. of attacked fish)/(no. of catch) 40 60 0 20 % Blue zone : fishing grounds
2000	
2001	
2002	
2003	
2004	

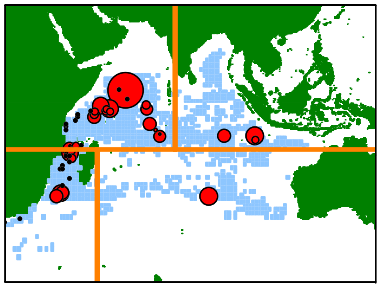
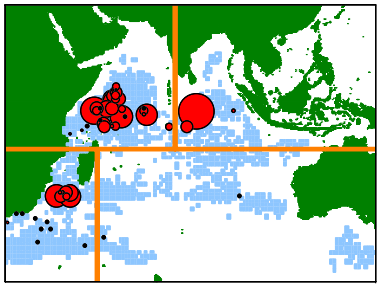
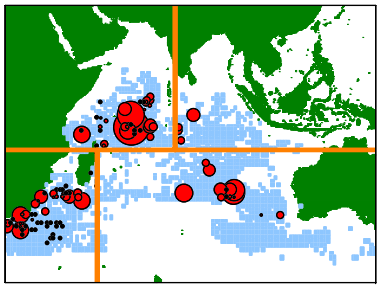
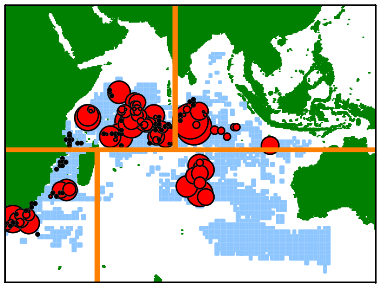
Map 9 Distribution of attacked fish (swordfish) by year (2000-2004)
Note: Size of red circle is proportional to the predation rates.

(ALL spp.) Legend	Predation rates(%) = (no. of attacked fish)/(no. of catch)  % Blue zone : fishing grounds
Q1	
Q2	
Q3	
Q4	

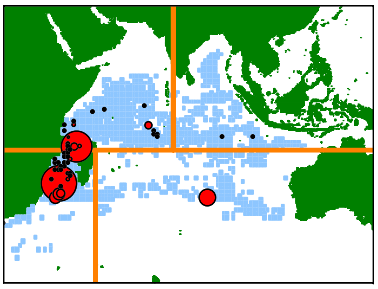
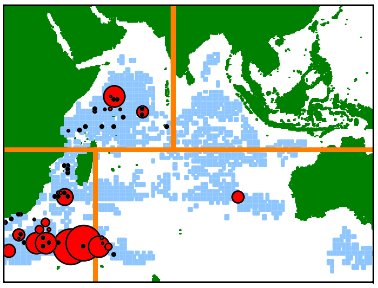
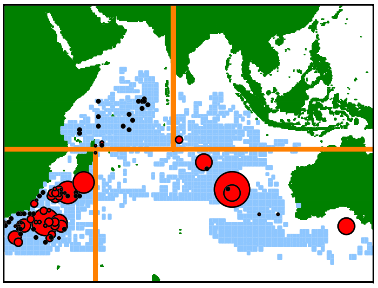
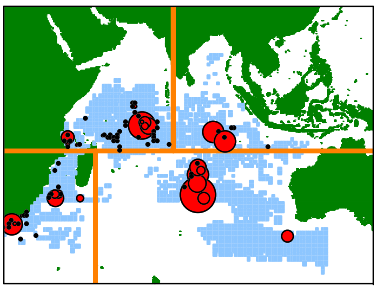
Map 10 Distribution of attacked fish (all species combined) by quarter (2000-2004)
Note: Size of red circle is proportional to the predation rates.

(YFT) Legend	Predation rates(%) = (no. of attacked fish)/(no. of catch) 40 0 60 20 % Blue zone : fishing grounds
Q1	
Q2	
Q3	
Q4	

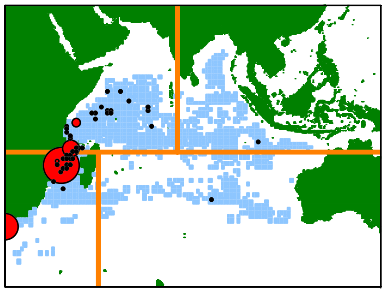
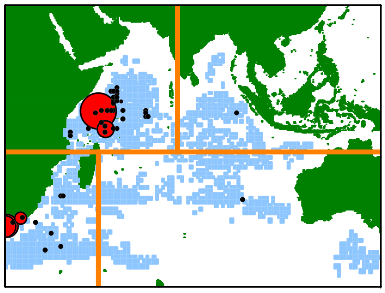
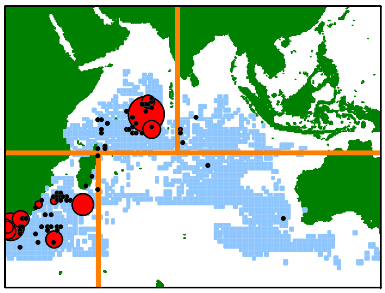
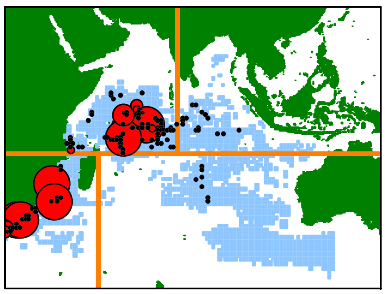
Map 11 Distribution of attacked fish (yellowfin) by quarter (2000-2004)
Note: Size of red circle is proportional to the predation rates.

(BET) Legend	Predation rates(%) = (no. of attacked fish)/(no. of catch) 40 60 0 20 % Blue zone : fishing grounds
Q1	
Q2	
Q3	
Q4	

Map 12 Distribution of attacked fish (bigeye) by quarter (2000-2004)
Note: Size of red circle is proportional to the predation rates.

(ALB) Legend	Predation rates(%) = (no. of attacked fish)/(no. of catch)  % Blue zone : fishing grounds
Q1	
Q2	
Q3	
Q4	

Map 13 Distribution of attacked fish (albacore) by quarter (2000-2004)
Note: Size of red circle is proportional to the predation rates.

(SWO) Legend	Predation rates(%) = (no. of attacked fish)/(no. of catch)  % Blue zone : fishing grounds
Q1	
Q2	
Q3	
Q4	

Map 14 Distribution of attacked fish (swordfish) by quarter (2000-2004)
Note: Size of red circle is proportional to the predation rates.

4. Discussion and Summary

From this report, the definition of the predation rate is changed as explained in page 5. Thus its interpretation and discussion are not comparable to those in the past.

(1) Predations (Table 5 and Fig. 2, page 8)

Number of predations reported in 2000-2004 was 1,564 individuals. Of these, 58% were sharks, 40% false killer (including killer whales) and others for 2%.

LL fishers can identify two types of predators between sharks and tooth whales based on the bite marks without any doubt. However, they have difficulty to identify two whale species between false killer whale and Killer whales, even looking at the bite marks as they are similar patterns. LL fishers can see them by eye on or near the sea surface, they can correctly identify two species.

According to the Japanese LL fishers, majority of the toothed whales attacking the LL caught tuna in the tropical and sub-tropical waters are likely false killer whales.

In average, one predator species attacked in one operation. In a few cases, two predator's species attacked against one longline operation.

There are a few cases that shark attacked the longline caught sharks.

There are a few cases that squids and fur seals attacked tuna.

(3) Attacked fish (Table 4 and Fig. 1, page 7)

Total number of fish attacked during 2000-2004 was 8,296. YFT, BET and ALB are three major attacked species by predations, which account 47%, 27% and 14% respectively. Those for SWO and SBT are 4% and 3% respectively.

(4) Annual distribution of predation rates by species (Maps 5-9)

As for YFT & BET there are high predations in the tropical western and SW Indian Ocean, For BET, high predation areas are also same as for YFT in addition to south eastern part. For ALB, predation areas are sporadic and scattered around the all Indian Ocean except the northern part. For SWO, predation areas are concentrated in central to southern part of the western Indian Ocean.

(5) Quarterly distribution of predation rates by species (Maps 10-14)

For YFT, predation areas are concentrated in the Mozambique channels in Q1 then the areas become wider as the later Quarters. For BET the area is concentrated in Q1-Q2 in the northern Indian Ocean then area spread to the whole Indian Ocean in Q3-Q4. For ALB, areas are concentrated in the SW part in Q1-Q3 in addition to the central area in Q3-Q4. For SWO, high predation in Q3-Q4 in the western Indian Ocean in Q3-Q4 while less in Q1-Q2.

(6) Species compositions of attacked fish per operation by season and area (Map 3)

Q1 show higher predation rates than other seasons. There is various seasonality in species compositions of attacked fish by area & Q. In NW, YFT and BET are dominants and there is less seasonality except for Q3 when ALB is dominant. In NE, YFT & BWT dominated in Q2-Q3

& Q4-Q1 respectively. In SW, dominant species is YFT in Q4-Q1, ALB in Q3 while no dominant species in Q2. In WE there are less predations in Q2-Q4 while high in Q3 and BET is dominat species.

(7) Species compositions of the predators by season and area (Map 4)

There is various seasonality in species compositions by time and area. In NW & SE, SHK is always dominant for all seasons. In NE False killer whales are dominant in Q2 & Q4 and sharks in Q4-Q1. in SW sharks are dominant all seasons except false killer whales in Q4.

(8) Mitigation (new information)

Nishida and Tanio (2001) reported that since 1959 that the tail-tied fishes tend not to be damaged by killer whales and judging from the intelligence of killer whales, it is assumed that they regard the reversed fishes as abnormal ones and they are afraid and don't eat them.

However we found out the real reasons through the LL fishers, which will be explained as follows: Tunas scared by whales naturally become panic. When such tunas are caught by the longline, they are easily entangled by the branch lines made by wire as they are in panic then their positions quite often turn to be up-side-down. The whales are actually not scared by the up-side-down shape (unless it is quite large like billfish, Sawadaishi, 2003) but they can sense the materials (wire) thus they keep away from such tuna as they know (learn) they can not bite the wire around tuna.

In fact, it has been reported by also LL fishers that, if the branch lines are made by nylon, whale attack the up-side-down tuna sounded by nylon wires as whales can sense the materiel (nylon) that they can bite tuna even sounded by nylon wire.

Applying this habit or ability there is one recent interesting development. Some American company developed the wire certain around the logline hooks to protect from the predators, i.e., when tuna are hooked, the hidden iron-made tiny wires strings in curtain form will cover the tuna to protect from predators as they can sense the materials (iron=Fe) (not edible for them) by the eco-location abilities. We have not yet seen the real device but Fig. 3 depicts its image.

(9) Estimation of catch including the uncounted tuna damaged by predators

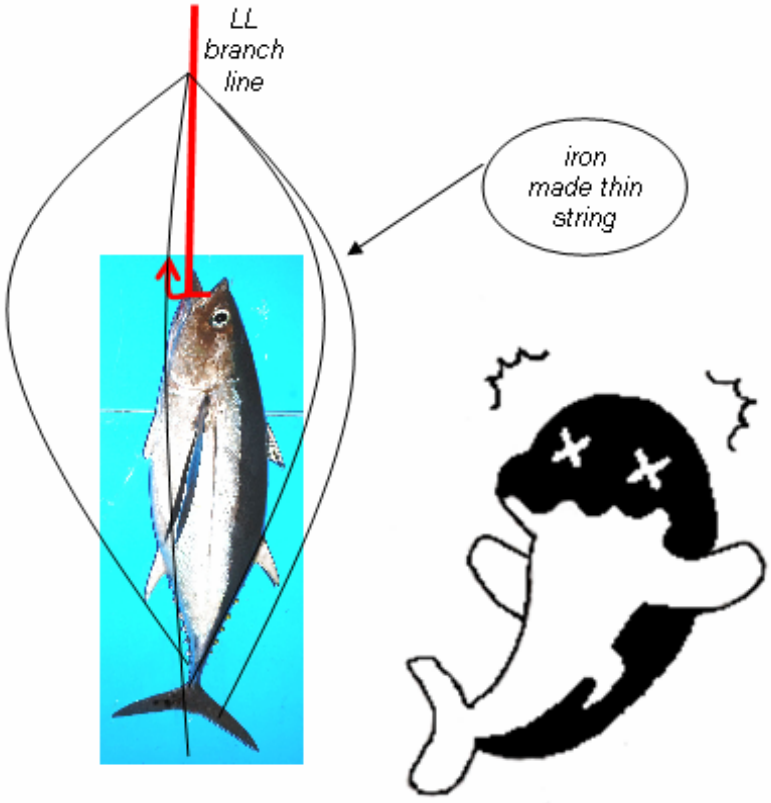
IOTC-WPTT & SC have been suggesting to estimate the total number of the damaged tuna by depredations in order to know the accurate catch because these damaged fish are normally not counted in the logbook as the catch. This will affect the stock assessment (SA) in various extend because the predation rates range 0-100% (mean around 10-20% depending on species) which imply that we will have biased results in the SA if we used such catch statistics missing uncounted number of damaged fish by predators.

To tackle this problem and to estimate the total damaged catch based on our predation survey, we need to understand the some basic problem which is shown in Fig. 4. There are unreported damaged fish which rates are unknown. Thus we need extra investigation about the unreported rates (raising factors). Or we can simulate using the assumed unreported rates (Nishida and Shiba, 2002) to see the whole pictures.

Fig. 3

Image of the recently developed mitigation method to prevent LL caught tuna from depredation by toothed whales.

Once tuna is hooked, thin? wire strings will be pulled down from the LL branch and surround the tuna body so that whales will keep away form tuna as they can sense the materials (iron) which is not edible for them through their echo location abilities.



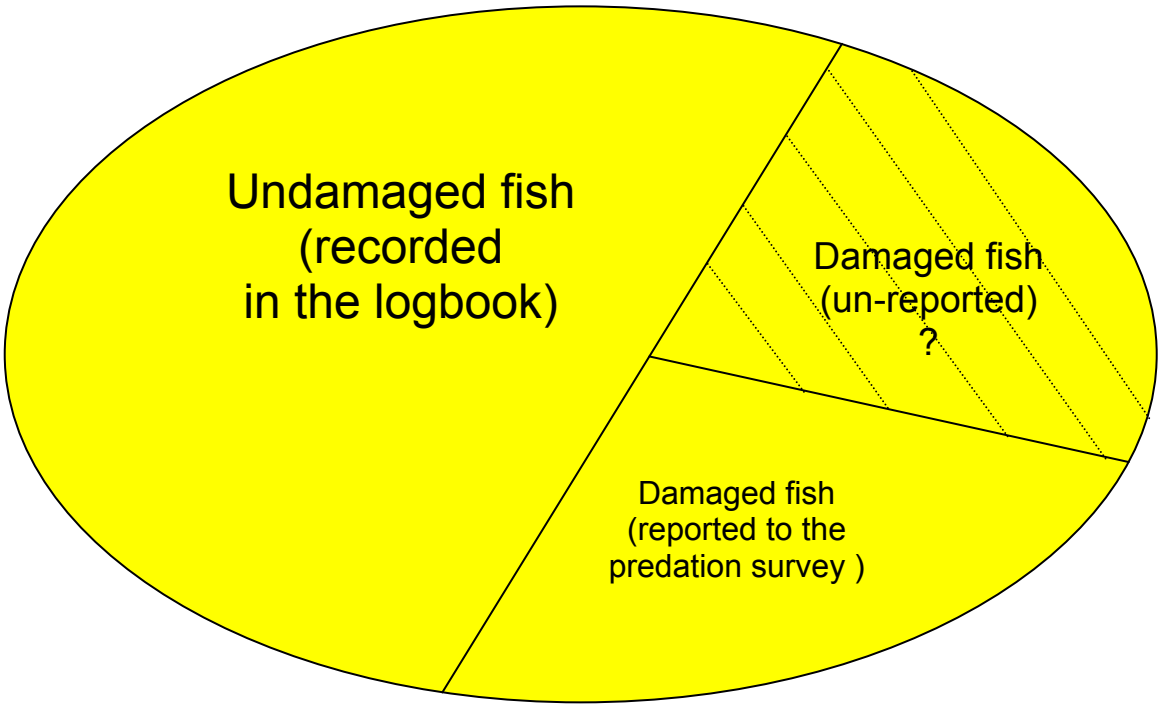


Fig. 4 Situation of the on-going predation survey

(10) Collaborative predation survey data preparations and workshop (Table 8)

Table 8 Predation surveys and schedule of the workshop (agreed by SC in 2003)

<table>
<tr><td>year</td><td>IOTC</td><td>Japan</td></tr>
<tr><td>1998</td><td>Predation survey was recommended in the 2nd Scientific Committee.</td><td></td></tr>
<tr><td>1999</td><td>Resolution 00/02 (Resolution on a survey of predation of longline caught fish) was adopted in the 4th Commissioner's meeting.</td><td></td></tr>
<tr><td>2000</td><td rowspan="4">(Jan : survey started)
↓
(Dec: end of the survey)</td><td rowspan="5">(Sept: survey started)
↓
(Aug : end of the survey:
next month !)</td></tr>
<tr><td>2001</td></tr>
<tr><td>2002</td></tr>
<tr><td>2003</td></tr>
<tr><td>2004</td></tr>
<tr><td>2005</td><td></td></tr>
<tr><td rowspan="3">2006</td><td></td><td>By middle of the year:
All survey data will be collected.</td></tr>
<tr><td colspan="2">Collaborative data compilation and processing</td></tr>
<tr><td>Later period or 2007: workshop</td><td></td></tr>
</table>

Reference

Nishida, T. and Tanio, M. (2001) : Summary of the predation surveys for the tuna longline catch in the Indian and the Pacific Ocean based on the Japanese investigation cruises (1954, 1958 and 1966-82), IOTC Third tropical tuna working group meeting (IOTC/WPTT/01/17):31pp.

Unlisted references will be provided by the first author upon request.

Acknowledgements

We very much appreciate for all the crews of the Japanese longliners (Japan Tuna Federation) who cooperated this predation survey and sent the records even in the tough work conditions. We further thank Mr. Miura (Japan Tuna Federation) and Mr. Hiyama (Japan Fisheries Cooperatives：JF or Zengyoren) who coordinate this survey.

(in Japanese)

操業で忙しいにもかかわらず本食害調査に協力し記録を送付してくださった、日かつ連および全漁連所属のはえ縄船乗組員の皆様へ深謝いたします。また、本調査のコーディネートをしていただいている、日かつ連国際部（三浦様）、全漁連海外事業課（桧山課長）にもこの場をかりて深くお礼申しあげます。