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

(September, 2000 - September, 2002)

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Abstract

This report summarizes the results of the predation survey conducted by the Japanese commercial tuna longline fisheries for two years and one month from September,2000-September, 2002. We conducted the descriptive data analyses to present results.

Contents

Submitted to the Fifth Working Party on the Tropical Tuna meeting (WPTT) (June 3-10, 2003), Victoria, Seychelles, organized by Indian Ocean Tuna Commission (IOTC).

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.

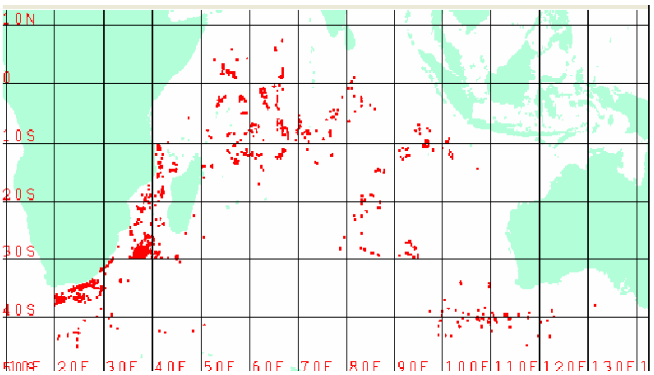
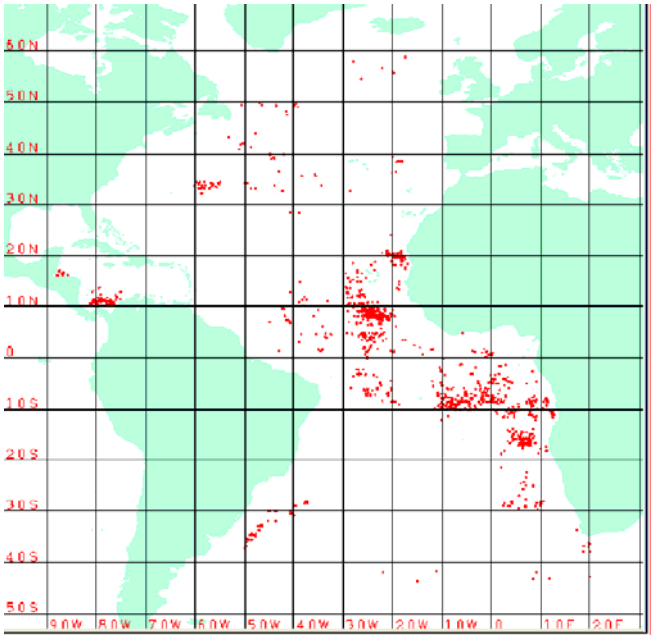
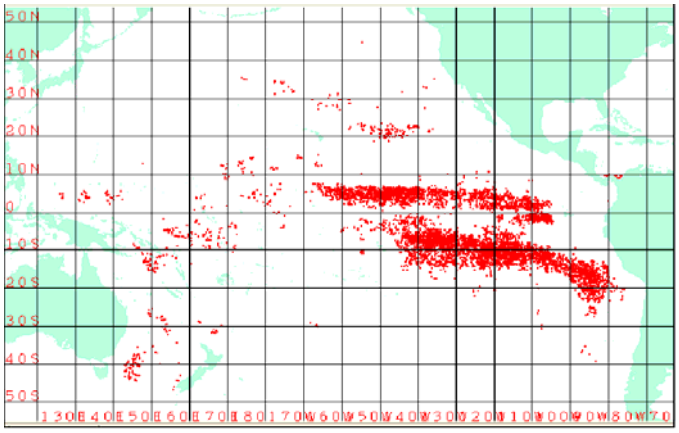
To investigate this predation problem and to find out possible mitigation methods, Fisheries Agency of Japan had conducted a number of surveys and research in the Pacific Ocean and the Indian Ocean, using public longline vessels (high school longline training vessels and prefecture fisheries stations' longline vessels) for 18 years in 1954, 1958 and 1965-81. Summary of these survey results are available by Nishida and Tanio (IOTC/WPTT/01/17, 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 1, 2000 for all the longliners belonging to Japan Tuna Federation in three Oceans. Currently about 450 longliners are cooperating to this survey. This report summarizes the results of the surveys for two years and one month from September, 2000 to September, 2003.

2. Materials and methods

As of May, 2003, we have collected predation survey data from September, 2000 to December, 2002. However, in this paper, we used the data for two years and one month (September, 2000- September, 2002) because recent data after October, 2002 have not yet fully recovered. Map 1 (a)-(c) shows locations of the predation survey reports for this period in three Oceans. We conducted the descriptive analyses for the data from the Indian Ocean by different presentations , i.e., summary tables, Figures and distribution maps using *Marine Explorer* version 3.2 (GIS software) developed by Environmental Simulation Laboratory.

Map 1 Reported locations in the predation surveys (September, 2000-September, 2002)

Indian Ocean (n=1,311 operations)	
Atlantic Ocean (n=1,172 operations)	
Pacific Ocean (n=8,455 operations)	

In the predation survey, when at least one fish in each operation was attacked, the information of the damaged fish by species are reported by the LL boats, while when there are no predation in one operation, they don't need to send the information. In addition, they also don't have to send the information of catch by species, although which are necessary information to compute the predation rates. This is because catch data by species are reported and obtained through the logbook, so that extra works to input duplicate (catch) information and also information on the 0 predation into the predation survey form can be reduced for the fishers who are busy for the fishing operations. Thus, in the predation survey, the input information have been minimized.

Even we take such cares and considerations for the LL fishers, to now, only 10-30% boats have reported the predation information to us (Table 2). Under such situation, we need to understand the meanings of two types of the predation rates that we compute. Fig. 2 summarizes the definition of such two types of the predation rates we evaluate based on the logbook and the predation survey information. The upper diagram of Fig. 2 shows the ideal situation when all the information were available, while the lower one implies the current situation using the predation survey and logbook information.

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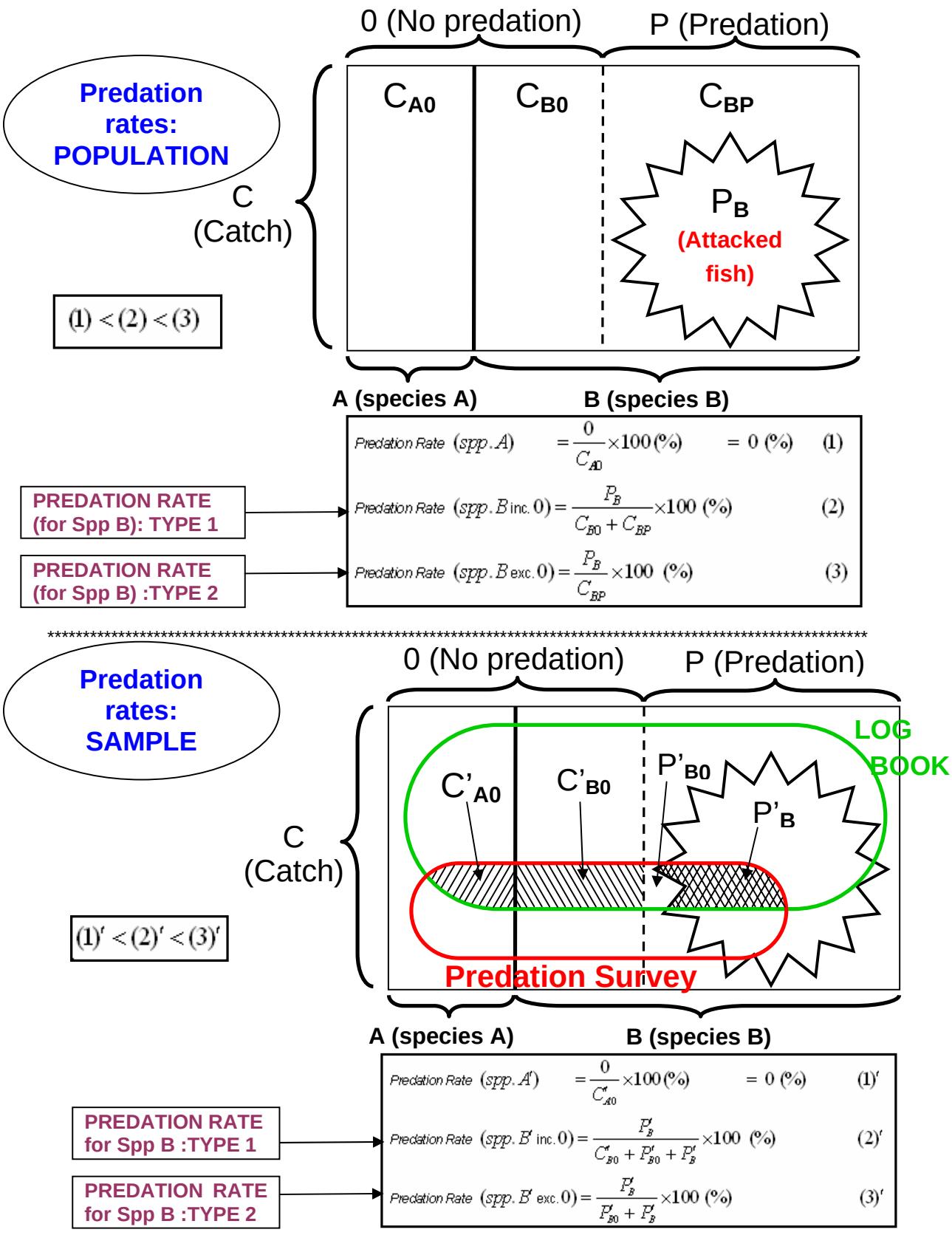


Fig. 2 Definition of the predation rates (in some area and some period). (Upper) Population, (Lower) sample based on predation survey and logbook (only two species are considered to simplify the situation). Two types of PREDATION RATES (for Spp. B) : TYPE 1 (data including LL operations with 0 predations) and TYPE 2 (the data excluding LL operations with 0 predations). Predation rate for Spp. A can be computed as 0% for both cases.
Note: If (2)′ ∝ (2) and (3)′ ∝ (3), sampled data from the logbook and the predation survey reflect the real situation (population).

3. Results

Results are summarized by different presentations such as Tables, Figs. and Maps as shown in Table 1.

Table 1 List of the presentations of the results of the predation survey (September, 2000 – September, 2002).

Table 2 Summary of the predation survey in the Indian Ocean (I) : Boat, operation and predators

Year	2000		2001				2002			**TOTAL**
Q(Quarter)	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	
[Boat]										
No. of boats reported	31	30	5	6	11	11	5	5	7	**111**
Total number boats operated	144	154	139	172	176	146	107	79	50	**1,167**
Reporting rates(%)	22	19	4	3	6	8	5	6	14	**10 (mean)**
Coverage (%) (estimated) (*)	44	38	8	6	12	16	10	12	28	**20 (mean)**
[Operation]										
No. of operations reported when at least one fish were attacked in one operation	207	471	94	113	110	66	72	44	134	**1,311**
Total number of operations	3,365	9,135	6,301	8,123	10,821	8,239	5,144	4,053	1,319	**56,500**
Reporting rates (%)	6	5	2	1	1	1	1	1	10	2 (mean)
Coverage (%) (estimated)(**)	30	25	10	5	5	5	5	5	50	10 (mean)
[Number of predators reported by species & quarter]										
Killer whale or false killer whale	56	202	20	7	37	44	31	7	9	**413**
Other whales	0	4	5	0	0	0	1	0	0	**10**
Sharks	169	303	79	35	77	27	42	73	112	**917**
Squid	0	0	0	0	0	0	0	0	0	**0**
Fur Seal	0	1	0	0	0	0	0	0	0	**1**
Un-identified	4	5	1	3	2	0	0	15	13	**43**
TOTAL	**229**	**515**	**105**	**45**	**116**	**71**	**74**	**95**	**134**	**1,384**

Note (*) *The longline boats report the data only when at least one fish is attacked. Thus, if 50% of the boats were assumed to have experiences of the attacks, the coverage of the boats are estimated as shown in the Table.*

Note (**) *The longline boats report the data only when at least one fish is attacked in the operation. Thus, if 20% of the operations were assumed to have experiences of the attacks, the coverage of the operations is estimated as shown in the Table.*

Table 3 Summary of the predation survey in the Indian Ocean (II) : Number of fish damaged by species

Year	2000		2001				2002			**TOTAL**
Q(Quarter)	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	
[Number of fish attacked by species & quarter] (- : no catch)										
N. bluefin	2	-	-	-	-	-	-	-	-	**2**
S. bluefin	14	26	-	24	60	61	-	24	2	**211**
Albacore	224	195	81	17	172	84	47	172	233	**1,225**
Bigeye	304	749	296	44	130	14	106	62	91	**1,796**
Yellowfin	437	994	744	11	34	224	278	14	17	**2,753**
Swordfish	31	91	6	1	15	20	11	1	2	**178**
Striped marlin	-	2	-	-	1	-	3	-	2	**8**
Blue marlin	8	29	-	-	-	-	2	-	-	**39**
Black marlin	1	-	1	-	-	-	-	-	-	**2**
Sailfish	3	2	1	-	-	12	6	29	-	**24**
Skipjack	-	-	-	-	-	-	2	-	47	**78**
Sharks	1	5	-	-	-	-	-	-	1	**7**
Others	14	49	1	-	123	70	2	74	74	**407**
Un-identified	7	29	-	-	-	-	-	-	-	**36**
TOTAL	**1,046**	**2,171**	**1,130**	**97**	**535**	**485**	**457**	**316**	**469**	**6,766**
[Average number of fish attacked per operation by species & quarter] (- : no catch)										
N. bluefin	1.0	-	-	-	-	-	-	-	-	**1.0**
S. bluefin	1.4	1.9	-	4.7	4.6	4.1	-	2.2	1.0	**2.8**
Albacore	2.3	2.3	2.0	1.1	3.7	3.8	2.5	1.3	2.9	**2.4**
Bigeye	3.7	3.4	4.6	4.6	2.3	1.3	3.1	1.8	1.8	**3.0**
Yellowfin	4.2	3.1	8.9	4.8	3.5	8.0	5.5	1.2	1.1	**4.5**
Swordfish	1.5	1.6	1.5	2.1	1.4	2.2	1.8	1.0	1.0	**1.6**
Striped marlin	-	1.0	-	-	1.0	-	1.5	-	1.0	**1.1**
Blue marlin	1.3	1.2	-	1.5	-	-	2.0	-	-	**1.5**
Black marlin	1.0	-	1.0	-	-	-	-	-	-	**1.0**
Sailfish	1.5	1.0	1.0	2.0	-	4.0	1.2	-	-	**1.8**
Skipjack	-	-	-	-	-	-	1.0	-	4.3	**2.7**
Sharks	1.0	1.3	-	-	-	-	-	-	1.0	**1.1**
Others	1.8	1.9	1.0	1.0	5.9	5.4	1.0	-	5.7	**3.0**
Un-identified	2.3	4.1	-	-	-	-	-	-	-	**3.2**
TOTAL	**1.9**	**2.1**	**2.9**	**2.7**	**3.2**	**4.1**	**2.0**	**1.5**	**2.2**	

Table 4 Summary of the predation survey in the Indian Ocean (III) : Average predation rates

Year	2000		2001				2002			TOTAL
Q(Quarter)	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	
[Average predation rates (%) per operation by species & quarter including 0 predation data : see TYPE 1 (SAMPLE) in Fig. 2] *Note (3) Based on the data of the operations with at least one damaged fish. Refer to the equation (3)' in Fig. 2.* *Note (4) Figurers with high predation rates (15% or more) in almost all the seasons are highlighted.*										
N. bluefin	-	-	-	-	-	-	-	-	-	**-**
S. bluefin	28	22	-	52	27	55	-	25	6	**31**
Albacore	9	9	8	6	16	10	8	14	16	**11**
Bigeye	12	15	19	22	15	9	13	12	11	**14**
Yellowfin	12	16	14	16	11	14	18	14	6	**13**
Swordfish	8	10	2	5	8	5	12	0	0	**7**
Striped marlin	0	0	0	0	0	0	0	0	-	**-**
Blue marlin	8	10	0	1	0	0	0	-	-	**6**
Black marlin	0	0	7	0	-	0	0	-	0	**7**
Sailfish	0	1	0	-	-	100	0	-	-	**51**
Skipjack	-	-	-	-	-	0	-	-	-	**-**
Sharks	0	1	0	0	0	0	0	0	0	**1**
Others	0	2	0	7	0	0	0	0	0	**5**
TOTAL	**13**	**10**	**10**	**16**	**15**	**32**	**13**	**16**	**10**	**15**
[Average predation rates (%) per operation by species & quarter excluding 0 predation data : see TYPE 2 (SAMPLE) in Fig. 2] *Note (1) Based on the data of the operations with NO predations. Refer to the equation (3)' in Fig. 2.* *Note (2) Figurers with high predation rates (30% or more) in almost all the seasons are highlighted.*										
N. bluefin	-	-	-	-	-	-	-	-	-	**-**
S. bluefin	32	42	-	52	30	55	-	29	6	**35**
Albacore	15	29	14	32	27	26	33	40	17	**26**
Bigeye	27	27	23	27	25	41	28	16	22	**26**
Yellowfin	22	21	16	17	25	31	21	46	39	**26**
Swordfish	60	57	47	60	70	75	85	-	-	**65**
Striped marlin	-	14	-	-	-	-	-	-	-	**14**
Blue marlin	100	65	-	29	-	-	-	-	-	**65**
Black marlin	-	-	33	-	-	-	-	-	-	**33**
Sailfish	-	50	-	-	-	100	-	-	-	**75**
Skipjack	-	-	-	-	-	-	-	-	-	**-**
Sharks	5	35	-	-	-	-	-	-	-	**20**
Others	-	13	-	50	-	-	-	-	-	**32**
TOTAL	**37**	**35**	**27**	**38**	**35**	**55**	**42**	**33**	**21**	**37**

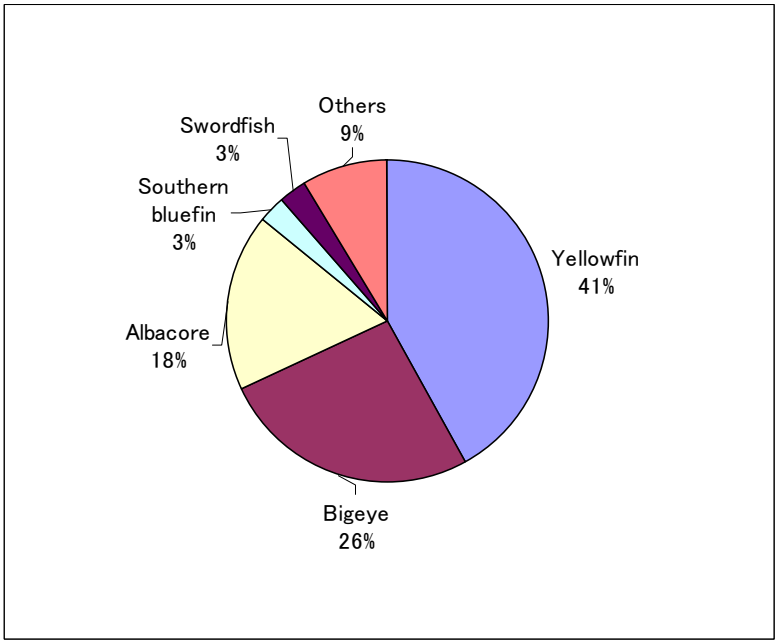


Fig. 2 Species compositon of the attacked fish (September, 2000- September, 2002)

Note: Others (9%) include unidentified species, white marlin, sailfish, sharks, northern bluefin tuna, black marlin, striped marlin, skipjack and butterfly fish.

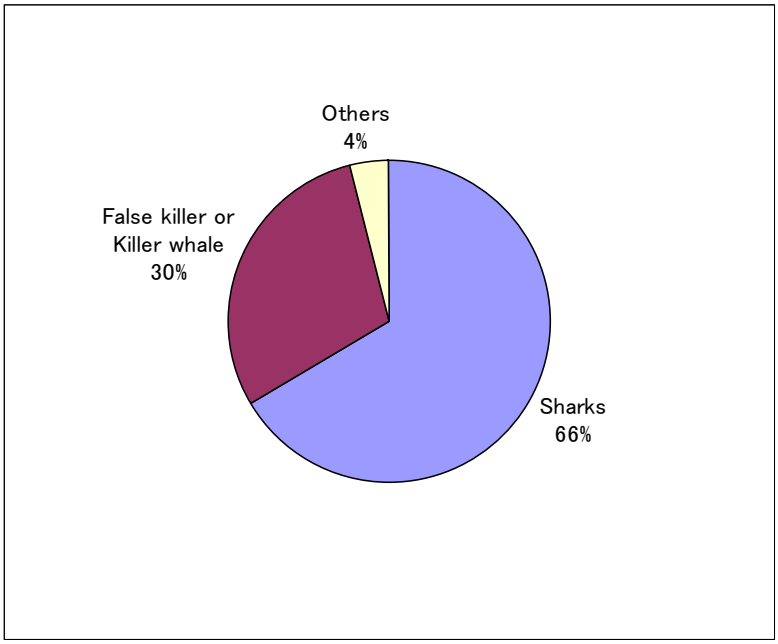
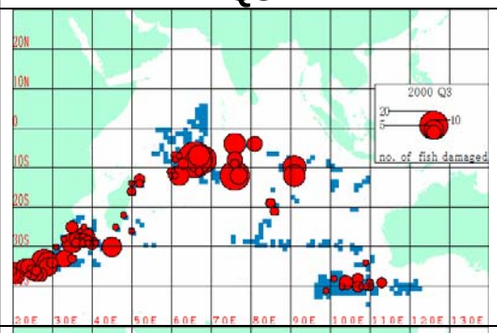
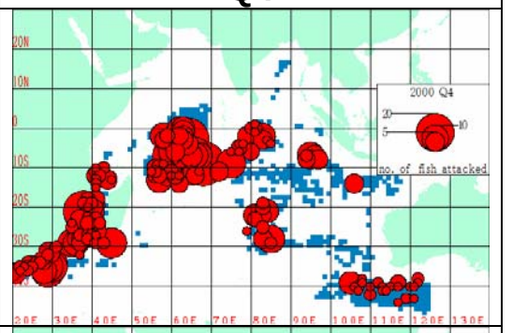
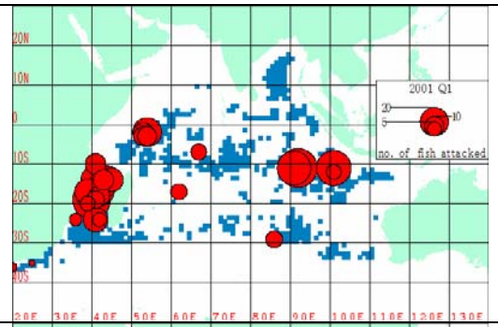
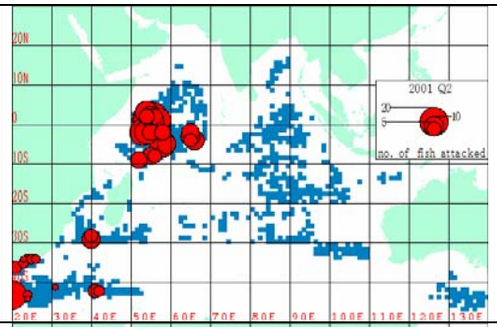
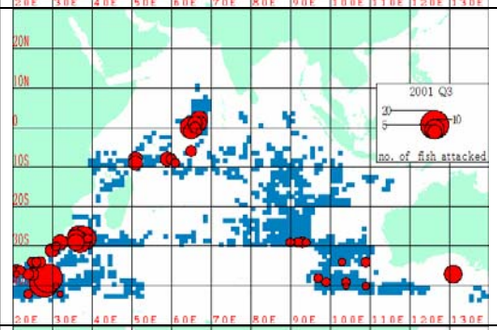
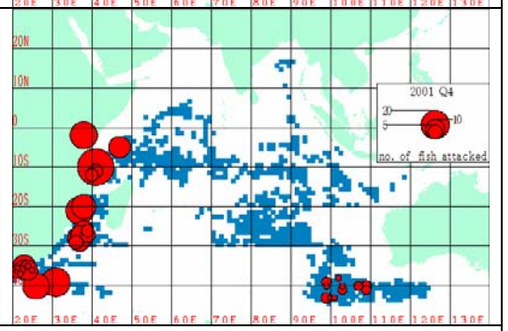
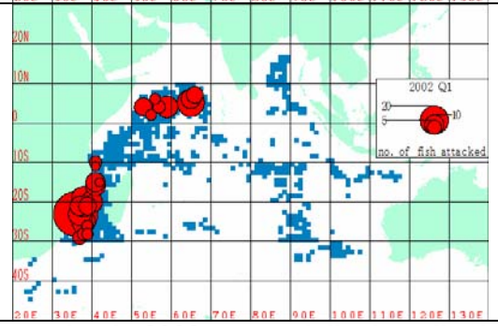
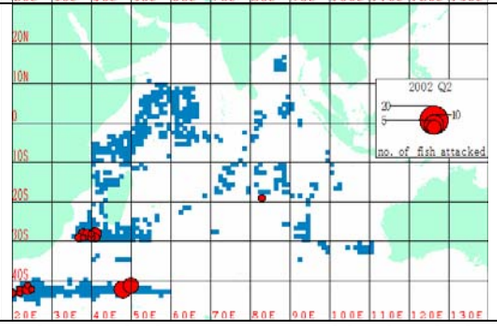
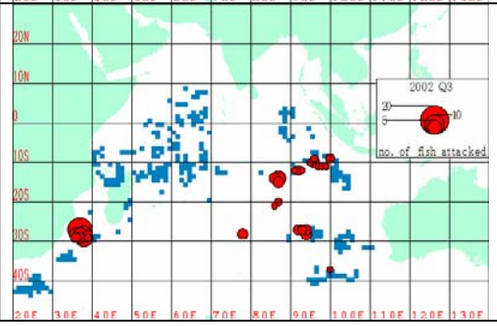


Fig. 3 Species composition of the predators (September, 2000- September, 2002)

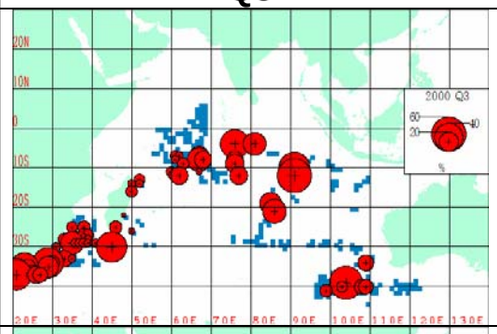
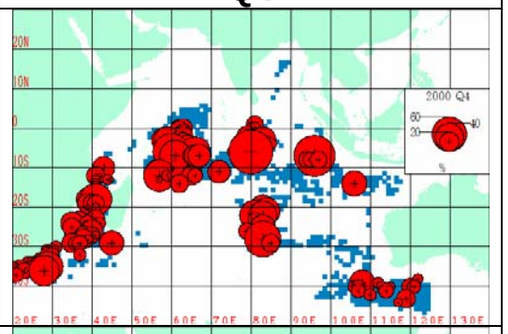
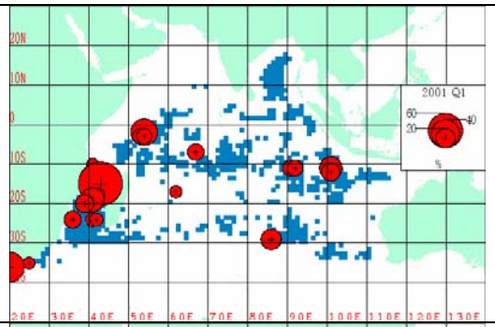
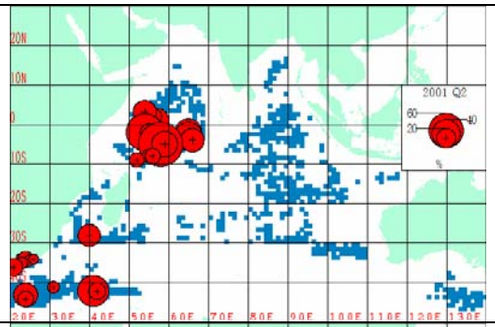
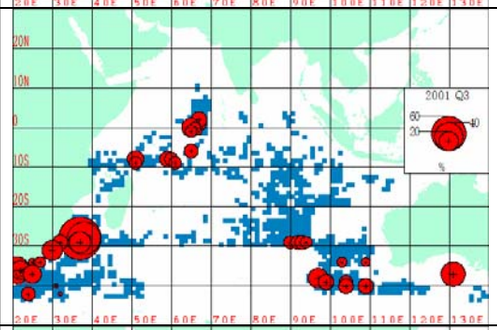
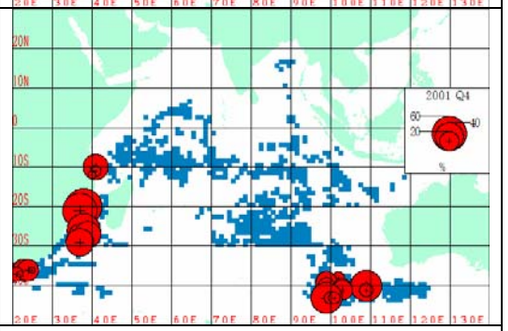
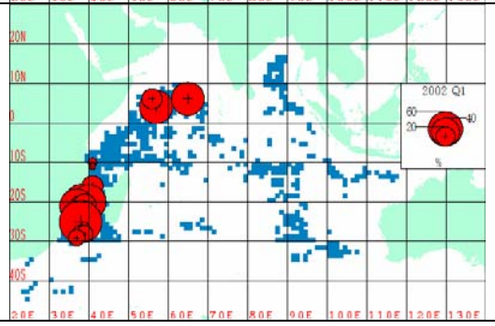
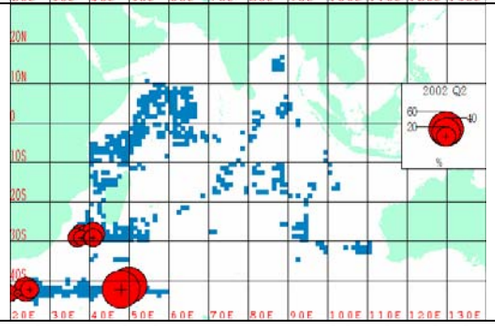
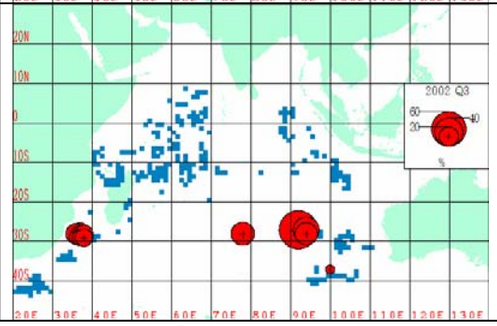
Note: Others (4%) include unidentified species, other whales, squid and fur seal.

Map 2 **Average number of fish attacked per operation in the reported area of the predation survey (ALL SPECIES COMBINED) (red) and Japanese tuna longline fishing grounds (blue) by quarter (Q) (2000-2002) (1^{o}x1^{o} based map)**

	Q1	Q2	Q3	Q4
2000				
2001				
2002				

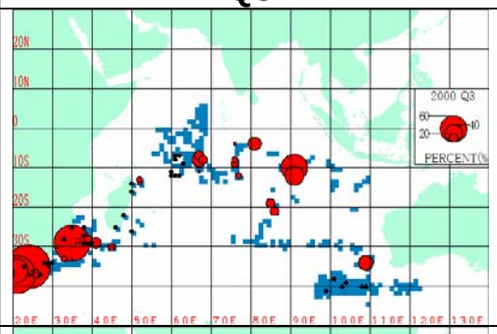
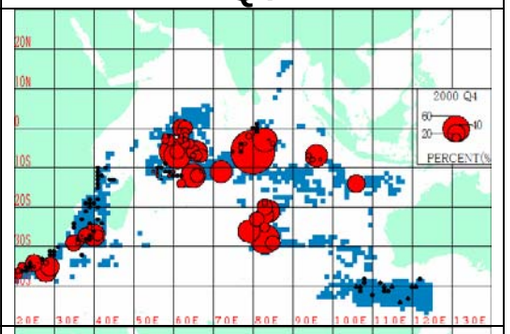
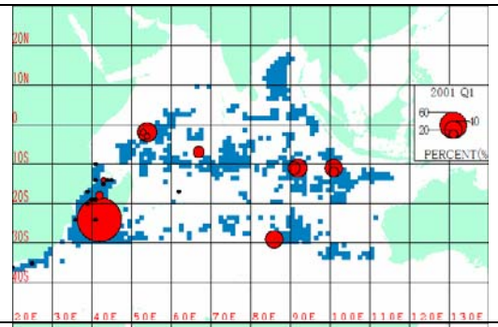
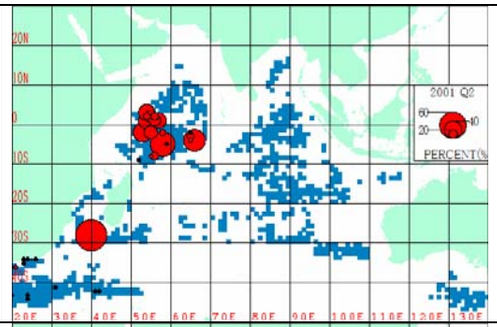
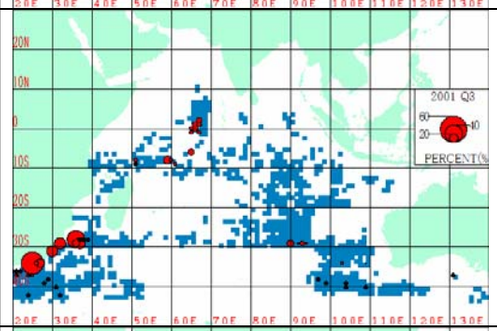
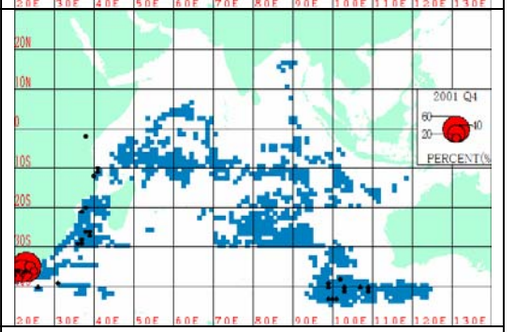
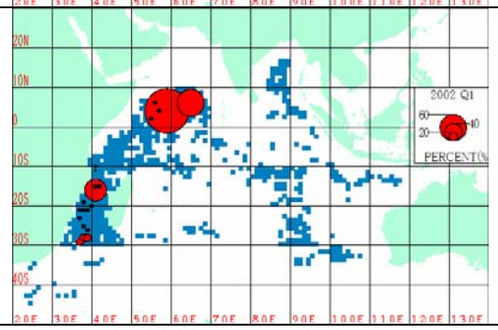
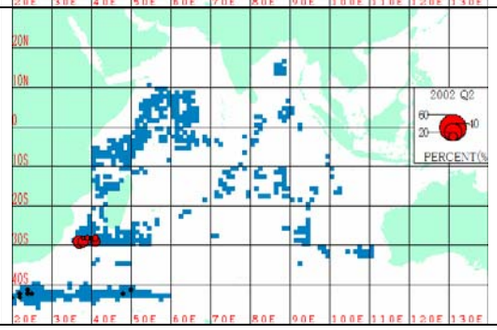
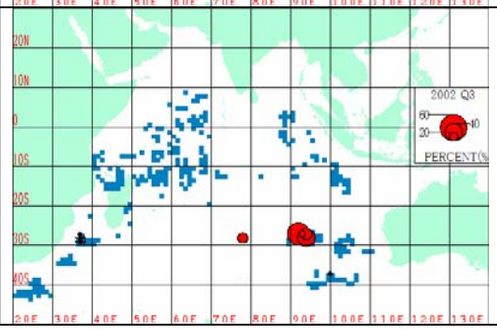
Note: Information in 2002 are partially described as the predation survey and logbook data have not yet fully recovered.

Map 3 **Average predation rate (%) (number of fish attacked*100/total catch) per operation in the reported area of the predation survey (ALL SPECIES COMBINED) (red) and Japanese tuna longline fishing grounds (blue) by quarter (Q) (2000-2002) (1^{o}x1^{o} based map)**

	Q1	Q2	Q3	Q4
2000				
2001				
2002				

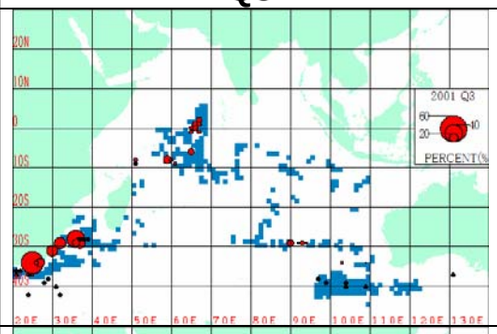
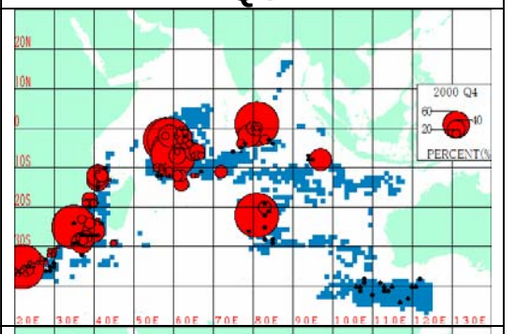
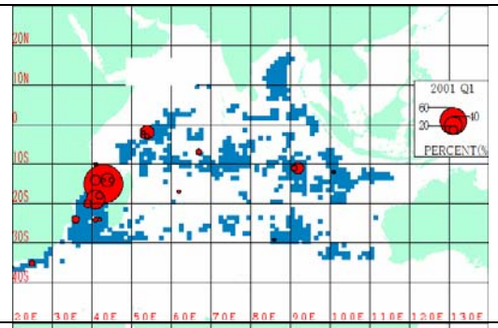
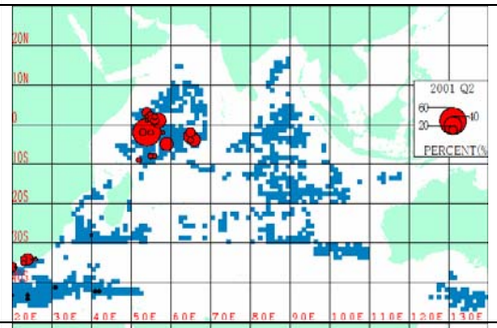
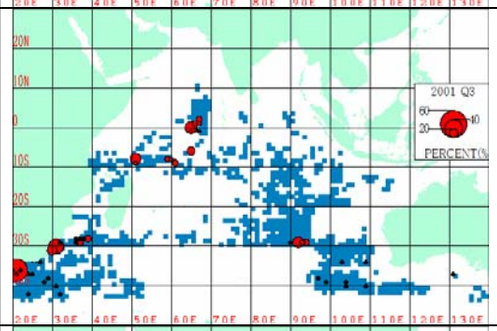
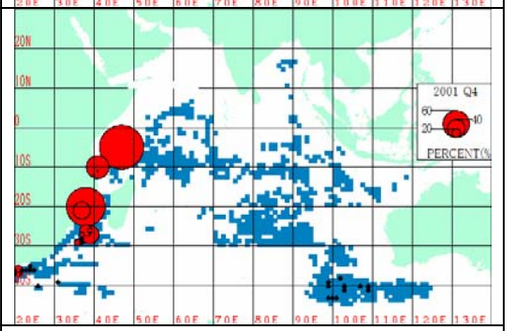
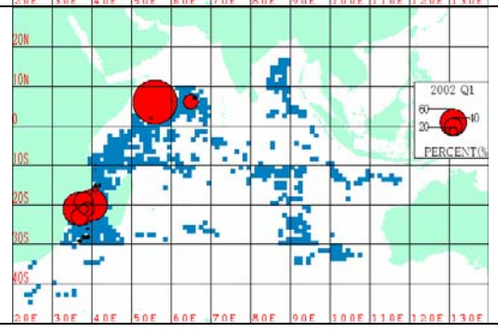
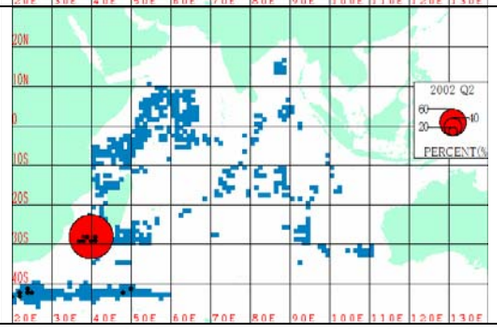
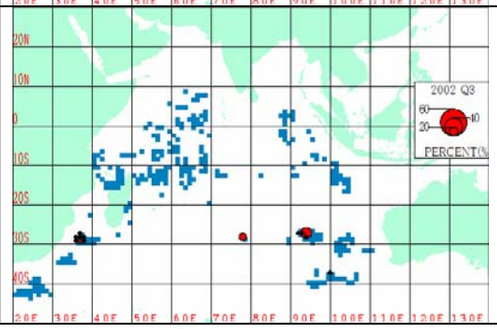
Note: Information in 2002 are partially described as the predation survey and logbook data have not yet fully recovered.

Map 4 **Average predation rate (%) of BIGEYE TUNA (number of fish attacked*100/total catch) per operation in the reported area of the predation survey (red) and Japanese tuna longline fishing grounds (blue) by quarter (Q) (2000-2002) (1^{o}x1^{o} based map)**

	Q1	Q2	Q3	Q4
2000				
2001				
2002				

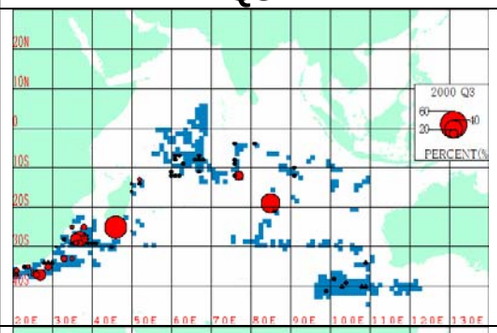
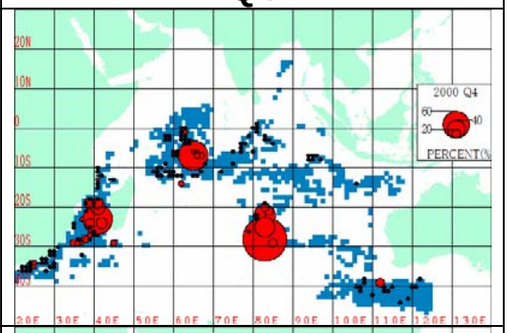
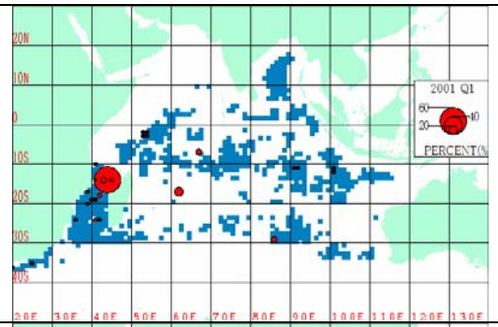
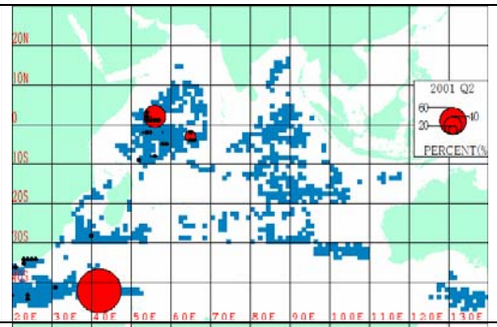
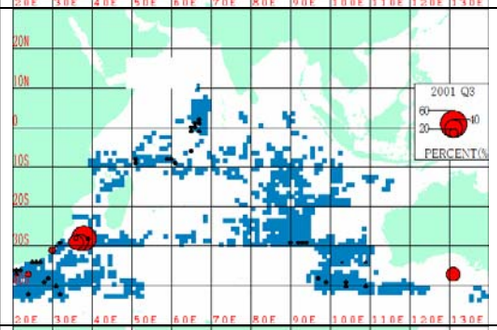
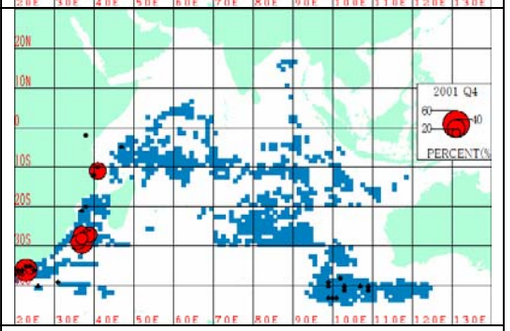
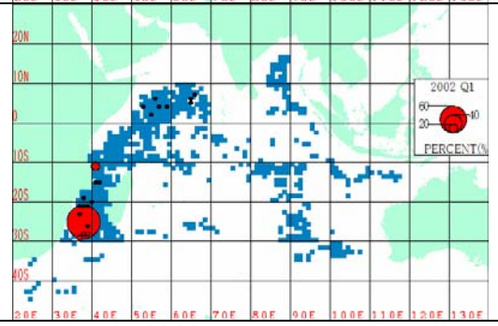
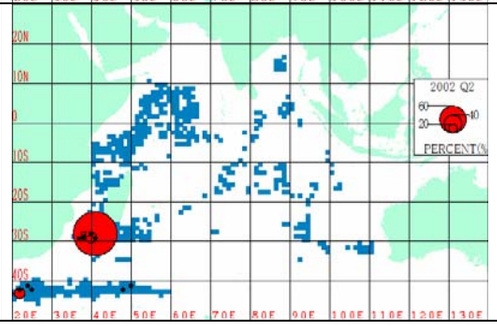
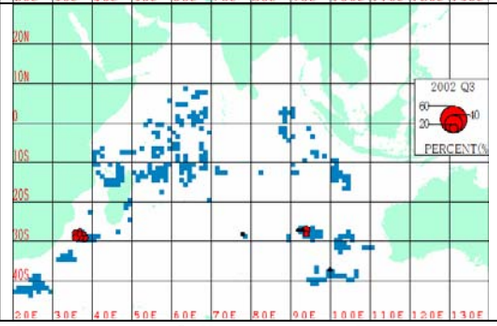
Note: Information in 2002 are partially described as the predation survey and logbook data have not yet fully recovered.

Map 5 **Average predation rate (%) of YELLOWFIN TUNA (number of fish attacked*100/total catch) per operation in the reported area of the predation survey (red) and Japanese tuna longline fishing grounds (blue) by quarter (Q) (2000-2002) (1°x1° based map)**

	Q1	Q2	Q3	Q4
2000				
2001				
2002				

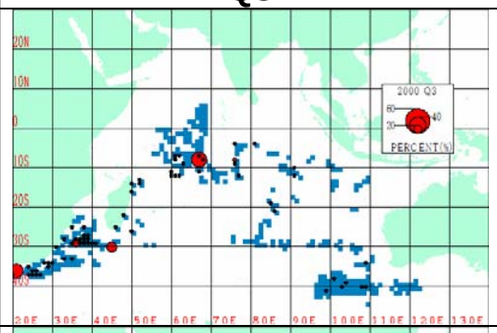
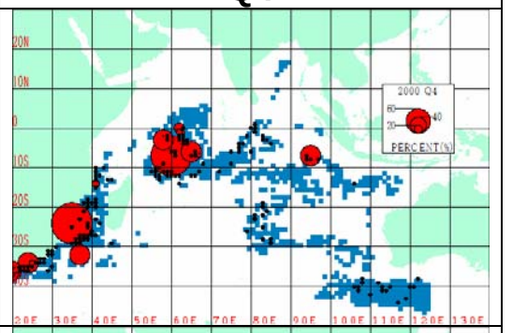
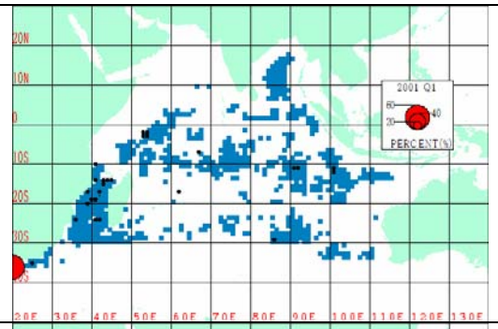
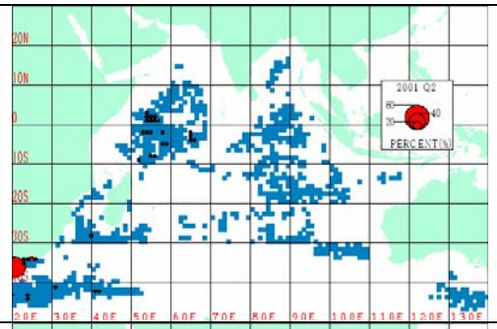
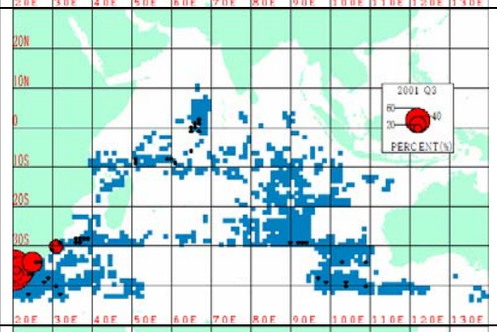
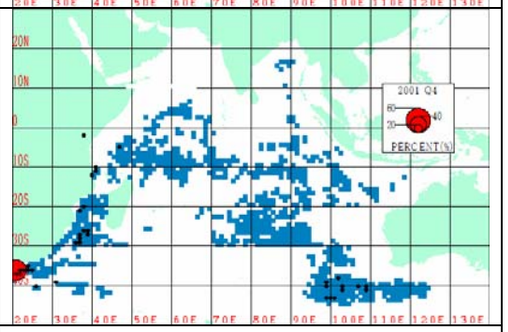
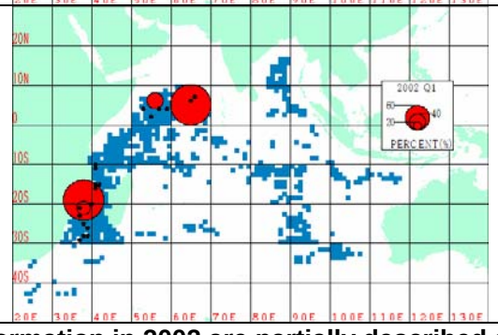
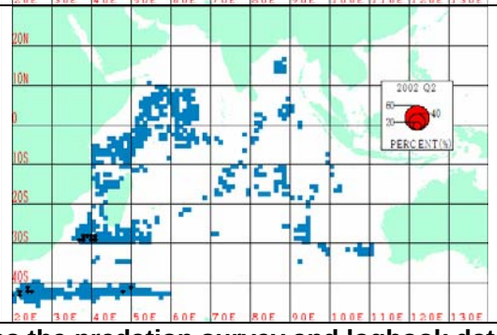
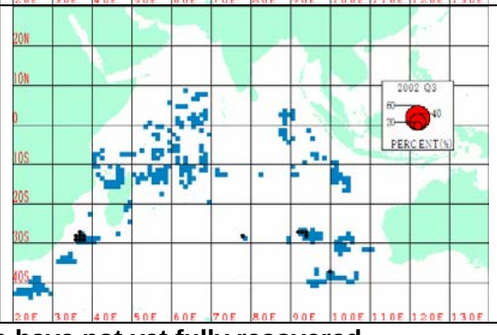
Note: Information in 2002 are partially described as the predation survey and logbook data have not yet fully recovered.

Map 6 **Average predation rate (%) of ALBACORE TUNA (number of fish attacked*100/total catch) per operation in the reported area of the predation survey (red) and Japanese tuna longline fishing grounds (blue) by quarter (Q) (2000-2002) (1°x1° based map)**

	Q1	Q2	Q3	Q4
2000				
2001				
2002				

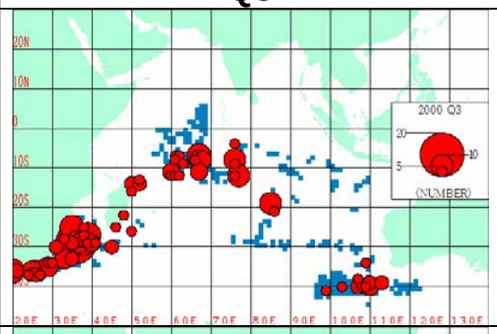
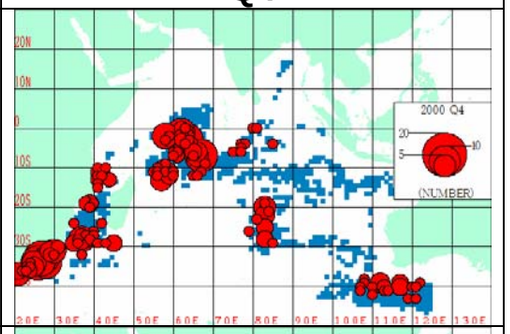
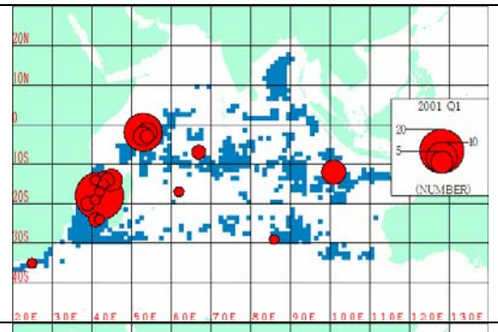
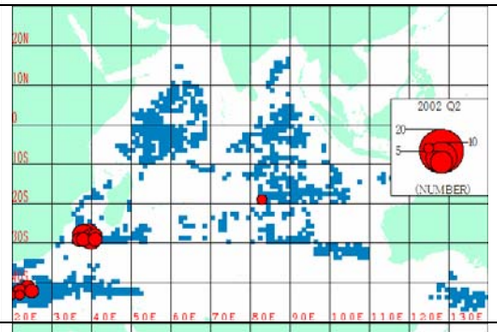
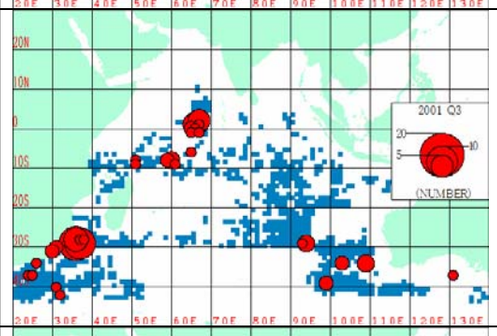
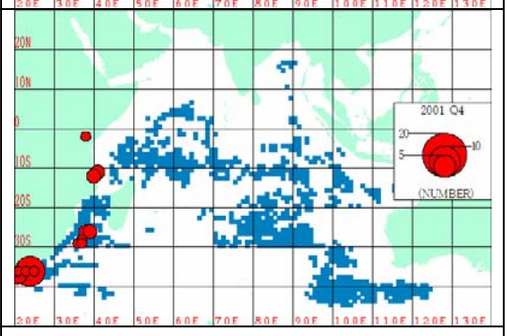
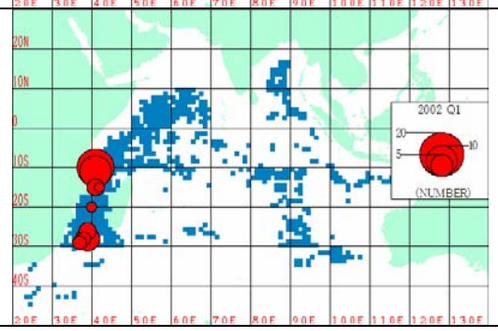
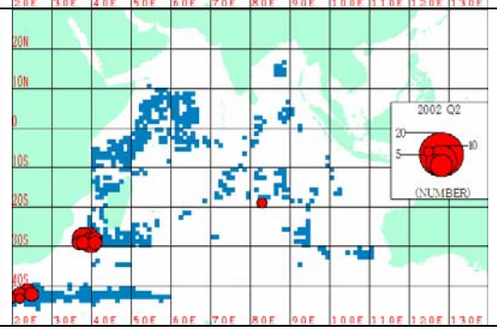
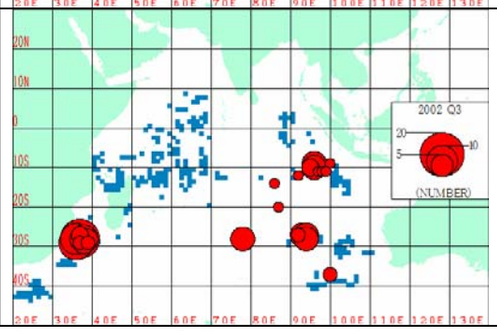
Note: Information in 2002 are partially described as the predation survey and logbook data have not yet fully recovered.

Map 7 **Average predation rate (%) of SWORDFISH (number of fish attacked*100/total catch) per operation in the reported area of the predation survey (red) and Japanese tuna longline fishing grounds (blue) by quarter (Q) (2000-2002) (1^{o}x1^{o} based map)**

	Q1	Q2	Q3	Q4
2000				
2001				
2002				

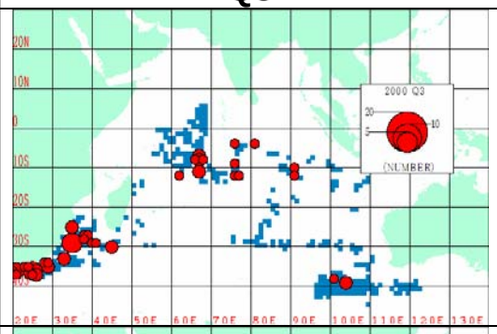
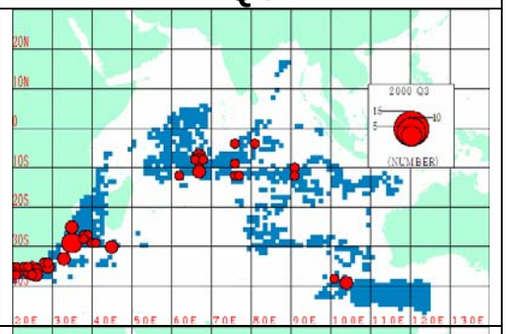
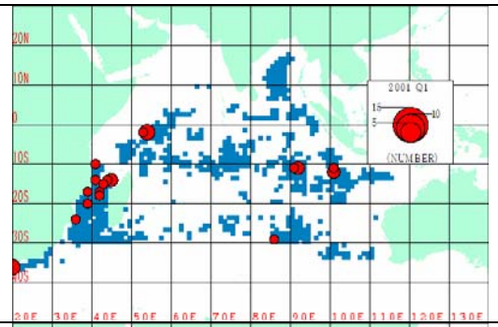
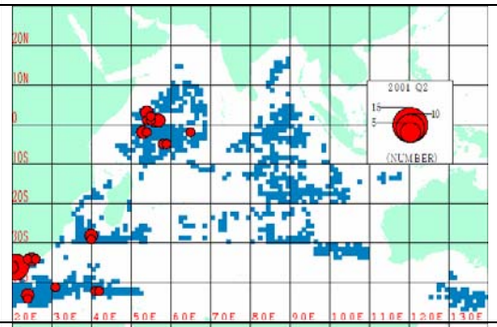
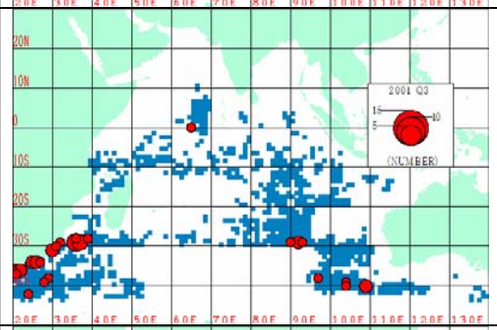
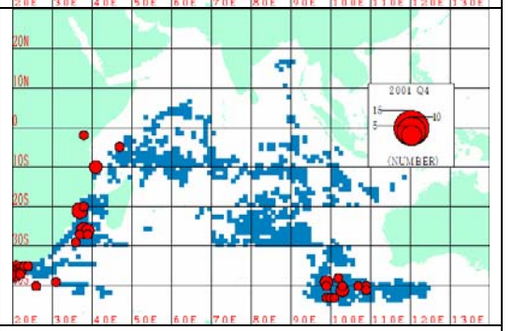
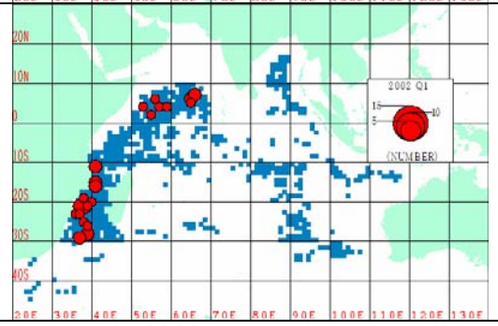
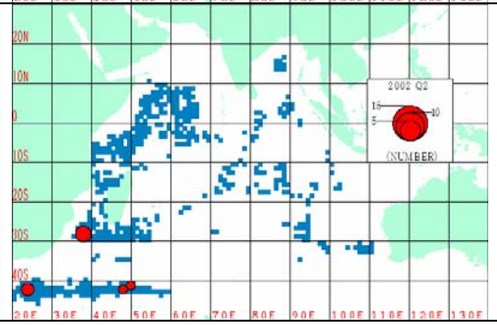
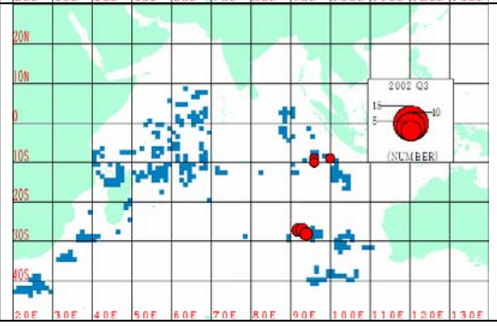
Note: Information in 2002 are partially described as the predation survey and logbook data have not yet fully recovered.

Map 8 **Occurrence of predators (SHARKS) (in number) in the reported area of the predation survey (red) and Japanese tuna longline fishing grounds (blue) by quarter (Q) (2000-2002) (1^{o}x1^{o} based map)**

	Q1	Q2	Q3	Q4
2000				
2001				
2002				

Note: Information in 2002 are partially described as the predation survey and logbook data have not yet fully recovered.

Map 9 **Occurrence of predators (KILLER WHALE or FALSE KILLER WAHLE) (in number) in the reported area of the predation survey (red) and Japanese tuna longline fishing grounds (blue) by quarter (Q) (2000-2002) (1^{o}x1^{o} based map)**

	Q1	Q2	Q3	Q4
2000				
2001				
2002				

Note: Information in 2002 are partially described as the predation survey and logbook data have not yet fully recovered.

4. Discussion and Summary

Reporting rates and areas

(1) We have collected predation survey data for 25 months, but the reporting boats have been decreasing from around 20% (beginning) to less than 10% recently. To solve this problem, Japan Tuna and NRIFSF have sent the letter to the all the LL boats in November, 2002 in order to seek further cooperation on the predation surveys.

(2) The predation are reported mainly from the SW Indian Ocean and the central tropical Indian Ocean. There are less reports from other parts of the Indian Ocean.

High predation waters

(3) From predation Maps, we observe that there are extremely high predation areas such as of the east coast of Africa, waters around Seychelles and equatorial waters.

Attacked fish

(4) YFT, BET and ALB are three major attacked species by predations, which account 41%, 26% and 18% respectively. Those for SWO and SBT are 3% respectively.

Seasonality

(5) There are seasonality in the distribution of the predators(sharks and toothed whales). Accordingly, attacked tuna and billfish have similar seasonality in their distribution patterns.

Predators

(6) Sharks and toothed whales (false killer whale and killer whale combined) are two major predators, which account 66% and 30% (in terms of number of the predators) respectively.

(7) 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. However, if LL fishers can see them by eye on or near the sea surface, they can correctly identify two species.

(8) 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.

(9) In average, one predator species attacked in one operation. In a few cases, two predators species attacked in one longline operation.

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

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

Predation rates

(12) We need to understand differences between the real predation rates in the population and the sampled situations based on log book and predation survey information as shown in Fig. 4. Predation rates based on the sampled information might include biases if the sampled predation rates are not proportional to those in the population. Keeping this potential problems in mind, we need to look at the figures with caution.

(13) We, then, further understand two types of predation rates as shown in Fig. 4., i.e., (type 1) predation rates including the data from the operations with 0 predations, while (type 2) those from excluding the data from the operations with 0 predations, i.e., the data from the operations when there are at least one predations.

(14) The overall average predation rates based on the data excluding 0 predation is 37% per operation, while those including 0 predation is 15 %, which is more than twice of the difference.

(15) Five major species with high predation rates per operation for almost all seasons (in order) are swordfish (SWO) (65% for type1 vs. 7 % for type 2 in overall average), southern bluefin tuna (SBT) (35% vs. 31%), albacore (ALB) (25% vs. 11%), bigeye (BET) (26% vs. 14%) and yellowfin tuna (YFT) (26% vs. 13%).

Collaborative predation survey data analyses

(16) We will have the workshop on the predations in 2005 or 2006 as recommended by the SC in Kyoto. For the preparation of the workshop, it was suggested in the last SC for Japan to build the database for available information (e.g. Seychelles, India, China and other countries). For this work, we need the collaboration from these countries. See the announcement on the collaborative work (IOTC/WPTT/Info. __).

Mitigation

(17) Based on Nishida and Tanio (2001), it has been reported since 1959 that the tail-tied fishes tend not to be damaged by killer whales. 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.

(18) Thus, the potential effective method to mitigate the attacks by killer whales or false killer whales, is to catch tuna from the tail of fish (see Fig. 4). As a first step, it is necessary to investigate this fact in details by interviewing the LL fishers, to get photos on site and etc.

(19) If this fact were learned to be realistic, we need to think about developing to catch tuna from the tails. However, it will be difficult and impractical. In more practical way, we may test by putting the tail-tied dummy tunas to the hooks in the longline gears (for example, one dummy every 30 baskets, so that we need 100 dummies if LL use 3000 hooks) to see if real tuna and billfishes can be protected from the attacks. This is because predators can smell tuna and billfish and could have chances to attack them, but they are more frightened by looking at the shapes of the up-side-down tuna and billfish than reaching and attacking (Fig. 4).

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.

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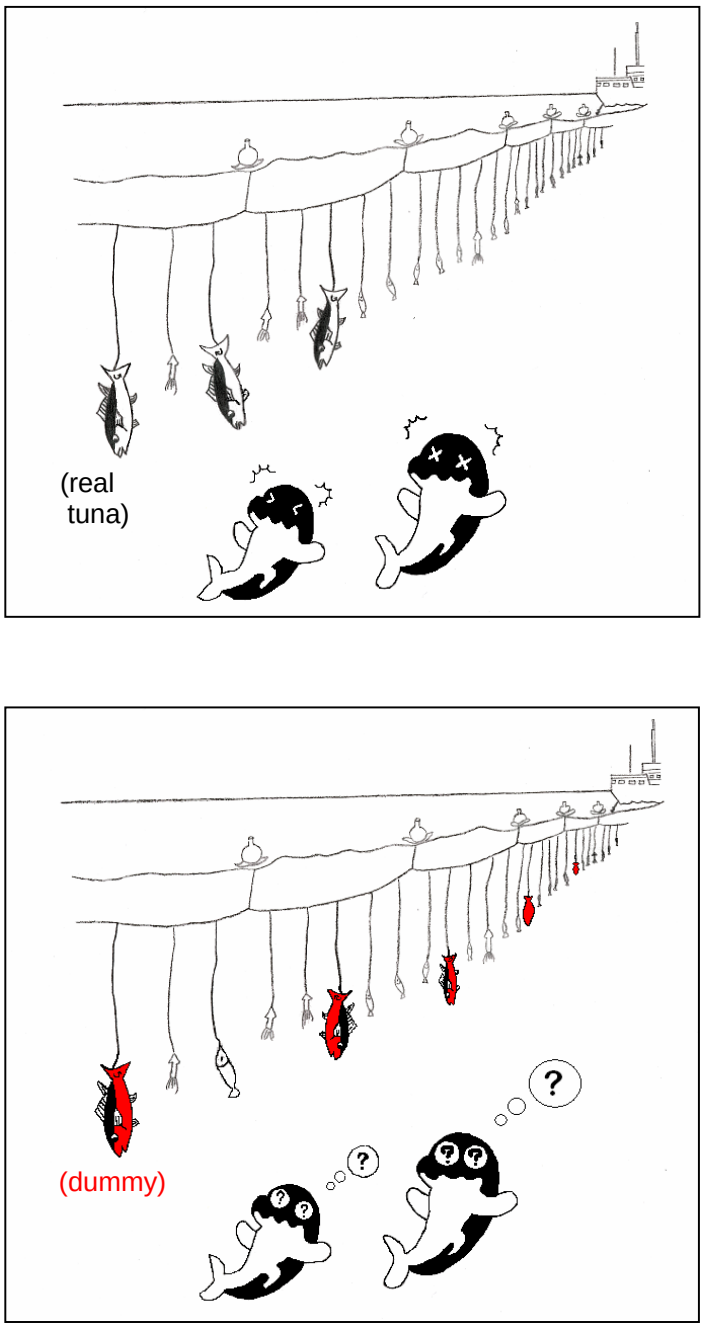

Fig. 4 Potential mitigation method by deploying dummy tunas to the hooks from its tail side (*lower panel*) as it has been reported that false killer and killer whales had been scared away from tail hooked tunas due to unusual shapes of the tunas (even though they could smell tuna) in almost all occasions, according to tuna longline fishers (upper panel).