

**Report of the predation survey by the Japanese commercial tuna longline fisheries
(September, 2000 – December, 2002)**

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Abstract

This report summarizes the results of the predation survey conducted by the Japanese commercial tuna longline fisheries for 2 years and 3 months from September,2000-December, 2002. We conducted the descriptive data analyses to present results.

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Submitted to the Sixth Working Party on the Tropical Tuna meeting (WPTT) (July 13-21, 2004), Victoria, Seychelles, organized by Indian Ocean Tuna Commission (IOTC).

1. Introduction

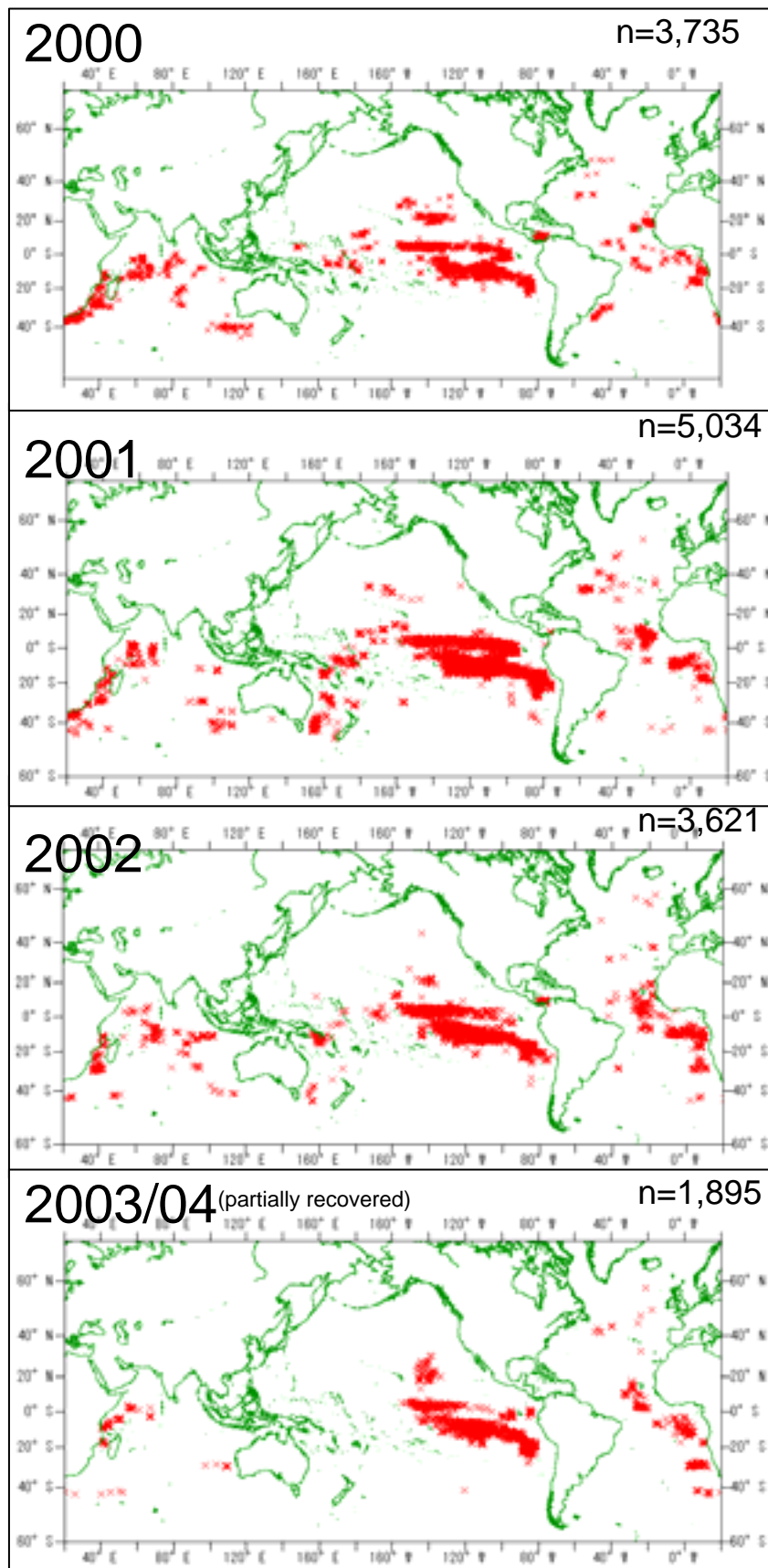
Predation problems by killer whales (*Orcinus orca*) and false killer whales (*Pseudorca crassidens*) on Japanese tuna longline fisheries have been continued to the present in three Oceans since the start of its fisheries in 1952. The first report was from the Palau water in 1952. In the earlier years, 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, 2000 for all the longliners belonging to Japan Tuna Federation and nationwide Fishers' Union. JF (Japan Fisheries Cooperatives or Zengyoren in Japanese). Currently about 450 longliners from Japan Tuna and 30 from JF are cooperating to this survey. This report summarizes the results of the surveys for two years and three months from September, 2000 to December, 2002.

2. Materials and methods

As of June, 2004, we have collected predation survey data for 3.5 years from September, 2000 to March, 2004. Map 1 shows the world-wide location of the survey report by year and Table 1 and 2 show number of boats and operations reported by Ocean respectively. However, in this paper, we used the data for 2 years and 3 months (September, 2000- December, 2002) because recent one year of the data (2003-2004) have not yet fully recovered. We conducted descriptive data analyses for the Indian Ocean using different presentations, i.e., summary tables, Figures and maps using *Marine Explorer* version 3.2 (GIS software) developed by Environmental Simulation Laboratory.



Map 1 Locations of predations reported by longliners (as of June, 2004, total n=14,285)

Table 1 Reported number of boats affected by predations by Ocean

Year	Quarter	Pacific Ocean	Indian Ocean	Atlantic Ocean	Total
2000	Q3	66	30	27	123
	Q4	75	30	28	133
	Total	141	60	55	256
2001	Q1	40	5	14	59
	Q2	47	6	14	67
	Q3	50	11	4	65
	Q4	51	11	10	72
	Total	188	33	42	263
2002	Q1	47	5	9	61
	Q2	47	6	6	59
	Q3	42	9	7	58
	Q4	40	10	8	58
	Total	176	30	30	236
2003	Q1	32	3	7	42
	Q2	28	2	8	38
	Q3	20	1	8	29
	Q4	13	1	4	18
2004	Q1	1	0	3	4
	Total	94	7	30	131
Total		599	130	157	886

Table 2 Reported number of operations affected by predations by Ocean

Year	Quarter	Pacific Ocean	Indian Ocean	Atlantic Ocean	Total
2000	Q3	825	207	182	1,214
	Q4	1,847	471	197	2,515
	Total	2,672	678	379	3,729
2001	Q1	1,126	94	287	1,507
	Q2	1,010	113	134	1,257
	Q3	1,043	110	10	1,163
	Q4	949	66	92	1,107
	Total	4,128	383	523	5,034
2002	Q1	821	72	136	1,029
	Q2	618	48	58	724
	Q3	790	162	69	1,021
	Q4	610	85	152	947
	Total	2,839	367	415	3,621
2003	Q1	445	54	119	618
	Q2	401	16	84	501
	Q3	436	4	68	508
	Q4	214	5	26	245
2004	Q1	10	0	13	23
	Total	1,506	79	310	1,895
Total		11,145	1,507	1,627	14,279

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, 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 logbook, so that extra works can be avoided for fishers to re-write (duplicate) catch data and 0 predation data into the predation survey forms during busy fishing operations. Thus, the predation rates by species are computed by [number of fish damages (predation survey)/total catch (log book)] when there is predation at least one fish in each operation.

3. Results (Indian Ocean)

Results are summarized by different presentations such as Tables, Figs. and Maps 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	4	6	Summary of the predation survey in the Indian Ocean (I) : Boat, operation and predators
	5	7	Summary of the predation survey in the Indian Ocean (II) : Number of fish attacked by species
	6	8	Summary of the predation survey in the Indian Ocean (III) : Average predation rates (%)by year
	7	8	Summary of the predation survey in the Indian Ocean (IV) : Average predation rates by quarter
	8	9	Summary of the predation survey in the Indian Ocean (V) : Average predation rates by area
Fig.	1	10	Species compositions of attacked fish
	2	10	Species compositions of the predators
Map	2	9	Sub area
	3	11	Species compositions of attacked fish by quarter and area
	4	12	Species compositions of predator by quarter and area
	5	13	Situation of the predation by year (all species combined)
	6	14	(Yellowfin tuna)
	7	15	(Bigeye tuna)
	8	16	(Albacore tuna)
	9	17	(Swordfish)
	10	18	Situation of the predation by quarter (all species combined)
	11	19	(Yellowfin tuna)
	12	20	(Bigeye tuna)
	13	21	(Albacore tuna)
	14	22	(Swordfish)

Table 4 Summary of the predation survey in the Indian Ocean (I) : Boat, operation and predators (*)

Year	2000	2001	2002	TOTAL
[Boat]				
Number of boats reported	60	33	30	123
Total number boats operated	162	199	123	484
Reporting rates(%)	37.0	16.6	24.4	25.4
[Operation]				
Number of operations reported	678	383	367	1,428
Total number of operations	12,535	34,327	27,807	74,669
Reporting rates (%)(*)	5.4	1.1	1.3	1.9
[Number of predators reported]				
False killer whale (or Killer whale)	258	139	111	508
Other whales	1	5	0	6
Sharks	410	237	240	887
Squid	0	0	0	0
Fur Seal	1	0	0	1
Un-identified	10	3	16	29
TOTAL	680	384	367	1,431

Note () These figures are based on the reported data when at least one fish is attacked in each longline operation, thus those in case of no predation are not included.*

Table 5 Summary of the predation survey in the Indian Ocean (II) : Number of fish attacked by species

Year	2000	2001	2002	TOTAL
[Number of fish attacked](- : no catch)				
1. Northern bluefin	2	--	--	2
2. Southern bluefin	40	154	36	230
3. Albacore	419	348	363	1,130
4. Bigeye	1,053	806	356	2,215
5. Yellowfin	1,131	1,583	459	3,173
6. Swordfish	122	66	25	213
7. Striped marlin	2	1	6	9
8. Blue marlin	37	3	3	43
9. Black marlin	1	1	--	2
10. Sailfish	5	15	9	29
11. Skipjack	--	--	49	49
12. Sharks	6	--	1	7
13. Un-identified	36	--	--	36
14. Others	59	197	76	332
15. Butterfly fish.	4	--	9	13
TOTAL	2,917	3,174	1,392	7,483
Reported no. of operations affected by predations	678	383	367	1,428
[Average number of fish attacked per operation](- : no catch)				
1. Northern bluefin	0.0	--	--	0.0
2. Southern bluefin	0.1	0.4	0.1	0.2
3. Albacore	0.6	0.9	1.0	0.8
4. Bigeye	1.6	2.1	1.0	1.6
5. Yellowfin	2.1	4.1	1.3	2.4
6. Swordfish	0.2	0.2	0.1	0.2
7. Striped marlin	0.0	0.0	0.0	0.0
8. Blue marlin	0.1	0.0	0.0	0.0
9. Black marlin	0.0	0.0	--	0.0
10. Sailfish	0.0	0.0	0.0	0.0
11. Skipjack	--	--	0.1	0.1
12. Sharks	0.0	--	0.0	0.0
13. Un-identified	0.1	--	--	0.1
14. Others	0.0	0.5	0.2	0.2
15. Butterfly fish.	0.0	--	0.0	0.0
TOTAL	4.8	8.3	3.8	5.5

Note (*) These figures are based on the reported data when at least one fish is attacked in each longline operation, thus those in case of no predation are not included.

Table 6 Summary of the predation survey in the Indian Ocean (III) :Average predation rates (%)(*)by year (**)

-- : no catch

year	2000	2001	2002
1. Northern bluefin	0.0	--	--
2. Southern bluefin	19.2	44.4	18.7
3. Albacore	10.2	10.6	13.5
4. Bigeye	13.6	16.5	12.7
5. Yellowfin	14.2	13.5	9.1
6. Swordfish	11.8	5.3	3.8
7. Striped marlin	0.2	0.0	0.0
8. Blue marlin	11.8	0.4	0.0
9. Black marlin	0.0	2.2	--
10. Sailfish	1.9	0.0	0.0
11. Skipjack	--	--	0.0
12. Sharks	0.0	--	0.0
14. Others (inc. 13 unidentified)	0.0	6.3	2.4
15. Butterfly fish.	0.4	--	0.0
Overall average	14.1	16.5	17.9
Reported no. of operations affected by predations	441	331	165

Table 7 Summary of the predation survey in the Indian Ocean (IV) :

Average predation rates(*) by quarter (**) (2000-2002)

-- : no catch (np) : no predation

year	Q1	Q2	Q3	Q4
1. Northern bluefin	--	--	--	--
2. Southern bluefin	--	31.7	21.6	34.3
3. Albacore	8.6	10.2	13.8	9.7
4. Bigeye	14.1	19.2	13.1	14.0
5. Yellowfin	11.7	16.7	11.3	14.3
6. Swordfish	2.1	6.1	8.8	11.1
7. Striped marlin	(np)	(np)	NP	0.2
8. Blue marlin	(np)	0.7	6.7	11.7
9. Black marlin	6.7	(np)	(np)	(np)
10. Sailfish	np	--	(np)	2.0
11. Skipjack	--	--	--	(np)
12. Sharks	(np)	(np)	0.1	(np)
14. Others (inc. 13 unidentified)	(np)	12.5	(np)	(np)
15. Butterfly fish.	--	(np)	(np)	0.3
Overall average	14.9	18.0	15.2	15.3
Reported no. of operations affected by predations (total n=937)	137	136	302	362

Note (*) Predation rates(%)= (no. of attacked fish)/(no. of catch). Those with yellow markers indicate that predation rates are larger than 15%.

Note (**) These figures are based on the reported data when at least one fish is attacked in each longline operation, thus those in case of no predation are not included.

Table 8 Summary of the predation survey in the Indian Ocean (V) :

Average predation rates (*)by area (**)(***) (2000-2002)

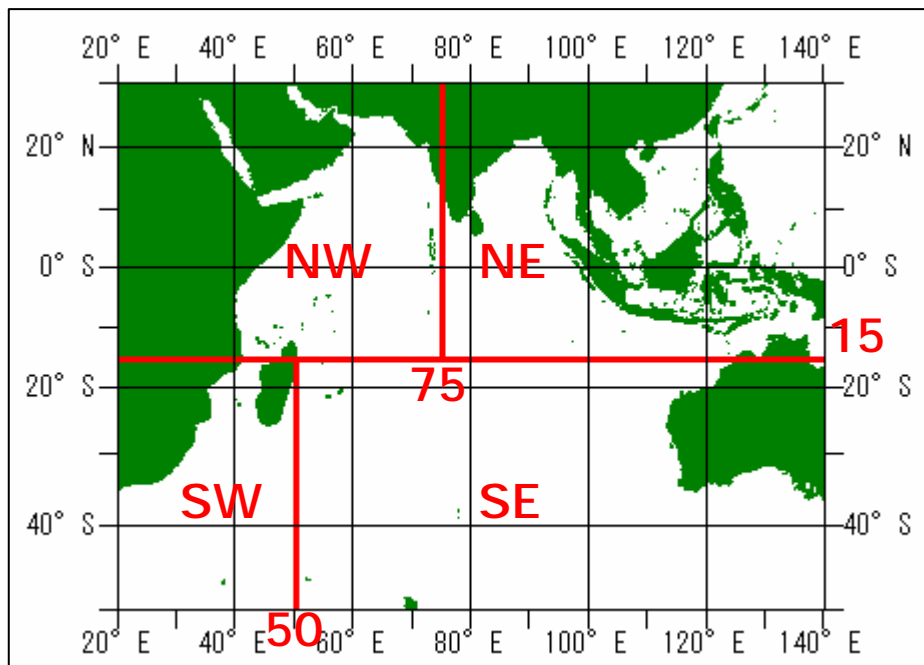
-- : no catch

year	NE	NW	S	SW
1. Northern bluefin	--	--	--	--
2. Southern bluefin	--	--	33.9	22.7
3. Albacore	16.7	7.5	24.7	10.7
4. Bigeye	17.6	16.6	26.2	10.7
5. Yellowfin	18.5	16.9	15.3	10.3
6. Swordfish	2.2	3.8	(np)	13.2
7. Striped marlin	1.8	(np)	(np)	(np)
8. Blue marlin	(np)	9.5	--	(np)
9. Black marlin	(np)	(np)	(np)	1.3
10. Sailfish	(np)	(np)	(np)	25.0
11. Skipjack	--	--	--	(np)
12. Sharks	(np)	(np)	(np)	(np)
14. Others (inc. 13 unidentified)	--	(np)	--	2.1
15. Butterfly fish.	--	--	0.2	(np)
Overall average	16.0	15.8	22.0	14.0
no of operations reported (total n=937)	36	278	117	506

Note (*) Predation rates(%)= (no. of attacked fish)/(no. of catch). Those with yellow markers indicate that predation rates are larger than 15%.

Note (**) Definition of the sub-area is as shown in Map 2 below:

Note (***) These figures are based on the reported data when at least one fish is attacked in each longline operation, thus those in case of no predation are not included.



Map 2 Sub-areas

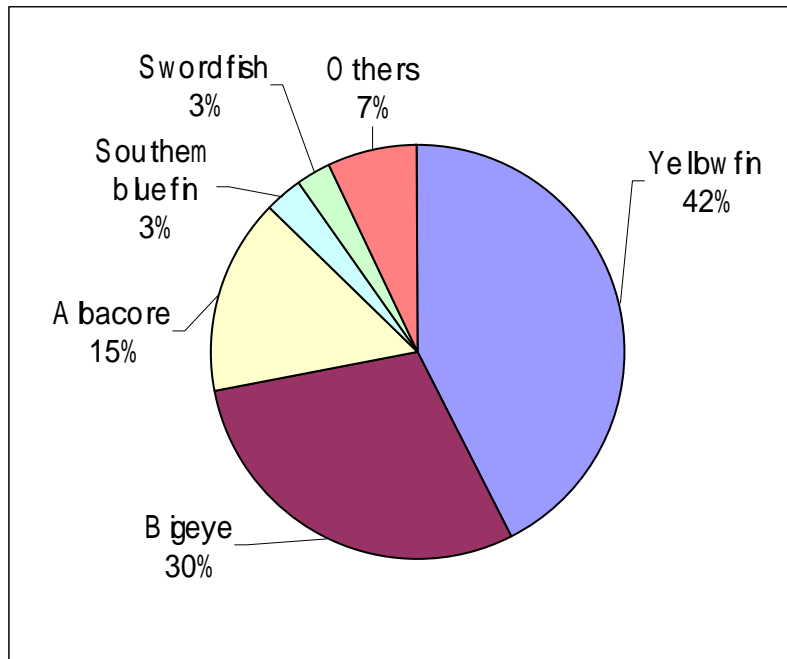


Fig. 1 Species composition of the attacked fish (September, 2000- September, 2002) (n=7,483)

Note: Others (7%) include unidentified species, white marlin, sailfish, sharks, northern bluefin tuna, black marlin, striped marlin, skipjack and butterfly fish.

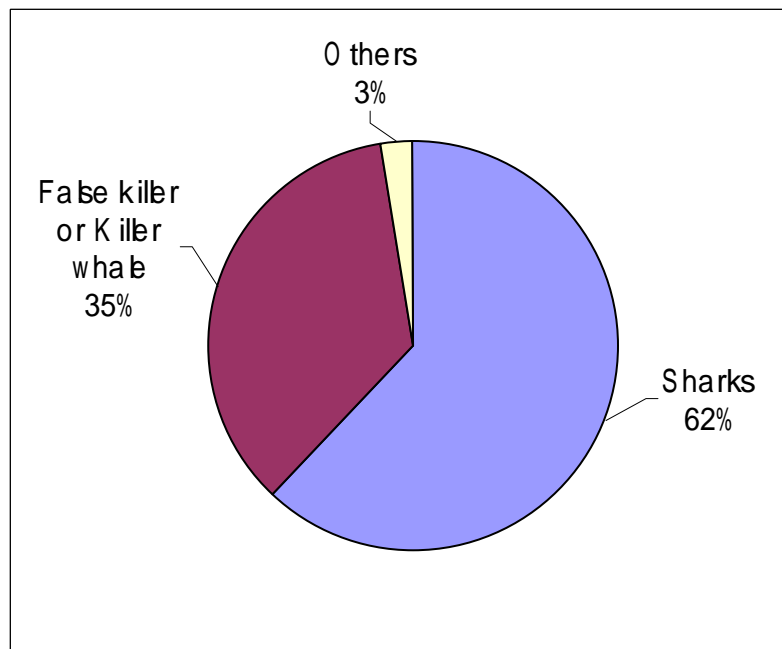
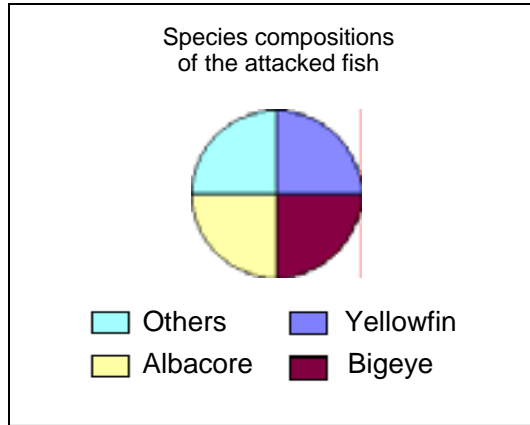
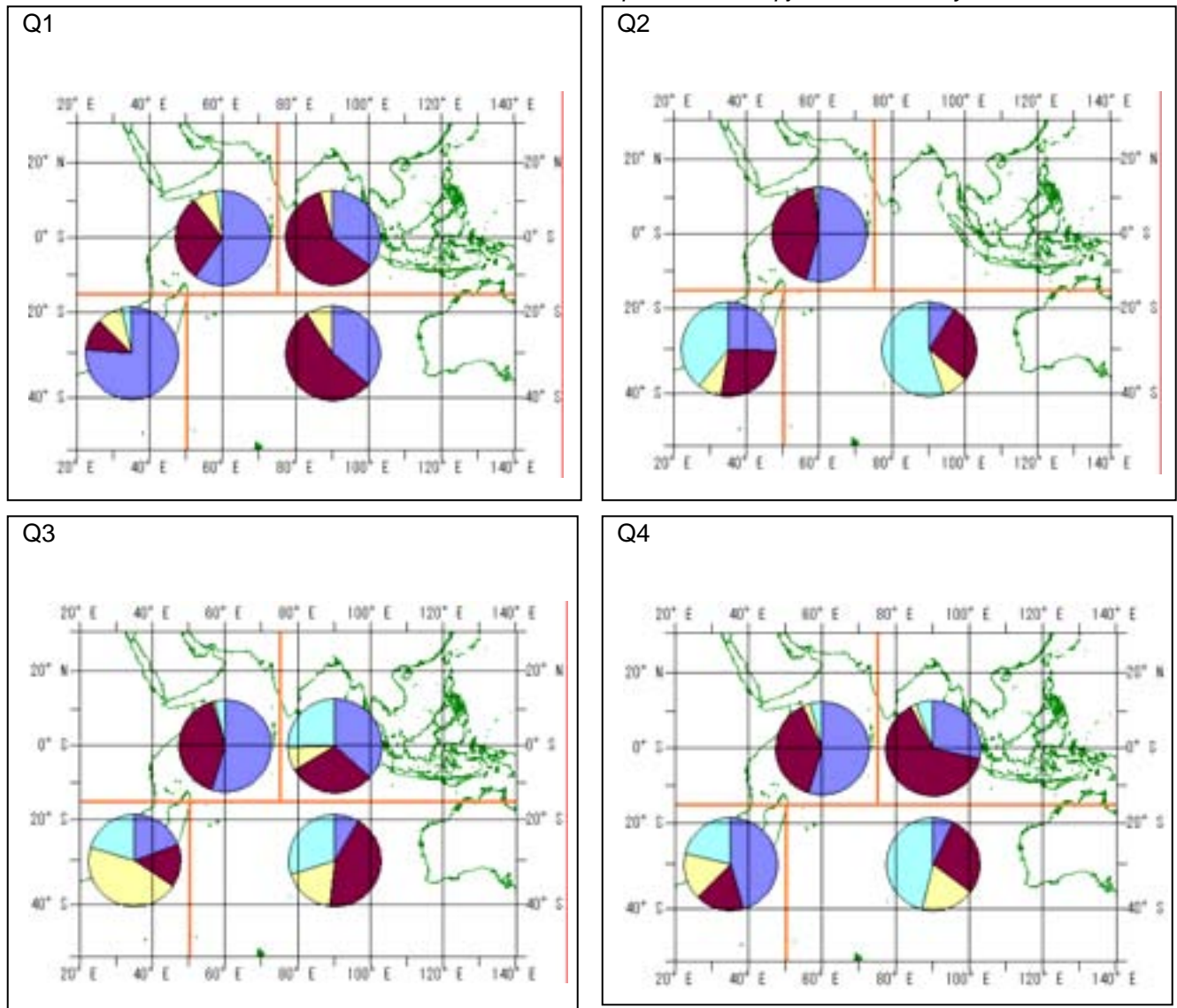


Fig. 2 Species composition of the predators (September, 2000- September, 2002) (n=1,431)

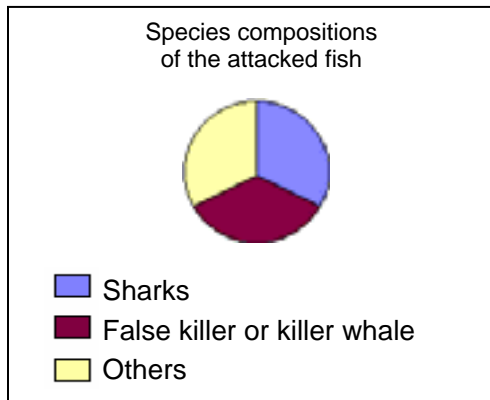
Note: Others (3%) include unidentified species, other whales, squid and fur seal.



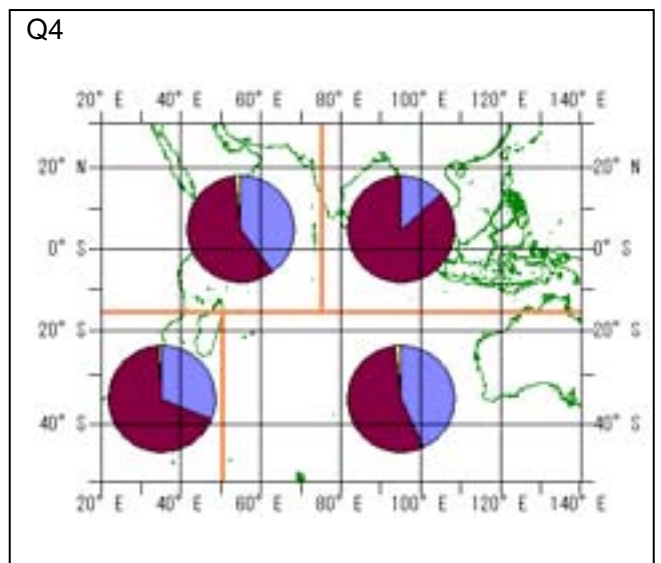
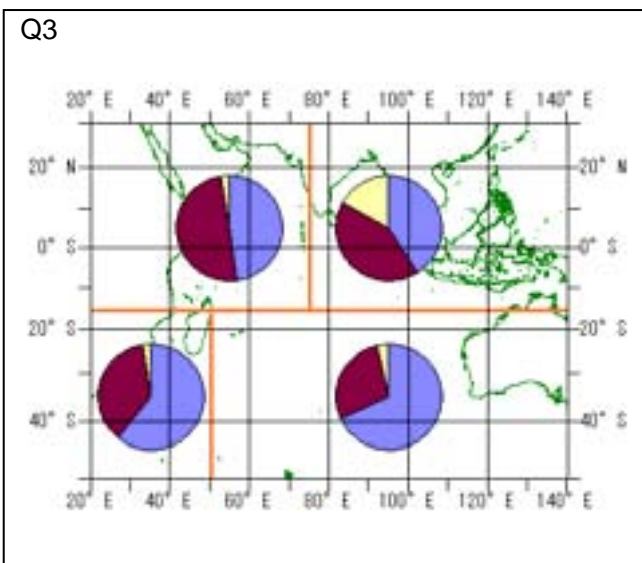
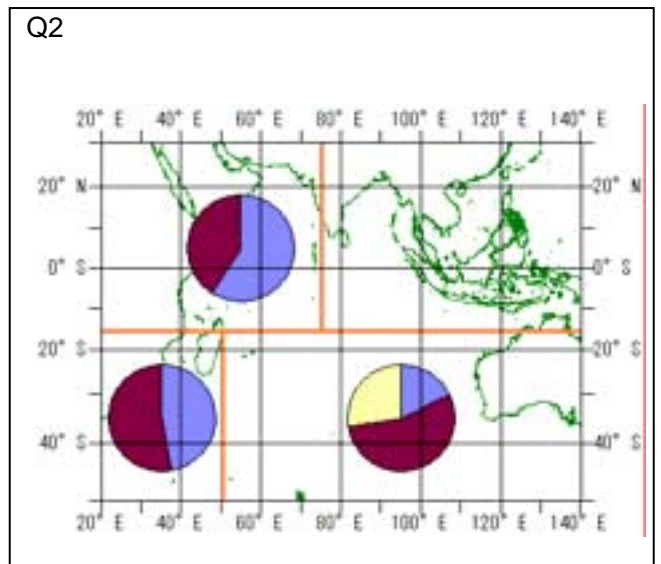
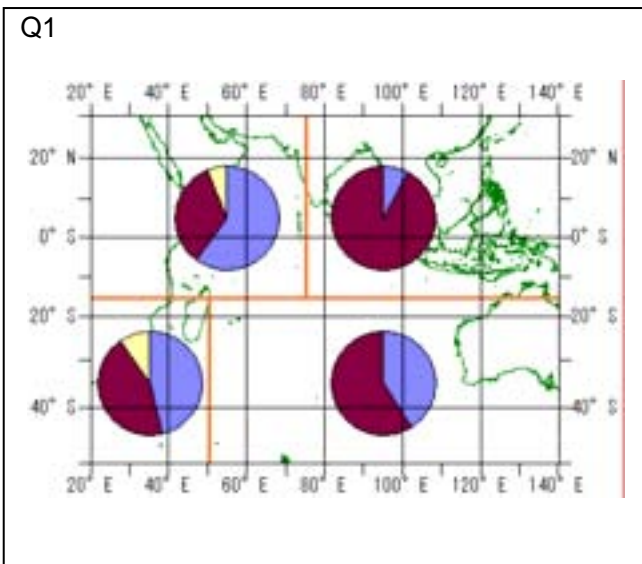
(Note) Others include swordfish, southern bluefin tuna, unidentified species, white marlin, sailfish, sharks, northern bluefin tuna, black marlin, striped marlin, skipjack and butterfly fish.



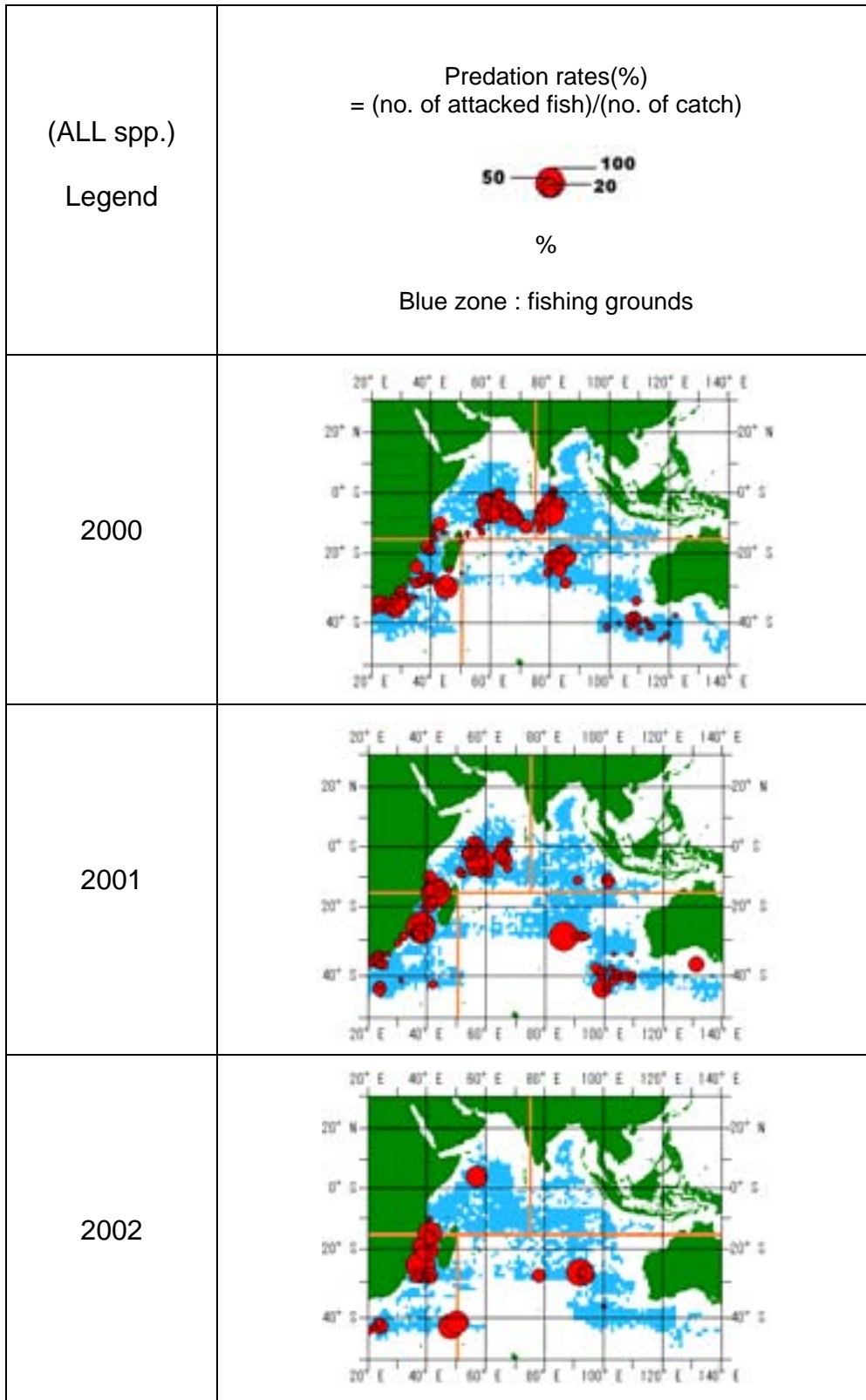
Map 3 Species compositions of attacked fish by quarter and area (Sept. 2000- Dec. 2002)



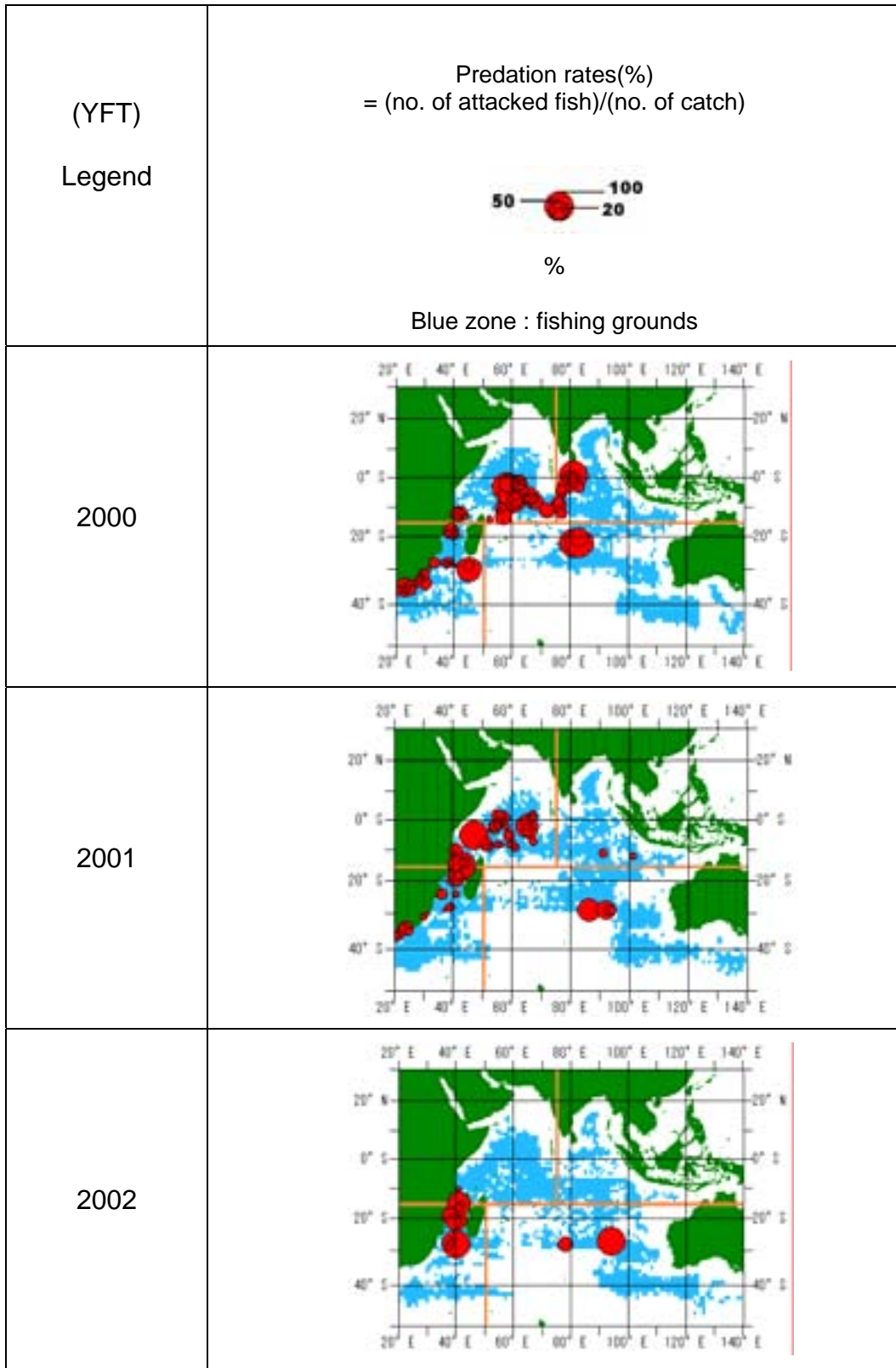
(Note) Others include unidentified species, other whales, squid and fur seal.



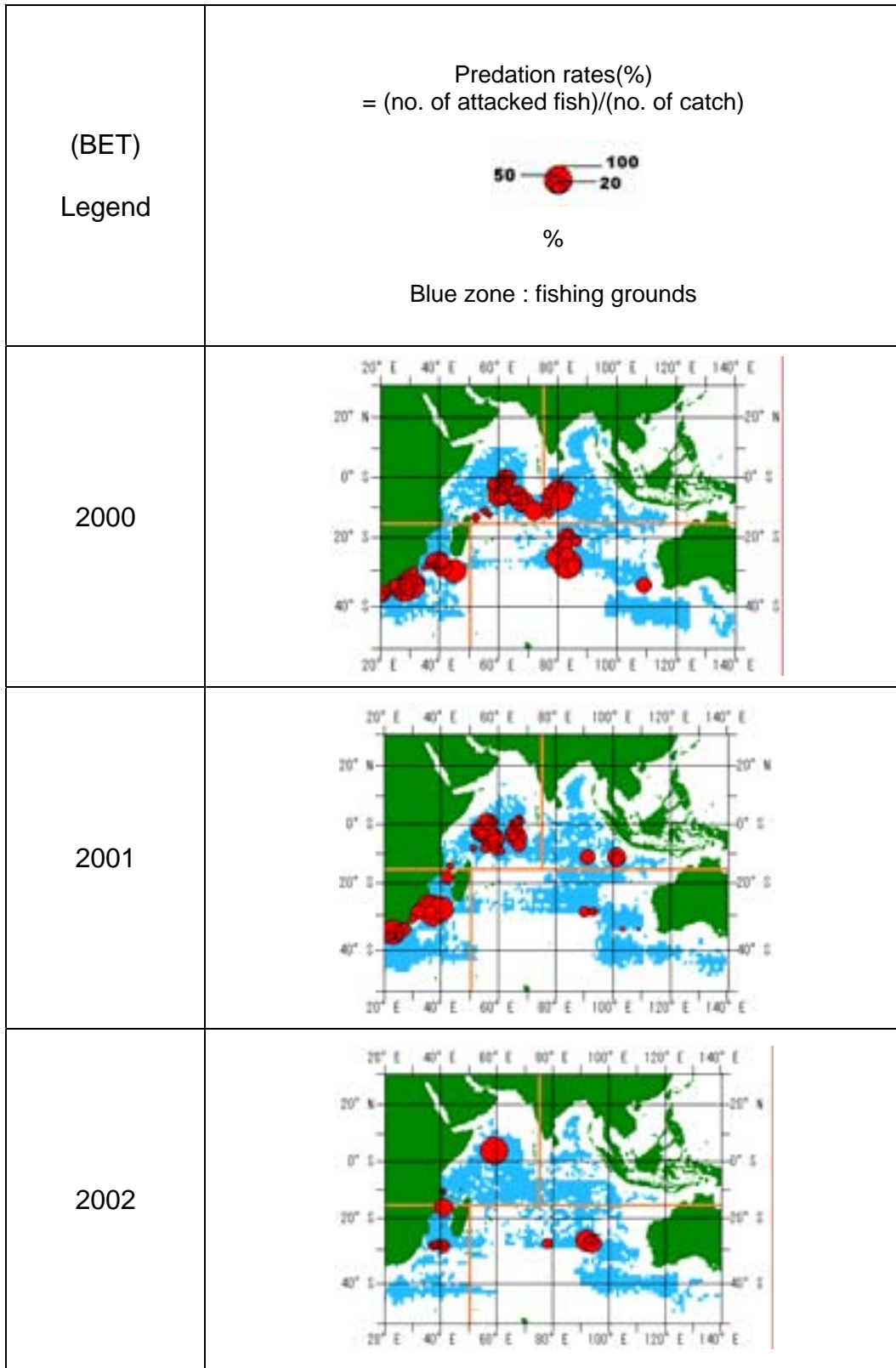
Map 4 Species compositions of predator by quarter and area (Sept. 2000- Dec. 2002)



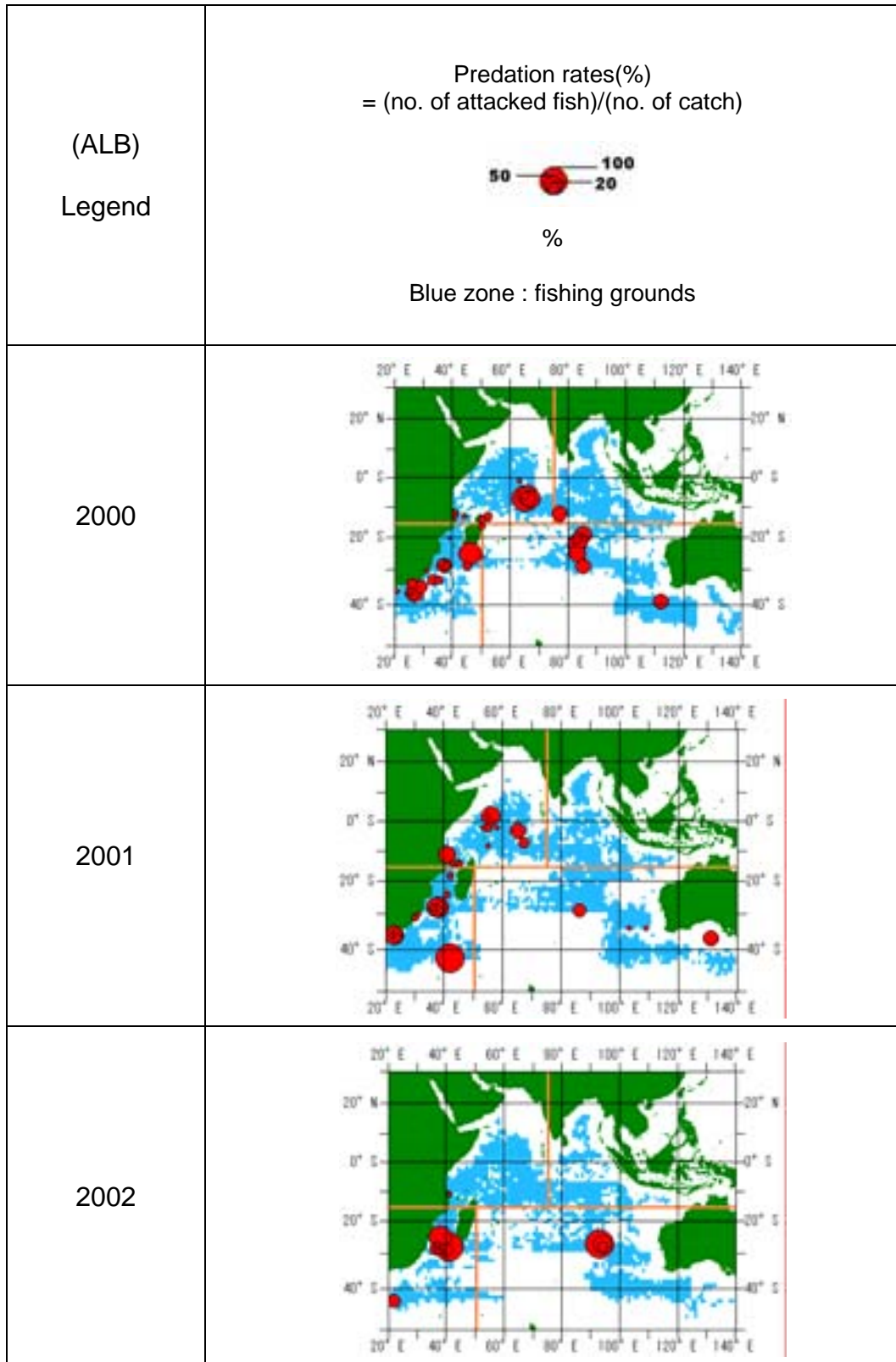
Map 5 Situation of the predation by year (all species combined) (Sept. 2000- Dec. 2002)



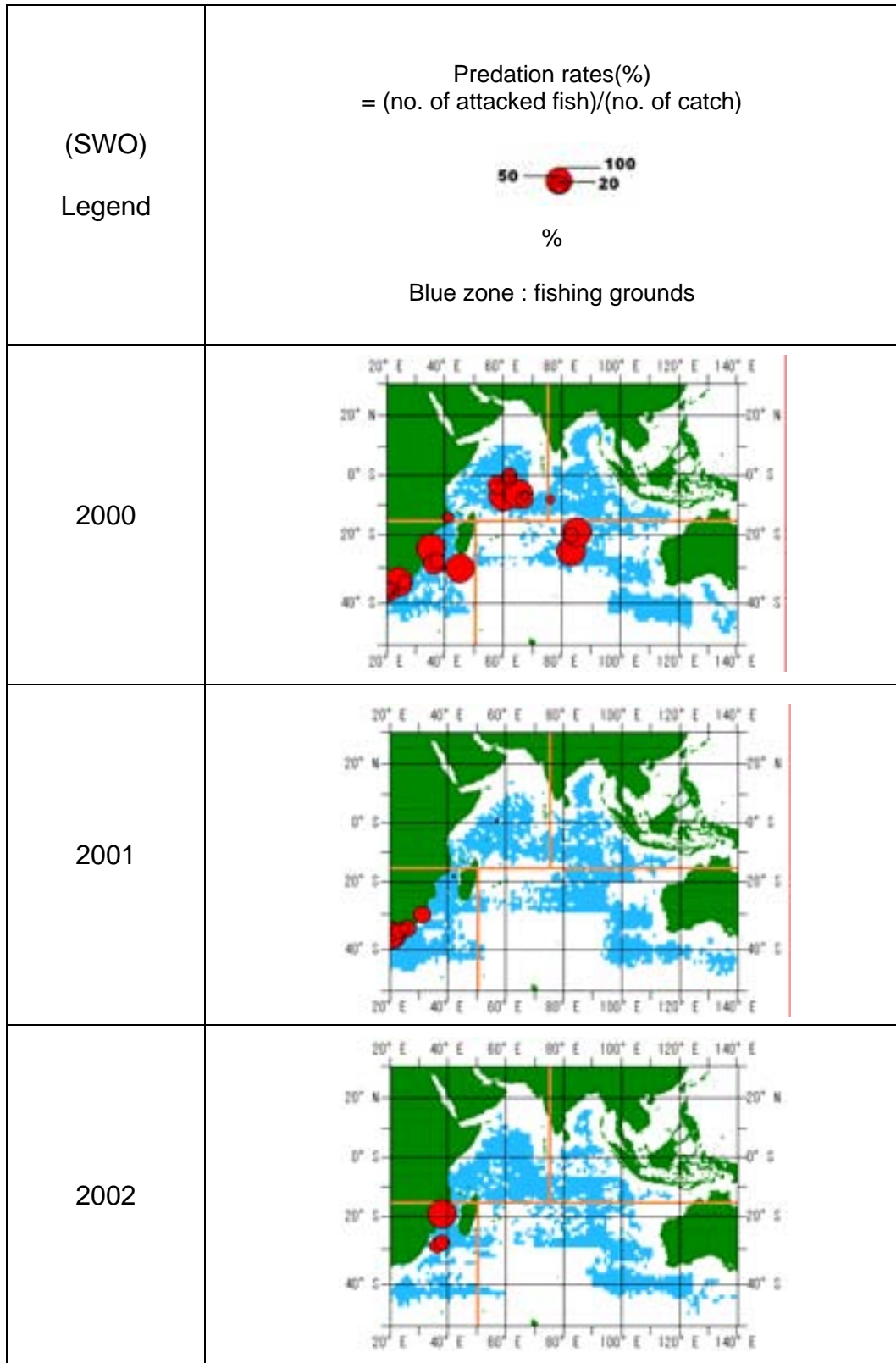
Map 6 Situation of the predation by year (Yellowfin tuna) (Sept. 2000- Dec. 2002)



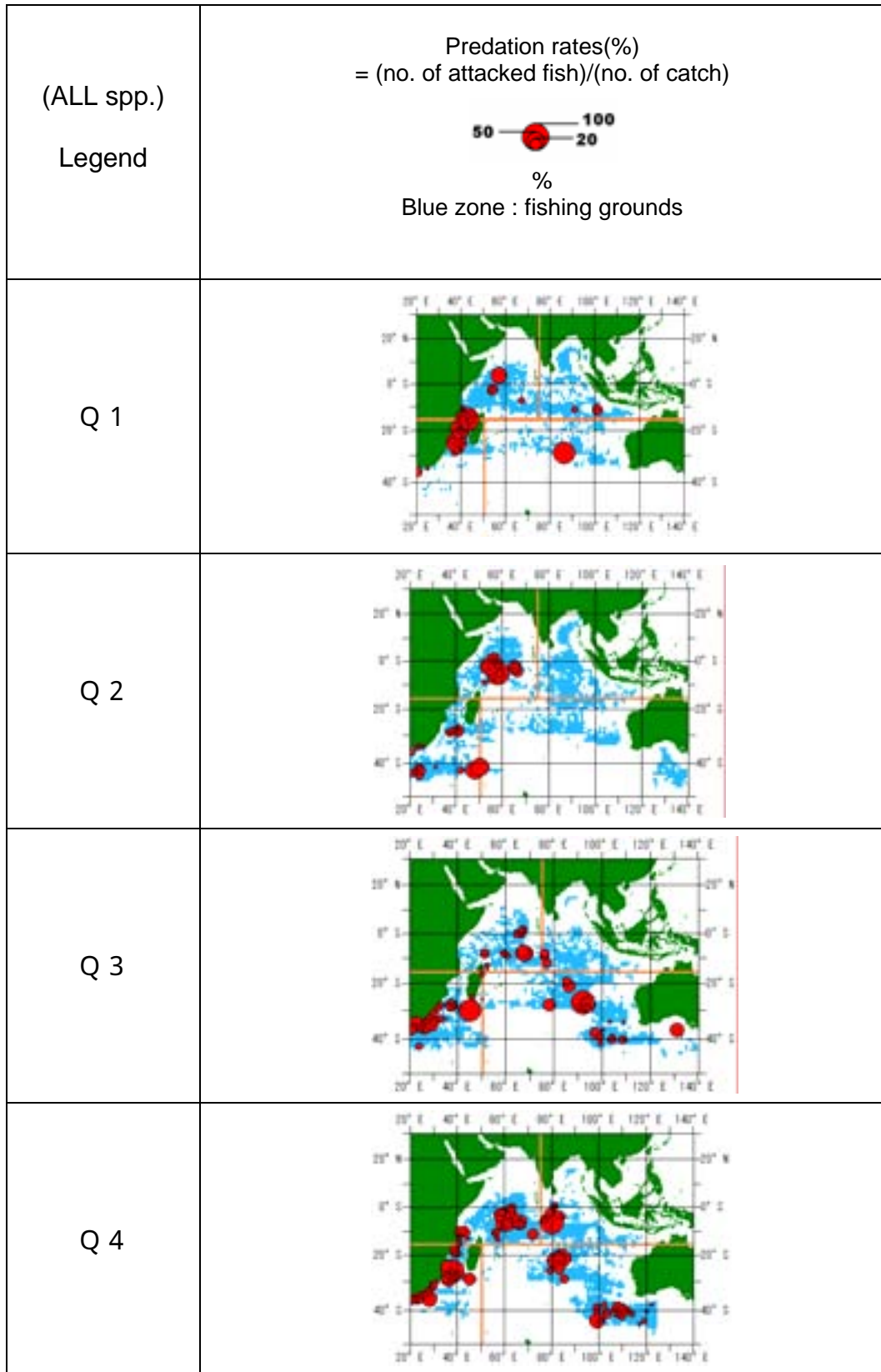
Map 7 Situation of the predation by year (Bigeye tuna) (Sept. 2000- Dec. 2002)




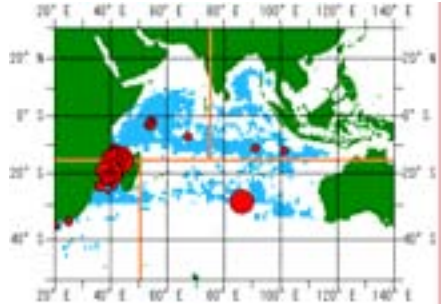
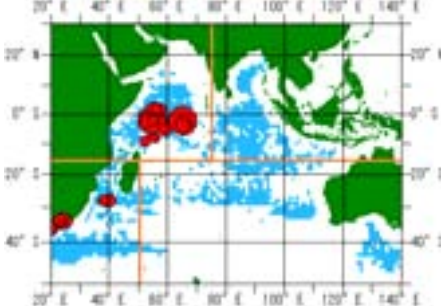
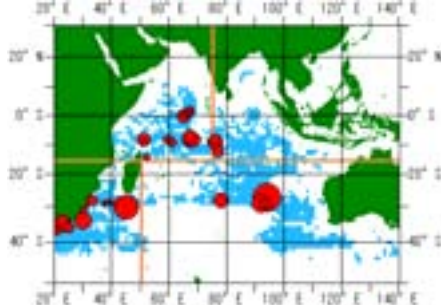
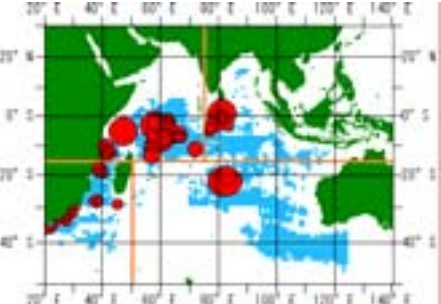
Map 8 Situation of the predation by year (Albacore tuna) (Sept. 2000- Dec. 2002)




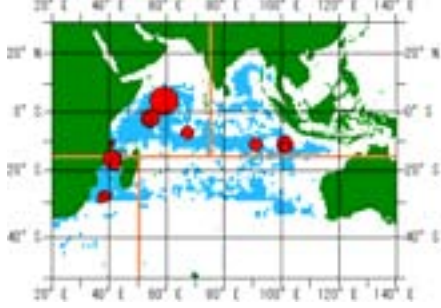
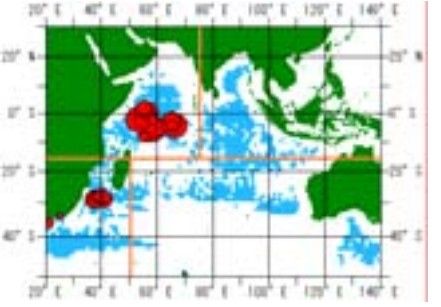
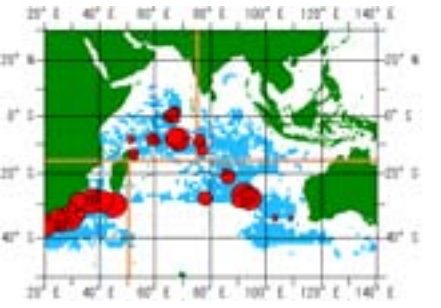
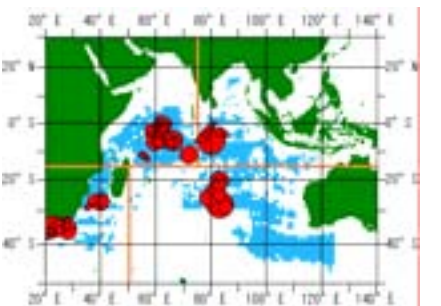
Map 9 Situation of the predation by year (Swordfish) (Sept. 2000- Dec. 2002)



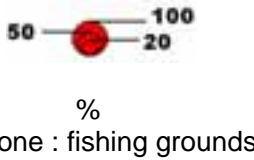
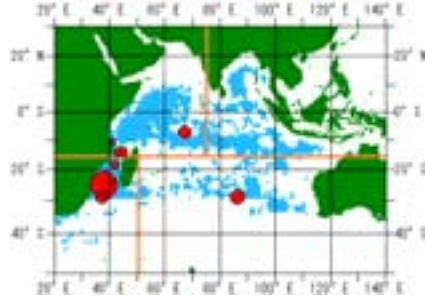
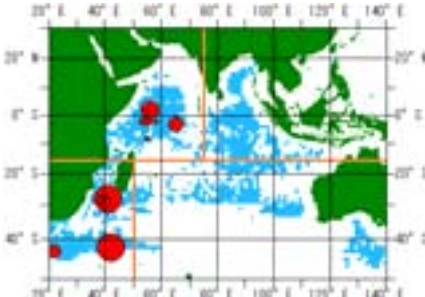
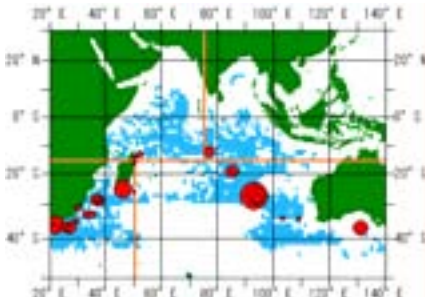
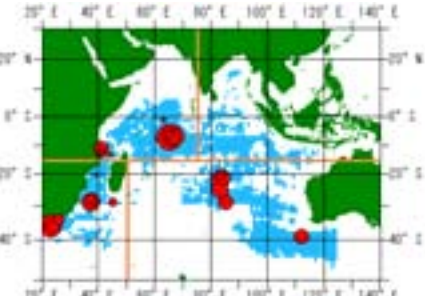
Map 10 Situation of the predation by quarter (all species combined) (Sept. 2000- Dec. 2002)

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

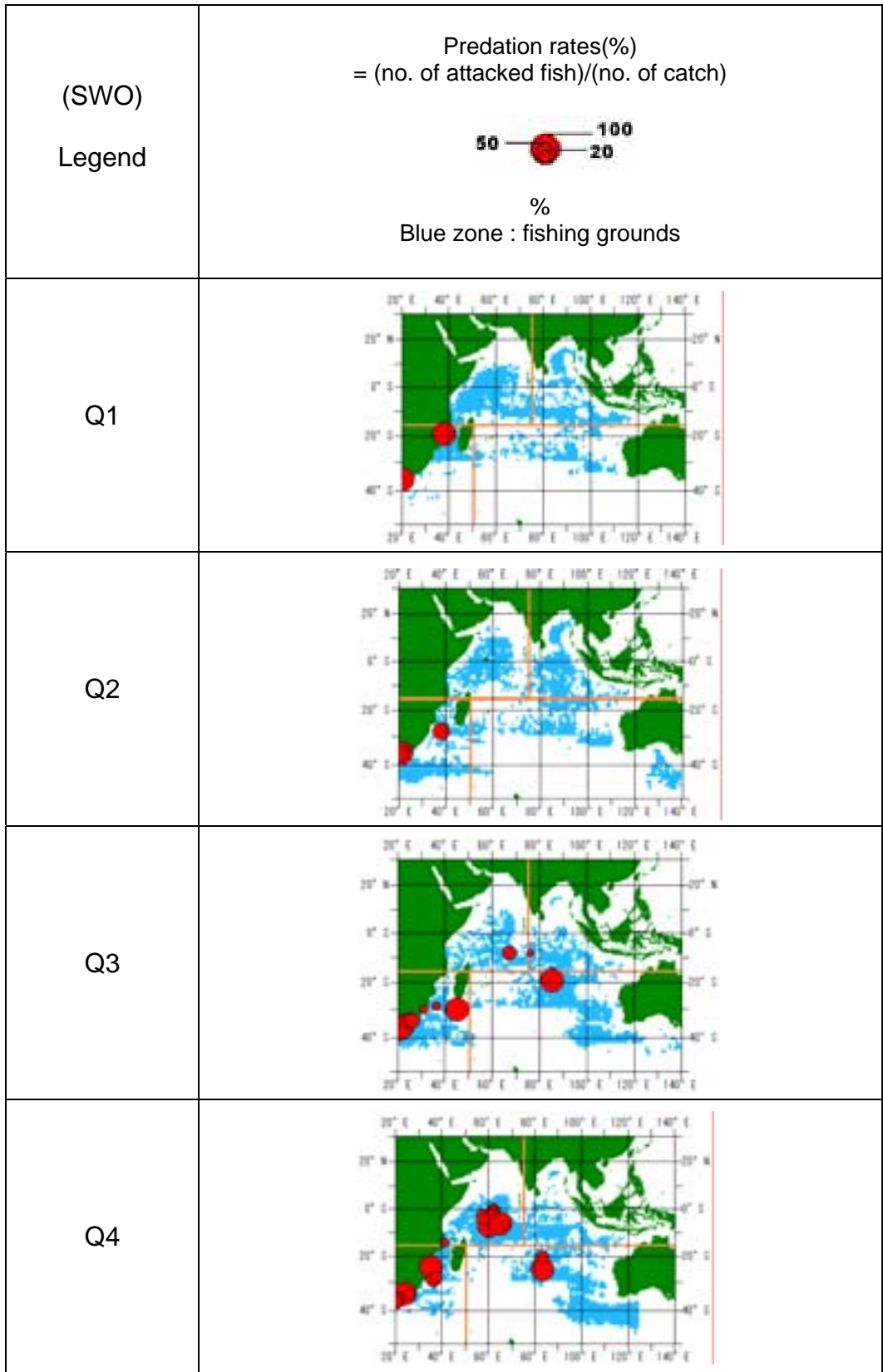
Map 11 Situation of the predation by quarter (Yellowfin tuna) (Sept. 2000- Dec. 2002)

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

Map 12 Situation of the predation by quarter (Bigeye tuna) (Sept. 2000- Dec. 2002)

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

Map 13 Situation of the predation by quarter (Albacore) (Sept. 2000- Dec. 2002)



Map 14 Situation of the predation by quarter (Swordfish) (Sept. 2000- Dec. 2002)

4. Discussion and Summary

The information used in the discussion is based on the analyses by the data for 2 years and 4 months from September, 2000- December, 2002.

(1) Reporting rates (Table 4)

About 25% of LL boats have been cooperating this survey. For these boats, the reported operations with predation were very low (about 2%) because it is likely that there were no predations in majority of operations.

(2) Predations (Table 4 and Fig. 2)

Number of predations reported was 1,431 individuals. Of these, 62% were sharks, 35% false killer or killer whales and others for 3%.

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.

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 predators 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 (Fig. 1)

Total number of fish attacked was 1,428. YFT, BET and ALB are three major attacked species by predations, which account 42%, 30% and 15% respectively. Those for SWO and SBT are 3% respectively.

(4) Predation rates (Tables 6-8)

The predation rates are based on the reported data when at least one fish is attacked in each longline operation, thus those in case of no predation are not included.

Average predation rates for 2000-2002 were 14%, 17% and 18% respectively. Southern bluefin tuna and bigeye tuna recorded higher predations rates than others.

Average predation rates by quarter were 15%(Q1), 18%(Q2), 15%(Q3) and 15% (Q4), respectively. Q2 shows higher predation rates than other quarters.

Average predation rates by area were 16 %(NE), 16 %(NW), 22 %(S) And 14 %(SW), respectively. Predation rates in the S area shows higher predation rates than other areas (due to SBT?).

(5) Locations and seasonality of predations (Maps 5-9 and Maps 10-14)

Major predation areas are the western part of the tropical waters around Seychelles (YFT and BET) and the Mozambique Channels (YFT but less in Q2-Q3) and the waters off southern Africa (BET but less in Q1-Q2).

For ALB, areas are scattered around the western part of the Indian Ocean (but less in the tropical waters in Q1 and Q3), while for SWO, it is few information to determine, but areas are likely similar to those of ALB and BET (but less in the tropical waters in Q1-Q3).

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

There are various seasonality in species compositions of attacked fish by area. In NW, YFT and BET are dominants and there are less seasonality. In NE, BET dominated in Q4 and Q1.

In SW, YFT dominated in Q4 and Q1, while BET for Q2 and ALB for Q3. In S, BET dominated in Q1 and Q3, while OTH(SBT) for Q2 and Q4.

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

There are various seasonality in species compositions of the predators by area. In NW, more SHK is in Q1-Q2, while more Whales in Q3-Q4. In NE, more Whales dominated in Q4 and Q1, while same levels of SHK and Whales in Q3. In SW, same levels of SHK and Whales in Q1 and Q2, while more SHK in Q3 and more whales in Q4. In S, whales Q1-Q3, while SHK in Q3.

(8) Mitigation (it was found that tail-up caught tuna is not effective for mitigation)

The real reason was found why killer whales don't attack the tail-up tuna. 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 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 whale know (learn) that they can bite tuna even sounded by nylon wire.

(8) Collaborative predation survey data preparations and workshop (Table 9)

Table 9 Predation surveys and schedule of the workshop (agreed by SC in 2003)

year	IOTC	Japan
1998	Predation survey was recommended in the 2 nd Scientific Committee.	
1999	Resolution 00/02 (Resolution on a survey of predation of longline caught fish) was adopted in the 4 th Commissioner's meeting.	
2000	(Jan : survey started)	(Sept: survey started)
2001	↓	↓
2002		
2003		
2004		
2005		(Aug : end of the survey)
2006		By middle of the year: All survey data will be collected.
	Collaborative data compilation and processing	
	Later period : workshop	

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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