SCIENTIFIC COMMITTEE
THIRD REGULAR SESSION

13-24 August 2007
Honolulu, United States of America

REPORT OF THE ONGOING TAGGING PROJECT ON TROPICAL TUNAS IN THE SOUTHERN PART OF JAPAN

WCPFC-SC3-BI SWG/WP-5

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Report of the ongoing tagging project on tropical tunas in the southern part of Japan

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Summary

Tropical tuna tagging project in the southern part of Japan has been conducted by Fisheries Agency of Japan since 2000. By the end of 2006, 2,083 bigeye and 9,155 yellowfin tunas, mainly small fish, were tagged and released around Nansei Islands of Japan (24-29°N, 123-130°E), and 223 bigeye (recapture rate is 10.7%) and 732 yellowfin (8.0%) were recaptured. Many fish were recovered within a short time and distance, but some fish made a long distance movement (more than 1000nm). The range of the movement is mostly limited to the vicinity of Japan and most movements are usually northeastward. Yellowfin indicated slightly larger movement than bigeye during the first 300 days. Archival tagging was also conducted. Of 105 bigeye and 80 yellowfin attached with archival tag, 19 bigeye and 5 yellowfin were recaptured. Data could be successfully downloaded from 16 bigeye and 5 yellowfin. Archival tag data indicated that swimming depth of bigeye and yellowfin tunas changed depending on the time of the day; it usually dived deeper during the daytime and stayed in the shallower depth during the night.

1. Introduction

Yellowfin and bigeye tunas, which distribute from tropical to temperate water, are commercially very important not only in Japan but also in many countries in the world. In the past, tropical tunas, especially bigeye tuna, were caught mostly by longliners, but in recent years, the proportion and the amount of surface catch, especially purse seine fishery, is increasing. As for yellowfin tuna, purse seine fishery is now main fishing gear in all oceans. But most stocks of both species are reducing their stock sizes or at a lower level than before probably because of high exploitation including by surface fisheries. To utilize the resources of these species, maintaining them in the sustainable level is important issue for all regional fisheries management organizations for tunas. That is the reason why more detailed and more precise stock assessment studies are necessary and urgent. Therefore, it is one of the important scientific surveys to collect basic biological parameters for the stock assessment models, such as, movement, migration, growth, natural mortality (M) and so on for adult fish as well as for juveniles in order to answer the above questions.

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Tagging is very important and useful for the stock assessment studies of tunas. Natural mortality, movement, growth and so on can be estimated from tagging data, and these results are used to analyze the status of stocks with the assessment models such as VPA, production model and integrated model (for example, Multifan-CL or Stock Synthesis Ⅱ). In the past, there was no large scale tagging programs around Japan targeting tropical tunas except for skipjack tuna. Under these situations, Fisheries Agency of Japan (Japanese government) started its own tropical tuna tagging project around Japan in 2000 in order to collect information on movement and other biological features of tropical tunas (yellowfin and bigeye tunas). In this project, it was originally aimed to tag and release about 1,000 fish (tropical tunas, mainly bigeye tuna) annually. Southern part of Japan (around Nansei Islands) was selected for the location of tagging because there are many coastal fisheries targeting small tropical tunas all year round and so it is possible to tag and release many fish at one time. Preliminary results were presented at SCTB meeting in 2003 (Matsumoto *et. al.*, 2003). This paper briefly summarizes updated results of this project conducted by the end of 2006.

2. Method

2.1 Catch and release of the fish

This tagging project of Fisheries Agency of Japan has been entrusted to and conducted by Kagoshima (Kagoshima Prefectural Fisheries Technology and Development Center) and Okinawa (Okinawa Prefectural Fisheries and Ocean Research Center) Prefectures in cooperation with National Research Institute of Far Seas Fisheries (NRIFSF) with the assistance of Japan NUS Co., Ltd. Several researches were conducted by NRIFSF itself.

Fish were caught by pole-and-line, handline or trolling and partly by rod and reel (jigging or bait fishing) with minor amount by longline gear using chartered or research vessels. These operations were conducted around several islands of Kagoshima and Okinawa Prefectures (Nansei Islands, southern part of Japan, about 24-29°N, 123-130°E, Fig. 1), mostly by the operations around ‘payao’ (anchored floating or underwater fish aggregating devices, Fig. 2). A total of 283-day fishing was conducted from March 2000 to December 2006 (Table 1). Although tagging was conducted almost all year round, the percentage of the first quarter (January to March) is less than the other quarters because winter is off-season for tuna fishing.

Dart tags (conventional tag, about 2mm in diameter and 15cm long, yellow in color, produced by HallPrint) were mainly used, and most fishes were double tagged (attach two tags for one fish). Archival tag (data storage tag, at first Lotek Ver.1.0 or Ver.1.1 and from 2003 onward Lotek LTD-2310) was also applied by inserting a tag into the abdominal cavity. Relatively larger fish were used for archival tagging. Archival tags were set to record depth and ambient/internal temperatures every 256 seconds for Lotek Ver.1.0 or Ver.1.1 and every 60 seconds for Lotek LTD-2310. These tags internally estimate daily position, though not so accurate, from the time of sunset and sunrise.

Species, fork length (to the nearest 0.1, 0.5 or 1cm), time and position of release (including the name of payao) were recorded for the fish released.

Priority was given to tag bigeye and yellowfin tunas, but other species such as skipjack were also

tagged and released in some cases deploying the same dart tags.

3. Results

3.1 Summary of release and recapture

Table 2 shows summary of the number of tagged and recaptured fish. A total of 2,083 bigeye and 9,155 yellowfin have been tagged and released around Nansei Islands by the end of 2006. Recapture of 223 bigeye (recapture rate is 10.7%) and 732 yellowfin (8.0%) have been reported as of July 2007. Besides, 2,715 skipjack was also tagged and 82 were recaptured (3.0% recovery rate). In this report we report the results of only bigeye and yellowfin hereafter.

Length frequencies of tagged fish are shown in Fig. 3. As for bigeye tuna, most fish ranged between 30cm and 70 cm FL with the mode around 50cm. As for yellowfin, the fish were relatively smaller than bigeye and the mode was around 40 cm.

3.2 Horizontal movements of tagged fish by conventional tagging

Fig. 4 shows horizontal movement (straight course) of recovered fishes between released and recaptured position. Many of bigeye and yellowfin tunas were recaptured nearby Nansei Islands. Both species usually moved northeastward when they moved long distance with some exceptions (one bigeye and some yellowfin) of southward movement (moved to close to Taiwan or Philippines). Their movement appears to have relationship with the Kuroshio Current. Some bigeye and yellowfin were recorded to reach to east off Honsyu (around 35°N, 145-155°E), but there is no report of recapture in the further east and further north.

Fig. 5 shows distribution of the recapture of tagged fish by season. Both bigeye and yellowfin tunas were recaptured mostly near Nansei Islands and several individuals were recaptured north of 30°N. As for the fish recaptured north of 30°N, most bigeye tuna were recaptured offshore area (east or southeast of Honsyu), but yellowfin tuna were usually recaptured inshore area of Kyusyu, Shikoku, Honsyu or Izu Islands. Both bigeye and yellowfin tunas were recaptured all year round near Nansei Islands, but most fish recaptured north of 30°N were caught in spring through autumn.

Fig. 6 and Fig. 7 show number of fish recaptured and cumulative frequency of recapture plotted against days at liberty, respectively. As for both bigeye and yellowfin, the number of recapture quickly decreased as the time passes in the early period, especially within a month or so. About the half of the fish were recaptured within a month and most fish (about 80%) were recaptured within 150 days at liberty. Only small number of fish spent one year or more of liberty. This trend was similar between bigeye and yellowfin, but the decline of the recapture of yellowfin after 150 days at liberty was a bit quicker than that of bigeye.

Fig. 8 shows the relationship between days at liberty and the distance (straight course) moved. As for bigeye, most fish recaptured within 100 days did not make long distance movement (usually less than 100 nm) but most fish recaptured after 140 days made longer distance movement than the former, that is, mostly between 200 and 2,000 nm. Many yellowfin tuna also didn't move long within 150 days, but unlike bigeye, some individuals moved long distance (more than 1,000 nm) from after

50 days at liberty. Therefore, it seems that yellowfin moved on average faster than bigeye during the first 300 days. There are almost no yellowfin individuals that didn't move more than 100 nm after 150 days at liberty, which is similar to the results of bigeye. Given that almost all the fish were released close to payao, these results may suggest that small bigeye and yellowfin tunas stayed around the same or nearby payao for up to about 150 days.

3.2 Results of archival tagging

As is shown in Table 2, 105 bigeye and 80 yellowfin were tagged with archival tag and 17 (16.2%) bigeye and 6 (7.5%) yellowfin were recaptured and the tag was recovered. However, in the three cases of bigeye tuna, data could not be downloaded due to malfunction of tag or only the stalk of the tag having been recovered. Summary of archival tagging is shown in Table 3. Usable data for bigeye and yellowfin were obtained for fishes that were 7 to 564 days and 27 to 132 days at liberty, respectively. Some of them were recaptured at the same or nearby payao where they were released, but some individuals made a long distance movement, up to 2417.6nm in a straight course.

Fig. 9 and Fig. 10 show typical pattern of the temporal change in swimming depth, external water temperature and internal temperature of bigeye and yellowfin tuna, respectively, recorded by Lotek LTD-2310 tag. In both species, the fish stayed deeper during the daytime and swam at shallower depth at night, regularly with making quicker up and down movements. Although both bigeye and yellowfin tunas usually dived to about 400m depth during daytime, bigeye tuna usually stayed in the deep layer (about 300 to 400m depth), while yellowfin tuna frequently moved between shallow (more or less 100m depth) and deep (300 to 400m depth) layer. Regarding the internal (abdominal) temperature, it seemed to have changed in accordance with swimming depth. Internal temperature during the deep diving was much higher than the ambient water temperature, and its variation was much smaller for both bigeye and yellowfin tunas than the water temperature.

4. Future outlook of tagging program

Current annual target is set to tag and release 1000 fish (mainly bigeye tuna) including 10 fish for archival tagging. However, data of long distance movement are very limited especially off Honsyu (east of 150°E). Therefore, we have started tagging of tropical tunas mainly targeting bigeye tuna in the east area of Honsyu. Summary of the tagging in that area is reported by Semba *et. al.* (2007).

References

Matsumoto, T., M. Okuhara, I. Ohta, M. Mizoguchi and N. Miyabe (2003). Report of the ongoing tagging project on tropical tunas around Japan. SCTB16-RG4. 12pp.

Semba, Y., T. Matsumoto, and H. Okamoto (2007). Experimental tagging research for bigeye tuna (*Thunnus obesus*) in the East off Japan. WCPFC SC3 BI-IP-4. 11pp.

Table 1. Number of days of tagging cruise in each year and quarter.

Year/quarter	1	2	3	4	Total
2000	2	14	4	13	33
2001	1	12	10	8	31
2002	2	18	6	10	36
2003	12	23	15	10	60
2004	8	15	13	12	48
2005	10	12	9	10	41
2006	5	7	14	8	34
Total	40	101	71	71	283

Table 2. Summary of tag release and recapture by year, species and tag. Data is limited to the fish tagged and released by December 2006 and reported about the recapture by July 2007, and also limited to bigeye and yellowfin tunas. "Year" is based on the year of release.

Species	Bigeye tuna						Yellowfin tuna						Total					
Tag	Dart tag			Archival tag			Dart tag			Archival tag			Dart tag			Archival tag		
Year	Re-lease	Re-capture	Percentage of recap-ture	Re-lease	Recap ture	Percent-age of recapture	Re-lease	Re-capture	Percentage of recap-ture	Re-lease	Re-capture	Percentage of recap-ture	Re-lease	Re-capture	Percent-age of recapture	Re-lease	Recap ture	Percent-age of recapture
2000	442	99	22.4%	20	6	30.0%	1,174	164	14.0%	13	0	0.0%	1,616	263	16.3%	33	6	18.2%
2001	374	38	10.2%	16	1	6.3%	1,435	90	6.3%	24	2	8.3%	1,809	128	7.1%	40	3	7.5%
2002	170	15	8.8%	19	4	21.1%	970	53	5.5%	10	1	10.0%	1,140	68	6.0%	29	5	17.2%
2003	365	40	11.0%	7	2	28.6%	1,580	240	15.2%	19	1	5.3%	1,945	280	14.4%	26	3	11.5%
2004	188	13	6.9%	9	1	11.1%	1,463	86	5.9%	10	1	10.0%	1,651	99	6.0%	19	2	10.5%
2005	265	13	4.9%	21	4	19.0%	1,354	77	5.7%	3	0	0.0%	1,619	90	5.6%	24	4	16.7%
2006	279	5	1.8%	13	1	7.7%	1,179	22	1.9%	1	0	0.0%	1,458	27	1.9%	14	1	7.1%
Total	2083	223	10.7%	105	19	18.1%	9155	732	8.0%	80	5	6.3%	11,238	955	8.5%	185	24	13.0%

Table 3. Summary of archival tagging for bigeye and yellowfin tunas.

Item	Bigeye tuna	Yellowfin tuna
Fork length at release (cm)	42-75cm (average 57.6cm)	38-120cm (average 56.9cm)
Number of release	105	80
Number of recapture*	19	5
Percentage of recapture	18.1%	6.3%
Number of tags whose data were downloaded	16	5
Days of data acquired**	7-564days (average 96.9days)	27-132days (average 72.2days)
Distance moved (nm, in a straight course)**	0.0-2417.6nm (average 357.6 nm)	1.7-1728.4nm (average 406.3 nm)

*Limited to the fish whose tag was recovered.
*Limited to the fish whose data of the tag was downloaded.

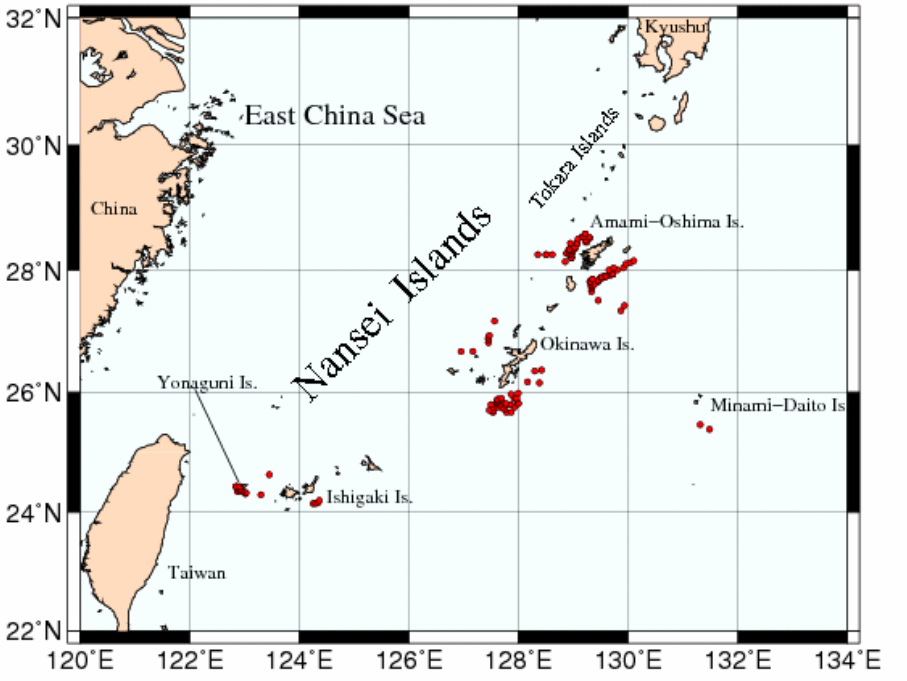

Fig. 1 Position of tag and release.

Fig. 2 An example of 'payao' around which tagging was conducted.

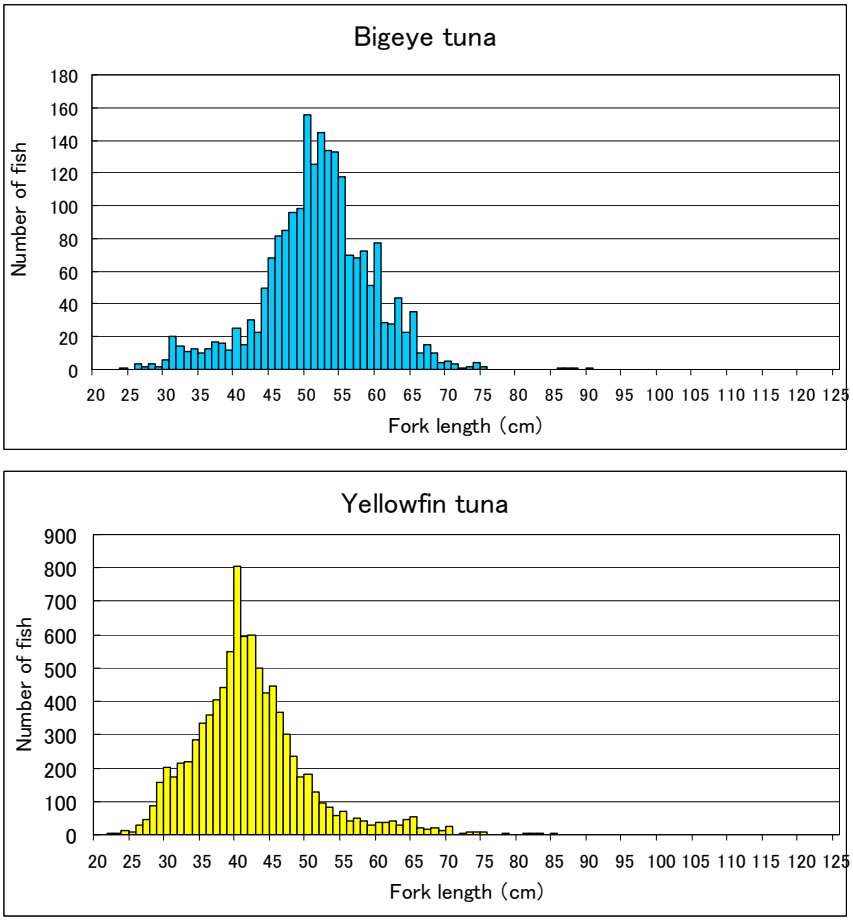

Fig. 3 Length frequency of tagged and released fish.

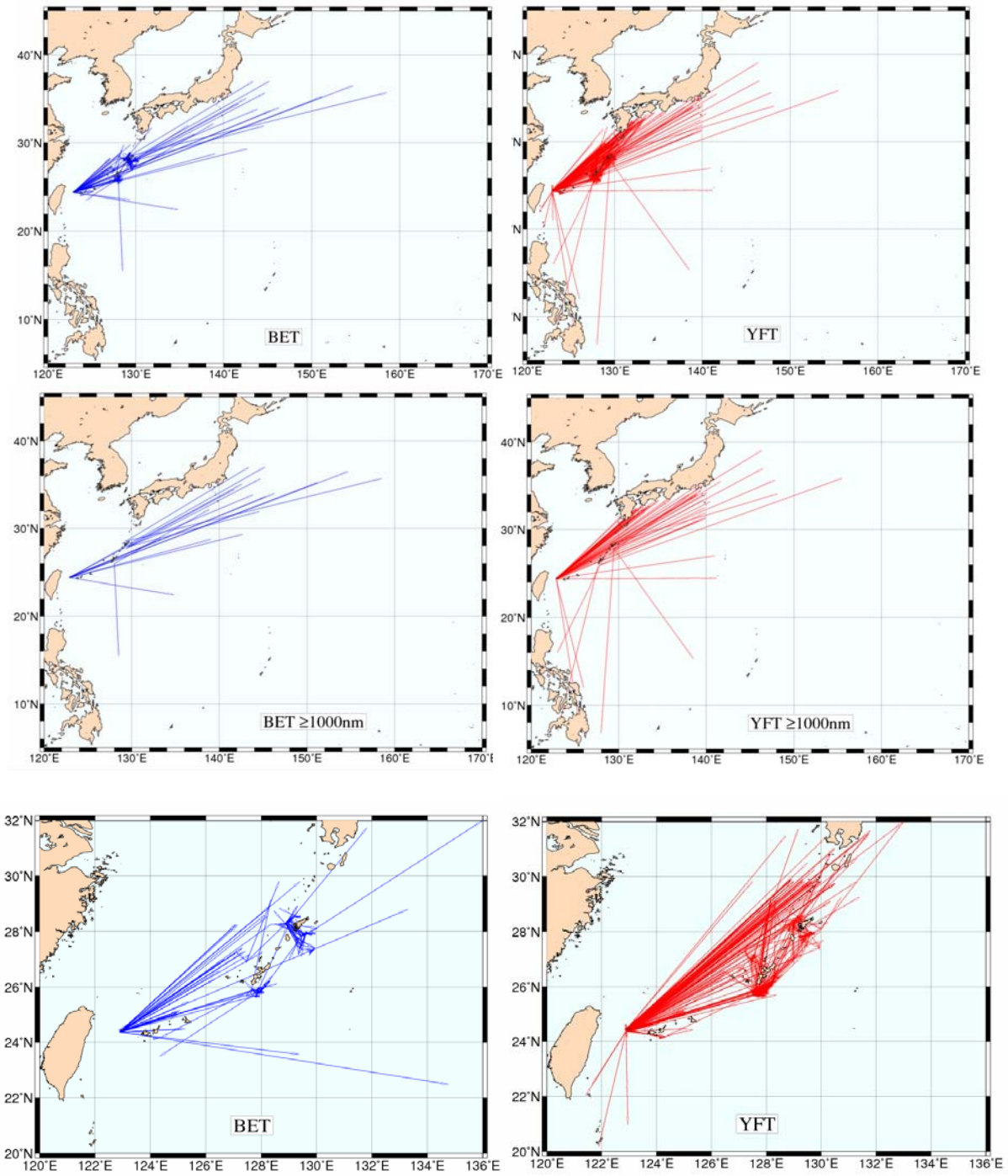

Fig. 4. Movement of bigeye (left) and yellowfin (right) tunas based on tag release and recapture. Top: entire area, middle: entire area and long distance (>1000nm) movement, bottom: limited to the fish recaptured around Nansei Islands (southern part of Japan).

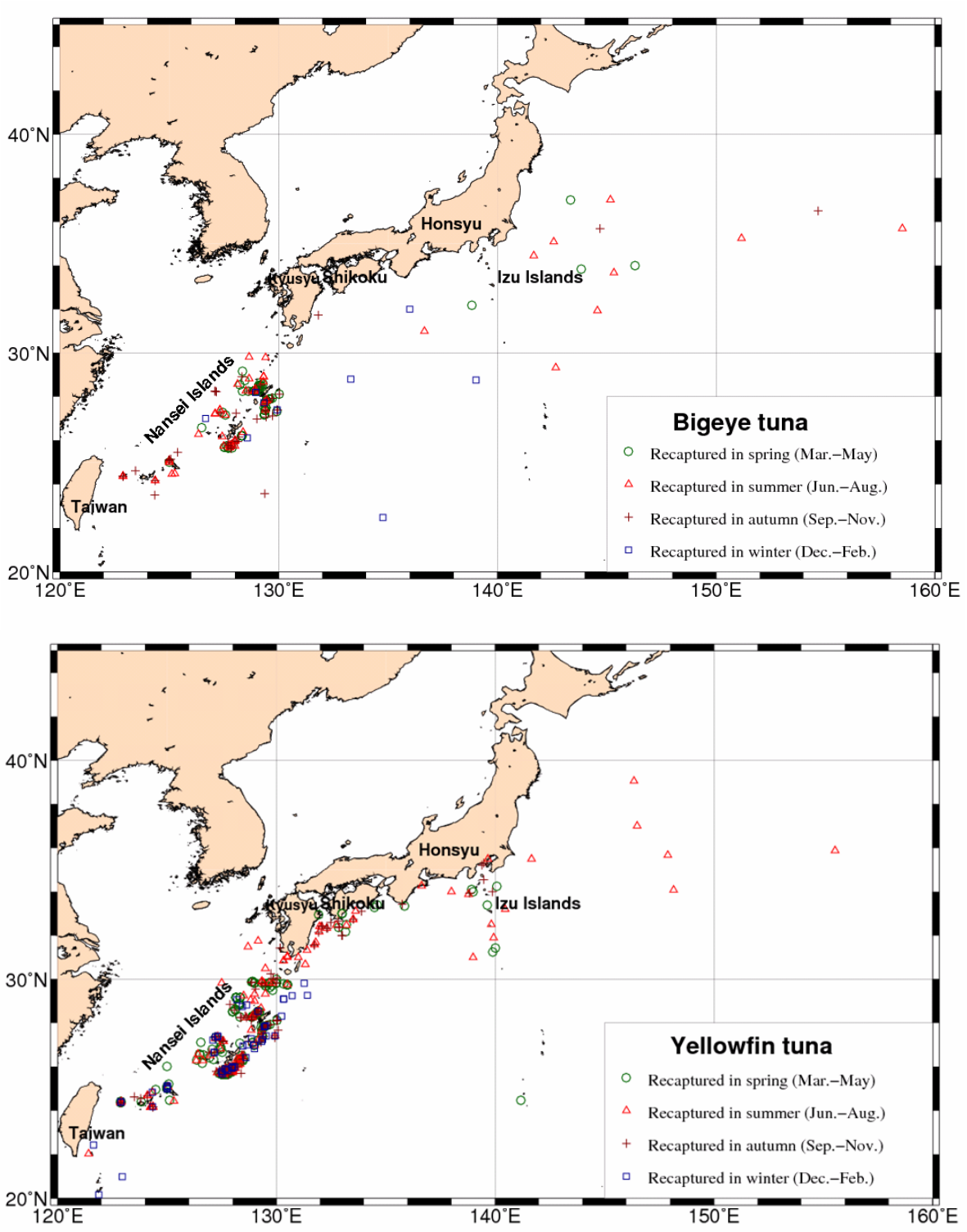

Fig. 5. Position of recapture of the fish by each season.

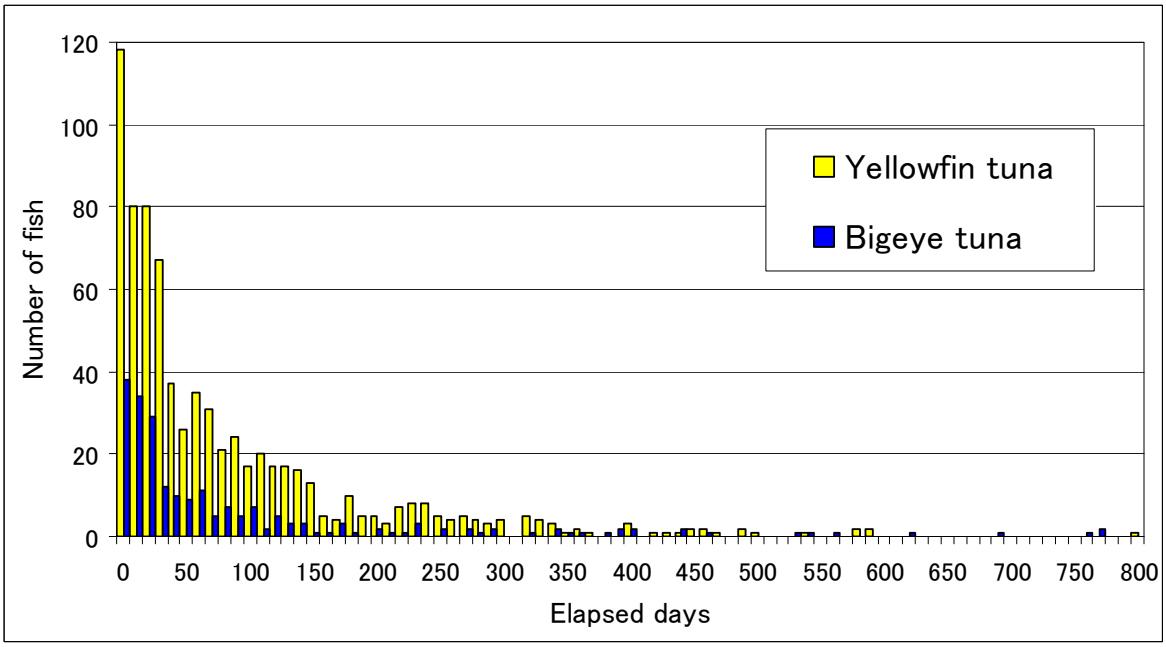

Fig. 6. Frequency of elapsed days (days at liberty) for recaptured fish.

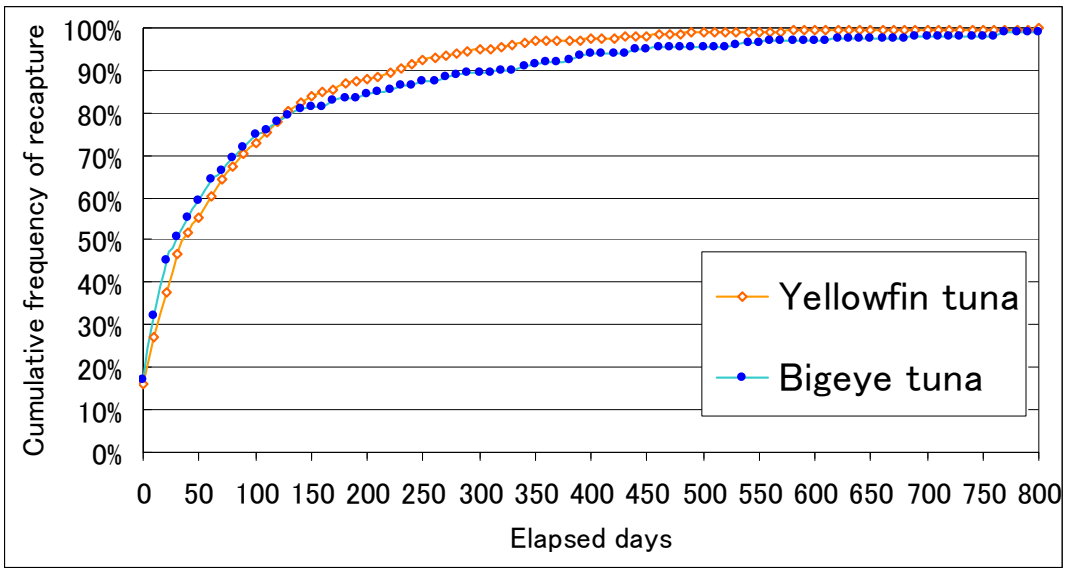

Fig. 7. Cumulative frequency of elapsed days (days at liberty) for tag recapture.

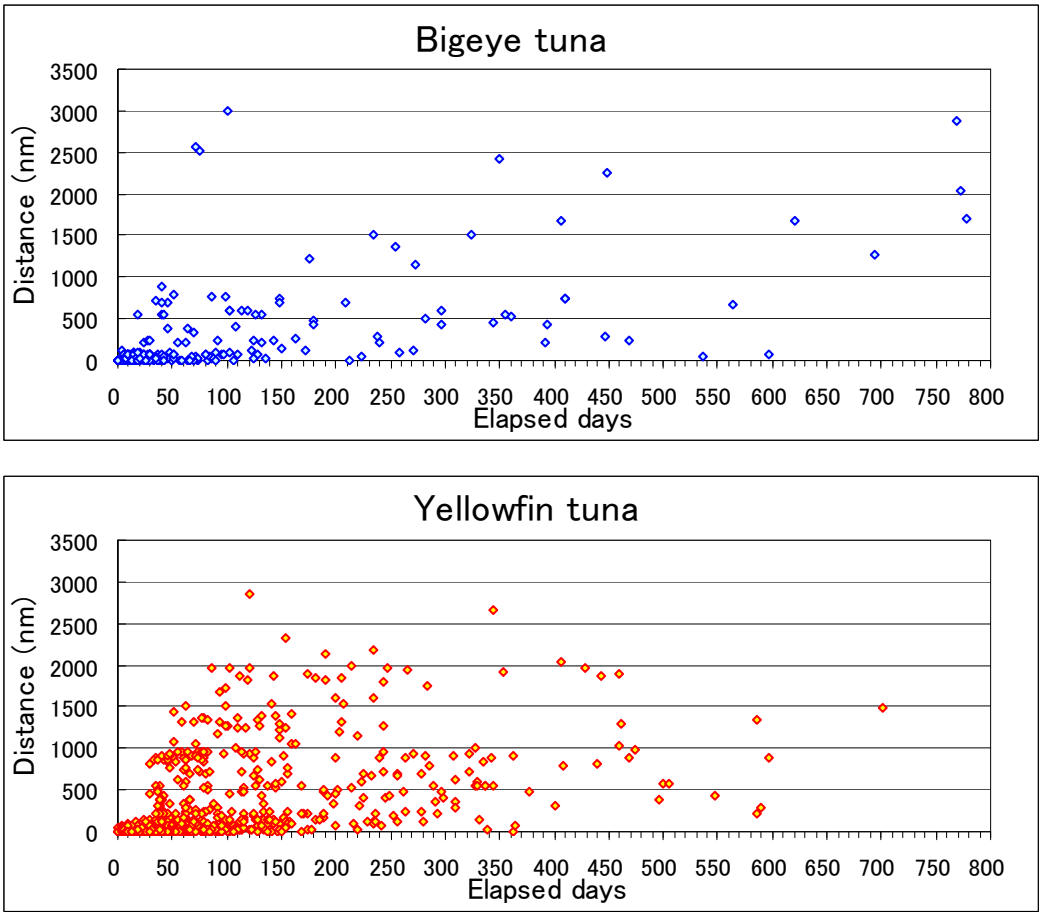

Fig. 8 The relationship between elapsed days (days at liberty) and distance moved (straight course) based on tag recapture data.

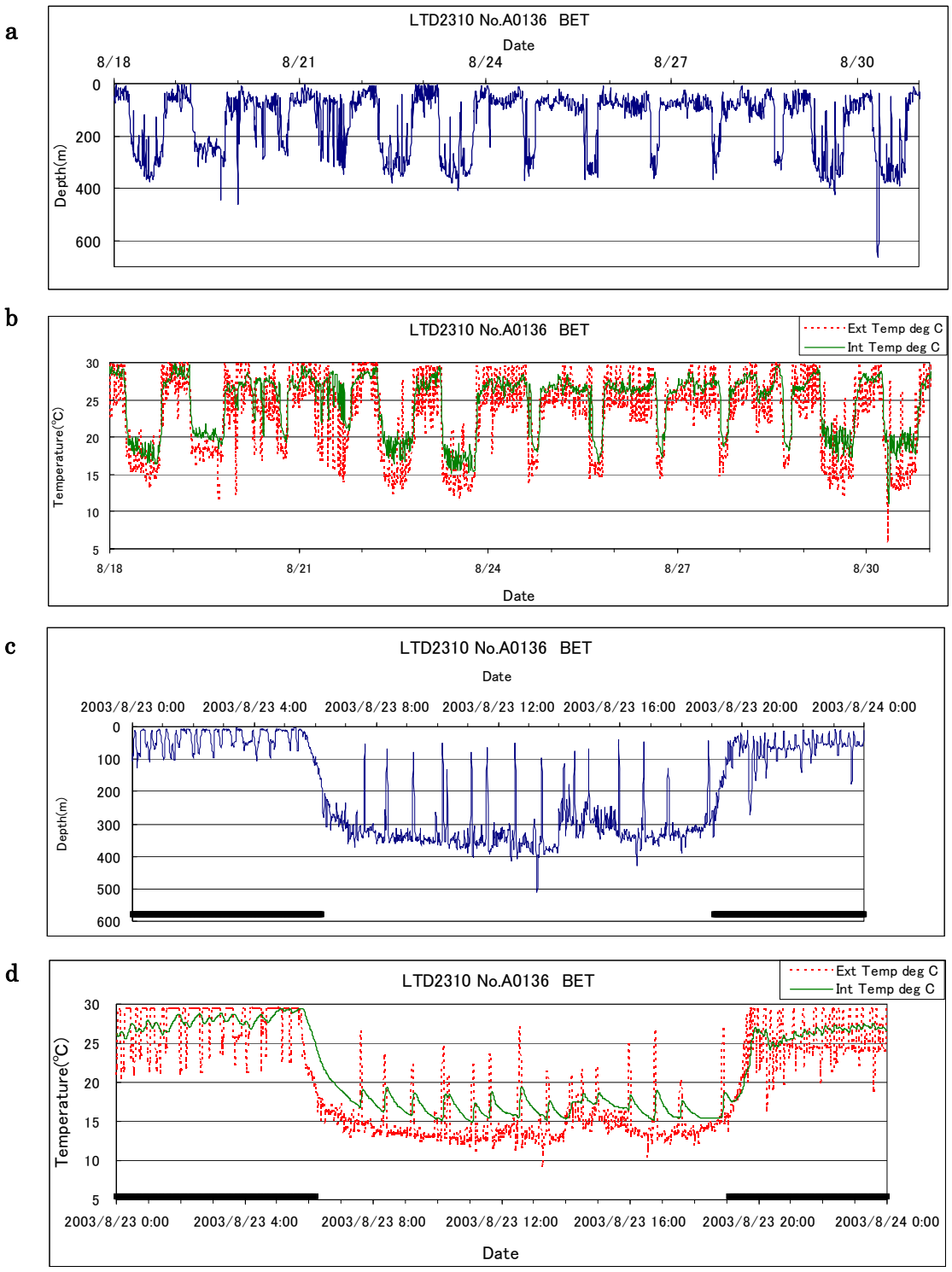

Fig. 9. Typical pattern of the movement (time series swimming depth) and external/internal temperature of bigeye tuna (55.6cm at release) recorded by archival tag. a: swimming depth for two weeks, b: ambient and external temperature for two weeks, c: daily pattern of swimming depth, d: daily pattern for external and internal temperature. Solid bars mean nighttime.

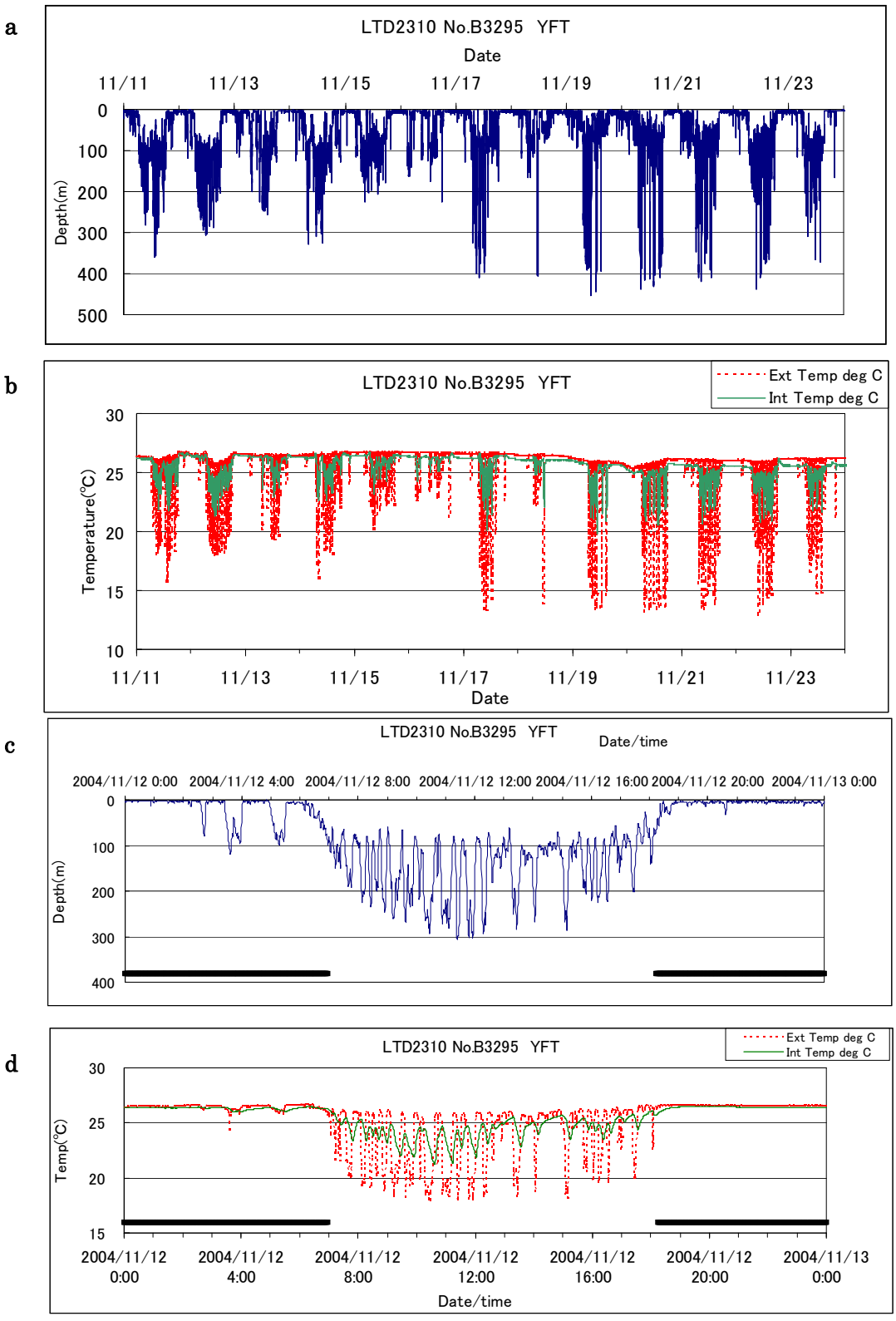

Fig. 10. Typical pattern of the movement (time series swimming depth) and external/internal temperature of yellowfin tuna (62.0cm at release) recorded by archival tag. a: swimming depth for two weeks, b: ambient and external temperature for two weeks, c: daily pattern of swimming depth, d: daily pattern for external and internal temperature. Solid bars mean nighttime.