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VERTICAL HOOKING PATTERN OF BIGEYE AND YELLOWFIN TUNA CAUGHT IN THE TROPICAL AND THE TEMPERATE AREAS IN THE NORTHWEST PACIFIC ESTIMATED USING DATA BY 2006 SHOYO-MARU LONGLINE RESEARCH CRUISES, AND ITS IMPLICATION TO THE INTRODUCTION OF GEAR SET DEPTH REGULATION

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Introduction

Vertical hooking pattern of tunas and billfishes caught by longline gear is the one of the key issue for the longline operation because this information can be used for developing effective operational method to reduce the catch ability of the gear for by-catch species or increase it for target species. At the same time, because the vertical hooking pattern of tunas and billfishes may change by area and seasons which have different oceanographic conditions (Brill et. al., 2001; Bigelow et. al., 2000; Goodyear et. al., 2002; Saito and Yokawa, 2005; Yokawa et. al., 2006), the improvement of longline operational strategy by modifying the set depth of the gear should be carefully investigated its effectiveness before its application. This document reports reported preliminary results of the estimates of the hooking depth of bigeye and yellowfin tuna, and their implication to the introduction of gear set depth regulation is discussed.

Materials and Methods

1) Longline research cruise

In the period between September 2006 and December 2006, Japanese RV Shoyo-maru carried out longline research cruises primary targeting bigeye tuna in the northwest Pacific (Fig.1). Total of 36 longline sets were conducted, and 13 sets in the 2nd cruise were conducted in the temperate area (around Kuroshio - Oyashio frontal area) and 23 sets in the 1st and 3rd cruise were conducted in the tropical area. Among the sets in the temperate area, 3 night time and shallow sets, which was targeting swordfish, were conducted, and the data by these 3 sets were analyzed separately.

Number of hooks between float (NHF) used in the sets of temperate area was 9 or 15, and the one used in the tropical area was 15, 19 or 21. Value of NHF was modified during the cruise based on the information of the oceanographic survey conducted using CTD, XCTD and XBT. In the 2nd to 7th sets in the 1st cruise, deep and shallow gear configuration were conducted together in a single operation to confirm the shallowest limit of bigeye hooking depth. In these sets, 9 or 11 NHF were used for the shallow gear and 21 NHF were used for deep gear. Squid were used as baits in sets in the temperate area and Jack mackerel were used in sets in the tropical area. Length of float line was 45 m in sets in the tropical area, and 10 m in sets in the temperate area and shallow gear in the tropical area (2nd to 7th sets in the 1st cruise). Length of branch line was 45m in all sets. Number of hooks deployed in a single set changed from 855 to 1065 mainly due to the change of NHF.

2) Estimation of hooking depth of fishes

In every sets, about 200 time, temperature and depth recorders (TDRs, product of Murayama electric Co., LTD; SBT-500) and 300 – 500 hook timers (product of Lindgred-Pitman Co., LTD; HT 600) were attached on branch lines to monitor the hooking time and underwater movement of the hooks. TDRs were attached at a point just above hook line (2m above hooks), and recorded depth and temperature of TDRs were approximated to the ones of the hook. TDRs are attached on at least two or three branch lines for a basket and the position of branch lines with TDR were changed in order so that the TDR data can be collected from all position of branch lines evenly.

TDRs used in this study recorded depth and temperature by every 10 seconds during operation. These data are used to determine hooking time, depth and temperature of the hooked fishes as well as vertical distribution of hooks. Time of hooking of fish is identified by unnatural change of recorded depth of hook. The hook time was used to determine the time of hooking of fish. The hooking depth of fish caught by the branch line with the hook timer was estimated using hooking time monitored by the hook timer and the depth of hook of the nearest and same position of branch line with TDR to the hooked one.

Results

Figure 2 shows the estimated vertical hooking pattern of bigeye and yellowfin tuna by temperate area (2nd cruise) and tropical area (1st and 3rd cruises). Hooking depths for 19 and 24 bigeye tunas were successfully estimated in the temperate and tropical areas. Bigeye tunas were hooked in the depth between 54 m and 260 m in the tropical area with its peak in 150 – 160 m depth layer. In the temperate area, Bigeye tunas were hooked in the depth between 36 m and 190 m with its peal in 100 – 11

0 m and 130 – 140 m depth layers. In tropical area, 17 % of bigeye tunas were caught in the layer shallower than 120 m, and 8 % were caught in the layer shallower than 100 m. In temperate area, hooking depth of bigeye tuna became shallow, and 47 % of bigeye tunas were caught in the layer shallower than 120 m, and 26 % were caught in the layer shallower than 100 m.

Number of catch of yellowfin tuna were rather small than the bigeye tuna catch, and hooking depths of only 2 and 11 yellowfin tunas were successfully estimated in the temperate and tropical areas respectively (Fig. 2). Two yellowfin tuna caught in the temperate area were hooked at 59 m and 88 m depths. In the tropical area, yellowfin tuna were hooked in the depth between 77 m and 211 m. In the tropical area, 36 % of yellowfin tunas were hooked in the depth shallower than 120 m, and 27 % were hooked in the depth shallower than 100 m.

In the longline fishing ground around Kuroshio - Oyashio frontal area, bigeye tunas become important by-catch for Japanese longliners targeting swordfish operating by night and shallow sets. Figure 3 shows the vertical hooking distribution pattern of bigeye tunas caught by night and shallow sets in the 2nd cruise conducted in the temperate area. All bigeye tunas were caught in the depth shallower than 80 m.

Discussions

In the present study, the vertical hooking pattern of bigeye and yellowfin tunas were estimated using data obtained by the Shoyo-maru research longline cruises conducted in 2006 in the tropical and temperate areas in the northwest Pacific. The estimation of hooking depths of the bigeye and yellowfin tunas were conducted using information obtained by TDRs and hook timers which were covered more than 70 % of total hooks deployed in a single set. High coverage of TDRs and hook timers indicates that the estimated hooking depth of bigeye and yellowfin tunas has high reliability.

The results of this study clearly indicated that the hooking depth of bigeye tuna changes by area, and it becomes shallower in temperate area than in tropical area. This would be at least partially due to the change of oceanographic condition between two areas. The vertical temperature profile in the tropical area is characterized by the deep surface mixed layer and wide thermocline below the surface mixed layer, and the one in the temperate area is characterized by the shallow surface mixed layer and narrow thermocline (Fig. 4). Some fishermen suggest that water temperature good for catching bigeye tuna is not so different by area and season. The results of this study also indicated that the hooking depth of yellowfin tuna was shallower than that of bigeye tuna.

Former study similar to the present one, which conducted by Boggs (1992), indicated that longline gear with hooks shallower than 120 m depth eliminated would have great effects in reducing the catch of striped and other marlins and increase the catch of bigeye tunas, using TDRs data collected by near Hawaii Islands area. But results of this study clearly indicated that the proposal by Boggs (1992) can only be applicable at the tropical area in the northwest Pacific. At the temperate fishing ground in the northwest Pacific, eliminations of hooks shallower than 120 m or 100 m will cause great loss in the catch number of bigeye tunas. In addition to this, the results of the present study indicates that the catch number of yellowfin tuna would be reduced when hooks shallower than 120 m are eliminated even in the tropical area in the tropical northwest Pacific.

Actual impact of the shallow hooks elimination, however, could not be estimated in this study because the vertical distribution pattern of effort was not uniform in the longline, the result shown in Fig. 2 and 3 indicates that non-negligible number of bigeye tunas were caught in the depth shallower than 120 m or 100 m in the temperate area in the northwest Pacific. The number of observations, the seasonal and area coverage of data used in this study would not be enough to consider appropriate methods to reduce the number of by-catch of marlins without minor effects on the catch of target species such as bigeye tunas, albacores, bluefin tunas and yellowfin tunas. Yokawa et. al., (2006) indicated that the vertical CPUE pattern of striped marlin was changed by areas. Further study about seasonal and area variability of the vertical CPUE or hooking pattern of tunas and marlins should be necessary to investigate effective way to reduce catch number of non-target species in the longline operations.

References

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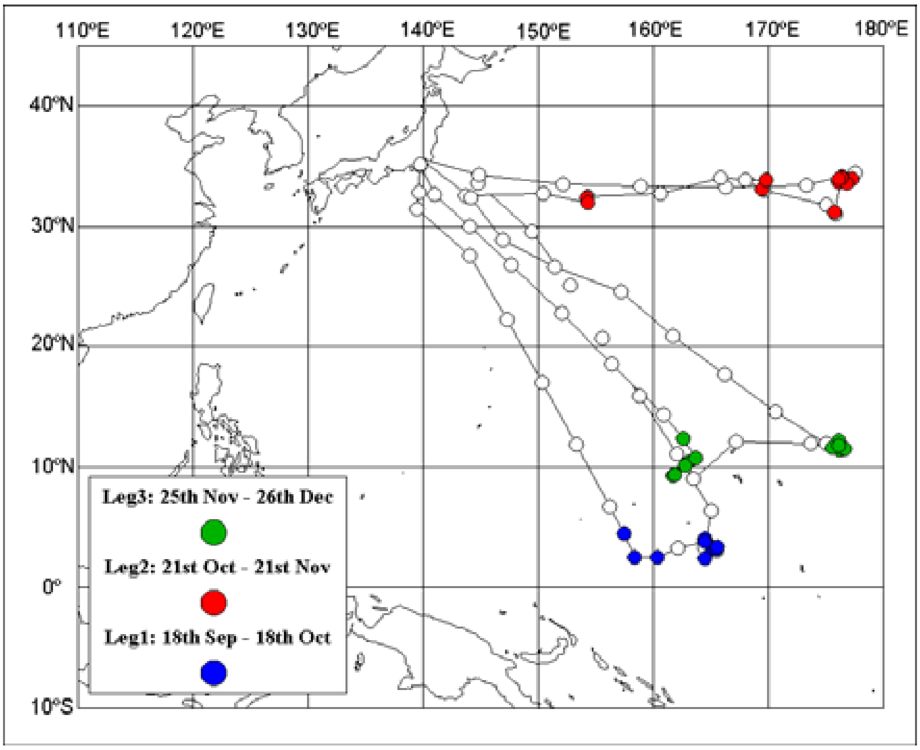


Fig. 1. Track charts and the operational points of the Shoyo-maru longline research cruises conducted in the autumn of 2006 in the northwest Pacific. Open circles shows the noon position of cruising days, and closed ones shows the noon position of days of longline operations.

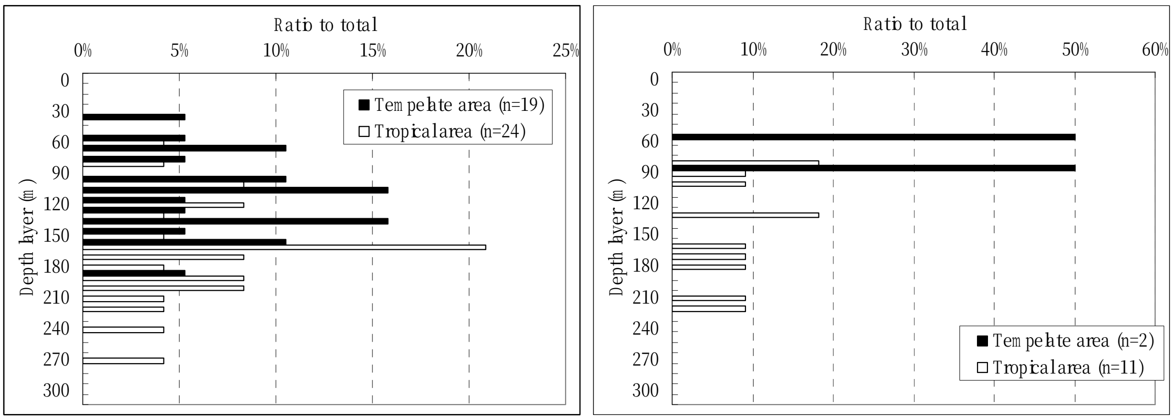


Fig. 2. Estimated vertical pattern of hooking depth of bigeye tuna (left) and yellowfin tuna (right) by temperate and tropical area.

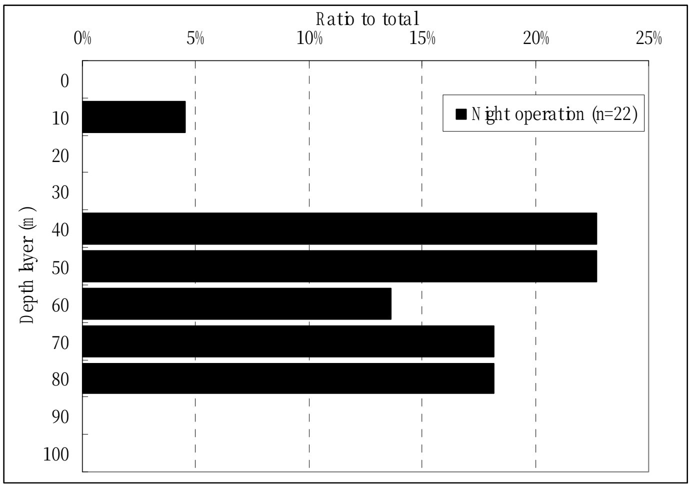
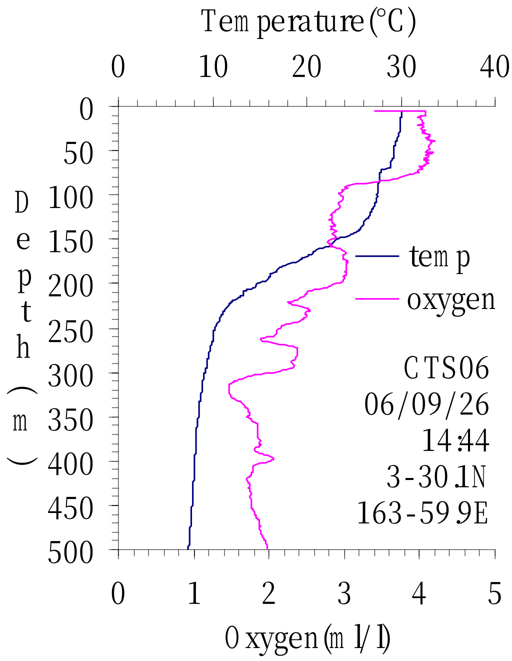


Fig. 3. Estimated vertical pattern of hooking depth of bigeye tuna caught by the night sets in the temperate area.



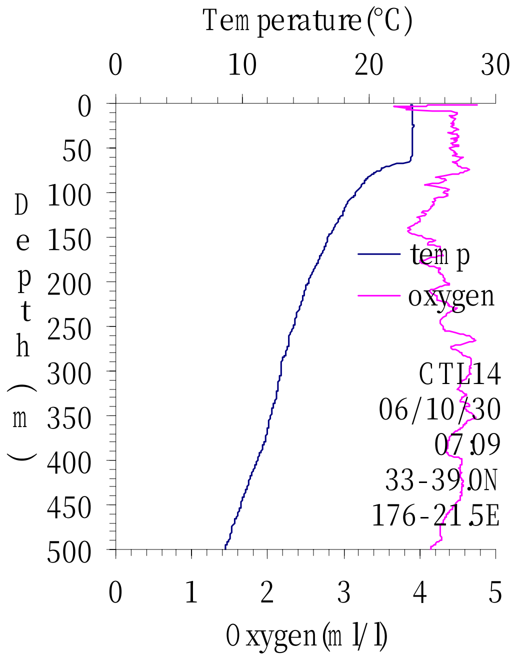


Fig. 4. Example of vertical temperature and oxygen profiles obtained by CTD survey conducted in the operational points in the tropical area (left) and in the temperate area (right).