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EFFECT OF CIRCLE HOOKS AND FEASIBILITY OF DE-HOOKING DEVICES TO REDUCE INCIDENTAL MORTALITY OF SEA TURTLES IN THE JAPANESE LONGLINE FISHERY

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Abstract

Effects of circle hooks on catch rates of target species and sea turtles were investigated through scientific fishing surveys in the western North Pacific from May to September 2005. There was no difference in hooking rates of loggerhead turtles (*Caretta caretta*) between tuna and small-sized circle hooks, but large-sized circle hooks had potential to reduce the hooking rates of loggerheads. The ingestion of circle hooks, especially the large-sized hooks, occurred less frequently than that of tuna hooks, which means circle hooks have the potential to improve post-hooking survival of sea turtles. Use of circle hooks had little effects on the catch rates of tuna, but large-sized circle hooks showed negative impacts on billfish catch. Analysis of the resultant data indicated that the effect was variable among the types of circle hooks associated with hook morphology. We are exploring better shape and size of circle hooks in reducing incidental mortality of sea turtles through fishing and captive experiments. To improve post-hooking survival of sea turtles, simple and practical de-hooking devices were developed and distributed to some fishermen for on-site performance tests.

Introduction

Due to their amphibious life cycles, sea turtle populations have been affected by a large variety of factors on land and at sea. Holistic approach to manage various factors affecting sea turtle populations is necessary for the conservation of sea turtles. Report of the expert consultation and guidelines of FAO emphasize the importance of holistic management (FAO 2004, 2005). Japan has already launched programs to reduce fishery

interactions and to conserve nesting populations of sea turtles. From a part of holistic management for sea turtle populations, a variety of mitigation techniques, circle hook, bait type, bait color, deep setting and de-hooking devices, have been developed and tested to reduce incidental mortality of sea turtles in the Japanese longline fishery (Kiyota et al. 2005). A number of studies have been conducted by many scientists to avoid and minimize interactions between longline fishery and sea turtles and were reviewed by FAO (2004) and Gilman et al. (2006). Use of circle hook is one of effective mitigation measures to reduce incidental mortality of sea turtles (Gilman et al. 2006, Watson et al. 2005).

This paper provides recent progress in the Japanese mitigation research on the effect of circle hooks for the reduction of incidental mortality of sea turtles as well as on catch rates of target fish species in our experimental fishing operations conducted in the western North Pacific. We also introduce de-hooking devices developed to reduce the post-hooking mortality of sea turtles.

Materials and Methods

Experimental fishing operations were conducted by two research vessels, the Taikei-maru No.2 and Kurosaki in the western North Pacific from May to September 2005. The experimental fishing gear was shallow-setting style longline which use 4 hooks and blanch lines per basket. Conventional 3.8-*sun* tuna hook and Mutsu Hokubei type 4.3 and 5.2-*sun* (approximately 18/0) circle hooks (Keisaku Komatsu Shokai Co., Ltd.; Fig. 1) were used, alternating the hook type by every 5 baskets. To maximize the hooking rate of sea turtles, only squid was used as bait during the survey. Detailed information on experimental design is described in Yokota et al. (2006a).

A total of 52 experimental operations were conducted and 48,600 hooks were observed during line hauling. Hooking rates of sea turtles and major target species, bigeye tuna (*Thunnus obesus*), swordfish (*Xiphias gladius*) and striped marlin (*Tetrapturus audax*), and hooking positions of sea turtles were compared between hook types.

To improve post-hooking survival of sea turtles, we developed simple and practical de-hooking devices which facilitate removal of hooks from hooked sea turtles. Performance of the devices was tested in the experimental survey and in commercial fishing operations.

Results and Discussion

1. Effect of circle hook

A total of 74 loggerhead turtles (*Caretta caretta*) were caught during the survey. All the turtles were hauled and released alive. The standard straight carapace lengths of loggerheads averaged 70.3 cm and ranged from 57.2 to 81.3 cm. The size class of loggerheads caught in the western North Pacific might be larger than that caught in the North Atlantic (average: 56.8 cm, range: 32.4-68.0 cm; Watson et al. 2005).

Average hooking rates of loggerhead turtles for each hook type are shown in Fig. 2. There was no significant difference in hooking rates of loggerhead turtles between tuna and small-sized circle (4.3-*sun*) hooks (Wilcoxon signed-rank test, p=0.9623), but large-sized circle hooks (5.2-*sun*) were effective in reducing the hooking rates of loggerheads (Wilcoxon signed-rank test, p=0.0088; Fig. 2). Watson et al. (2005) demonstrated that 18/0 circle hook is highly effective in reducing turtle interactions with longline fisheries, but also suggested that circle hook might not reduce the catch rates of a larger size class of loggerheads. The insignificant effect of small-sized circle hooks in reducing loggerhead turtle catch in this study might be related to small hook size and/or large turtle size. More research is needed to determine the effective size of circle hook relative to the size of sea turtles.

Hooking positions of hooked turtles for each hook type are shown in Fig. 3. The ingestion of circle hooks, especially the large-sized hooks, occurred less frequently than that of tuna hooks (Fig. 3). Bolten et al. (2002) found that small-sized circle hooks (16/0) decreased the proportion of swallowed hooks in loggerhead turtles but did not reduce the rate of turtle interaction. Watson et al. (2005) found that large-sized circle hook (18/0) reduced incidental catch of sea turtles and rate of hook ingestion. From these studies, circle hooks have the potential to improve post-hooking survival of sea turtles because circle hooks reduce the rate of hook ingestion by sea turtles. However, the small-sized circle hooks used in this study (Mutsu Hokubei type 4.3-*sun*) seem to be less effective in avoiding hook ingestion, compared with another types of circle hook (Tankichi type 3.8-*sun*) conducted in our previous survey (Fig. 3). Therefore, performance of circle hooks appears to be dependent on hook size and morphology. In general, hook size affects hooking rate of sea turtles and hook shape affects hooking position of sea turtles. We collected circle hooks available commercially in Japan and compared their morphology to determine appropriate measurement of hook morphology and its relation to hook performance (Yokota et al. 2006b).

During the survey, 11 bigeye tuna, 34 swordfish and 17 striped marlin were caught. Average hooking rates of these tuna and billfish for each hook type are shown in Fig. 4. Although catch data of these fish species was small sample size, use of circle hooks had little effects on the catch rates of bigeye tuna, but large-sized circle hooks showed negative impacts on billfish catch (Fig. 4). Yokota et al. (2006a) analyzed catch rates of sharks and found that there were no significant difference in catch rates of blue sharks between 3.8-*sun* tuna, 4.3 and 5.2-*sun* circle hooks.

We are continuing development and test of circle hooks on better shape and size for the reduction of sea turtle hooking and/or hook ingestion, and for the compatibility of fishing performance on target species.

2. Development of de-hooking devices

In our previous experiments, we found several practical problems on the use of de-hooking devices so far available: Some de-hooking devices were difficult to remove hooks from turtles because they could not hold on tight to hooks. Other de-hooking devices were too expensive to be distributed widely to commercial fishermen. We developed pliers which had gaps in the jaws fitted the diameter of hook axis (Fig. 5). Performance of the de-hooking pliers was tested in the experimental and commercial fishing operations, and provided satisfactory results in removing hooks from the mouths of sea turtles on the deck (Fig. 6). Some Japanese fishermen developed voluntarily de-hooking devices for light ingestion of hooks by sea turtles (Fig. 5) and are testing it in their fishing operations.

Captive studies on post-hooking survival of sea turtles were conducted in Japan. The hooked turtles survived for a period of more than 1 year and remaining hooks were discharged. These results indicate that safe handling and live release is effective in reducing incidental mortality of sea turtles. As we discussed above, circle hooks reduce the rate of hook ingestion by sea turtles compared to tuna and J hooks. Therefore, combining the use of circle hooks and effective de-hookers would reduce sea turtle hooking and/or hook ingestion and increase the survival of hooked turtles. In developing safe handling and live release techniques, both scientific data from experimental survey and empirical information from fishers are indispensable.

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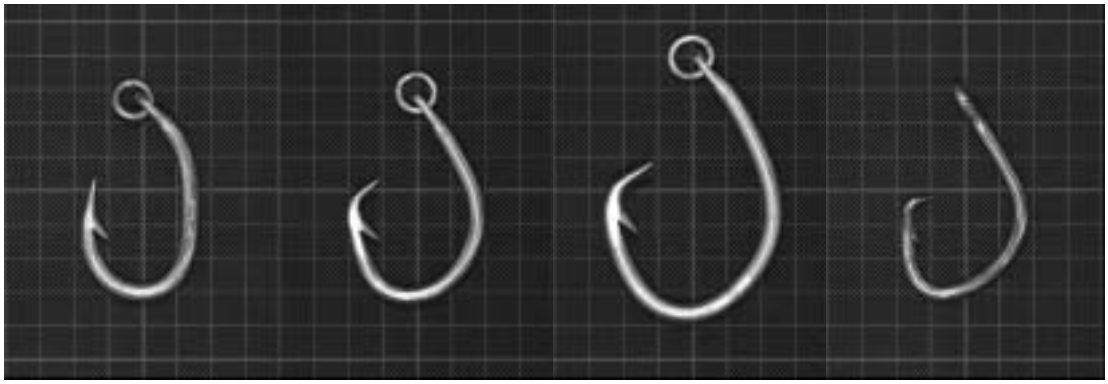

Tuna hook (3.8 sun) | Mutsu Hokubei type Circle hook (4.3 sun) | Mutsu Hokubei type Circle hook (5.2 sun) | Tankichi type Circle hook (3.8 sun)

Fig. 1. Tuna and circle hooks used in experimental operations.

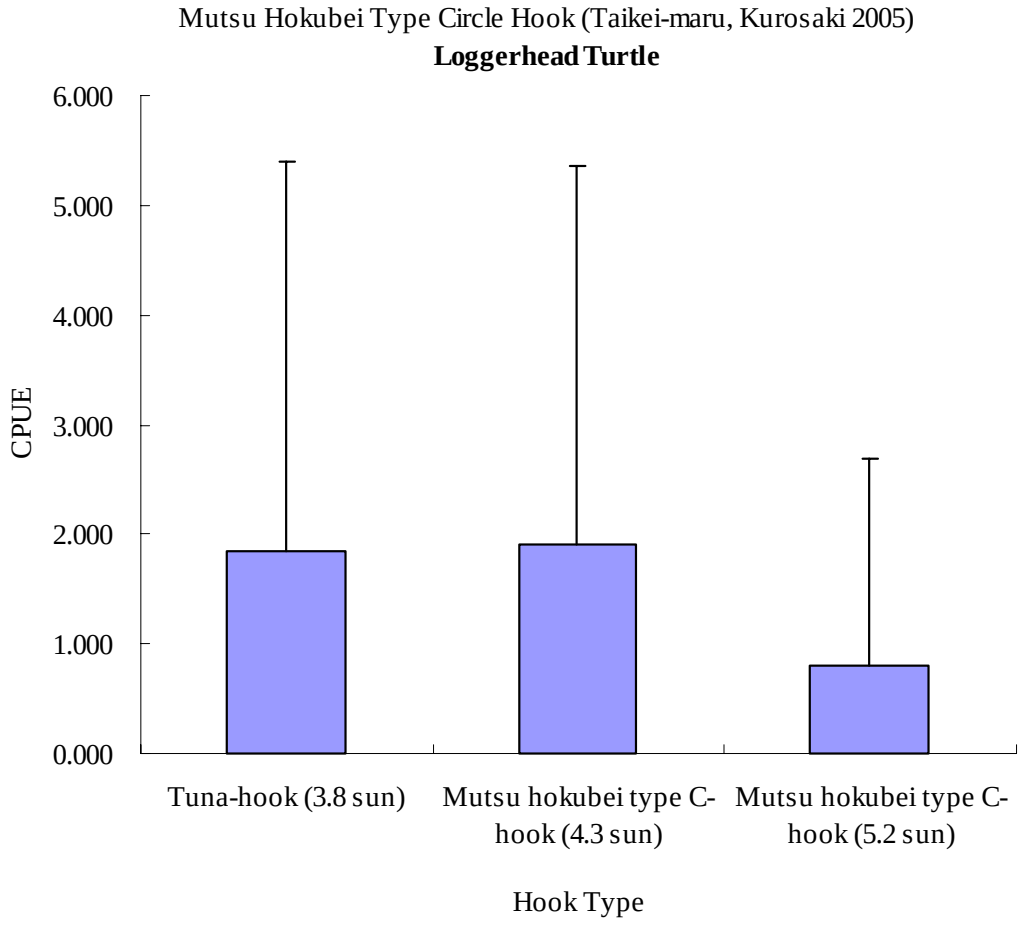

Fig. 2. Catch rates (catch number per 1,000 hooks) of loggerhead turtles for tuna and circle hooks.

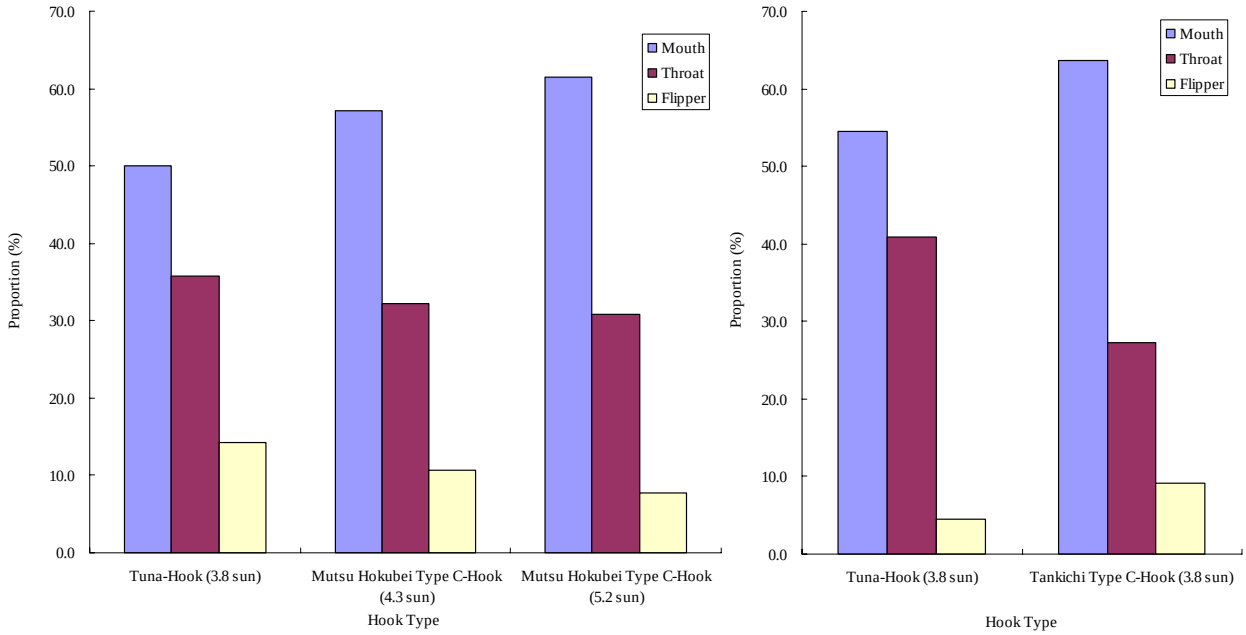

Fig. 3. Hooking positions of hooked turtles for tuna, Mutsu Hokubei type and Tankichi type circle hooks.

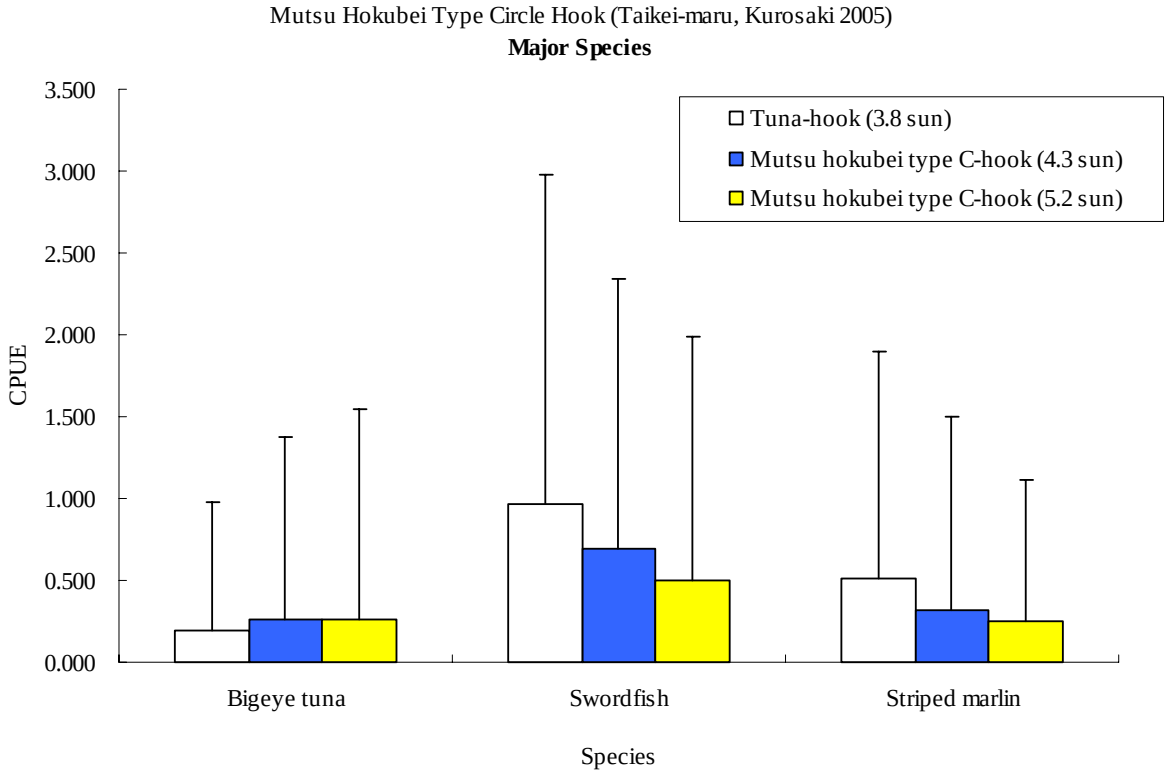

Fig. 4. Catch rates (catch number per 1,000 hooks) of target species, bigeye tuna, swordfish and striped marlin for tuna and circle hooks.

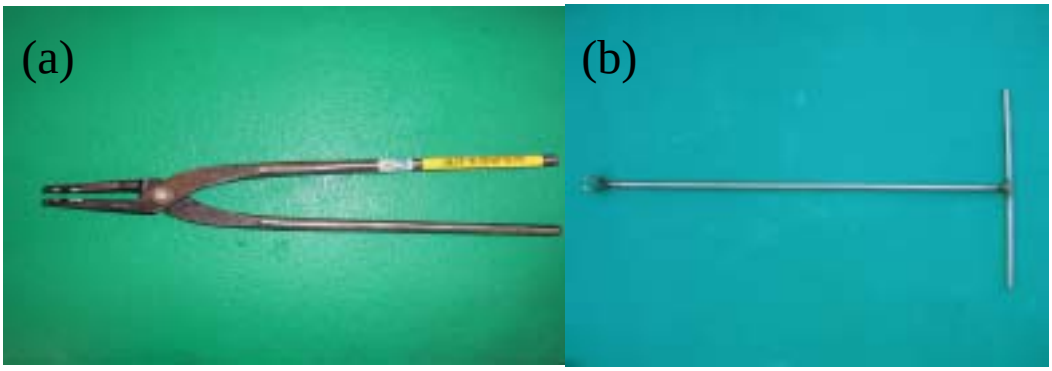

Fig. 5. De-hooking devices, a). de-hooking pliers and b) fisher's de-hooker.


Fig. 6. Scene of hook removal using de-hooking pliers.