Development of sea turtle releasing system for large scale set net/pound net fisheries 2 - practical study to release sea turtle from an experimental bag net

DAISUKE SHIODE[1], MUTSUKI TAKAHASHI[1], FUXIANG HU[1], TADASHI TOKAI[1], MASATO KOBAYASHI[2] AND OSAMU ABE[3]
[1]*Tokyo University of Marine Science and Technology, 108-8477 Tokyo, Japan*
[2] *Ishigaki Tropical Station, Seikai National Fisheries Research Institute, 907-0451 Okinawa, Japan*
[3] *National Research Institute of Far Seas Fisheries, 424-8633 Shizuoka, Japan*
E-mail: shiode@kaiyodai.ac.jp

ABSTRACT
We developed a new releasing system to allow turtles to escape spontaneously from underwater bag net of set nets. This system consists of a turtle releasing device (TRD) which is a square vent (1m x 1m) with a flap and a 20 degrees sloping upper panel of the bag net. In this study, we examined the behavior of sea turtles in the experimental bag net and escaping capability through the TRD. The experimental bag net was composed of quadratic-prism shaped upper panels of 20 degrees angle on a box-shaped net (8m x 8m, 1.8m high in total) and the TRD attached on the top of the upper panel. Eleven captive loggerhead, six wild green, and twelve captive hawksbill turtles were used. All the loggerhead and green turtles and about half the hawksbill turtles successfully escaped out through the TRD. Loggerhead turtles reached the TRD by pushing their heads up continuously, while green and hawksbill turtles swam to the shallowest position directly along the upper panel and reached the TRD. All loggerhead and green turtles pushed up the flap strongly and escaped out successfully, while half of the hawksbill turtles didn't push the flap strongly enough to open it.

KEYWORDS: by-catch, pound net, sea turtle, set net, TRD, turtle releasing device, turtle releasing system

INTRODUCTION

Incidental catch of endangered species is an important management issue in marine fisheries. In recent years, special concern on interaction of sea turtles with coastal fisheries as well as pelagic longline and trawl fisheries has been expressed (Gilman *et al*., 2010, Abe, 2006, Abe *et al*., 2002).

Set net fishery is a major and important coastal fishery in Japan. The set net occasionally catches sea turtles, and turtles entering a bag net fully submerged into the water often drown because the upper panel of the bag net blocks the turtles from swimming up to the surface to breath (Abe, 2006, Abe *et al*., 2002).

To reduce incidental death of sea turtles straying into the underwater bag net of the set net, we have developed a new releasing system to allow turtles to escape spontaneously from the bag net (Takahashi *et al*., 2010). The releasing system consists of a turtle releasing device (TRD) which is a square vent (1m x 1m) with a flap and a 20 degrees sloping upper panel of the bag net. This sloping upper panel induces the turtle to move to the shallower depths and then eventually guides it to the TRD installed at the upper part of the bag net (Takahashi *et al*., 2010). The turtle encountering the TRD can go out of the bag net through the vent, when it pushes up the flap to open it. The flap over the vent automatically closes by the bounce of the flexible plastic net surrounding the vent after the turtle has escaped (Abe, 2006, Abe *et al*., 2002).

In order to confirm the effectiveness of this system for three species of sea turtles (loggerhead, green, and hawksbill) which migrate to the coastal areas of Japan, we examined their behavior in the experimental bag net with the releasing system and evaluated their capability to escape from the bag net.

MATERIALS AND METHODS

The experimental bag net used in this experiment was comprised of quadratic-prism shaped upper panels of 20 degrees angle on a box-shaped net (8m x 8m, 1.8m high in total) and the TRD attached on the top of the upper panel (Fig.1). The experimental bag net was constructed of polyethylene knotless net with a square mesh of 75mm mesh size that is the most popular material for Japanese set nets. The TRD consisted of 200cm square flexible plastic net and a turtle escaping hole (100cm x 100 cm) with a covering flap (110cm x 130 cm) , which was located in the centre of the plastic net (Fig.2). In this device, the flexible plastic net surrounding the hole could supply consistent tension to rebound the

flap and close it.

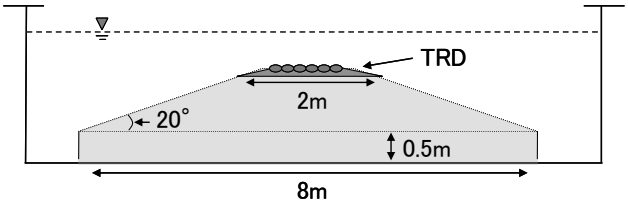

Fig. 1 Experimental bag net with turtle releasing system

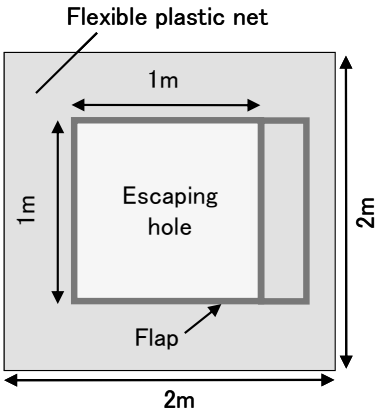

Fig. 2 Schematic of turtle releasing device (TRD).

Behavior observations of sea turtle in a bag net were performed at the outdoor tank (10 m × 10 m × 2.1 m) of Ishigaki Tropical Station, Seikai National Fisheries Research Institute, Fisheries Research Agency, from 31 July to 2 August 2007, and 28 to 30 August 2009.

In these experiments, eleven captive loggerhead (SCL: 67.6cm - 75.6cm), six wild green (SCL: 38.6cm - 64.4cm), and twelve captive hawksbill turtles (SCL: 45.4cm - 57.5cm) were prepared. Of these turtles, five green and one hawksbill turtles were used for two observations in the experiment. In the observation, a single turtle was put into the bag net set in the water tank, and the behavior was recorded by two video cameras from lateral and overhead views. From the video images of overhead view, the horizontal location of the turtle was measured every five seconds. When the turtle pushed up the upper panel with its body axis vertical to the video image of the lateral view, the horizontal positions of the turtle pushing-up were also recorded. In case the turtle in the bag net began to swim up frantically, the observation was terminated and the turtle was released out of the net by divers to avoid it suffocating to death.

RESULTS

All the loggerhead and green turtles and about half the hawksbill turtles successfully escaped out through the TRD (Table 1). The percentages of the escaping success in the trials were 100% (11/11) in loggerhead and green turtles, and 54% (7/13) in hawksbill turtles (Table 1). All turtles pushed their heads up against the upper panel of the bag net after about five minutes' swimming along the net. Patterns of behavior in pushing up and escaping differed among the sea turtle species.

Table 1 Number and size of turtles and results of the experiment

Turtle	Number	SCL (cm)	Success of Escaping
Loggerhead	11	67.6 - 75.6	100% (11/11)
green	6	38.6 - 64.4	100% (11/11)
hawksbill	12	45.4 - 57.5	54% (7/13)

After entering the bag net, loggerhead turtle swam at a constant speed along the side wall or the upper panel of the bag net for around five minutes. Loggerhead turtle sometimes reached near the TRD by swimming along the upper panel of the bag net, but at this time the turtle didn't have so much need to breathe, so swam back down to the periphery. Then, with time elapsing, loggerhead turtles started to push the head up against the upper panel frequently with the body axis vertical. Loggerhead turtle reached the TRD by pushing their heads up continuously, and pushed up the flap of the device and successfully escaped out of the bag net (Fig.3). Loggerhead turtle pushed up the upper panel continuously, and the average number of continuous pushing up motions in one series was 5.6.

Green turtles also swam along the side wall or the upper panel of the bag net for around five minutes after entering the net. All green turtles encountered the TRD by swimming along the sloping upper panel (Fig.4). However, moving to the TRD by continuous pushing up like loggerhead turtles was not seen in green turtles. Green turtles stayed around the TRD, the highest place in the bag net, and with time elapsing, started to push up around the TRD and successfully escaped out of the net. The average number of continuous pushing up motions in one series was 4.1, and this high number of continuous pushing up motions lead to success of escaping.

On the other hand, many hawksbill turtles pushed up the upper panel a few times only, and didn't push up continuously. The average number of continuous pushing up motions in one series was only 2.3. Some hawksbill turtles encountered the TRD by swimming along the sloping upper panel like a green turtle, and pushed up the TRD continuously and escaped out of the bag net. However, the other hawksbill turtles could

not escape, because they didn't push up strongly and continuously, and swam away or down after a few pushing up motions.

DISCUSSION

Loggerhead and green turtles reached the TRD by swimming along the upper panel or by pushing their heads up continuously. Then, all loggerhead and green turtles pushed the flap of the TRD strongly and continuously, and successfully escaped out of the net. These results suggested that the turtle releasing system would be effective for the escaping of loggerhead and green turtles.

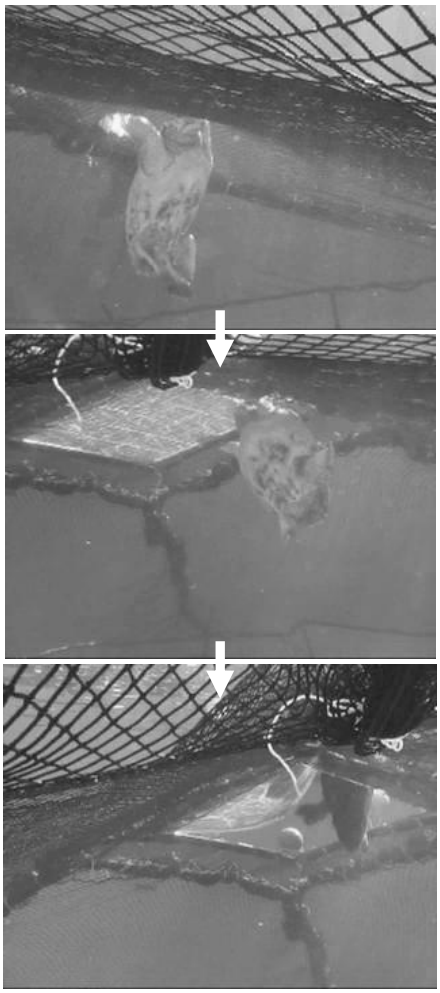

Fig. 3 Pictures of approaching the TRD and escaping of the loggerhead turtle by pushing up continuously

The patterns of encountering the TRD differed among the turtle species. Loggerhead turtle had two patterns, moving to the shallowest position by continuous pushing up and by swimming along the sloping upper panel. On the other hand, green and hawksbill turtles encountered the TRD by swimming along the sloping upper panel, but didn't move to the device by continuous pushing up motions. The guiding method with the sloping upper panel of 20 degrees was effective for not only loggerhead but also green and hawksbill turtles, although the process of approaching the TRD differed among turtle species (Takahashi *et al*., 2010).

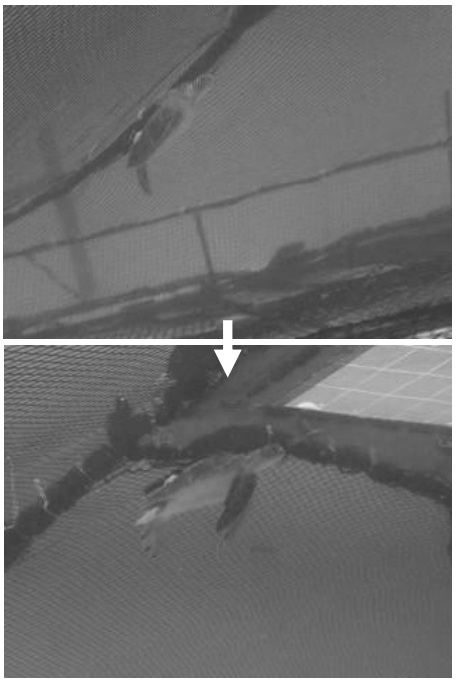

Fig. 4 Pictures of approaching the TRD of the green turtle by swimming along the sloping upper panel

The strong and continuous pushing up behavior was very important for escaping (that is, opening the flap of the TRD and going out). The average numbers in one series of continuous pushing up motions were 5.6 for loggerhead, 4.1 for green, and only 2.3 for hawksbill. Consequently, some hawksbill turtles couldn't open the flap and escape out of the net.

The dimension of the bag net used in the experiment was only 8m × 8m square base and 1.8m high owing to the restriction of tank capacity. The usual bag net in a large-scaled set net is much larger. The validity of the turtle releasing system in large-scaled commercial set net gears should be assessed. In particular, the effectiveness of the guiding method with sloping upper panel is still unknown in such a large bag net. Moreover, technical difficulty in constructing the sloping upper panel in the bag net of large-scaled set nets should be also considered. Further trials and observation of the turtle behavior in large-scaled set nets would be required for the future practical application of this system.

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