# OBSERVATION ON SET NET FISHERIES IN JAPAN WITH BIBLIOGRAPHICAL REVIEWING
## Case Study in Tateyama Bay and Ishigaki (Okinawa Islands)

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Set net is one of the most popular fishing methods operated along the coastal waters of Japan with a big variety of size and design. This report describe about set net fisheries which were collected from literature study and direct observation. In case in Ishigaki Island, the construction of set net is very simple, consisting of leader net, play ground, funnel net, and one bag net. For the fishing operation, the set net is kept in the sea for a long period of time. Different with the small set net, the large set net is the most important type. Its construction is more complex than small set net. The large set net was operated by 10-15 fisherman and used 3 boat where one is the main boat and others are supporting boat.

**Introduction**

Set net (called"teiichi ami" in Japanese) is one of the most popular fishing methods operated along the coastal waters of Japan with a big variety of size and design. The set net were operated in most coastal waters of Japan, from Hokkaido to Okinawa islands, to catch wide varieties of fish (pelagic, demersal, migration and resident species) and other Aquatic animals (Masatsune, 1980;Baskoro, 1995)

In 1997 there were 1704 unit of large set net and 13272 unit of small set net. The set net fisheries play an important role 10,6 % in fish total production in Japan (Agriculture-Forestry Economic Bureau, 1999). The set net fisheries is divided into three categories; the salmon set net, common large set net and small set net. The salmon set net is kind of large scale set net which the main catch is salmons *Onchorhynchus sp* . Common large set net is others type of large scale set net which commonly set at 45 m depth of water or more. The large scale, for example has a 50 m wide and 300 m length body net with a 700 m long leader net. This net usually constructed in the sea area between 60 - 80 m in depth (Inoue and Arimoto, 1988). Tuna *Thunnus sp,* skipjack *Katsuwonus pelamis* , mackerel *Scomber sp*, sardin *Sardinops melanosticta,* round herring *Etrumeus microps,* squids *Loligo sp,* and etc were mainly caught by common large set net. The small set net is a type of set net which commonly set in the swallow water area of about less than 25m depth, which is very popular a long the coastal in Japan.

This study was conducted in order to know more information about set net fisheries in Japan with emphasizing in fishing method and fish behavior.

**Materials and Methods**

This report was collected from literature study, direct observation and interview to set net fisherman. Direct observation of the large set net was conducted in Tateyama Bay, Japan on November 11-12 1999, (Fig.1). While the small set net was observed in Ishigaki Island (Okinawa) on November 15 - 19, 1999 in the Southern part of Japan (Fig.2.)

**Results and Discussion**

**Fishing Gear and Methods**

A. Small Set Net in Ishigaki

Small set net in Ishighaki Island was operated by using a boat of Sabani Type which conducted by one fisherman who has diving skill. The specific dimension of the boat are Length Over All 9.5 m, Breadth 2.2 m and Depth 0.98m (Fig.3).

The construction of Ishigaki set net is very simple, consists of leader net (150 m), play ground (18m x 12m), two funnel nets, and one bag net (Fig.4). For the fishing operation, the set net is kept in the sea for a long period time. Generally, the bag net of set net was hauled by the fisherman at every morning.

In set net operation, firstly, the fisherman to observe catch by diving and then detach the bag net rope from the sinker. After that the bag net was hauled

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on the deck, and then open the bag net (Fig.5 - 6) for collecting of the catch (Fig. 7 - 8). One time fishing operation required 20 minutes.

Different with the others fishing grounds of set net in Japan, set net fishing ground in Ishigaski almost the same with the gear in the tropical country area which have a coral lagoon fishing ground of shallow waters (5-10 m).

B. Large Set Net in Tateyama

There are some types of set net were operated in Tateyama Bay, the large set net was one of most important type in this fishing ground. The construction of large set net is more complex than small net as shown in Fig. 9. The gear consisted of leader net which measured 1125m length and the pound net was 450m x 105m. The slope and funnel net supplements the function of bag net, and it also acts as a trap door which the fish in and then cut off the route of escape. In addition, it also lead the fish schools into the bag net. Finally, the bag net gathers the fish and prevent escaping. The large set net was operated by 10-15 fisherman and used 3 boat where one is the main boat and others are supporting boat (Figs.10 - 11). The set net in Tateyama bay was set at 40 - 50 m depth, and where the bottom consisted of sand and mud.

The first step of the operation method of the large set net was started from carrying up the bottom net by line haulers (Fig.12), for herding fish to the final bag net. The catch were lifted up on the main boat. One time operation requires 40 minutes. The dominant catch of this gear consisted of; Jack mackerel (*Trachurus japonicus*), Saury ( *Cololabis saira*) and Anchovy ( *Engraulis japonica*) (Akiyama, 1997).

**Location of the Set Net, Choosing a Fishing Ground and Relation to the Fish Behavioral Aspect**

Bottom topography, Water mass distribution and coastal circulation patterns are all important in selection of an optimum site for a set net (Nomura, 1980). Concerning the depth and location of the set net, the direction at which the leader net is set is important. Usually the leader net is set perpendicular to the coast to reach deeper waters and ranges from 500 to 5,000m long. The function of the leader net is to guide the fish to the play ground or bag net (Nomura, 1980).

In establishing a set net fishery operation it goes without saying that the biggest factor is to secure a net location where large fish schools are migrating. When looking for a new fishing ground to develop one must first of all be certain that the sufficient amount of fish species suitable for catching by set net are present. In order to locate a suitable fishing ground, it is necessary to study the types of fish species present and their seasonal migrating habits in the coastal waters. The areas or routes that school of fish pass is high frequency are referred to as fish routes (Fishery Journal, 1986). Further more the important factor that determine the configuration of the fish routes are :

1. The coastal isobath

In the case of large-scale set net fisheries catching mainly migrating species such as yellowtail, horse mackerel, mackerel, sardine and anchovy, the areas chose as fishing ground are the steep coast areas near the mouth of deep bay where a branch of the ocean current that has entered the bay and circled it is about to leave the bay again. The reason for this is that fish species that are migrating with the circulating current along a coast form fish routes, and because each species migrates at a given that, when they come to a place on the coast where the isobaths lines are close together it is believed that the schools of fish are forced together and thus become concentrated in a small area.

2. The existence and configuration of natural reefs

The natural reef that dot the coastal waters are beneficial in they lure migrating fishes, but the same time they also function as substantial obstacles. In the attempt to learn more about the relationship between natural reefs and the movement of fish school as they approach the coastal waters.

3. Physical characteristics of the sea

Most set nets need to be set in area with relatively mild current power. If the current power is too strong it tends to distort the shape of the net, thus lowering its catching efficiency and also tend to caused various difficulties in the hauling operation. The maximum current power under which net hauling can be successfully performed is consider to be 0.4 knot/hour for an "otoshi-ami" and 0.6 knot/hour for under water set net.

A set net fishing ground must be an area with mild wind and wave conditions. Area with strong wind in variably have rough wave condition which hinder the net hauling operation and increase the rate of breakdown of the net and other fishing gear. Rocky sea bottom areas are not suitable for set net operations because of the possibility of net destruction. The best sea bottoms for set net are mud, sand, pebble and shell or combination of these.

4. Effects of the tides on fish behavior

There are a variety of traditional fishing methods that take advantage of the movement of fish and shellfish with the tide in shallow sea areas which area change into an expansive tideland at high tide, among these the fishing methods is tate-ami is one of the most common.

Areas in which inland marshes, lakes or rivers are connected to the shallow sea by estuaries provide excellent nursery grounds for the fry and fingerlings of various ocean fish species, due to abundance of nutrients that these inland water bodies are sending into the sea water, and also due to the constant tidal exchange with the open sea. Therefore, these areas make ideal fishing grounds for small scale set net fishery.

Many research have been performed to investigated the set net fishing gear in relation to the fish behaviour, fishing ground, as well as design and construction. With regard to influence of fish behaviour on use and design of set net, it was found that visibility and audibility of the leader net are important in turning and guiding fishes toward the bag net(Nomura, 1980). The design characteristics of the bag net greatly depend on whether the species has a tendency to swim close to the webbing or at a distance from it and whether the fish tend to enter the net during day time or during dawn/dusk and at night time. The use of the ascending or descending chuter is especially important for fish that approach the webbing closely if good catches are to be obtained.

Miyamoto (1957) studied the behaviour of some kinds of fishes using a 2-mouth-2-bag- type of trap net in regard to the selectivity of the position of bags and the entrapping efficiency affected by current direction and velocities when they entered the bag net. Actually current direction and velocity influence too the gear shape of leader, body, funnel and bag nets. He found that adult Blue fin tuna when approaching to the fishing ground are more liable to turn to right than to left, and at the same time they are likely to follow the current when entrapped in the play ground. Catch were most abundance when the current velocity ranging from 0-0.3 knot, but a considerable number of them were also caught even under stronger current. They were never entrapped in double traps. Young Bluefin tuna also showed almost the same habit as the adult, except a sharp decrease in catch under the velocity over 0.3 knot. From the coastal line direction, the school of tunas usually enter from the left side of the entrance, while no entry was evident from the right according to Miyamoto. Pelagic fishes like Bluefin tuna, Dolphin and Mackerel showed a remarkable behaviour, common among them, to choose the right bag. They showed a peculiar habit to enter thought a very narrow opening to a bag which was specially constructed to entrap them. The faster speed of current can cause the poorer of catches. Particularly, catches, except for plaice, sharply declined when the velocities of current are over 0.3 knot. The upper limit of current velocity for the operation of trap net has been estimated about 0.5-0.6 knot.

Inoue and Arimoto (1988) observed the behaviour of salmon schools with the aid of a scanning sonar in relation to the capturing process of the gear when the schools enter the set net and escape from it. The surveyed set nets have two mouths on the both sides of the leaders net, and are classified as a trap net of"Otoshi-ami" type. They found that the Salmon schools entered the set net mostly during the daytime. All of them, however, were not always accumulated in the main net. The detail of the entering behaviour of Salmon school is as follows; the migration salmon schools are blocked off their courses and led to the entrance (the mouth of the main net) by the leader net. The Salmon schools enter through one of the two mouths (the front or the back mouth), according to its approaching side for the leader net which separates the coastal area from the front and backyard sides. When escaping, the schools may escape from either mouth. They can expect more escaping chance than entering, because the inside width of the mouth (the exit) is equivalent to the sum of the both mouths. Hence, the school is occasionally dispersed and escaped from the both sides of mouth. A set net with two mouth is considered to be more suitable for the approaching behaviour of salmon schools, as they can enter the main net from both sides of the leader net. The escaping chance, my increase on the contrary.

The fish school of Flying fish migrated inshore from afternoon until evening and they moved offshore from early in the morning until noon. They were caught by the trap net in the morning. The fish school of Spotted mackerel approach the gear in the same direction as the current and tend to take a migration route towards the deep and enter the trap net because of the leader net . Salmon schools came into the bay with the flow of the water in the bay, than they moved a long the coast around the bay. When they went out of the bay the leader net blocked their route, and they changed direction to the mouth of the trap and therefore caught. The fish schools which swam offshore were not caught, while the fish schools which took routes near the seabed on the mouth of the trap net along the isobathic topography were entrapped by the leader net based on experiments by Inoue and Arimoto (1988).

Baskoro (1995) have studied typical movement patterns of fish in the funnel net, and indicated that 61% of fish schools swam into the bottom trap and were caught, while 39 % did not enter the bottom trap but turned around, swam out of the funnel and escaped. The migrating behavior of fish schools around the gear, fish schools behavior from around the leader net until entering the play ground and fish school behavior in the funnel net until entrapment in the trap. the swimming behavior of most fish schools when swim trough the entrance into the trap showed downward swimming pattern.

When fish school first approaches the net they are usually guided by the leader net to enter the play ground, however they may turn around, swim through and leave again (Baskoro, 1995). Data from acoustic survey gathered at the mouth of the play ground showed that 28 % of the fish schools were leaving (Nomura,1980). Only 8% of the fish schools passed through the leader net, 76 % encountered the leader net and moved along it, while the direction of the other 16 % could not be determined base on scanning sonar survey by Inoue and Arimoto (1988). Depending on the condition, fish may swim along the leader net toward the entrance, swim through the leader net, gilled into the leader net or leaving the leader net after having reacted to it. Fish tend to pass through the leader net if they are frightened, if size of fish is very small compared with mesh size, if a very large schools of the same species on the other side of the net. If one species moves through, others my follow. Fish will gill into the leader net if size of fish is large enough to be gilled (Baskoro, 1995). Data from underwater TV camera survey gathered data alongside the funnel net and the entrance of the bag net showed that 29% of salmon fish schools move ascend to the surface, 7% of them moved straight forward and 64% move descend to the bottom when they swim through the entrance into the bag net (Inoue,1988). This indicates that generally fish schools showed a downward movement immediately when they encountered an obstacle or get out from the narrow area. This information is very important and should be considered when designing the funnel for effective entrapping of fish school. The function of the tapering funnel as a non-return device to the trap is one of the key point in the capturing process of a set net (Inada et al. 1992).

**Advantages of the Set Net Fishing Gear**

Set net fishery is very important in Japan and it has many advantages from others Fishing gears. Some of the advantages of set net fishing methods are (Baskoro, 1995): (1) set net is wait and see passive gear and can be operated around the clock continuously, (2) set net fishery is economically because it is set in shallow coastal waters; because it is short distance to the landing area the fuel consumption needed by the operator is low, (3) it is also economical in term of labor force be caused operation procedure is very easy and can be operated by e few to several fisherman even on large size of net, (4) the operation consumes little time in two or three hours thus allowing fisherman to do others supplementary works, (5) the fish caught by set net are alive so it is easy to keep the fish fresh and smaller size fish can be used for cage culture, (6) the set net gear is stationary and selective, can not cause over fishing because it catches migratory species.

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