

# Final Report

## Assessing the State of Japanese Coastal Fisheries and Sea Turtle Bycatch

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### 1. Purpose

The Sea Turtle Association of Japan (STAJ) receives over 500 reports annually regarding dead stranded sea turtles. Fishery bycatch is assumed to be the greatest source of mortality of stranded turtles in coastal Japan. In addition, STAJ conducts research and monitoring on sea turtles that are bycaught in pound nets in Kochi, Mie, and Kagoshima prefectures, where approximately 100 turtle bycatch are recorded at each pound net site (Ishihara et al., 2006; Iwamoto, 2006; Yamashita, 2007; Takeuchi, 2008). Of the monitored sites, the site in Mie prefecture has a very high mortality rate, suggesting that fishery bycatch cannot be ignored as a source of sea turtle mortality.

Moreover, many of the fishers operate with various fishing gear and method depending on the season, leading to extensively varied operation size and type of fisheries across the country. As a result, determining the types of coastal fisheries that pose the greatest threat to turtle populations as well as the extent of bycatch is critical in recovering the population of loggerhead turtles, green turtles, hawksbill turtles, and leatherback turtles that utilize coastal Japan as their habitat. Development of a plan for reducing bycatch mortality in coastal Japan will be possible with such an assessment.

### 2. Methodology

We divided Japan into seven study areas to conduct the assessment. For each area, data collection and analysis were conducted for (a) fishing gear, method, and operating seasons, (b) strandings, and (c) pound net monitoring at selected sites.

#### 2-1. Study Areas: Interview sites of “Kyushu” area and “Sea of Japan” area

In 2010, assessments were conducted in “Kyushu” area and “Sea of Japan Sea” area (Figure 1). For Kyushu area, 72.9-83.9% of all loggerhead turtle nests in the north Pacific in the past 5 years have occurred in this area. In other words, Kyushu is the most important nesting area for north pacific loggerhead turtles and one of the key areas for conservation of

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the loggerhead turtle. For Sea of Japan area, there are very few information about sea turtles because of the lack of a sea turtle network, while sea turtles are known to migrate in this area. We selected 31 and 30 fishing ports and/or fisheries cooperatives for Kyushu area and Sea of Japan area, respectively (61 total) shown as red pins on Figure 1 as interview sites. Locations were selected as follows: All fisheries cooperatives were listed and numbered in each study area; then we selected 20 numbers using a random number table, and corresponding fisheries cooperatives were selected as interview ports; 11 or 10 additional interview ports were selected based on existing information and/or interview interim results. However, we deselected 9 sites located in Aomori, Akita and Niigata prefectures in the Sea of Japan area because of impacts from the large earthquake on March 11<sup>th</sup> 2011. We then reselected 9 new sites for Sea of Japan area based on same method as above. Three sites in Akita and Yamagata had already been researched before the earthquake, so these were retained in the sample.

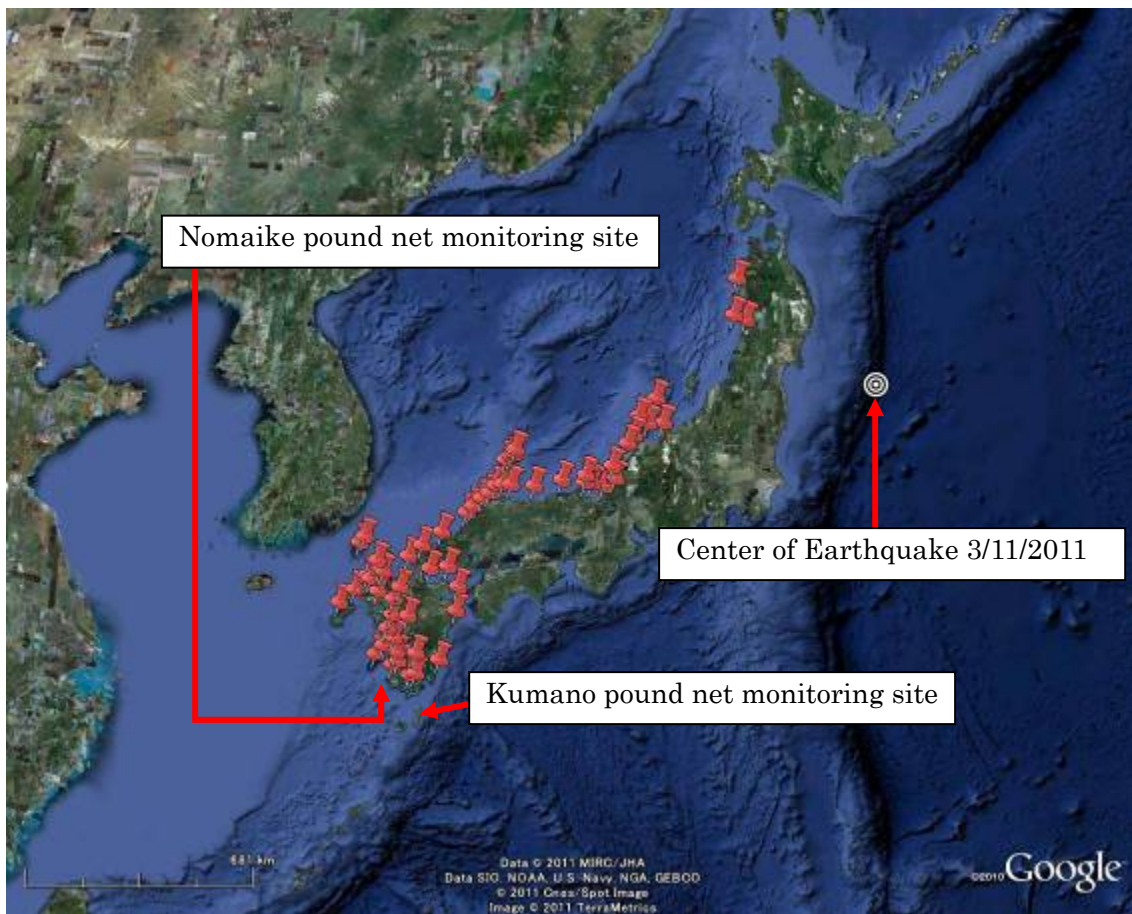


Figure 1. Interview sites of “Kyushu” area and “Sea of Japan” area. A total of 60 fishing ports and/or fisheries cooperatives have been selected. Red pins indicate interviews sites. Red arrow shows bycatch monitoring site for pound net fisheries (Nomaike and Kumano pound nets, Kagoshima Prefecture).

## 2-2. Assessment of Fishing Gear, Method, and Season

Interview sheet was same as the one developed during the 2009-2010 project period. Interviews were conducted as informal conversations with limited note taking, and the interview sheet was completed by the interviewer after leaving the port. The interview sheet

contained questions regarding the fishermen's demographic information (such as age and years of fishing experience), but we did not place a high priority in obtaining these information as some interviewees may consider them confidential or unnecessary.

Data collection started in September from Kagoshima Prefecture (Kyushu area) and finished in May at Shimane prefecture (Sea of Japan area). The interviews were structured to determine the following: type of fishing method used; amount of catch; amount of fishing effort; operating season for each fishing method; and possibility of mortality in bycaught turtles. In addition to questions regarding target fish species, questions regarding non-target species are also asked to elicit responses for species, seasonality, and amount of sea turtle bycatch whenever possible. Interviews were conducted with fishers, with one survey form filled out per respondent, and we targeted at least five fishers to be interviewed at each fishing port. Fishers were told that the survey is for the following purposes: assessment of local characteristics of fisheries, and status of non-target bycatch species such as sea turtles.

### **2-3. Stranding survey**

Possible causes of mortality for stranded turtles include fishery bycatch, predation, external injuries from boat collisions, deterioration of health due to diseases, and lowered activity level from low sea temperatures. To determine source of mortality for stranded turtles, we examined the extent of external injuries, stomach contents, and sea surface temperature of the area. If no external injuries were present, predation and boat collisions could be excluded as possible causes of death. The presence of stomach contents indicated that the individual had been foraging until several hours prior to death, suggesting that the individual did not have any serious diseases that led to death. Cold stunning is known to occur when sea temperatures drop below 10°C (Morreale et al., 1992; Witherington and Ehrhart, 1989), and thus cold stunning might be excluded as a cause of mortality during seasons with sea temperatures above 15 °C. Fish have only been found in the esophagus and stomach of the digestive tracts of dead bycaught turtles, (Iwamoto et al., 2005; Iwamoto et al., 2006), suggesting that fish found in stomach contents of stranded turtles may indicate that the individual consumed fish caught in fishing gear immediately before dying. Based on the above justifications, STAJ staff focused detailed stranding examinations to estimate causes of stranding mortality. When STAJ staff could not examine at the stranding site, we made an evaluation using photographs.

### **2-4. Bycatch Monitoring at Pound Net Fisheries**

Two pound nets were monitored for turtle bycatch numbers, species composition, and mortality in the Kyushu area. Monitoring took place in Nomaie and Kumano (Kagoshima Prefecture) (Figure 1) in collaboration with fishermen who learned measuring techniques from STAJ researchers and have a good record from 2004 and 2007, respectively. STAJ researchers contacted collaborating fishermen periodically by phone, e-mail, and in person. The monitoring determined the degree and seasonality of sea turtle migrating to the areas. The pound net at Nomaie is open-type, which operate year-round. Between November and May, roofed-type nets called *Kinko-ami* targeting *Buri* (yellowtail, *Seriola quinqueradiata*) is also used. Since an entrance of the *Kinko-ami* in Nomaie is too small to enter for sea turtles, no turtle was trapped in roofed net. Kumano pound net is set at Tanegashima Island, which is close to Yakushima Island known as biggest rookery in the North Pacific. Kumano pound net stopped fishing from the end of June to the early November because of the typhoon season and the declining fish catches.

### 3. Results

#### 3-1. Assessment of Fishing Gear, Method, and Season

##### 3-1-1. Kyushu area

We started interviews in the southern part of Kyushu and conducted interviews with 186 participants and 7 prefectural Fisheries Experiment Stations (Miyazaki, Kagoshima, Kumamoto, Oita, Saga, Nagasaki and Fukuoka prefectures) in Kyushu.

We have detected 21 categories with 78 sub-categories of fisheries. But we feel more sub-categories exist that were not identified through the survey. Then, we categorized 12 subareas as follows based on geographic characteristics and fisheries operated: A: Genkai-nada, B: Iki-Tsushima, C: Hirado, D: Goto, E: Northwest coast, F: Ariake-kai, G: Southwest coast, H: Koshiki, I: Minami-satsuma, J: Kinko-bay, K: Hyuga-nada, L: Setouchi (Figure 2).

Of the 186 participants, we were able to gather demographic information from 158 participants, including participant's age (n = 116) and fishing history (n = 98) (Table 1). The majority of the participants who provided their age were older than 50 years (n = 94; 81.0 % of the respondents). Fishing history mainly range between 10-59 years (n = 90; 91.8 % of the respondents), of which 30-59 years (n = 62; 63.3 % of the respondents) are more common. Considering the higher age of fishermen, relatively large number of fishermen had shorter fishing histories. This is because some fishermen had changed job to fisheries from other industries after they had changed careers or retired.

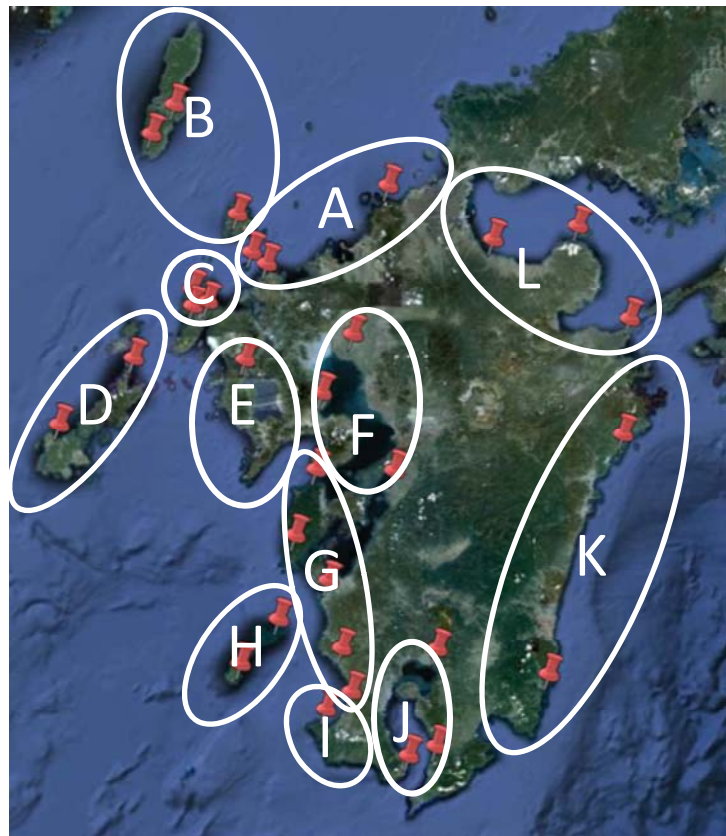


Figure 2. Subareas in Kyushu categorized by fisheries operated and geographic characteristics. A: Genkai-nada, B: Iki-Tsushima, C: Hirado, D: Goto, E: Northwest coast, F: Ariake-kai, G: Southwest coast, H: Koshiki, I: Minami-satsuma, J: Kinko-bay, K: Hyuga-nada and L: Setouchi.

Red pins indicates interviewed sites.

Table 1. Demographic composition of interview participants in Kyushu area. A: Genkai-nada, B: Iki-Tsushima, C: Hirado, D: Goto, E: Northwest coast, F: Ariake-kai, G: Southwest coast, H: Koshiki, I: Minami-satsuma, J: Kinko-bay, K: Hyuga-nada and L: Setouchi.

	Participants												sub total	%
	A	B	C	D	E	F	G	H	I	J	K	L		
Interview Point	3	3	3	2	3	1	5	2	1	3	2	3	31	
Interviewd Participant	25	18	16	14	12	5	35	11	5	14	13	16	184	
<b>Demographic Parameters</b>														
Age Range														
20-29	0	0	0	0	1	0	1	0	0	0	1	0	3	2.6
30-39	0	0	2	1	0	0	2	0	0	1	2	0	8	6.9
40-49	0	0	1	1	2	0	1	0	1	2	1	2	11	9.5
50-59	3	1	0	0	2	0	9	5	0	5	5	1	31	26.7
60-69	4	2	3	0	0	0	9	5	1	1	2	8	35	30.2
70-79	2	1	2	0	1	0	11	1	2	3	1	0	24	20.7
80-89	0	0	0	1	1	0	1	0	0	1	0	0	4	3.4
Fishing History														
Less than 10 years	0	0	0	1	1	0	0	0	0	0	1	0	3	3.1
10-19 years	2	3	0	5	0	1	3	0	0	2	0	0	16	16.3
20-29 years	0	0	0	2	4	0	0	1	1	2	1	1	12	12.2
30-39 years	3	3	0	2	1	1	5	1	1	1	0	1	19	19.4
40-49 years	8	3	1	1	0	1	2	1	0	2	0	3	22	22.4
50-59 years	7	3	2	0	2	0	0	0	1	0	0	6	21	21.4
More than 60 years	0	1	0	1	0	0	2	0	0	0	1	0	5	5.1

Fisheries likely to have greatest impacts on sea turtles were large pound nets, small pound nets, gill nets, and trawl nets. Gill nets, small pound nets and trawls nets were found to be distributed throughout the survey area, but large pound nets were concentrated in sub-area C, D, H and K. Bycatch rates of large and small pound nets were higher than that of gill nets and trawl nets, however, the number of vessels or operating bodies were opposite. Large pound net in Kyushu area are generally open-type nets. Some small pound nets were found to have bycatch of tens of turtles per year, but the nets were also mostly open-type that allows turtles to breathe. Loggerhead turtles were mainly bycaught by some large pound nets and are also likely caught in bottom trawls. Green turtles were likely bycaught in large pound nets, small pound nets, and gill nets. We suspect that the distribution of bycatch is likely related to the depth of fishing operation. Distribution of green turtles tends to be closer to the shoreline than loggerhead turtles, and large pound nets tend to be set deeper than small pound nets and gill nets.

Subareas C, D and H which face the East China Sea were found to have relatively high bycatch rates of both loggerhead and green turtles compared to other subareas in Kyushu. This does not appear to be related to the distribution of nesting beaches. We suspect that the higher bycatch rates in subareas C, D and H are related to seabed topography, ocean currents and existence of large pound nets. The Tsushima warm current flows on the western side of Kyushu, while subarea K is not suitable for setting pound net and subarea L faces an inland sea.

### ***A: Genkai-nada***

Genkai-nada sub-area is located on the northern side of Kyushu. Although some loggerhead turtles nest in the area, there is a general lack of sea turtle information. Main fisheries are rod/handline fishing, long lines and gill nets. While small pound nets and trawls are also operating, only one large pound net is operated in Karatsu, Saga prefecture.

Rod/handline fisheries were often operating on the edge of Tsushima current (which

passes through between mainland Kyushu and Tsushima Island) to target various species, including mackerels and juveniles tuna. Sightings of sea turtles were very rare (0-1 turtle per year) at fishing grounds, although fishermen thought that they saw more turtles (a few to 5 turtles per year) few decades ago. Almost no bycatch was reported in rod /handline fisheries. Small scale long lines, *Tate-nawa*, and some gill nets were operated all year round, however, almost no turtles were caught in these fisheries. Small open-type pound nets bycaught a few turtles per year alive. A small pound net fisherman said that number of bycaught turtles varies between years and may catch approximately 20 turtles per year. Another small pound net fisherman thought that number of turtles is increasing in recent years.

### ***B: Iki-Tsushima***

Main fisheries are rod-fishing and large and small pound nets. In this area, 18 large pound nets and 53 small pound nets were operated (Ministry of Agriculture, Forestry and Fisheries of Japan 2009). However, interviewed fishermen noted they caught zero, one, or a few turtles per year (probably loggerhead and green turtles) and almost all turtles were released alive. Some of the large and small pound nets were removed from the water during the winter, probably due to the severe weather conditions in the Sea of Japan. *Hiki-nawa*, long lines, handline fishing were also operated. All but large pound nets were basically individual- or family-operated fisheries and sea turtle bycatch was very rare.

The main target species for pound nets, rod/handline fishing include *Kawahagi* (*Stephanolepis cirrhifer*), *Yokowa* (juvenile of bluefin tuna, *Thunnus orientalis*), *Hiramasa* (*Seriola lalandi*), *Isaki* (*Parapristipoma trilineatum*), and *Buri*. Squids fishing is also popular, and the fishermen lead lines with hundreds of hooks at night time. Longlines target not only *Yokowa* and *Buri* but also species such as *Kidai* (*Dentex tumifrons*) and *Amadai* (tilefishes, *Branchiostegus* spp.), using small size hooks.

We expected more information on turtles would be gained from this area, especially from pound net bycatch. As discussed later in the report, hundreds or thousands of sea turtles likely inhabit the Sea of Japan area and these turtles may pass the Tsushima Strait that runs between mainland Kyushu and Tsushima Island to go back and forth between the East China Sea and the Sea of Japan. Despite the difference in our expectation and what we found from the interviews, we do not suspect that fishermen lied or underreported the numbers of turtle bycaught in this subarea.

### ***C: Hirado***

In Hirado subarea, large and small pound nets are prominent. Number of large and small pound nets was less than Iki-Tsushima sub-area, but more turtles (probably loggerhead and green turtles) seem to be caught. Number of turtles varied among the pound nets. Some of the pound nets bycaught tens of turtles but others bycaught a few per year. Most pound nets are open type and sea turtles can breathe when they are caught. Unfortunately, species of bycaught turtles were unknown. In this subarea, all large pound nets and most small pound nets are administered by fisheries cooperatives. Thus, private pound net owners are very rare.

Aside from pound nets, *Gochi-ami* bycaught most sea turtles, but the number of catch was only a few turtles per year. *Gochi-ami* looks like the mixture of trawls and gill nets, where fishing boats tow a net and fishes captured in or entangled in the net. Two boat trawls, gill nets, round haul nets and handline fisheries were also operating in the subarea but bycatch of turtles were very rare (less than once a decade). One type of gill net was set on sandy bottom for targeting fishes such as *Hirame* (olive flounder, *Paralichthys olivaceus*).



*Ago-ami* and *Isomi-ryo* are characteristic fisheries in this subarea. *Ago-ami* is one of the two boat upper trawls and target flying fish. Flying fish are valuable as they are used as to make soup stock especially in Kyushu area. *Isomi-ryo* targets sea cucumbers.

#### ***D: Goto***

In Goto, large and small pound nets are prominent similar to Hirado. Number of turtles caught by small pound nets were relatively low. Fishermen said that they caught one to a few turtles per year and most of turtles were loggerhead turtles. Bycatch rate of some of large pound nets was relatively higher than that of small pound nets and they bycaught mostly loggerhead turtles followed by green turtles. Most of the large pound nets are open type and turtles were released alive. Large pound nets sometimes caught small turtle (referred to by fishermen as “*kogame*” or small turtle; probably hatchlings of loggerhead turtles). It is not surprising that hatchlings enter into pound nets because large number of loggerhead turtles nest on the beach of Kyushu, although we have never seen hatchlings in our monitoring pound nets at Nomaike, Kumano, Muroto, and Shimakatsu. Large pound nets in this subarea also seem to bycatch leatherback turtles and hawksbill turtles on rare occasions. Most fishes are carried to Sasebo, which is located on mainland Kyushu and is one of the central places of Nagasaki prefecture. Therefore, fish captured in this subarea will arrive at the market on the next day. Fish catches appear to be declining in recent years.

Small scale long lines and rod/handline fishing are also common in this area but only a few trawls are operated. All of these fisheries in the subarea are individual- or family-operated fisheries. During the winter season, individual fishermen does not go fishing as the primary target catch for rod fishing is *Surumeika* (Japanese Common Squid, *Todarodes pacificus*),.

#### ***E: Northwest***

This subarea is composed of a portion of Nagasaki prefecture. Although large and small pound nets were well operated in Nagasaki prefecture, bottom trawls and gill nets are prominent and there is no large pound net. Shrimp are the primary and high-priced target for bottom trawls. Gill nets are also set on the bottom to target benthic species. *Jibiki-ami* is a signature fishery in this subarea. In the past, *Jibiki-ami* operated all around Japan but it is unprofitable. Here, *Jibiki-ami* targets *katakuchi-iwashi* (Japanese Anchovy, *Engraulis japonica*) to use as live bait for bonito-fishing.

Fishermen saw dolphins (probably bottlenose dolphin, pacific white-sided dolphin, and spinner dolphin) and finless porpoise but have not seen sea turtles. While dolphins and finless porpoise are known as destructive animals in fisheries and fishermen confirmed this in the interviews, it is likely that bycatch of sea turtles rarely occurs in this subarea.

#### ***F: Ariake-kai***

Ariake-kai is a large inland sea which has an area of 1,700 square meters. Sea turtle information was nearly nonexistent in the area. Fisheries of Ariake-kai is very different from other sub-areas. Ariake-kai is suitable for aquaculture and *Nori* (dried laver seaweed) from Ariake-kai is very famous in Japan. In addition, some types of *Hari-ami*, *etsu* drift net, and other fisheries were found only in Ariake-kai.

*Hari-ami* is a small pound net using nets and bamboo poles. *Hari-ami* is set shallow (approximately 10-15 m depth) but at a distance of approximately 2,000 m from the land. Hundreds of bamboo poles are placed at both sides as guides for the net.

In many case, fisheries is not enough for fishermen to earn a living. Almost all fishermen combine fishing with farming or receive pension to supplement their income.

### ***G: Southwest***

Along the Southwest coast of Kyushu area, bottom trawls, gill nets and small-scale longlines were active instead of pound nets. Fishermen said that these fisheries caught none to a few turtles per year. Fishermen did not identify the species of sea turtles. Bycatch of sharks and rays is more abundant and pose a problem for fisheries in the subarea.

There are many types of gill nets and drift nets in this subarea. We detected gill nets for shrimp, *Iseebi* (spiny lobster, *Panulirus japonicus*), *Hirame*, squid (mostly *Aoriika*: bigfin reef squid, *Sepioteuthis lessoniana*), *Chiko* (crimson sea-bream, *Evynnis japonica*), *Bora* (flathead mullet, *Mugil cephalus*), and *Karasumi* (dried ovaries of *Bora*) and drift net for *Kajiki* (billfish, Xiphioidei spp.). *Hikimawashi-ami* takes net around shallow area to catch *Kisu* (Sillaginidae spp.). These nets differ in mesh size, strength, length, height, depth of setting, and other gear and set characteristics. *Kakoi-ami* is a type of gill net for *Aoriika*, whereby fishermen enclose a sea grass bed with the net, and then force squid out by making a sound. There are only a few large pound nets in the subarea. Small pound net is also not abundant. Almost all fisheries are individual- or family-operated fisheries.

### ***H: Koshiki***

In Koshiki, small pound nets are common and small pound nets caught a few to less than 10 turtles per year. Fishermen did not identify the species of sea turtles. There are only three large pound nets in this area. Gill nets are also common and many types of gill nets were used for each target species (e.g. *Iseebi*, *Kibinago* [silver-stripe round herring, *Spratelloides gracilis*] and *Kajiki*).

*Ebi-sashiami* (to catch *Iseebi*) is standard type of gill nets and does not bycatch sea turtles in this subarea. *Kibinago* gill net is also active. *Kibinago* is a small and slender fish. Fishermen caught *kibinago* as they enter the port at night time. *Kibinago* is collected by attracting them by light and then leading them into to the net set at the entrance of the port. *Kajiki*-drift net is also active on July to November. *Kajiki* refers billfish species, and *basho-kajiki* (Indo-Pacific sailfish, *Istiophorus platypterus*) is primarily caught offshore from sunset to next morning. The drift net is approximately 1 km long and usually operated by two fishermen. For *Kajiki* drift net, almost no sea turtles were bycaught.

### ***I: Minami-satsuma***

We conducted interviewed in northern Minami-satsuma where large and small pound nets are the primary fisheries. Nomaike pound net monitoring site is also located in Manami-satsuma subarea. Approximately 100 turtles per year (more than 90% of which are green turtles) are released alive at a large pound net in Nomaike due to the open type design that allows turtles to breathe after being caught. The large pound net in Nomaike started operating approximately 100 years ago and only small changes have been made since. Materials for the net were originally *Kazura* (a type of bine plant) and then changed to *Wara* (rice plant), Manila fiber, and synthetic fibers. Operating life of synthetic fibers are approximately 10-15 years. Most other pound nets also use open type net and catches 20-50 sea turtles per year. Pound nets are usually set all year round except during typhoon season. A large amount of trash with Korean or Chinese characters are found floating in the area.

Gill nets and rod/handline fisheries are also common but trawls and longlines are rare. Although almost no sea turtles were bycaught in these fisheries, fishermen occasionally saw sea turtles (mostly loggerhead turtles) along the northern coast of this subarea.



### ***J: Kinko-bay***

Kinko Bay is enclosed with Satsuma peninsula and Osumi peninsula and has an area of 1,130 square meters. Major fisheries are aquacultures, especially at the head of the bay. Fishing activity is relatively low compared to other subareas. Because of Kagoshima city, which is the biggest city in Southern Kyushu located at the head of Kinko Bay, ship traffic is busy and inhibits fishing activity.

A few fleets based at the head of Kinko bay operated round haul net in the bay to catch *Katakuchi-iwashi* to use as live bait for bonito-fishing at night time. The fleets were composed of 3-4 searching vessels, 1-2 netting vessels, and 1-2 carrier vessels. It takes approximately 2 hours from setting the net to retrieving the net. Number of fleets for this fishery is declining, similar to other fisheries. Bottom longlines for species such as *Tachiuo* (largehead hairtail, *Trichiurus lepturus*), *Tai* (sea breams, *Pagrus* spp.), *Kagsago* (rockfishes, *Sebastiscus* spp.) used approximately 10 sets of 50-150 subsets of 1.5 cm hooks on the bottom at depths of 100-200 m. Sea turtles were very rare, especially around the head of the bay.

Net fisheries are not common at the mouth of the bay and fleets tend to go fishing outside of the bay. While aquaculture is also abundant, *hiki-nawa*, longlines, rod/handline fisheries are common fisheries. Major target is bonito for *hiki-nawa* and rod fishing, and *Kinme-dai* (*Beryx splendens*) for bottom longlines. These fisheries did not catch any sea turtles.

### ***K: Hyuga-nada***

The coastline of Hyuga-nada mainly constitutes of long sandy beaches. These beaches are major rookeries of loggerhead turtles but severe beach erosion is in progress. In Hyuga-nada, round haul nets, longlines, gill nets, bottom trawls and large and small pound nets are common.

Large and small pound nets are mostly absent in central Hyuga-nada presumably because of sandy shoaling geography. Majority of large and small pound nets are open type which keep sea turtles alive. Bycatch rate and species of bycatch varied from pound nets to pound nets. For instance, a small pound net fisherman at the southern part of this subarea said that 80 % of sea turtles were green turtles with a size range of 40-100 cm. Conversely, crews of a large pound net at the northern part of this area said that 60-70 % of sea turtles were loggerhead turtles and most of the remaining were green turtles.

Round haul nets are operated not only in this subarea but also offshore of Shikoku Island to target *Saba* (*Scomber* spp.), *Soudagatsuo* (*Auxis* spp.) and other species by three-vessel fleets. Round haul nets caught a few sea turtles alive every year.

There are two main types of bottom trawls. One is the typical small bottom trawl, or *kogata-sokobiki* which targets shrimp and sandy benthic fish species such as Pleuronectiformes at depths of 40-100 m, and the other is the deep-sea bottom trawl, or *shinkai-sokobiki* which trawls at depths of 200-300 m to target *Mehikari* (greeneyes, *Chlorophthalmus albatrossis*). Although *kogata-sokobiki* was found to bycatch a few sea turtles, *shinkai-sokobiki* did not catch any sea turtles. *Shinkai-sokobiki* uses 1,000m-long ropes and are prohibited to use devices such as otter boards to enlarge the mouth of the net. In this subarea, fishermen must be careful of submerged battle plane and submarine remains from World War II.

### ***L: Setouchi***

This area faces the Seto Inland Sea and information on sea turtles (e.g. nesting, stranding and bycatch) are rare. Major fisheries are round haul net, bottom trawls, gill nets,

rod/handline fishing. No large pound nets are operated in this subarea. Diving is more common than other subareas in Kyushu area and targets *Awabi* (abalone, *Haliotis sorenseni*) and sea cucumbers. In many cases, dive fishing is conducted with the husband diving while the wife operates the boat. Aquaculture is also very active. Saganoseki is known nationwide as producers of high quality *Masaba* (Chub mackerel, *Scomber japonicus*) and *Maaji* (japanese jack mackerel, *Trachurus japonicus*), which are branded as *Seki-saba* and *Seki-aji*, respectively. *Seki-saba* and *Seki-aji* are targeted using rod/handline fishing to harvest them without damaging the product.

### 3-1-2. Sea of Japan area

For the Sea of Japan area, we conducted interviews with 168 participants and 9 prefectural Fisheries Experiment Stations (Akita, Yamagata, Ishikawa, Fukui, Kyoto, Hyogo, Tottori, Shimane, Yamaguchi prefectures). We have detected 19 categories with 57 sub-categories of fisheries. However, we suspect more sub-categories exist that were not identified through the survey, as the researcher of Akita Prefectural Fisheries Experiment Station mentioned that there are almost 700 types of fisheries.

We categorized 7 subareas as follows based on geographic characteristics and fisheries operated: M: Sea of Japan Tohoku, N: Eastern Noto, O: Western Noto, P: Wakasa Bay, Q: Kinki and Eastern Chugoku, R: Central Chugoku, S: Western Chugoku (Figure 3).

Of the 168 participants, we were able to gather demographic information from 120 participants, including participant's age ( $n = 73$ ) and fishing history ( $n = 83$ ) (Table 2). The majority of the participants who provided their age were older than 50 years ( $n = 60$ ; 82.2 % of the respondents). Fishing history mainly ranged 0-59 years ( $n = 81$ ; 97.6 % of the respondents) and 30-49 years were most common ( $n = 39$ ; 47.0 % of the respondents). considering the higher age of fishermen, fishing history seems to be relatively short, and this trend is stronger than that of Kyushu area. One of the reasons for this trend, similar to the Kyushu area, is that some fishermen started fishing after they changed careers or retired.

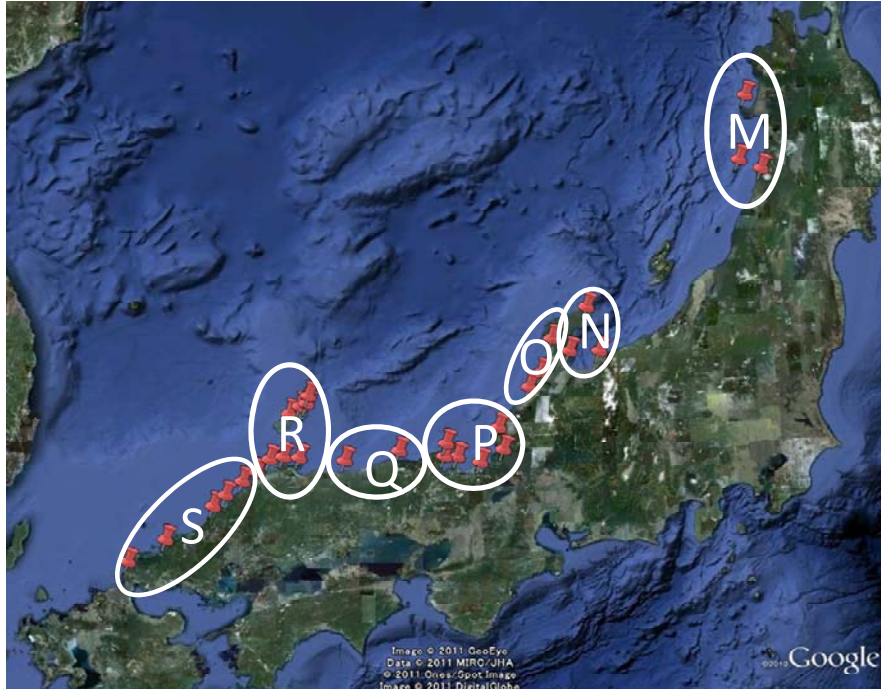


Figure 3. Subareas in Sea of Japan categorized by fisheries operated and geographic characteristics. M: Sea of Japan Tohoku, N: Eastern Noto, O: Western Noto, P: Wakasa Bay, Q: Kinki and Eastern Chugoku, R: Central Chugoku and S: Western Chugoku. Red pins indicates interviewed sites.

Table 2. Demographic composition of interview participants in Sea of Japan area. M: Sea of Japan Tohoku, N: Eastern Noto, O: Western Noto, P: Wakasa Bay, Q: Kinki and Eastern Chugoku, R: Central Chugoku, S: Western Chugoku.

	Participants							subtotal	%
	M	N	O	P	Q	R	S		
Interview Point	3	3	3	6	2	7	6	30	
Interviewed Participant	18	18	20	31	12	39	30	168	
<b>Demographic Parameters</b>									
<b>Age Range</b>									
20-29	0	1	0	0	1	1	2	5	6.8
30-39	0	2	0	0	0	0	0	2	2.7
40-49	0	2	0	0	0	3	1	6	8.2
50-59	3	3	0	0	1	7	1	15	20.5
60-69	4	4	0	2	1	8	4	23	31.5
70-79	5	3	2	0	1	7	3	21	28.8
80-89	0	0	0	0	0	0	1	1	1.4
<b>Fishing History</b>									
Less than 10 years	0	0	2	1	1	2	5	11	13.3
10-19 years	0	1	1	0	0	1	4	7	8.4
20-29 years	1	2	4	0	2	0	3	12	14.5
30-39 years	3	1	5	0	3	3	3	18	21.7
40-49 years	2	1	5	2	1	3	7	21	25.3
50-59 years	4	1	2	1	3	1	0	12	14.5
More than 60 years	0	0	0	0	0	1	1	2	2.4

Based on the interviews, the occurrence of sea turtle bycatch is concentrated in subareas N, P and S, although the number of bycatch was fairly-low compared to Kyushu area and Shikoku area where we conducted this research in 2009. Among them, bycatch in subarea N appear to be rather high, because pound net density of eastern coast of Noto Peninsula (Toyama Bay) is very high and total estimated bycatch number would also be high. Following subarea N, sea turtle density seems to be high in subarea P (Wakasa Bay). Although the number of bycatch per operation body or vessel in subarea S was relatively same as subareas N and P, fisheries density is considerably less than N and P. Most pound nets in these areas are open-type and turtles can breathe and are released alive. Geographic characteristics of subareas N and P are similar, and features a bay that opens to the Sea of Japan. This suggests that sea turtles in the Sea of Japan region may congregate and inhabit bay areas (Toyama Bay and Wakasa Bay). This is not the case in Kyushu and Shikoku region. Although the bay in Kyushu has small mouth and looks like an inland sea, Tosa Bay in Shikoku is widely open to the Pacific and sea turtles are concentrated at both ends of the bay (Cape Muroto and Cape Ashizuri). It appears that bay areas like subareas N and P in the Sea of Japan region is of great interest in terms of the ecology of sea turtles.

In addition, density of sea turtles in the Sea of Japan region is much higher than initially envisioned. We suspect that probably thousands of turtles live in Sea of Japan region. While population size is considerably less than that of Pacific or East China Sea, it is necessary to determine the population structure and ecology of sea turtles in the Sea of Japan region.

#### ***M: Sea of Japan Tohoku***

*Hatahata* (Sailfin sandfish, *Arctoscopus japonicas*), *Nihin* (Pacific herring, *Clupea pallasii*) and *Shirozake* (Chum Salmon, *Oncorhynchus keta*) are very famous and important target species in this area. Large and small pound nets and bottom trawls are used to catch these target species. For *Hatahata* and *Shirozake*, pound nets were set very close to shore (approximately tens of meters) to catch breeding aggregations that approach the shoreline for spawning.

Gill nets are usually set at the bottom. Main target species of gill nets are *Karei* (righteye flounders, *Pleuronectiformes* spp.), *Hirame* (lefteye flounders, *Paralichthys* spp.), *Tara* (codfishes, Gadinae), *Watari-gani* (swimming crabs, *Portunus* sp.), seabreams, and *Mebaru* (*Sebastes*). These nets differ in mesh size, strength, length, height, and depth of setting, depending on the target species.

Bycatch and stranding of sea turtles are very rare in this subarea. A number of communities in this subarea were found to have customs to enshrine stuffed loggerhead or loggerhead shell salvaged from stranded or bycaught turtles.

#### ***N: Eastern Noto***

Type of fisheries in the Eastern Noto subarea are similar to that of subarea M, however, the number and the density of pound nets are quite a high. Noto peninsula is located in the central part of the Sea of Japan region (Ishikawa prefecture), and small and large pound nets were set in high concentrations in the area with some set only tens or hundreds of meters apart (279 pound nets set on approximately 90 km coast from Himi, Toyama prefecture, to Suzu, Ishikawa prefecture). Large and small pound nets are targeting yellowtail. Yellowtail of this subarea is considered to have high value in Japan because of their meat quality. In addition to the quality, local customs in Himi city also raise the value of yellowtail, where the fish is used as gifts for celebrations. Occasionally a fish of 10 kg class are sold at over 100,000 yen (approximately 1,300 dollars). Many of the pound nets are

thought to have bycatch of approximately 2-5 turtles per year except at the tip of Noto Peninsula where bycatch are less frequent (1-2 turtles every few years). However, pound nets were usually open type and turtles can breathe and be released alive.

Gill nets are set on the bottom to catch lefteye flounders, cods, swimming crabs, and other benthic fishes using specific types. Although some types of gill nets are set all year round, no sea turtle bycaught by gill nets.

### ***O: Western Noto***

Fishing activity in Western Noto subarea is rather limited compared to other subareas. Large pound nets were limited to the northern part near the tip of Noto Peninsula. Fishermen said sea turtle bycatch occurs about once a decade.

Gill nets, round haul nets and small pound nets are relatively large in Western Noto. This subarea also set some types of gill nets on the bottom to catch righteye flounders, lefteye flounders, *Sazae* (horned turban, *Turbo comutus*), *Amadai*, and others species. Round haul nets are operated by approximately 30-40 fishermen per fleet to catch *Hamachi* (juvenile yellowtail), *Maaji*, and *Katakuchi-iwashi*. In the winter, the Sea of Japan is very rough, so pound nets have to be retrieved and other fisheries are also limited in the number of fishing days.

### ***P: Wakasa Bay***

Wakasa Bay forms a ria coastline and is known as one of the fertile fishing grounds. The eastern edge of the bay is the most famous for *Echizen-gani* (brand name of snow crab, *Chionoecetes opilio*). *Echizen-gani* is caught using bottom trawls from November to March. Bottom trawls are prohibited from April to October for resource protection. Bottom trawl fishermen usually switch to rod/handline fishing or diving to harvest *Sazae* or *Wakame* (a kind of brown algae, *Undaria pinnatifida*) during their off-season.

Many coves in the bay make suitable fishing grounds for pound nets and large pound nets are set around the coastline. Most of the large pound nets seem to use *nidan-bako* (or *nidan-ototi-ami*) which is a type of open type net and set at depths of 40-50 m. Each large pound nets seem to have 1-5 bycaught turtles (loggerhead and green turtles) per year.

Target species and fishing methods of gill nets, trawls and small pound nets are similar with that of other subareas. These fisheries seem to only catch about one turtle per decade.

### ***Q: Kinki and Eastern Chugoku***

*Zuwai-gani* (Snow crab) is a famous and very important fishery product in this area. *Zuwai-gani* is caught by bottom trawls from November to March. Other bottom trawls take righteye flounders, *Kisu* (sillago, *Sillago* spp.), *Nodoguro* (rosy seabass, *Doederieinia berycoides*), and *Hatahata*. Bottom trawl fishermen change the depth of operation and equipment according to their target species. Bottom trawl fisheries are seasonally closed from June to August in the eastern side of the subarea (interviewed at Kasumi, Hyogo prefecture) and from April to May in western side (interviewed at Tomari, Tottori prefecture). Squid fishing using capstan is also major and target species of squid varies with the season. Gill nets are used for *Hamachi*, *Maaji*, and *Sawara* (Japanese Spanish mackerel, *Scomberomorus niphonius*). *Hamachi* gill net is set for 2-3 hours on the bottom near fishing reef, and is usually repeated 2-3 times per night.

All but large pound nets were basically individually- or family-operated fisheries. Each fisherman operates multiple fisheries according to the season. Sea turtle bycatch is very rare in this area not only in bottom trawls but also in other fisheries (e.g. gill nets).

### ***R: Central Chugoku***

This subarea include Okinoshima Island. We considered assessing Okinoshima Island separately from the rest of the subarea because fisheries and bycatch situation in islands tend to differ from those of mainland areas (e.g. subarea B, D, and H in Kyushu area). However, the research result of Okinoshima Island was similar to that of the adjacent mainland area so we treated Okinoshima Island as part of the Central Chugoku subarea.

Gill nets are the major gear type in this area. Many types of gill nets were used to catch *Mebaru*, *Maaji*, *Kamasu* (*Sphyraena* spp.), *Kasago*, *Hamachi*, *Hirame*, *Sazae*, *Tai*, *Ishidai* (striped beakfish, *Oplegnathus fasciatus*), *Ago* (flying fish, Exocoetidae), and other species. Many individually-operated fishermen fish many species of squid by *Jidou-makitsuri*. Target species of squid vary with the season. Round haul net fleets operate around Okinoshima Island to catch *Maaji*, *Saba*, *Iwashi*, and *Maguro* (tuna, *Thunnus* spp.) and land the fish at Sakaiminato, a big fishing port on mainland. Although the number of round haul net operations is small, this fishery has the largest amount of catch. Some large and small pound nets are operated in the subarea and most of them are open type.

In this subarea, sea turtle bycatch is very rare; even in large and small pound nets, only a few turtles were bycaught per year. Sea turtle bycatch in other fisheries is also very rare.

### ***S: Western Chugoku***

Main fisheries in this subarea are large pound nets, longlines, bottom trawls, gill nets and round haul nets. Large scale round haul nets are operating year around.

There are 14 large pound nets that operate from Izumo, Shimane prefecture, to Shimonoseki, Yamaguchi prefecture, and each net bycaught less than 10 turtles per year and released them alive as they are open-type nets. Majority of small pound nets are also open type and each net bycaught 0-5 sea turtles per year. The season of bycatch seems to be spring to autumn.

Shimonoseki, located on the westernmost of Honshu Island and of the Western Chugoku subarea, is famous production center of *Torafugu* (Japanese pufferfish, *Takifugu rubripes*), and fishing for *Torafugu* is active. However, price of *Torafugu* declined due to the development of aquaculture. Number of *Torafugu* longline vessels is decreasing considerably and the fishery community is aging. Bycatch rate of this longline fishery was approximately one turtle per decade. Since hooks used in this fishery are small and the fishing line are lightweight, any bycaught sea turtles are able to breathe and can be released alive.

Bottom trawls catch species such as *Karei*, *Fugu* (puffer fish, Tetraodontidae spp.), *Ankou* (monkfish, Lophiidae spp.), and *Akamutsu* (rosy seabass, *Doederleinia berycoides*). Small scale longlines target *Torafugu*, other *Fugu* species, and *Amadai*. Gill nets are set on the bottom to target *Mebaru*, *Tai*, and other species, and do not have any sea turtle bycatch. Round haul nets are operated by 30-60 fishermen using approximately 5 vessels per fleet. Main target of round haul net is common species such as *Maaji* and *Saba*.

### 3-2. Analysis of Stranding Data

In 2010, STAJ recorded 63 new dead stranded sea turtle data from January to December in “Kyushu” and “Sea of Japan” areas. Thirty one turtles (11 loggerheads, 18 greens and 2 hawksbills) were stranded in Kyushu area and 32 turtles (21 loggerheads, 8 greens, 2 leatherbacks and 1 hawksbill) were stranded in the Sea of Japan area (Tables 3 and 4). In Kyushu area, stranding information was focused on subareas A: Genkai-nada and G: Southwest, although no information was gathered from E, F, H, J and L. This spatial bias is likely a reflection of the difference in research effort among the areas. Most abundant species was green turtles. In the Sea of Japan area, information was focused in subarea O: Western Noto, followed by M and S. Unlike Kyushu area, most abundant species was loggerhead turtles. Seasonality differed among Kyushu and Sea of Japan area. Although sea turtles stranded evenly throughout the year in Kyushu area, 84.4% was concentrated through October to March in Sea of Japan area. Cold stunning occurred only at the coast of Sea of Japan and 14 of the 32 turtles stranded in the Sea of Japan area were found at a time of cold sea surface temperature (< 15 °C).

Table 3. Sea turtle strandings in Kyushu area.

	Total	Species Composition				
		<i>Cc</i>	<i>Cm</i>	<i>Dc</i>	<i>Ei</i>	Un
<b>All strandings</b>	<b>31</b>	<b>11</b>	<b>18</b>	<b>0</b>	<b>2</b>	<b>0</b>
sub-area						
A: Genkai-nada	11	4	6	0	1	0
B: Iki-Tsushima	1	0	1	0	0	0
C: Hirado	2	2	0	0	0	0
D: Goto	3	1	1	0	1	0
E: Northwest	0	0	0	0	0	0
F: Ariake-kai	0	0	0	0	0	0
G: Southwest	10	1	9	0	0	0
H: Koshiki	0	0	0	0	0	0
I: Minami-satsuma	1	1	0	0	0	0
J: Kinko-bay	0	0	0	0	0	0
K: Hyuga-nada	3	2	1	0	0	0
L: Setouchi	0	0	0	0	0	0
Seasonality						
Jan-Mar	8	2	5	0	1	0
Apr-Jun	9	3	6	0	0	0
Jul-Sep	8	3	4	0	1	0
Oct-Dec	6	3	3	0	0	0



Table 4. Sea turtle strandings in Sea of Japan area.

	Total	Species Composition				
		<i>Cc</i>	<i>Cm</i>	<i>Dc</i>	<i>Ei</i>	Un
<b>All strandings</b>	<b>32</b>	<b>21</b>	<b>8</b>	<b>2</b>	<b>1</b>	<b>0</b>
sub-area						
M: Sea of Japan Tohoku	6	2	3	1	0	0
N: Eastern Noto	0	0	0	0	0	0
O: Western Noto	13	9	3	0	1	0
P: Wakasa Bay	1	1	0	0	0	0
Q: Kinki-Eastern Chugoku	2	1	1	0	0	0
R: Central Chugoku	3	3	0	0	0	0
S: Western Chugoku	7	5	1	1	0	0
Seasonality						
Jan-Mar	12	9	3	0	0	0
Apr-Jun	2	1	0	0	1	0
Jul-Sep	3	1	2	0	0	0
Oct-Dec	15	10	3	2	0	0

### 3-3. Bycatch Monitoring at Nomaike and Kumano pound net

Pound net bycatch monitoring in the Kyushu area took place at Nomaike pound net (Kagoshima Prefecture), and Kumano pound net (Kagoshima Prefecture). Nomaike pound net is set in the East China Sea and bycaught 23 loggerhead turtles, 56 green turtles and 1 unidentified turtle from January to December 2010, with 0.0 % mortality (Figure 5). Kumano pound net is set at Tanegashima Island, which is close to Yakushima Island known as biggest rookery in the North Pacific. Kumano pound net bycaught 63 loggerhead turtles, 12 green turtles, 1 hawksbill turtle and 4 unidentified turtles from January to December 2010 with 6.3 % mortality (5 dead/ 80 turtles) (Figure 6). Kumano pound net operation was closed during Typhoon season, and was back in operation on 8<sup>th</sup> November 2010.

High season of bycatch for loggerhead turtles was April to June in Nomaike and May in Kumano pound net. This loggerhead bycatch high season coincided with nesting season and the mean value of SCL during this time period was similar to that of nesting females, which is on average  $84.8 \pm 5.1$  cm (Kamezaki et al., 1995). The mean SCL at Nomaike between April and June was  $83.6 \pm 3.4$  cm (n=15) and the mean SCL at Kumano in May was  $82.4 \pm 6.4$  cm (n =22). Thus we suspect that reproductive value of bycaught loggerhead turtles were relatively high during the nesting season. On the other hand, high season of bycatch for green turtles was September to October in Nomaike.

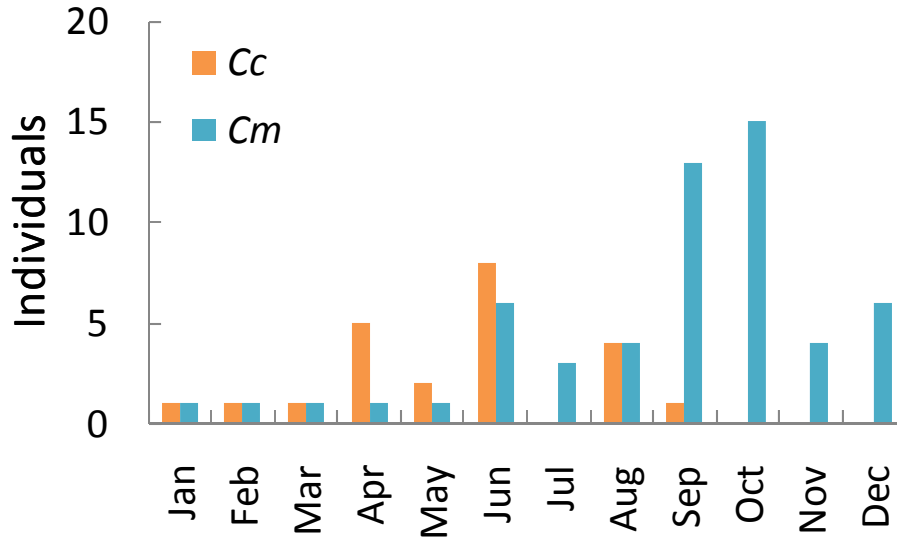


Figure 5. Bycatch of sea turtles by Nomaie pond nets in 2010. *Cc*: loggerhead turtle, *Cm*: green turtle.

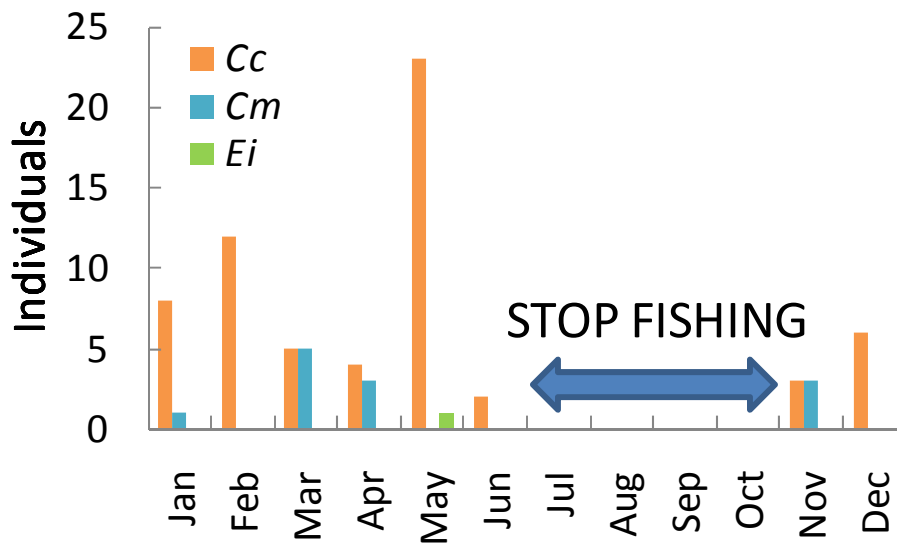


Figure 6. Bycatch of sea turtles by Kumano pond nets in 2010. Kumano large pond net stopped fishing from the end of June to the early November. *Cc*: loggerhead turtle, *Cm*: green turtle, *Ei*: hawksbill turtle.

#### 4. Discussion

In the present study, interview results indicate that bycatch rate was relatively high in subareas C, D, E, G, H, I, K, N and P, although mortality by fisheries in Kyushu and Sea of Japan area is low. However, sea turtles stranded mostly at subareas A, G, M, O and S. The difference in bycatch and stranding distribution is likely a result of the spatial bias in stranding research effort. Number of strandings in Kyushu area and Sea of Japan area were both approximately 30 per year, which is approximately 5 % of all stranding in Japanese

coast. However, stranding research only covers a limited area where stranding information were reported, so the actual number of stranding is unknown.

As for the seasonality, the large pound net monitoring at Nomaike in subarea I shows migration trends of turtles to western coast of Kyushu. Loggerhead turtles appear mainly in late spring to summer but green turtles appear mainly in autumn. However, stranding of both loggerhead and green turtle were found all year round. Although the amount of stranding data is not enough for statistical analysis, available data suggest that large pound net is likely not the only source of sea turtle mortality. While bycatch in each of the small-scale fisheries (e.g. gill nets and longlines) was very rare with only 0 to a few turtles caught annually per vessel at most, collectively these fisheries may be one of the sources of mortality resulting in strandings, given that there are several thousand small-scale vessel in the region.

In the Sea of Japan area, main stranding sites and bycatch sites detected from fishermen interviews did not correspond to each other. This difference may be a result of spatial bias of effort in stranding research, as it is the case in Kyushu area. As for the seasonality, stranding information was concentrated during the cold season and this indicates that cold stunning is one of the major factors of mortality, and mortality from fisheries may be low for strandings in Sea of Japan.

It is notable that this study yielded insights about the sea turtle population in the Sea of Japan. It is our view that thousands of turtles likely live in Sea of Japan region. We only have a limited dataset of sea turtles in this area to date. We had assumed that sea turtles found in Sea of Japan may be temporary migrants to the area, but the amount turtle bycatch from this study indicates that sea turtles use the area as major habitat. More studies are needed to better understand the population and ecology of sea turtles in Sea of Japan.

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Appendix 1. Photographs of fisheries.



1. Vessels of *Hako-ami* of large pound net in Himi, Toyama.



2. A model of Salmon pound net in Akita.



3. A model of *Soko-date* in Akita.



4. A model of *Hatahata-teichi* in Akita.





5. A location where large size pound net was set in Miko, Fukui.



6. Gill net for *Watari-gani* in Yusa, Yamagata.





7. *Shinkai-sokobiki* (a kind of bottom trawl operated at deep sea) in Kitaura, Miyazaki.



8. Artificial fish reef in Kyoden, Toyama.



9. Vessels for *Hassoubari* fishery in Himi, Toyama.



10. Middle size round haul net in Sakaiminato, Tottori.



11. Gear of small scale long line in Takahama, Nagasaki.



12. A vessel of *Nisou-biki* which is a kind of trawls operated by 2 vessels in Sakaiminato, Tottori.





13. *Kakari-ami* for *Asahi-gani* in Kagoshima.



14. Vessels for *Kanagi-ryo* in Mitsu, Shimane.



15. A view at Wakasa Bay in Fukui.



16. A view of *Funa-ya* (means ship house) in Ine, Kyoto.