

**Notes on Migration of the Masu Salmon, *Oncorhynchus masou*
(BREVOORT), in the Japan Sea as Determined by Tagging**

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Introduction

In recent years, the results of tagging experiments for the Pacific salmon (Genus *Oncorhynchus*) conducted on a large scale by the United States of America and Japan were reported by HARTT (1962:1966) and KONDO *et al* (1965). However, since the geographical distribution of masu salmon is restricted to the Asiatic side of the North Pacific and its adjacent seas (TANAKA, 1965), no masu salmon were tagged in the experiments made by the U. S. A.. On the other hand, since this species has a coastal nature as compared with other species of *Oncorhynchus*, the masu salmon tagged in the Japanese experiments were very few in number, and it is reported that no recovery has been obtained from the recent experiments conducted in the Japan Sea.

In the offshore areas of the Japan Sea, the drift gillnet fisheries are extensively operated from early-March through mid-June for the pink and masu salmons. From the catch records of the fisheries, it is shown that most catches are made for pink salmon, and catches of masu salmon are less than 10 per cent of the total number of fishes inclusive of pink salmon. Therefore, the abundance of masu salmon in the offshore areas of the Japan Sea is fairly lower than that of the pink salmon, but it is also true that the population density of masu salmon in the offshore areas in the Sea is the highest during early-March and thereafter it decreases rapidly. So, the fishing efforts for the masu salmon are concentrated on the earlier part of the fishing season. Masu salmon are also fished from January through June by coastal fisheries, such as trapnet, longline, trolling and handline etc., along the Japan Sea coast of Hokkaido and Honshu north of Ishikawa Prefecture. Since masu salmon is one of the dear fishes in Japan, although the amount of its catch is rather little, the fluctuation in the abundance of this fish has an important effect on the economy of these coastal and estuary fisheries.

Some biological studies of the pink salmon and masu salmon in the Japan Sea were made by the members of the Prefectural Fisheries Experimental Stations, mainly distributed north of Ishikawa Prefecture, and the Japan Sea Regional Fisheries Research Laboratory, under a program sponsored by the Fishery Agency, Japanese Government. Informations obtained on the marine life of the masu salmon, however, are very

ed as compared with those of the pink salmon. The main reason is that most research vessels operate in the offshore areas where the population density of the masu salmon is low. In addition, the density of the masu salmon in the offshore areas decreases rapidly as the season progresses.

Since 1965, the tagging experiments for pink and masu salmon have been carried out in various offshore areas of the Japan Sea during the spring season of each year. The main purpose of the experiments is to determine the interrelation between the oceanic distribution of these species and their migration routes probably destined for particular coastal areas where their spawning streams drain out. In this paper, the author deals with the informations obtained from the tagging experiments for only masu salmon. Those for pink salmon will be reported at another occasion.

Method of Tagging

In 1965 and 1966, longline was operated in the Japan Sea to catch salmon for tagging by the research vessel Ariso-maru, a training ship of the Ariso High School, Himi City, Toyama Prefecture, chartered by the Fishery Agency. A pair of red and white celluloid disk tag, 16mm in diameter, was attached by a pin to the base of the dorsal fin of the fish. The head of the pin was looped for holding a numbered disk. After inserting the pin, a plier was used to secure an opposite non-numbered disk by twisting a loop-knot at the end of the pin. During the process mentioned above, the fish was held on a tagging cradle scaled for measuring the fork length, and thereafter the fish was released to the sea.

Tagging in the Japan Sea prior to 1964

In the Japan Sea, the first tagging experiments for masu salmon were conducted by the Fisheries Experimental Station of the Government-General of Tyôsen (Korea) in May and June of 1928. Thirty-four salmon, including masu and pink salmon, caught by the trapnet, were tagged and released in the coastal waters along northern Korea. Of these fishes, three specimens which were thought to be masu salmon were reported to be recovered, two of them from a place very near to the released point 30 or 41 days after releasing, and the other one from 85 nautical miles north of the released point 48 days after the released date (FISH. EXP. STN. GOV. GEN. TYÔSEN, 1930; YOSHIDA, 1942).

In 1959 and 1960, the tagging studies on the pink and masu salmon fished by the driftnet were conducted by the Hakusan-maru of the Ishikawa Prefectural Fisheries Experimental Station. Sixteen specimens of masu salmon in 1959 and only one in 1960 were released, respectively, after tagging a small celluloid elliptic plate around the

* In KONDO *et al* (1965), this recovery was reported as that of pink salmon. The present author, however, recognized through the personal communication from Mr. KIROKU TABATA, Captain of the Hahusan-maru, the Ishikawa Prefectural Fisheries Experimental Station, that this fish was masu salmon as cited by TANAKA (1965).

caudal peduncle of the fish by a fine vinyl tube. From these taggings, only one recovery* was obtained, i. e., the fish released at 38°-48'N, 138°-23'E on April 21, 1959 was recaptured in a small trapnet near Sawabe, Iwasaki Village, Nishitsugaru-gun, Aomori

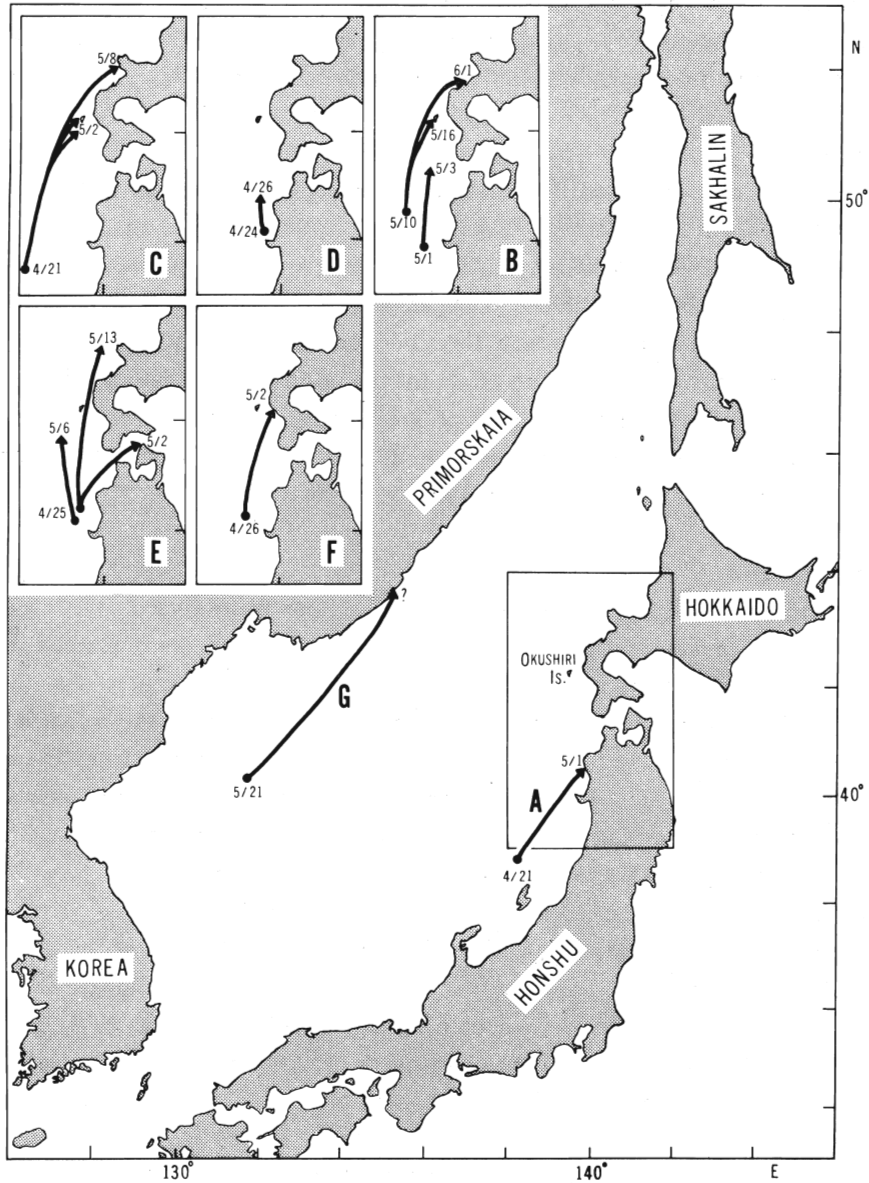


Fig. 1 Distribution of recoveries of masu salmon tagged in the Japan Sea in 1959(A), 1965(B) and 1966 (C, D, E, F, and G). Numerals in Figure show the date of release or recovery by means of month/day.

Prefecture, on May 1 (Figure 1-A; TABATA, 1959).

In May of 1961, ten masu salmon fished by longline were tagged and released by the Mogami-maru of the Yamagata Prefectural Fisheries Experimental Station, but

none recovered (YAMAGATA PREF. FISH. EXP. STN., 1961).

Results of Tagging in 1965 and 1966

Since the abundancy of masu salmon in the offshore areas of the Japan Sea, as described earlier, is much lower than that of pink salmon, the masu salmon tagged by us in 1965 and 1966 were also limited in numbers as in the previous years.

Tagging in 1965

Of 16 masu salmon tagged from late-April through mid-May of 1965, three were recovered. The recovery rate was 18.8 per cent. As illustrated in Figure 1-B, one tagged at 39°-51'N, 139°-15'E on May 1 was recaptured by the salmon driftnet at 85 nautical miles north of the released point on May 3. Another two were recovered in the coastal waters of southwestern Hokkaido, one being caught by the trolling near Okushiri Island on May 16, and the other by the gillnet for atkafish, *Fleurogrammus azonus* JORDAN *et* METZ, near the coast of Tomiura, Shimamaki Village, Hokkaido, on June 1. These two fishes were released at 40°-32'N, 138°-50'E on May 10, and had travelled 90 and 152 nautical miles in 6 and 22 days, respectively.

Tagging in 1966

From mid-April through late-May, 63 masu salmon were tagged. Of the 49 masu salmon released in the offshore areas of the west coast of northern Honshu, 8 specimens were recovered, thus giving the recovery rate of 16.3 per cent. As illustrated in Figure 1-C, D, E and F, the general pattern of movement of these fishes showed northeastward or northward migration. Of these, 3 were obtained from the offshore areas, and 2 from around Okushiri Island, and another 2 from the west coast of southern Hokkaido. It should be noticed that one was found in the coastal waters near Cape Omasaki, the northernmost point of Honshu, facing the Tsugaru Strait, on May 2. This fish was released at 40°-21'N, 139°-33'E on April 25.

As shown in Figure 1-G, of 14 masu salmon tagged and released in the offshore areas of northeastern Korea, only one was recovered. The fish was tagged on May 21, and recaptured at Avakumevka, Sadacha River, Primorskaia area, U. S. S. R., situated at 43°-45'N, 135°-18'E, while the date of recovery was unknown. This was the first recovery of masu salmon with a Japanese tag, in the coastal waters of U. S. S. R.

Swimming Speed of Masu Salmon in the Sea

These tagging experiments provided the data to calculate the rate of travel of the maturing masu salmon in the sea. Table 1 shows the summary of the rate of travel data for the masu salmon tagged and released in the Japan Sea during the spring season of each year. The general distances between the tagging and recovery points were measured as a straight line, but in a few cases in which the straight line lay across the land, the shortest curved distance was taken. Data without exact date of

recovery were omitted from the present calculation.

Although the three recoveries obtained from the coastal waters of northeastern Korea in 1928 showed very slow swimming speed, giving approximately 0.8 nautical miles in average per day, all other returns indicated rather faster swimming speed. One return in 1959 showed a northeastward movement of 127 miles in 10 days, averaging 12.7 miles per day. From three and eight recoveries in 1965 and 1966, it is shown that their mean swimming speed is 10.9 and 13.3 miles per day, respectively. The swimming speed of individual specimens, except tagging in 1928, ranged between 6.9 miles and 42.5 miles per day.

Table 1 Rates of travel of masu salmon tagged and released in the Japan Sea

Year	Date of release	Date of recovery	No. of days out	Distance traveled in miles	No. of miles per day	Area of release
1928	5/15	6/14	30	4	0.1	Coastal waters of North Korea
	"	6/25	41	4	0.1	"
	"	7/2	48	85	1.8	"
1959	4/21	5/1	10	127	12.7	Off North Honshu
1965	5/1	5/3	2	85	42.5	Off North Honshu
	5/10	5/16	6	90	15.0	"
	"	6/1	22	152	6.9	"
1966	4/21	5/2	11	167	15.2	Off North Honshu
	"	"	11	165	15.0	"
	"	5/8	17	250	14.7	"
	4/24	4/26	2	37	18.5	"
	4/25	5/2	7	93	13.3	"
	"	5/6	11	93	8.5	"
	"	5/13	18	180	10.0	"
	4/26	5/2	6	121	20.2	"
5/21	?	?	268	?	Off North Korea	

Consideration

The analysis on tag return of masu salmon is greatly simplified, because this species migrates northward in the spring season after spending only one winter in the sea (TANAKA, 1965). As shown in Figure 2, it is clearly recognized by size that masu salmon tagged in both years were composed only of maturing fishes, although the fork length of masu salmon tagged in 1965 was smaller than that in 1966 (FUKATAKI *et al.*, 1961; TANAKA, 1965). However, since tagging and recovery sites of masu salmon were limited, it is impossible to give any conclusive opinion on the interrelation between the oceanic distribution and migration manners of this species arriving at the spawning streams.

From the results of tagging and recovery, it is suggested that most of masu salmon which appear in the waters off the west coast of northern Honshu tend to migrate for the Japan Sea coast of southern Hokkaido, and it is also assumed that they are partially destined for the Pacific coast of Hokkaido through the Tsugaru Strait. In the taggings of 1965 and 1966, the returns from the Japan Sea coast of southern Hokkaido were obtained during the period from early-May to early-June. According to SANO (1947), upstream migration of masu salmon starts in mid-June or later and is completed by the end of July, in the Shinsha River which drains into the Japan Sea coast of Hokkaido. ONO (1933) reported that upstream migration of masu salmon in Hokkaido starts in May with a peak in July and August. At least, therefore, the starting time of upstream migration corresponds almostly with the period when the recoveries are obtained from the coastal waters of southern Hokkaido.

The masu salmon appears on the west coast of southern Sakhalin in mid-May and late-May, being most abundant in June and are usually present until early-July. As soon as they appear in the coastal waters, they start upstream migration into the rivers (DVININ, 1956). Since the time of release of the masu salmon in the offshore areas of northern Honshu was limited within about 20 days between late-April and early-May (Appendix table 2), and since some returns were obtained from the offshore areas of southern Hokkaido (Figure 1), though none returned from the Japan Sea coast of northern Hokkaido and Sakhalin or from the Okhotsk Sea coast of these Islands, it will be improper to neglect the possibility that they may migrate to areas farther than mentioned above.

According to YOSHIDA (1942), on the other hand, masu salmon are caught trap-nets along the east coast of northern Korea from February till June. Upstream migration there starts in April, when the river ice breaks up. The largest migration goes into the Tumen River. Landing of masu salmon at Tori located in the lower course of this river, begins in early-April with its peak in May and continues throughout June.

As shown in Table 1, the swimming speed of masu salmon, released in the coastal waters of northern Korea in mid-May and recaptured in the same waters during mid-June to early-July, was very slow. This information suggests that they had already entered "to-and-fro" movement to search their home estuaries. From the results of tagging in 1966, however, it is evident that at least some of masu salmon, found off northeastern Korea in late-May, had travelled a long way, and reached as far as the estuary along the coast of southern Primorskaia area, U. S. S. R. (Figure

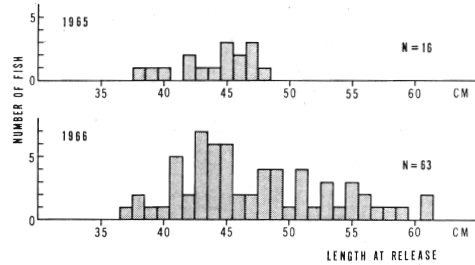


Fig. 2 Fork length frequencies of masu salmon tagged in the Japan Sea in 1965 and 1966.

1-G).

Generally speaking, recoveries of masu salmon were obtained from points located more closely to the coast than their released points (Figure 1). Therefore, it is evident that masu salmon in the offshore areas emigrate to the coastal waters. The drastic seasonal decline in the abundance of masu salmon in the offshore areas may be attributable to such movement.

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標識放流試験結果からみた日本海におけるサクラマスの回遊

深 滝 弘

要 約

1965年と1966年の春に、日本海の沖合水域で実施したカラフトマスとサクラマスに対する標識放流試験結果のうち、この報告ではサクラマスについて得られた知見のみをのべた。筆者らはこの両年に水産庁が日本海マス調査のために用船した有磯丸(富山県立有磯高等学校練習船)に乗船し、延縄によつて活力のある放流対象魚を採捕し、その背鱗基底下にピンを貫通して1対のデスク・タグを固定する方法で標識放流を実施した。

日本海の沖合海域におけるサクラマスの魚群密度は、カラフトマスのそれに比較して非常に低いため、1965年と1966年に放流したサクラマスは、それぞれ16尾と63尾にすぎず、そのうち3尾と9尾がそれぞれ再捕された。

サケ・マス類の標識放流は、広がりをもつた沖合分布域の各部分と、各産卵遡上(起源)河川地方との対応関係を明らかにすることをおもな目的の一つにしている。両年を通じてサクラマスの放流尾数が比較的多かつた水域は北部本州沖合であるが、4月下旬から5月上旬の間に、この水域で放流されたものの大部分は、北～北東方向に回遊して、南部北海道の沿岸水域か奥尻島周辺をふくむその沖合水域において、5月上旬から6月上旬の間に再捕された(第1図—B～F)。また、同じ水域で放流された1尾が、津軽海峡内の本州最北端に位置する大間崎付近の沿岸水域で再捕された(第1図—E)。

したがつて、4月下旬から5月上旬の間に北部本州沖合に出現するサクラマスの大部分は、

南部北海道の日本海側に流入する河川への遡上群と深い関連をもち、ほかにその一部分は、津軽海峡を通過して、北海道の太平洋側に流入する河川にも達するものと考えられる。

一方、5月下旬に朝鮮海湾の東方沖合で放流されたサクラマスの1尾が、北東方向に回遊して、南部沿海州のオリガ付近に流入する河川内で再捕された。これは日本側で放流したサクラマスがソ連沿岸で再捕された最初の記録である。北鮮の沿岸水域に出現するサクラマスが豆満江を始めとする同地方の河川に遡上することは知られていたが、その沖合水域に出現する魚群が南部沿海州地方の河川に遡上する事実は、今回の試験によつて初めて確証された。

放流地点と再捕地点間の1日平均最短移動距離を求めたところ、1965年の3尾、1966年の8尾について、それぞれ10.9 哩/日、13.3 哩/日という平均値を得た。

一般に、放流地点から比較的短時日の間に接岸して再捕されている傾向が強く、これはサクラマスの急速な接岸回遊を示すものであろう。そして、沖合水域におけるサクラマスの魚群密度が、毎年3月以降急速に減少し続けるという現象は、大部分この急速な接岸回遊の結果を反映していると考えられる。

Appendix Table 1 Detailed release and recovery information of masu salmon tagged in the Japan Sea during spring seasons of 1965 and 1966

Tag no.	Date of release	Date of recovery	Location		Fork length(cm)		Fishing Gear at recovery
			At tagging	At recovery	At tagging	At recovery	
(1965)							
ND 6417	5/1	5/3	39°-51'N, 139°-15'E	41°-16'N, 139°-22'E	38	40	Driftnet
ND 6440	5/10	5/16	40°-32'N, 138°-50'E	Okushiri Is, Hokkaido	47	..	Trolling Gillnet for atkafish
ND 6441	"	6/1	" "	42°-47'N, 140°-09'E	47	..	
(1966)							
0008	4/21	5/2	39°-27'N, 138°-08'E	42°-02'N, 139°-25'E	43	..	Longline
0017	"	5/8	" "	43°-11'N, 140°-20'E	44	..	Trolling
0021	"	5/2	" "	42°-00'N, 139°-20'E	41	..	Longline
0052	4/24	4/26	40°-12'N, 139°-37'E	40°-49'N, 139°-34'E	50	51	Driftnet
0054	4/25	5/13	40°-21'N, 139°-33'E	43°-20'N, 140°-00'E	51	..	Longline
0058	"	5/2	" "	41°-29'N, 140°-51'E	47	..	Handline
0063	"	5/6	40°-11'N, 139°-20'E	41°-43'N, 139°-00'E	44	45	Longline
0073	4/26	5/2	40°-13'N, 139°-13'E	42°-10'N, 139°-50'E	49	52	Handline
0202	5/21	?	40°-20'N, 131°-37'E	43°-45'N, 135°-18'E	48	..	Unknown

Appendix Table 2 Number of salmon tagged in the Japan Sea, by date, location and species, 1965-1966

Year	Date	Location	No. of Skates used	No. of fishes tagged		
				Pink	Masu	Total
1965	4/30	39°-49'N, 138°-54'E	30	6	2	9
	5/1	39°-51'N, 139°-15'E	27	7	1	8
	5/1	38°-57'N, 138°-57'E	30	-	3	3
	5/9	40°-30'N, 138°-30'E	27	16	-	16
	5/10	40°-32'N, 138°-50'E	47	21	4	25
	5/11	40°-45'N, 138°-49'E	30	5	1	6
	5/12	41°-19'N, 138°-09'E	40	3	-	3
	5/14	39°-38'N, 133°-34'E	35	22	1	23
	5/15	39°-46'N, 133°-35'E	50	21	4	25
	5/25	41°-08'N, 131°-40'E	30	4	-	4
	5/26	41°-16'N, 131°-52'E	49	40	-	40
5/26	41°-14'N, 131°-50'E	28	10	-	10	
	<i>Total</i>		423	155	16	171
1966	4/20	39°-44'N, 138°-55'E	85	-	2	2
	4/20	39°-29'N, 139°-00'E	43	2	3	5
	4/21	39°-27'N, 138°-08'E	80	7	11	18
	4/21	39°-34'N, 138°-16'E	40	3	6	9
	4/22	40°-03'N, 138°-40'E	80	3	1	4
	4/22	39°-45'N, 138°-44'E	40	3	1	4
	4/24	40°-12'N, 139°-37'E	40	3	7	10
	4/25	40°-21'N, 139°-33'E	80	1	5	6
	4/25	40°-11'N, 139°-20'E	40	1	4	5
	4/26	40°-13'N, 139°-13'E	60	5	6	11
	5/6	41°-25'N, 139°-36'E	29	2	-	2
	5/7	41°-34'N, 139°-39'E	40	4	1	5
	5/7	41°-26'N, 139°-32'E	43	1	2	3
	5/17	38°-54'N, 133°-26'E	80	9	1	10
	5/17	38°-49'N, 133°-17'E	40	5	-	5
	5/19	39°-04'N, 131°-45'E	50	10	-	10
	5/19	39°-14'N, 131°-45'E	38	2	1	3
	5/20	40°-20'N, 131°-37'E	40	79	5	84
	5/21	40°-20'N, 131°-35'E	81	3	1	4
	5/21	40°-20'N, 131°-37'E	40	3	1	4
	5/22	40°-20'N, 131°-13'E	60	53	3	56
	5/24	40°-16'N, 131°-39'E	60	41	-	41
	5/24	40°-13'N, 131°-35'E	40	34	-	34
	5/25	40°-13'N, 131°-33'E	30	5	-	5
	5/25	40°-15'N, 131°-32'E	40	4	-	4
	5/26	40°-28'N, 131°-23'E	60	9	1	10
	5/26	40°-36'N, 131°-35'E	40	72	-	72
	5/27	40°-38'N, 131°-47'E	80	44	-	44
	5/27	40°-40'N, 131°-37'E	40	57	-	57
	5/28	40°-30'N, 132°-05'E	60	17	1	18
	6/1	40°-51'N, 131°-42'E	30	8	-	8
	6/2	40°-58'N, 131°-46'E	60	13	-	13
	6/2	41°-05'N, 131°-46'E	40	9	-	9
	6/3	41°-18'N, 131°-55'E	60	7	-	7
	6/3	41°-22'N, 132°-10'E	41	11	-	11
	6/4	41°-35'N, 132°-24'E	60	3	-	3
6/5	41°-35'N, 136°-10'E	30	3	-	3	
6/6	41°-38'N, 136°-15'E	50	5	-	5	
6/8	42°-43'N, 136°-25'E	25	4	-	4	
	<i>Total</i>		1,975	545	63	608