

Easternmost Record for Ocean Distribution of Masu Salmon (*Oncorhynchus masou*)

Kazumasa Ohkuma¹, Shigehiko Urawa¹, Yasuhiro Ueno², and Nancy D. Davis³

¹*National Salmon Resources Center, Toyohira-ku, Sapporo 062-0922, Japan*

²*Tohoku National Fisheries Research Institute, Hachinohe, Aomori 031-0841, Japan*

³*University of Washington, School of Fisheries, Fisheries Research Institute, Seattle,
WA 98195-5020, USA*

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³University of Washington, School of Fisheries, Fisheries Research Institute, Seattle, WA 98195-5020, USA

Abstract

Masu salmon (*Oncorhynchus masou*) was caught in the central North Pacific Ocean (46°00'N, 180°00') on June 27, 1998 during a high-seas salmonid research cruise by the R/V *Wakatake maru*. The species was identified by morphological and genetic analyses. The capture location was far to the east from the previously recorded catches of masu salmon in the North Pacific Ocean (45-50°N, 157-162°E). The masu salmon was a maturing male (age 1.1), whose fork length was 540 mm and body weight was 2,460 g. Considering the location and date of capture, it is likely that the fish may have been a part of late run of fish and perhaps wandered far to the east in pursuit of prey.

Introduction

Masu salmon (*Oncorhynchus masou*) are distributed in the Asian side of the North Pacific Ocean and their ocean distribution is usually limited in the Sea of Okhotsk, Sea of Japan, and coastal waters along the Pacific side of northern Japan (Kato, 1991). Catches of only three specimens of masu salmon have been previously recorded in offshore waters of the western North Pacific Ocean (45-50°N, 157-162°E; Figure 1; Machidori et al., 1978). During a high-seas salmonid research cruise by the R/V *Wakatake maru*, a salmon, tentatively identified as a masu salmon, was caught in the central North Pacific Ocean far to the east of the previously known ocean distribution of these fish. The specimen was shipped to the National Salmon Resources Center, and positively identified as a masu salmon by morphometric and electrophoretic analyses.

Methods

The specimen was caught by drifting surface gillnet on June 27, 1998 in the central North Pacific Ocean (46°00'N, 180°00') during research salmon fishing operations of the R/V *Wakatake maru* (Figure 1). The surface seawater temperature was 7.3°C. The fish was caught in the 72 mm mesh panel of a research gillnet consisting of ten different mesh sizes ranging from 48 mm to 157 mm. In addition to this specimen, 5 sockeye (*O. nerka*), 26 chum (*O. keta*), 6 pink (*O. gorbuscha*), 159 coho (*O. kisutch*), and 3 chinook salmon (*O. tshawytscha*), and 13 steelhead trout (*O. mykiss*) were caught at the same location (Ueno et al., 1998). The specimen was frozen in the round at -40°C, and shipped to the National Salmon Resources Center for species identification.

After thawing the specimen, morphometric characteristics were observed, measured, and counted (Table 1). Scales were collected from the INPFC-preferred area for age determination. The heart was

removed and analyzed by gel electrophoresis for malate dehydrogenase (sMDH-B1,2; Aebersold et al., 1987) to compare the band patterns with those of known examples of *Oncorhynchus* (pink, chum, sockeye, coho, chinook, and masu salmon, and steelhead trout).

Results

Morphological characteristics

The fish was covered with silvery scales typical of high-seas caught salmon. The snout was slightly prolonged and the fish was likely to be maturing (Figure 2). The fork length was 540 mm and the body weight (BW) is 2,460 g (Table 1). The testis weight (GW) was 77.8 g with a gonad-somatic index ($100 \times \text{GW}/\text{BW}$) of 3.2. The caudal fin was truncated or slightly forked in shape with several weak silvery bands at its base. There were no black spots on the adipose fin, dorsal fin, or on the side of the body, but there were a few spots on the lower caudal lobe and the fish's back. There were firm teeth in both upper and lower jaws. Ten fin rays were counted in the each ventral fin, 14 in the dorsal fin, and 14 in the anal fin. Steelhead trout have 12 anal fin rays or less (Matsubara, 1955), therefore, our specimen could not be classified to this species. Our specimen had 18 rather short gill rakers on the right gill arch and 16 on the left one, and the rakers had a well developed spicule: all characteristics typical of masu salmon (Hikita, 1962). The number of lateral line scales was 130 (Table 1). The pyloric caecae count was 47. According to the morphometric characteristics given by Hikita (1962) and Masuda et al. (1984), our data suggest this specimen was a masu salmon.

Scale characteristics

The scale showed a band of narrow of circuli near the focus, which indicated a longer freshwater life period than either chum or pink salmon (Figure 3). Well-developed reticulations were present on the scale at the boundary of the anterior and posterior fields and covered a portion of the marine zone. The appearance of the reticulations was rather more globular than ladder-like, and they were different from the appearance of reticulations on sockeye, chinook, and coho salmon scales (Bilton et al., 1964). Close observation of the freshwater circuli clearly showed that the fish spent one winter in fresh water as a juvenile. On the ocean zone of the scale there was one annulus, indicating that this fish had spent one winter at sea. Thus the age of the specimen was designated as 1.1 according to the European formula.

Stomach contents

A small squid was found in the stomach of the specimen, but we could not identify it because the squid was too digested.

Electrophoretic analysis

The sMDH-B1,2 band pattern of the specimen coincided with that of masu salmon, but differed from that of other 6 species: pink, chum, sockeye, coho, and chinook salmon, and steelhead trout (Figure 4).

Discussion

The offshore distribution of masu salmon is generally limited to the Sea of Okhotsk and Sea of Japan, with scarce catches in the offshore waters of the western North Pacific Ocean (Machidori et al., 1978; Machidori and Kato, 1984). Masu salmon begin maturing after one winter at sea, and then return

to their natal stream from late spring to early summer. Our specimen was a maturing male, and would likely to be returning soon to its natal stream for spawning. The nearest spawning habitat of masu salmon may be the southwestern coast of Kamchatka, such as the Bolshaya River (Semko, 1956), but it was more than 1,700 km northwest from the catch location in the central North Pacific Ocean. Masu salmon ascend the Bolshaya River from mid-June to mid-July with a peak of early July (Semko, 1956). The previous records of masu salmon catches in the western North Pacific Ocean occurred earlier in the season and were closer to the Kamchatka Peninsula than our specimen (Figure 1; Machidori et al., 1978). Considering the location and date of capture, it is likely that the fish may have been a part of a late run of fish and perhaps it wandered far to the east in pursuit of prey.

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Table 1. Morphometric and meristic data of masu salmon caught in the central North Pacific Ocean.

Measurements		Counts	
Fork length	540 mm	Lateral line scales	130
Head length	123 mm	Dorsal fin rays	14
Snout length	47 mm	Pectoral fin rays	15 (L), 14 (R)
Upper jaw length	82 mm	Ventral fin rays	10 (L & R)
Body depth	137 mm	Anal fin rays	14
Caudal peduncle depth	43 mm	Gill rakers	16 (L), 18 (R)
Eye diameter	9 mm	Branchiostegals	12 (L), 13 (R)
Body weight	2460 g	Pyloric caeca	47
Gonad weight	77.8 g		

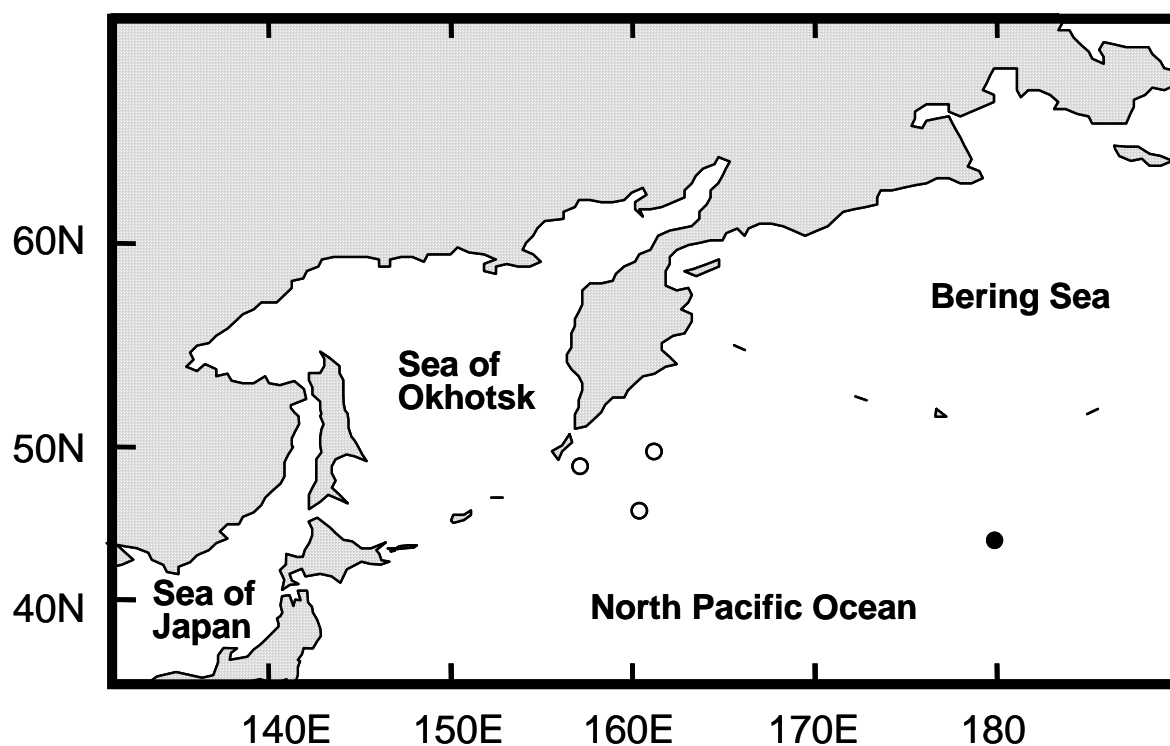
**Figure 1.** A map showing the catch locations of masu salmon in the North Pacific Ocean, recorded by a previous study (open circles; Machidori et al., 1978) and the present study (closed circle).



Figure 2. The specimen of masu salmon caught in the central North Pacific Ocean.

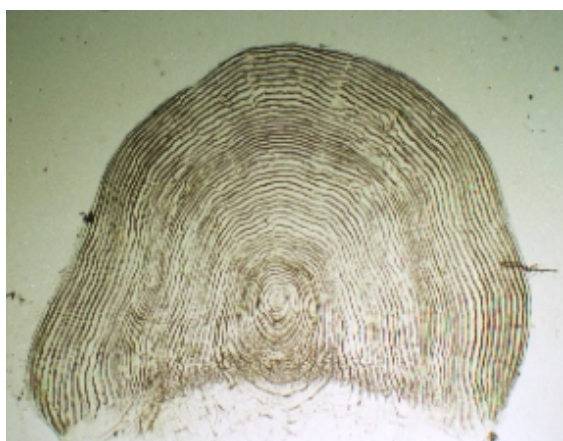


Figure 3. A scale from the specimen of masu salmon caught in the central North Pacific Ocean.



Figure 4. Starch gel electrophoretic patterns of sMDH-B1,2 in the heart tissues of *Oncorhynchus*. A, pink salmon; B, chum salmon; C, sockeye salmon; D, coho salmon; E, chinook salmon; F, steelhead trout; G, masu salmon; H, our specimen caught in the central North Pacific Ocean.