Dynamics of the Biological Structure of Commercial Stocks of Asian Coho Salmon in the Pacific Waters off Kamchatka and the Western Bering Sea

Zhanna H. Zorbidi
Kamchatka Research Institute of Fisheries and Oceanography (KamchatNIRO),
18, Naberezhnaya Street, Petropavlovsk-Kamchatsky 683602, Russia

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Kamchatka is a major region of natural reproduction and commercial fishing for coho salmon. The continuing decrease in the abundance of coho salmon stocks in Kamchatka necessitates more careful analysis of the changes that occur in spawning stocks, studies on the mechanisms that regulate stock abundance, and the development of conservation measures. The marine period of life of coho salmon remains poorly studied. Mostly, the complete marine period was studied by Birman (1985), Mathews and Ishida (1989), Ogura et al. (1991), Glebov (2000), and Erokhin (2002). The problem of stock identification of coho salmon was addressed by Zorbidi (1990) and Zorbidi and Antonov (2001).

This work is based on extensive scientific data collected by the author over many years (1993–2002) during the period of anadromous migrations of coho salmon in the Pacific waters off Kamchatka and in the Western Bering Sea. The qualitative structure of prespawning stocks of coho salmon in 1993–2002 showed significant temporal and spatial variations. Throughout the area in June–August, the age and sex ratio, size, weight, maturity, and growth rate of coho salmon varied by stock. The distribution of these stocks was very dynamic. Changes in biological parameters occurred at relatively small spatial and temporal scales (e.g., one area during one month), indicating extensive mixing among migrating cohorts of different populations.

Spring–summer anadromous migrations to the shores of Kamchatka occurred in different periods. Mixed aggregations of various cohorts and populations of migrants appeared first in the Pacific waters off Kamchatka and in the Western Bering Sea, and then in the Sea of Okhotsk, although they were sometimes later in these areas than in the vicinity of the northern Kuril Islands. The earliest migrations of spawning cohorts from southern oceanic districts to the Russian Economic Zone near the northern Kurils (Pacific side) started in mid June. After this, cohorts migrating from the east first appeared near the shores of southeast Kamchatka in mid July, and then one part migrated to the north along the shores of East Kamchatka, and the other part migrated to the Sea of Okhotsk. Males and less mature fish dominated the earliest spawning cohorts. To some extent, the females were usually more mature than males. Average (1993–2002) sex ratios of aggregations in the Pacific waters off Kamchatka showed a high percentage of males (53.0%) in July, and a lower percentage (up to 42.8% males) in September.

Temporal and spatial dynamics of the abundance of males and females may not be clear because of the presence of cohorts migrating at different times. For example, in the western Bering Sea females were dominant in prespawning aggregations in June (48.8% males), and males gained dominance only in early August (51.0%). There was a significant reduction in the percentage of males in September at the end of spawning migrations of summer coho salmon.

A tendency for the maturity coefficient (MC) to increase in the same area and time period was obvious. In the Pacific waters off Kamchatka, the MC of age 2.1+ females in the earliest cohorts ranged from 3.73 to 11.6, and that of males from 2.55 to 7.22. In September, the MC increased up to 5.16–12.8 for females, and 5.61–9.0 for males. In the western Bering Sea, the percentages of maturing fish in July were relatively high (7.3–9.4% females; 5.38–6.4% males). Whereas the MC in July was 1.5–2 times lower near the northern Kurils, than in areas situated to the north.

A standard set of age groups occurred throughout the study area (Table 1). Fish that spent two years in freshwater were dominant in all marine areas, as in areas of downstream migration. The age composition in marine aggregations, however, demonstrated spatial heterogeneity. Two age groups, 1.1+ and 2.1+, were dominant, however, in the western Bering Sea the percentage of age 2.1+ fish was higher. Age 3.1+ fish occurred in this area in relatively high numbers during the main part of the run in August. As shown in Table 1, there was a transformation in the age composition of migrating cohorts during the run. Jacks (age-.0+), not found in catches in the other areas, appeared in the Pacific waters off Kamchatka by late August and early September, and also in the Bering Sea by late June and early July; and apparently, jacks did not undertake any long-distance feeding migrations. Moreover, the stocks in the western Bering Sea were characterized by a relatively high percentage of fish that spent two years in the sea (1.2+ and 2.2+; Table 1).

All correspondence should be addressed to Z. Zorbidi.
e-mail: zorbidi@kamniro.ru

Table 1. Dynamics of age structure in marine aggregations of coho salmon in the Pacific Ocean waters adjacent to Kamchatka and the western Bering Sea (average %, 1993–2002).

Month	10-day period	Age (%)							
		1.1+	2.1+	3.1+	1.2+	2.2+	1.0+	2.0+	3.0+
Pacific Ocean waters adjacent to Kamchatka									
July	mid	26.4	70.6	3.0					
	late	40.6	53.9	5.5					
August	early	47.7	49.1	2.8	0.7				
	late	54.8	40.5	3.7	1.0				
September	early	44.6	41.1	6.8	0.9	-	0.3		0.9
Western Bering Sea									
June		48.8	45.3	4.3	-	1.2	-	0.4	-
July	late	22.2	77.8	-	-	-	-	-	-
August	mid	38.8	50.0	8.2	-	2.0	-	-	-
	late	31.7	62.6	2.9	1.0	1.8	-	-	-

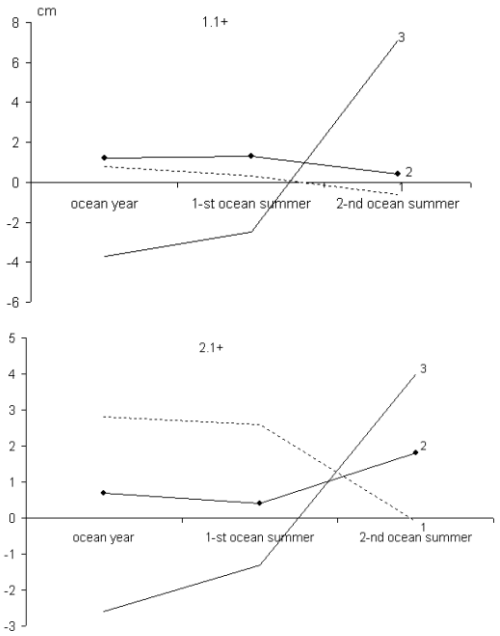
Although significant inter-annual variations occurred in all biological parameters, condition factor, length, and weight of migrants increased in recent years, as a result of favorable ocean feeding conditions. In Pacific waters off Kamchatka, average condition factor increased from 1.25 to 1.32 in 2000–2002, and average body length increased from 59.3 cm to 60.8 cm. At the same time, condition factor and body length of coho salmon in aggregations in the western Bering Sea also increased (1.33 until 2000; 1.36 in 2001–2002). Large variations in condition factor and body length were observed in the region southeast of Kamchatka only during one month, and were due to the migration of fish of different stocks of origin.

Improvement in marine trophic conditions is shown by data on the growth rates of migrants in the Pacific waters off East Kamchatka and in the western Bering Sea. Coho salmon in the western Bering Sea had a high growth rate while at sea. For example, in 2000–2002 the average increase in body length of 2.1+ fish in the year of migration was approximately 2 cm higher than in 1993–1999 (23.4 cm). However, fish with a different characteristic growth rate occurred during the same period in the aggregations near the southeast part of Kamchatka (Fig. 1). Everywhere, throughout the study area, we found a group of fish that had apparently overwintered in the Bering Sea and nearby the Aleutian Islands, identified by the small increment of scale growth (only 5–6 circuli) in the year of migration.

The marine growth characteristics of coho salmon differed to some extent depending on their age. As a rule, older (age 2.1+) fish in the earliest migrating cohorts had different characteristics of marine growth, lower condition factor, and higher maturity than younger (age 1.1+) fish (Fig. 1). This indicates that older and younger age groups of coho salmon may feed in different locations.

Variations in the biological parameters of aggregations near southeast Kamchatka, especially temporal variations, were mostly due to mixing of Okhotsk Sea and East Kamchatka stocks of coho salmon.

Fig. 1. Parameters of coho salmon growth by age group, 1.1+ (top panel) and 2.1 + (bottom panel), and marine life stage (1st ocean year, 1st ocean summer, 2nd ocean summer) in different regions of the North Pacific Ocean and Bering Sea in 2001–2002 (deviations from average body length data, 1993–2002). 1 –Pacific Ocean waters adjacent to Kamchatka; 2 - western Bering Sea; 3 - Southeast Kamchatka.



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