Spatial Distribution and Feeding Interactions between Chum and Pink Salmon Juveniles in the Coastal Water of the Okhotsk Sea in the Eastern Hokkaido

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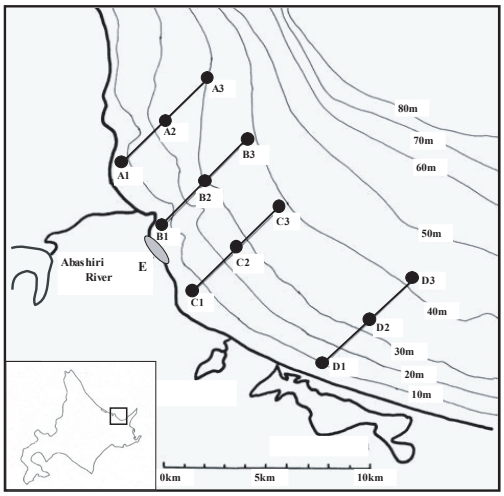
In Pacific salmon, chum and pink salmon go to the sea soon after they newly emerge and spend several weeks near shore before moving offshore. Our previous studies (Ando et al. 2005; Nagata et al. 2005) showed chum and pink salmon juveniles were captured together within 7 km offshore in the Okhotsk Sea. As their diet compositions are very similar (Okada and Taniguchi 1971), social competition between chum and pink salmon for habitat and feeding may occur in the coastal water.

We examined potential interactions between chum and pink salmon juveniles in terms of spatial distribution and food habit in the Abashiri Bay along the Okhotsk Sea coast of Hokkaido. Salmon juveniles were captured by a surface trawl net from 1 km to 7 km off the coastal water and by a beach seine in the littoral water, respectively (Fig. 1). CPUEs (catch per unit effort) of littoral and coastal waters were calculated as number of captured fish per beach seine and per 2 km towing, respectively. We examined an interspecific association between chum and pink salmon with a Point Correlation Coefficient (PCC) (Poole 1974) and an interspecific overlapping between two species with Morisita's C_δ (Morisita 1959) using CPUEs data in the coastal water. While the PCC ranges from -1 to +1, with +1 showing preference for the same environment, the Morisita's C_δ ranges from 0 to +1, with +1 indicating perfect overlapping. In the laboratory, we measured fork length (FL), body weight (BW) and stomach content weight (SCW), and calculated stomach content index (SCI) as SCI = (SCW / BW) x 100. Prey items in each stomach of both species were counted and identified to species whenever possible. We used Kimoto's C_π (Kimoto 1967) as a similarity index of stomach content composition between two species. This similarity index ranges from 0 to +1, with +1 indicating high similarity between two species on diet composition.

Fig. 1. Maps showing the study sites of the littoral area (E), 1 km, 4 km and 7 km off the Abashiri coast (A-D) in the Okhotsk Sea.



According to the results of CPUEs, most of both chum and pink salmon juveniles after seaward migration directly moved to the 1km offshore when SST (surface seawater temperature) in the coastal water exceeded 8˚C in May 2004, in contrast they densely aggregated in the littoral water when SST was below 8˚C in May 2003 (Fig. 2). In spite of these different dispersals of juvenile salmon depending on thermal conditions, the values of PCC and C_δ between chum and pink salmon in the coastal waters were relatively high when CPUEs in both years were high (Table 1). These results suggest that they lived together and preferred the same environment in the Abashiri Bay.

Mean stomach content indices (SCIs) for both chum and pink juveniles in the 1 km off for two years were relatively high in May, but sharply decreased in June and July (Fig. 3). While the SCIs of chum salmon in the 4 km off were relatively high from mid May to early June, those of pink salmon were maintained to be low except mid June 2003. SCIs of both chum and pink salmon in the 7 km off were relatively high from mid May to late June 2004, but those in both species in 2003 were relatively low. In the littoral waters, SCIs of juveniles with high CPUEs in May 2003 were significantly lower than those in 2004 with less CPUEs.

Chum and pink salmon juveniles consumed mainly copepods, cladocerans and appendicularians. The values of C_π in the coastal water were variable not only among different sized juveniles but also among times (Table 2). The

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Fig. 2. Changes in CPUE (catch per unit effort, the number of juveniles per 2 km towing or per beach seine) of juvenile chum (top) and pink (bottom) salmon captured at the littoral sites (beach seine) and the 1 km off the Abashiri coast (trawl net) in the Okhotsk Sea from 2003 to 2004.

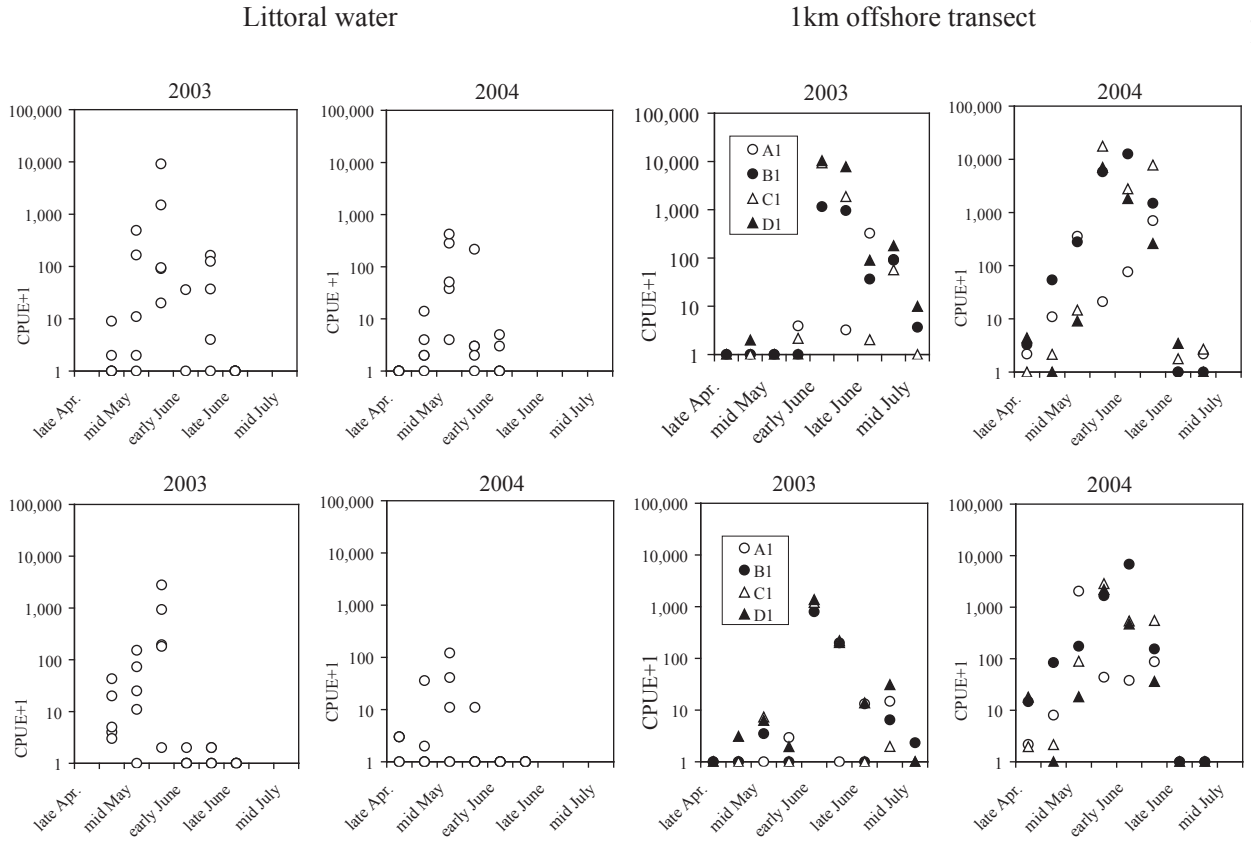


Table 1. Interspecific association (PCC) and overlapping (C_δ) between chum and pink salmon juveniles in the coastal water from 2003 to 2004.

PCC	early May	mid. May	late May	early June	mid. June	late June	early July
2003	0.478	0.000	0.125	1.000	0.522	0.674	0.522
2004	0.408	0.241	1.000	0.674	1.000	0.258	0.083

C_δ	early May	mid. May	late May	early June	mid. June	late June	early July
2003	0.588	0.186	0.608	0.924	0.716	0.734	0.726
2004	0.980	0.805	0.948	0.977	0.814	0.608	0.054

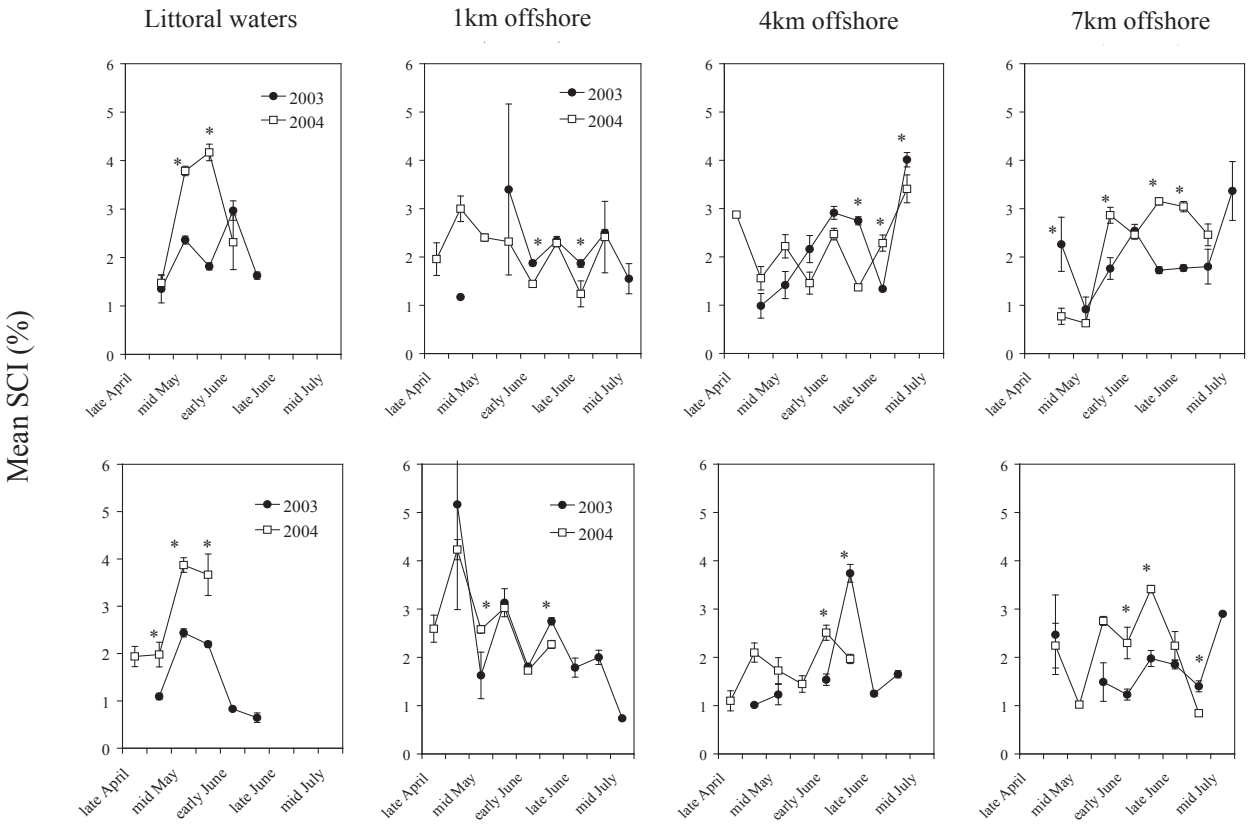
values were relatively high when CPUEs of both species were high and their fork lengths were ranged from 50 mm to 69 mm. The C_π values in the littoral water were relatively lower than those in the coastal water when CPUEs were high. While pink juveniles tended to consume smaller animals such as *Pseudocalanus* spp., chum juveniles had a tendency to consume larger animals such as *Neocalanus* spp.

Chum-pink salmon competition for feeding is known to occur in the early life (Salo 1991). Okada and Taniguchi (1971) showed when chum and pink salmon juveniles reached to 55 mm in fork length, the maximum size of diet eaten by juveniles changed rapidly from a small-size group less than 1.3 mm to a large-size group (1.3–3.8 mm). As our study also showed that similarity indices of juveniles whose fork length was 50–69 mm in the coastal water were higher than those of other size class, social competition between chum and pink salmon juveniles may be getting greater when both juveniles grew over 50 mm in fork length. It is concluded that there is a potential competition between chum and pink salmon juveniles for the habitat and food requirements during the early ocean life of juvenile salmon in the coastal waters.

Table 2. Comparison of Kimoto's C_π, as a similarity index of diet composition between chum and pink salmon juveniles in the littoran and coastal waters from 2003 to 2004.

Location	Size class (mm)	2003							2004					
		early May	mid. May	late May	early June	mid. June	late June	early July	early May	mid. May	late May	early June	mid. June	late June
Littoral	30-39	0.34	0.02	0.99	0.70				0.55	0.17	0.37			
	40-49	0.35	0.27	0.96						0.12	0.97			
	50-59		0.45	0.47		0.19				0.23				
	60-69		0.38			0.24								
1 km off	30-39				0.01				0.45	0.56	0.75			
	40-49			0.08	0.87	0.67	0.48		0.71	0.42	0.75	0.67	0.96	
	50-59	0.79			0.76	0.86	0.79	0.32	0.58	0.50	0.74	0.70	0.82	
	60-69				0.67	0.75	0.66	0.93		0.70	1.00	0.99	0.96	
	70-79					0.98		0.97			0.50	0.99	0.98	
	80-89					0.88		0.27				1.00	0.24	
4 km off	30-39								0.17	0.98			0.27	
	40-49				0.61	0.15			0.57	0.14	0.60	0.73	0.99	
	50-59				0.59	0.68	0.91		0.69		0.69	0.96	0.69	
	60-69				0.62	0.67	0.99	0.96			0.98	0.77	0.80	
	70-79					0.30	1.00	0.59			0.58	0.08	0.31	
	80-89					0.76	0.98	0.30						
7 km off	30-39				0.37						0.09	0.67		
	40-49				0.46						0.66	0.99	0.53	
	50-59				0.79	0.90	0.87				0.75	1.00	0.61	
	60-69					0.85	0.36					0.93	0.81	
	70-79					0.56	0.76	0.26					0.94	0.66
	80-89						0.01	0.07					0.93	0.19

Fig. 3. Changes in mean values with S.E. of stomach content indices (SCIs, stomach content weight x 100 / body weight) of chum (top) and pink (bottom) salmon juveniles captured at the littoral water and the 1 km, 4 km and 7 km off the Abashiri coast in Okhotsk Sea from 2003 to 2004. *A significant difference between two years at $p < 0.05$.



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