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Trophic Relations of Pacific Salmon in Epipelagic Water Layers of the South Kuril Islands

by

Svetlana V. Naydenko

and

Natalia A. Kuznetsova

Pacific Research Fisheries Centre (TINRO-Centre)
4, Shevchenko Alley, Vladivostok, 690600, Russia

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Abstract

Data on feeding and trophic relations of Pacific salmon, collected during 12 complex expeditions to the area of the South Kuril Islands, conducted by TINRO-Center in 1991-1996, were summarized in this work. Quality and quantity composition of food rations was analyzed, and indices of diet overlap and indices of selection of food organisms by salmons were calculated. Data on the amount of daily and seasonal consumption of marine organisms by Pacific salmon were presented.

Introduction

During summer-autumn period and even in early winter mass migration of salmons takes place through the South Kuril area. In summer they migrate to the spawning areas and in autumn – to the forage areas. During their migrations through the studied area salmons are well fed. This work summarizes numerous materials on salmon feeding, collected during complex expeditions to the area of the South Kuril Islands, conducted by TINRO-Center in 1991-1996 in summer-autumn and autumn-winter periods.

Methods

Averaging of all obtained information was conducted in accordance with standard biostatistic areas (1 – coastal Sea of Okhotsk, 2 – coastal Pacific, 3 – coastal oceanic), which were marked out taking into account water circulation and water mass allocation scheme (Shuntov et al., 1986) (Fig. 1).

Collecting and processing information on fish feeding was conducted using express method adopted by TINRO-Center (Volkov, Chuchukalo, 1986), according to which stomach contents of similar size fishes of a certain salmon species were combined, then food composition was determined, as well as its weight and weight of certain prey components.

Daily food rations of salmons were estimated by the method of A.V.Kogan (1963) and N.S.Novikova (1949) simultaneously. The share of ration, presented by invertebrates, was calculated as a sum of food consumed in every time interval. Another share of ration, consisted of big fishes and squids, was calculated on the basis of digestion rate of these components.

Composition of food rations was compared using the diet overlap index of Shorygin (1952):

$C_{xy} = ?\,^{n}_{i=1} \min (p_i\ q_i)$ – the sum of minimal values (shares) of the compared food rations, where p_i is a share of *i*-object in the *x*-type ration, q_i is a share of *i*-object in the *y*-type ration; *n* is a number of objects in the ration.

In order to estimate selection of prey organisms by salmons the index of selection of V.S.Ivlev (1955) was used:

$$G_{ij} = \frac{(p_{ij} - p_i)}{(p_{ij} + p_i)} \quad -1 = G_{ij} = +1,$$

where *i* is a type and *j* is an object of food, p_{ij} is a share of *j*-object in the ration of *i*-type, p_i is a share of object in plankton (in the given water basin).

In order to determine trophic importance of species weight of prey organisms consumed by these species during 24 hours and during a season was calculated. Consumption of prey organisms was determined by the following formula:

$$B = b*R*n,$$

where *B* is a biomass of the prey organisms, in tons; *b* is a species biomass, in tons; *R* is a daily ration, in %; *n* is a number of days. When calculating consumption of prey organisms, size-age, seasonal, annual and regional peculiarities of the species feeding, as well as data on salmon abundance and biomass, were taken into account.

Results

Distribution and feeding habitats of Pacific salmon

Among 6 species of *Oncorhynchus* genus, inhabiting the area of the South Kuril Islands, two are the most abundant – pink and chum salmon (Table 1). Biomass of these species within the studied period of time made 80-90% of the biomass of all salmon species, and from 1 to 68% of total nekton biomass of the upper (0-50 m) epipelagic water layers. Biomass of chinook (*O. tshawytscha*), sockeye (*O. nerka*), coho (*O. kisutch*) and masu salmon (*O. masou)* was not high and rarely exceeded 10% of all salmon species biomass (Table 1).

Pink salmon. In summer time pink salmon can be met during migration to spawning areas from June to September (Shuntov, 1989; Shuntov et al., 1993a, b; Shuntov, 1994; Takagi et al., 1981). During migration from spawning areas juvenile fishes of this species appear in the Sea of Okhotsk in July-August, and a considerable number of them stays in the south waters of the Sea up to the middle of winter (Shuntov, 1994). From November up to January-February a part of pink salmon juvenile fish comes out to the Pacific waters of the 2nd and 3rd areas (Radchenko et al., 1991).

During migration pink salmon continues to be well fed (Birman, 1985; Volkov, 1994) but the intensity of its feeding in this period is substantially lower than during winter-spring foraging in the ocean (Tutubalin, Chuchukalo, 1992; Chuchukalo et al., 1992).

In summer time pink salmon of various regional groups and maturity levels, as well as different food needs, comes to the South of Kuril Islands. Pink salmon with low maturity coefficients is usually well fed, its daily rations make from 3.7 to 8.8%. Mature pink salmon has lower intensity of feeding, its rations make from 1.3 to 3.2%.

Fish, passing Kuril waters on the way to the other areas of the Sea of Okhotsk, is likely to have higher feeding intensity in comparison with that observed when approaching reproduction areas.

Daily rations of juvenile fish can vary within the range of 0.3-7.6% of body weight (Gorbatenko, 1996).

Diet composition of pink salmon is very diverse which is caused by a high plasticity of its diet (Fig. 2, 3). As it was shown by the results of investigations in 1991-1996, amphipods, pteropods, euphausiids and various nekton species are the most frequent in food structure of pink salmon. At that, as to amphipods, *Themisto japonica* dominated in food structure in the Sea of Okhotsk waters, and *T. pacifica* dominated in the Pacific waters. In some cases pteropods reached 51% of food weight. As to nekton, which share in ration varied from 5 to 100% of food weight, young squid, mictophids, saury (*Cololabis saira*), young rasp (*Pleurogrammus azonus*) and recently *Japanese anchovy* (*Engraulis japonicus*) were preferred.

As regards size-age changes of food structure, many authors (Andrievskaya, 1970, 1975; Heard, 1991; and others) note that the share of nekton increases with the increase of pink salmon size. It is clear that pink salmon with the length of up to 30 cm is more planktophagous than euryphagous.

Talking about seasonal and annual changes of pink salmon diet composition, it is necessary to note that they did not have certain regularities and were related only to quantitative ratio of prey organisms.

Chum salmon. In summer-autumn period migration ways of different populations of summer and autumn runs go through the studied area to spawning areas on Sakhalin and Kuril Islands, as well as juvenile fish migration ways from reproduction areas to foraging areas; besides, a considerable part of chum salmon of Japanese industrial origin migrates through this area and salmons from rivers of this and other regions forage here (Neave et al., 1976; Birman, 1985; Radchenko et al., 1991; Salo, 1991; Ogura, 1994; Starovoitov, 1998). At that, juvenile salmon migrations are observed in the studied area up to January-February (Radchenko et al., 1991).

In summer chum salmon daily rations varied from 1.2 to 3.1% of body weight. At that, as it was shown by the results of investigations in the Sea of Okhotsk area in August, 1994, when gonado-somatic indices (GSI) of fish made 10.3-11.8%, feeding intensity was high, when GSI made 15-25.4%, feeding intensity was low.

In autumn-winter period daily rations of juvenile chum salmon changes from 1.4 to 6.3% of body weight.

Thus, chum salmon with various food needs can be met in the studied area in summer-autumn and autumn-winter periods: mature individuals with different feeding intensity, foraging immature individuals, which, according to A.N. Starovoitov (1998), move in a common migration pool together with mature fish, and fry.

Despite its considerable trophic plasticity, chum salmon has its favorite set of components, in most cases consisting of 2-4 species (Fig. 2, 3). In the first turn it is necessary to note the so-called "pteropodic" specialization of chum salmon diet structure, mentioned by many researchers (Andrievskaya, 1968, 1975; Volkov, 1994; Dulepova, 1998). However, it was clearly observed only for chum salmon from the Pacific areas (up to 91% of the consumed food weight). In the Sea of Okhotsk area the share of pteropods did not exceed 1-13%. Hyperiids, fishes and euphausiids were in the second place; squids, salps and medusas were quite frequent in chum salmon ration, at that the latter ones were typical for the end of anadromous period.

It is known that plankton becomes more important in chum salmon diet with the increase of individual size (Volkov et al., 1997; Dulepova, 1998), but according to data of 1991-1996 this chum salmon diet feature was not observed in the studied area.

Chinook salmon. In the period of study chinook salmon could be met in small number, mainly in the Pacific coastal waters. In general they were individuals of 40-50 cm body length, big individuals of 70-90 cm body length were met in isolated instances.

The present study showed that in the Sea of Okhotsk area euphausiids (up to 64% of ration) and fishes (up to 34%) prevailed in chinook salmon diet, among which mictophids and northern smoothtongue (*Leuroglossus schmidti*) predominated (Fig. 4). In the Pacific areas the bulk of food was mainly cephalopoda (up to 50%) and fishes (33%), whereas euphausiids made on the average 17% of the food ration. In winter small fishes, squids, euphausiids, hyperiids could be met in chinook salmon food ration.

According to the collected data, in summer-autumn time weight of daily ration of chinook salmon made from 0.3 to 3.5% of body weight (Glebov, 2000; Chuchukalo et al., 1994a; Volkov et al., 1997). In autumn-winter time daily rations of chinook salmon juvenile fish made 3.8-3.9% (Chuchukalo et al., 1994a).

Sockeye salmon. Sockeye salmon occurred in catches in small number, primarily of 50-60 cm body length. The present study showed that in the Sea of Okhotsk area plankton organisms prevailed in sockeye salmon diet, but in the Pacific areas prevailed nekton organisms (Fig. 4).

Daily ration of sockeye salmon up to 50 cm body length made from 0.5 to 5.4% of body weight and of fish above 50 cm body length - from 1.0 to 4.0% of body weight (Chuchukalo et al., 1994b; Volkov et al., 1997).

Coho salmon. In summer-autumn period both juvenile and mature finishing individuals could be usually met in the area of the South Kuril Islands. But according to the data of 1991-1996, coho salmon occurred in catches in small number, primarily of 50-70 cm body length.

The prey of this salmon species mainly consists of nekton organisms. At that, in the Sea of Okhotsk area the bulk of its diet included saury, northern smoothtongue**,** young rasp, and in the Pacific areas - saury, anchovy, juvenile banded Irish lord (*Hemilepidothus gilberti*). In addition to fishes, euphausiids were found in coho salmon ration in the Sea of Okhotsk area (Fig. 4).

Feeding intensity of coho salmon in the studied area was high, daily rations of sockeye salmon in summer time made 3.0-3.6% of body weight (Chuchukalo et al., 1994b; Volkov et al., 1997).

Masu salmon. Only finishing immature masu salmon (mainly 20-30 cm body length) could be met in the studied area in summer and autumn-winter period, mature individuals of masu salmon were not met in catches in this period. It is connected with the fact that masu salmon migrations to spawning areas take place in April-May (Machidori, Kato, 1984; Kato, 1991).

In the ration of juvenile masu salmon fishes (up to 30 cm body length) of the studied area hyperiids and copepods (*N. plumchrus*) dominated more often. As to the diet of bigger individuals, different nekton organisms (rasp, mictophids, Pacific sand lance *Ammodytex hexapterus*) were important for their diet. Calculated daily rations of masu salmon juvenile fish from 17 to 32 cm body length were equal to 3.8% of body weight.

Trophic relations of Pacific salmon

Every salmon species has a certain type of feeding, which is known to be determined by morpho-physiological features of the fish, and besides, diet composition depends on the structure of food reserve. Information about morpho-physiological features of salmons (Verigina, Savvaitova, 1974; Voronina, 1997), as well as a certain food trend, allows us to attribute chinook and coho salmon to typically nektophagous fishes, at that, as many researchers mention (Volkov et al., 1997; Karpenko, 1998; Major et al., 1978), preying on others is also characteristic of juvenile fish of these species. Pink, chum and sockeye salmon are euryphagous, in ration of which nekton organisms are very important, but plankton organisms are more important for the diet of juvenile fishes. Masu salmon is also euryphagous**,** but depending on the region of dwelling, both zooplankton and nekton may be important in its food.

The greatest diet overlap was typical for small and medium size groups of Pacific salmons in the period of their common life during autumn-winter and summer seasons. Big-size individuals more often had medium indices. At that, even the same pairs of species showed both high and very different indices of diet overlap (Tables 2-6).

Calculated indices of selection of prey organisms by salmons showed that the most preferable food for pink, chum, sockeye and masu salmon was pteropods and hyperiids, selection indices were usually equal to 0.69-0.99. These salmon species are indifferent to euphausiids, selection indices varied from -0.79 to 0.38. Copepods and chaetognaths are poorly selected by salmons, selection indices of these food organisms were often close to –1.

Type and peculiarities of the Pacific salmon diet determine in many respects its intra- and interspecific feeding relations, which are known to include competition for food. But the structure of feeding relations, implying competition for food, is rather complicated.

In order to create high intensity of feeding relations among salmons during their marine life period, several of the following factors should be present at the same time: composition of food rations (for certain size groups) and feeding intensity, distribution in the area of habitat, time of migrations and foraging, as well as high number of species and limited food reserve. Periods of mass gathering of different groups of pink and chum salmon last from July to September (for chum salmon – up to November). During the study feeding intensity and diet overlap for these species varied in a wide range, but more often they were medium, and just in some cases they were high. That is why it is difficult to estimate the intensity of food competition for these salmon species. We can just suppose that is cases of simultaneous mass gathering of these species in the given area, when they are actively foraging and have high diet overlap, tense feeding relations can arise. As to the other salmon species, taking into account their small number and distribution in the area, they can hardly compete with the other species or between themselves.

Consumption of prey organisms by salmons

Total values of prey organisms, consumed by salmons during a season in the studied area, were formed by two species – pink and chum salmon, at that with the increase of number of chum salmon of Japanese industrial origin its importance in trophic structure of the studied area increased. Biomass of the other salmon species was low, and consumption of prey organisms was accordingly low (Table 7).

Totally during a season salmons consumed from 15.2 to 40.7 thousand tons in the 1st area, 22,7-50.1 thousand tons in the 2nd area, and 14.5-24.4 thousand tons in the 3rd area (Table 8). In 1991 in the 1st area values of consumption were maximal and made 107.7 thousand tons due to the high trophic activity of pink salmon.

In summer period values of zooplankton consumption by salmons varied in different years and areas from 8.0 to 69.0 thousand tons (Table 8). During a season salmons consumed on the average from 1.1 to 40.4 thousand tons of fish objects. In the coastal zone they consumed from 0.1 to 3.3 thousand tons of cephalopods (in 1991 – 21.0 thousand tons), whereas in the 3rd area, where cephalopods biomass was the highest, their consumption was minimal (not more than 0.4 thousand tons during a season).

Comparing the obtained values with the weight of consumed prey organisms by mass nekton species in the studied area, it should be noted that except the period of sardine (pilchard) high abundance, salmons together with saury were one of the main consumers of prey organisms in the 1st area. In the 2nd area salmons were the third after saury and squid, and in the 3rd area the share of prey organisms consumed by salmons was not high in comparison with other species.

Thus, salmons, being one of the main consumers of prey organisms, occupy a significant place in trophic relations of epipelagic water layers of the South Kuril Islands.

REFERENCES

Andrievskaya L.D. 1968. Feeding of juvenile Pacific salmon in the sea. Izvestya TINRO. 64: 73-80.

Andrievskaya L.D. 1970. Feeding of juvenile Pacific salmon in the Sea of Okhotsk. Izvestya TINRO. 78: 105-115.

Andrievskaya L.D. 1975. Feeding of Pacific salmon in the marine period of life. Avtoref. dis…cand. boil. nauk. Vladivostok: TINRO, 28 p.

Birman I.B. 1985. Marine period of life and issues of stock dynamics of Pacific salmon. M., Agropromizdat. 208 p.

Chuchukalo V.I., Efimkin A.Y., Kuznetsova N.A. 1992. Distribution of mesoplankton and feeding of fish of the upper epipelagic water layers in the Sakhalin-Kuril area in summer 1991. TINRO. Vladivostok. Dep. Vo VNIERH # 1203-PX 92. 22 p.

Chuchukalo V.I., Volkov A.F., Efimkin A.Y., Blagoderov A.I. 1994(a). Distribution and feeding of chinook salmon (Oncorhynchus tschawytscha) in the North-Western Pacific. Izvestya TINRO. 116: 137-141.

Chuchukalo V.I., Volkov A.F., Efimkin A.Y., Kuznetsova N.A. 1994(b). Feeding and daily rations of sockeye salmon (Oncorhynchus nerka) in summer time. Izvestya TINRO. 116: 122-127.

Dulepova E.P. 1998. Trophic relations of mass salmon species in the Bering Sea in summer. Izvestya TINRO. V. 124. Part 2. P. 614-623.

Glebov I.I. 2000. Ecology of chinook and coho salmon from Asian stocks in the marine period of life. Avtoref. dis…cand. boil. nauk. Vladivostok: TINRO-Center. 24 p.

Gorbatenko K.M. 1996.Feeding of juvenile pink and chum salmon in the Sea of Okhotsk epipelagic water layers in winter. Izvestya TINRO. 119: 234-243.

Heard W.R. 1991. Life History of Pink Salmon (Oncorhynchus gorbuscha). Pacific Salmon life history. Ed. by C.Groot & L.Margolis. Canada., P. 119-230.

Ivlev V.S. 1955. Experimental ecology of fish food. M.: Pischepromizdat 252 p.

Karpenko V.I. 1998. Early marine period of life of Pacific salmon. M.: Izdatelstvo VNIRO. 165 p.

Kato F. 1991. Life histories of masu and amago salmon. Pacific salmon life histories. Vancouver: UBS Press. P. 448-520.

Kogan A.V. 1963. About daily ration and trophic rhythm of chehon (Pelecus cultratus) from Tsimlyanskoye reservoir. Zool. Zhurn. V. 42, issue 4. P. 596-601.

Machidori S., Kato F. 1984. Spawning populations and marine life of masu salmon (Oncorhynchus masou). Bull. INPFC. 43: 1-138.

Major R.L., Ito J., Ito S. and Godfrey H. 1978. Distribution and origin of Chinook salmon (Oncorhynchus tschawytscha) in offshore waters of the North Pacific Ocean. Bull. INPFC. 38: 54 p.

Neave F., Jonemori T., Bakkala R.G. 1976. Distribution and origin of chum salmon in offshore waters of the North Pacific: Bull. INPFC. 35: 472 p.

Novikova N.S. 1949. About the possibility of estimation of daily ration of fish in natural environment . Vestnik MGU. 9: 107-111.

Ogura. M. 1994. Migratory behavior of Pacific salmon (Oncorhynchus spp.) in the open sea. Bull. Nat. Res. Far Seas Fish. 31: 1–141.

Radchenko V.I., Volkov A.F., Figurkin A.L. 1991. About winter foraging of pink salmon in the Sea of Okhotsk. Biol. Morya. 6: 88-90.

Salo E.O. 1991. Life history of chum salmon (Oncorhynchus keta). Pacific salmon life histories. - Vancouver: UBC Press, P. 231-309.

Shorygin A.A. 1952. Food and trophic relations of fishes in the Caspian Sea. M.: Pischepromizdat, 267 p.

Shuntov V.P. 1989. Distribution of juvenile Pacific salmon of Oncorhynchus genus in the Sea of Okhotsk and adjacent Pacific waters. Voprosy ihtiologii. V. 29, issue 2. P. 239-248.

Shuntov V.P. 1994. New data on the marine period of life of Asian pink salmon. Izvestya TINRO. 116: 3-41.

Shuntov V.P., Radchenko V.I., Chuchukalo V.I. and others. 1993(b). The structure of plankton and nekton populations of upper epipelagic water layers of the Sakhalin-Kuril area in the period of anadromous migrations of salmons. Biol. Morya. 4: 587-597.

Shuntov V.P., Radchenko V.I., Lapko V.V. and others. 1993(a). Distribution of salmons in the waters of Sakhalin-Kuril area in the period of anadromous migrations. Voprosy ihtiologii. V. 33, issue 3. P. 348-358.

Shuntov V.P., Volkov A.F., Matveev V.I. and others. 1986. Peculiarities of formation of trophic zones in the Sea of Okhotsk in autumn. Biol. Morya. 4: 57-65.

Starovoitov A.N. 1998. Biologic parameters, abundance and distribution of chum salmon in the Sakhalin-Kuril area during marine anadromous migrations. Izvestya TINRO. 124: 444-455.

Takagi K., Aro K.V., Hart A.C., Dell M.B. 1981. Distribution and origin of pink salmon (Oncorhynchus gorbuscha) in offshore waters of the North Pacific Ocean. Bull. INPFC. 40: 195 p.

Tutubalin B.G., Chuchukalo V.I. 1992. Feeding of Pacific salmon of Oncorhynchus genus in the Northern Pacific in winter-spring period. Biol. Resursy Tihogo okeana. M.: VNIRO, P. 77-85.

Verigina I.A., Savvaitova K.A. 1974. Structure of digestive organs of sympathetic populations of loach (genus Salvelinus) from Azabachie Lake (Kamchatka). Voprosy Ihtiologii. V. 14, issue 3: 467-476.

Volkov A.F. 1994. Diet features of pink, chum and sockeye salmon during anadromous migrations. Izvestya TINRO. 116: 128-136.

Volkov A.F., Efimkin A.Y., Chuchukalo V.I. 1997. Regional diet features of Asian salmons in summer time. Izvestya TINRO. 122: 324-341.

Voronina E.P. 1997. Anatomo-histological features of digestive organs of salmon-like fishes (Salmonoidei). Voprosy Ihtiologii. V. 37, issue 5: 676-687.

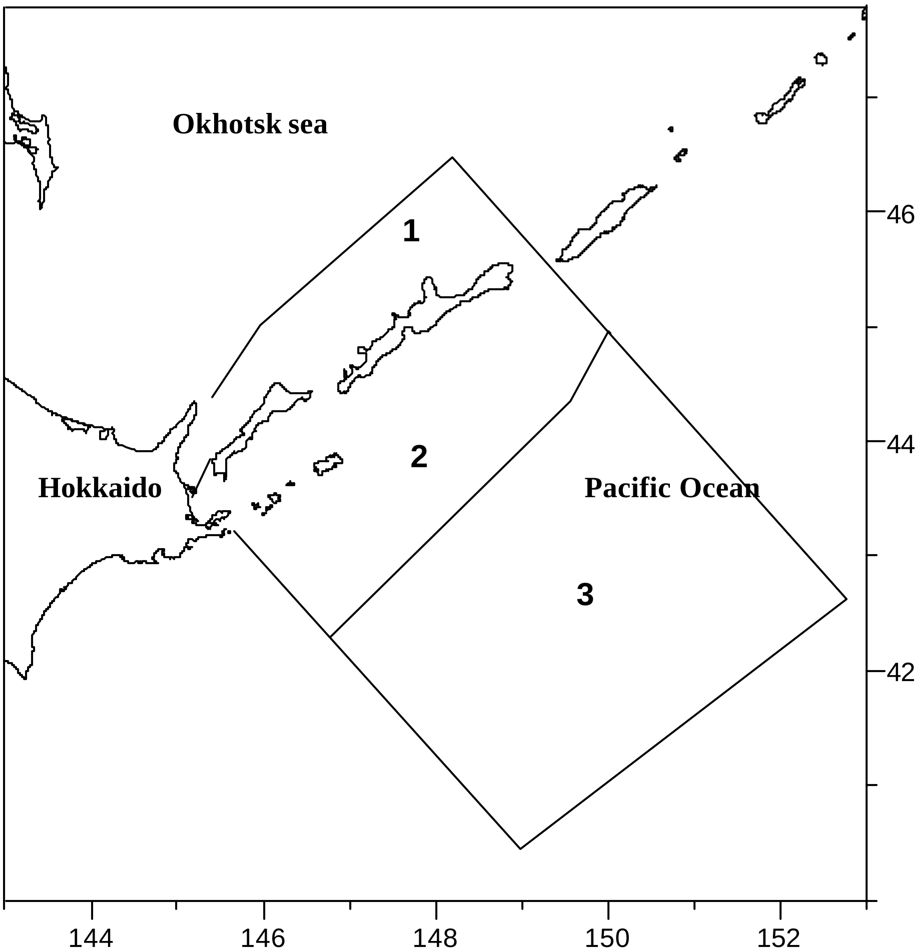

Fig. 1. Scheme of standard biostatistic areas in the South Kuril region.

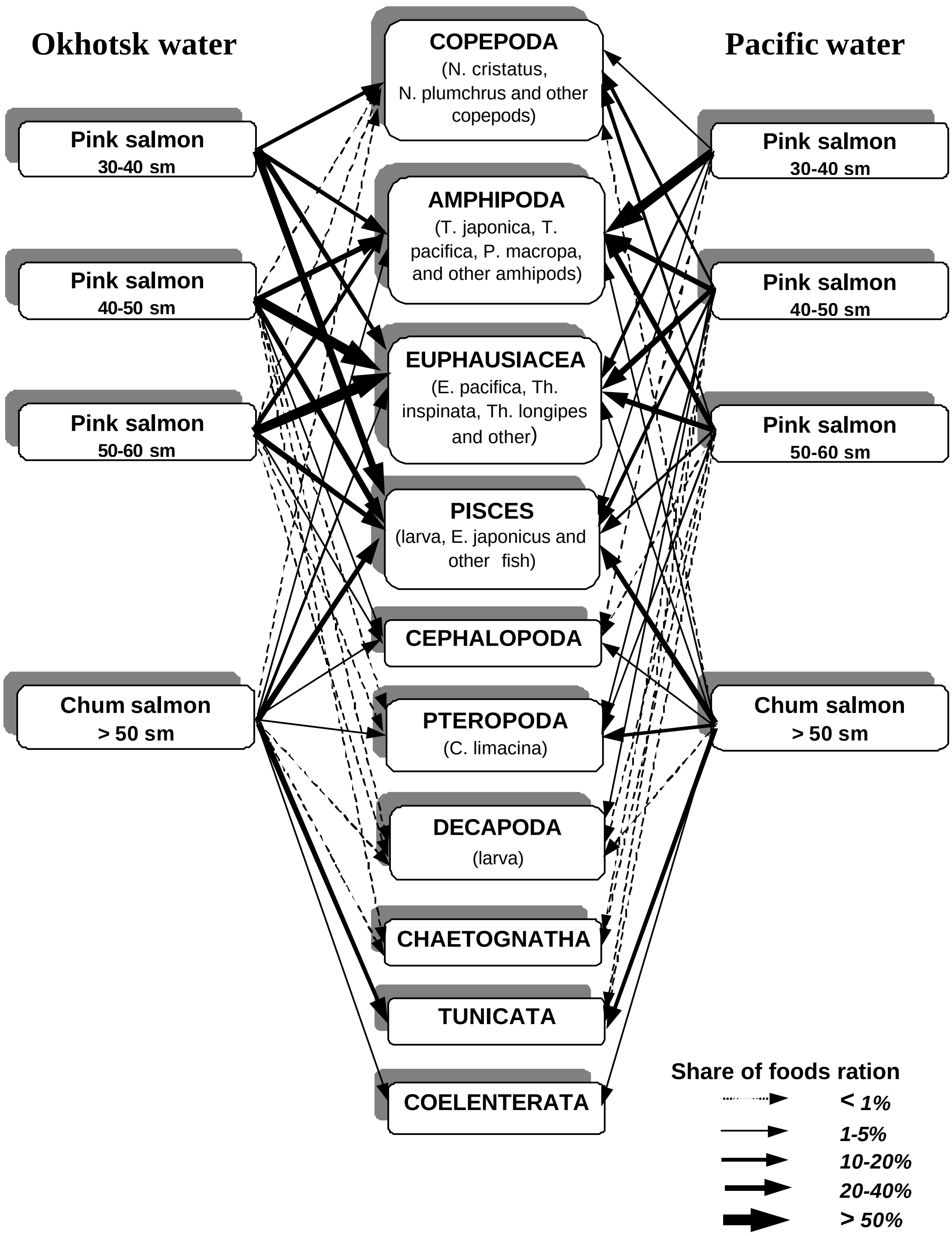

Fig. 2. Scheme of trophic relations of pink salmon and chum salmon in the South Kuril region in the summer.

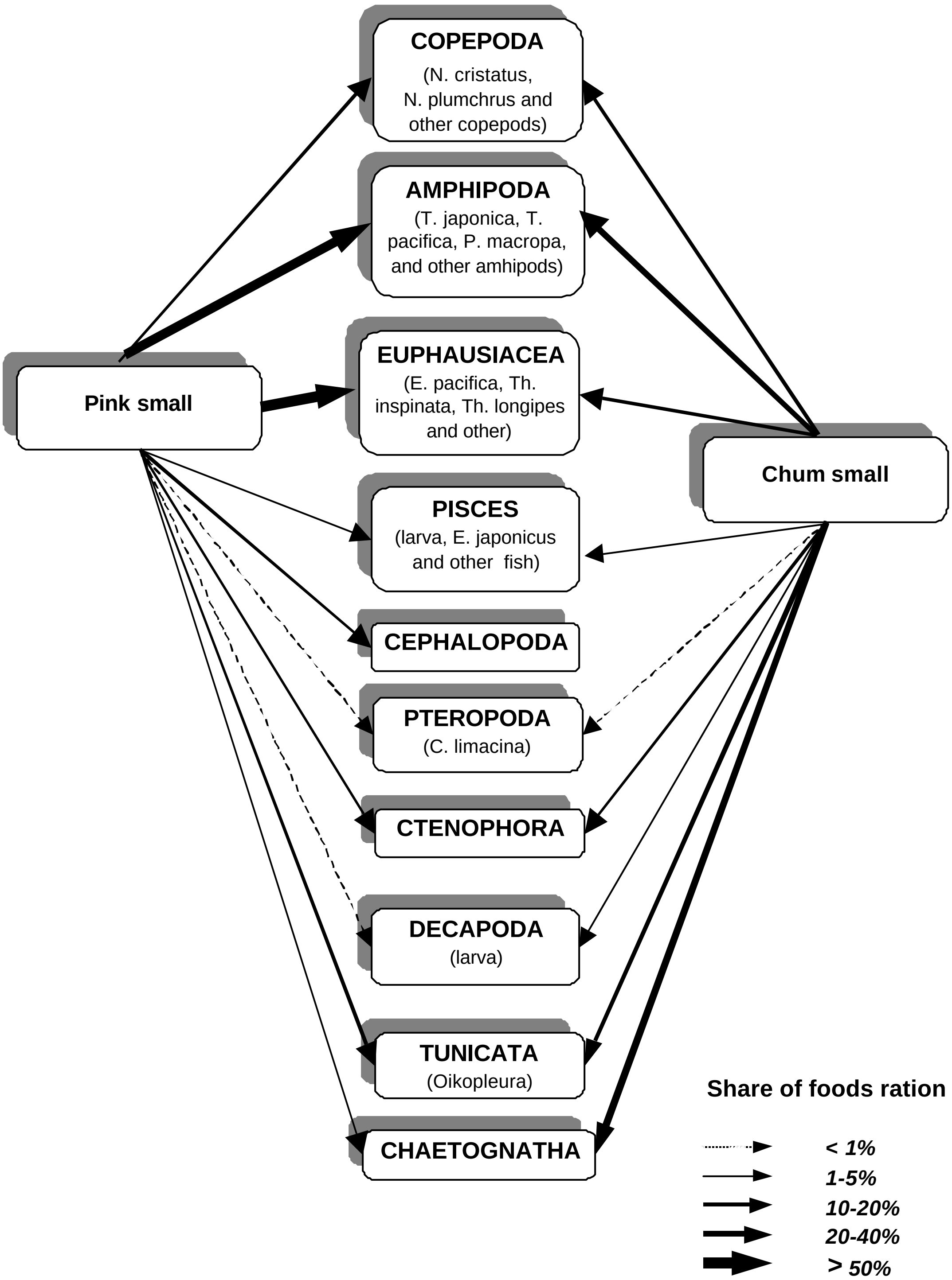

Fig. 3. Scheme of trophic relations of small salmon in the South Kuril region in the summer.

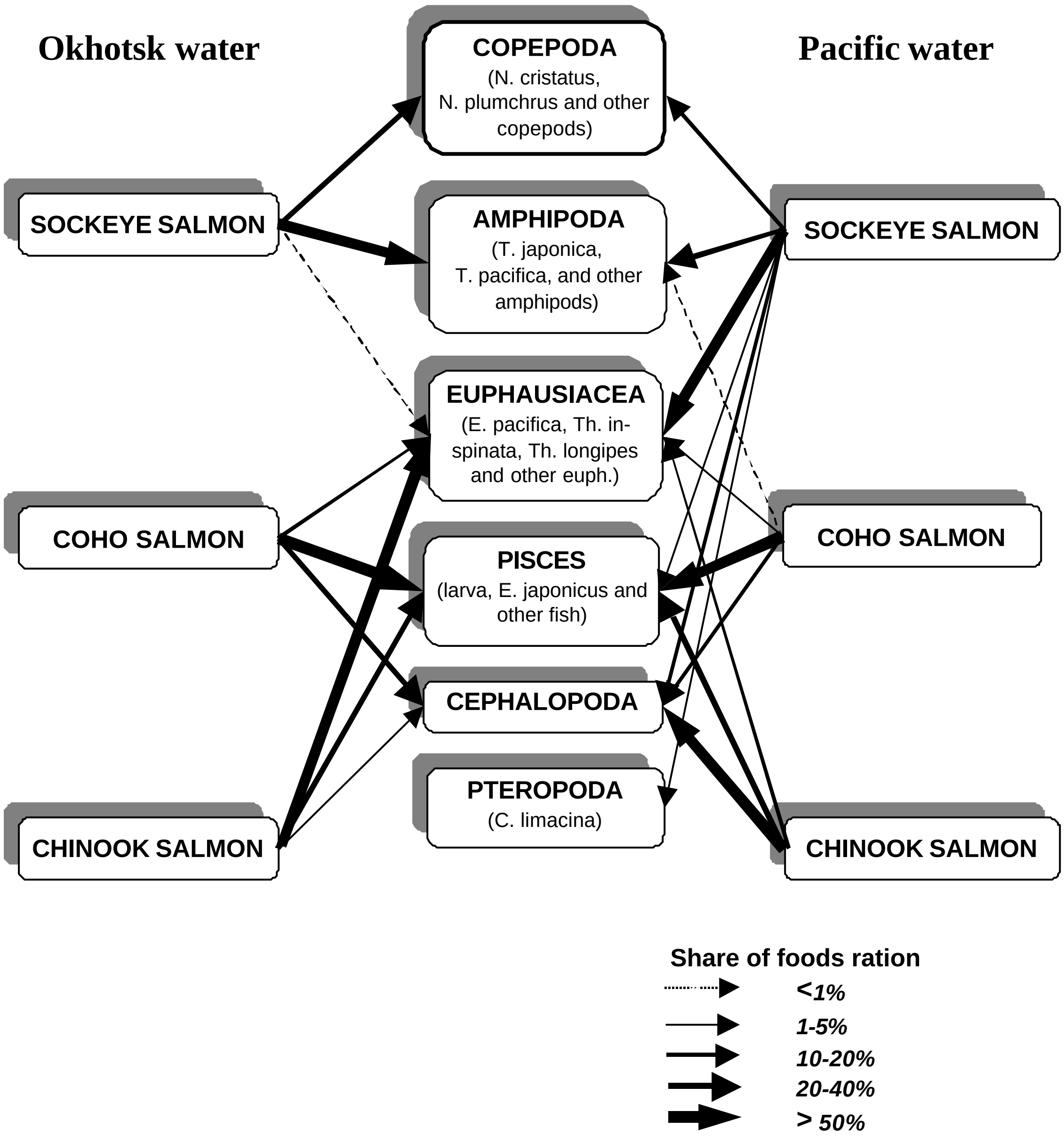

Fig. 4. Scheme of trophic relations of Pacific salmon in the South Kuril region in the summer.

Table 1. Biomass (th. t) of Pacific salmons in the South Kuril region in summer.

Species of Salmon	1991	1992	1993	1994	1995	1996
			1 area			
Pink salmon	75,5	39,4	34,4	66,6	64,8	51,6
Chum salmon	17,9	16,4	19,5	21,3	24,3	29,8
Other salmon	0,1	+	+	0,2	+	0,1
All salmon	**93,5**	**55,8**	**53,9**	**88,1**	**89,1**	**81,5**
			2 area			
Pink salmon	75,5	39,4	34,4	66,6	64,8	51,6
Chum salmon	41,0	28,2	38,7	42,4	46,4	29,8
Other salmon	0,6	0,5	0,3	+	+	0,2
All salmon	**117,1**	**68,1**	**73,4**	**109,0**	**111,2**	**81,6**
			3 area			
Pink salmon	15,1	7,9	6,9	13,3	12,9	10,3
Chum salmon	40,1	28,2	38,7	42,0	45,6	54,0
Other salmon	+	+	0,3	+	0.6	+
All salmon	**55,2**	**36,1**	**45,9**	**55,3**	**59,1**	**64,3**

Table 2. Indexes of food similarity of Pacific salmons in the South Kurile region (1 area) in summer in 1994.

Species of Salmon	Pink salmon 30-40 sm	Pink salmon 40-50 sm	Pink salmon 50-60 sm	Chum salmon 50-60 sm	Chum salmon 60-70 sm	Sockeye salmon 50-60 sm
Pink salmon 30-40 sm	?					
Pink salmon 40-50 sm	55,4	?				
Pink salmon 50-60 sm	49,6	76,2	?			
Chum salmon 50-60 sm	17,0	28,3	38,7	?		
Chum salmon 60-70 sm	18,6	27,0	29,5	78,4	?	
Sockeye 50-60 sm	37,7	25,3	22,7	8,5	10,5	?

Table 3. Indexes of food similarity of Pacific salmons in the South Kurile region (1 area) in summer in 1995.

Species of Salmon	Pink salmon 40-50 sm	Pink salmon 50-60 sm	Chum salmon 60-70 sm
Pink salmon 40-50 sm	?		
Pink salmon 50-60 sm	74,9	?	
Chum salmon 60-70 sm	24,4	22,7	?

Table 4. Indexes of food similarity of Pacific salmons in the South Kurile region (1 area) in summer in 1996.

Species of Salmon	Pink salmon 30-40 sm	Pink salmon 40-50 sm	Pink salmon 50-60 sm	Chum salmon 50-60 sm	Chinook 40-50 sm
Pink salmon 30-40 sm	?				
Pink salmon 40-50 sm	88,4	?			
Pink salmon 50-60 sm	54,3	57,2	?		
Chum salmon 50-60 sm	62,0	66,9	65,2	?	
Chinook 40-50 sm	33,6	29,5	0,32	3,1	?

Table 5. Indexes of food similarity of Pacific salmons in the South Kurile region (2 area) in summer in 1993.

Species of Salmon	Pink salmon 40-50 sm	Pink salmon 50-60 sm	Chum salmon 30-40 sm	Chum salmon 50-60 sm	Chum salmon 60-70 sm	Chinook ? 50 sm	Coho salmon ? 50 ??
Pink salmon 40-50 sm	?						
Pink salmon 50-60 sm	66,2	?					
Chum salmon 30-40 sm	10,6	19,7	?				
Chum salmon 50-60 sm	32,0	59,1	64,9	?			
Chum salmon 60-70 sm	33,7	48,0	37,7	51,8	?		
Chinook ? 50 sm	8,5	5,0	4,5	5,0	7,4	?	
Coho salmon ? 50 ??	16,5	4,6	9,0	1,7	2,3	25,3	?

Table 6. Indexes of food similarity of Pacific salmons in the South Kurile region (2 area) in summer in 1994.

Species of Salmon	Pink salmon 30-40 sm	Pink salmon 40-50 sm	Pink salmon 50-60 sm	Chum salmon 50-60 sm	Chum salmon 60-70 sm
Pink salmon 30-40 sm	?				
Pink salmon 40-50 sm	48,5	?			
Pink salmon 50-60 sm	39,4	45,4	?		
Chum salmon 50-60 sm	21,4	37,2	15,7	?	
Chum salmon 60-70 sm	11,7	9,2	5,4	48,1	?

Table 7. Seasonal consumption of the food hydrobionts (th. t) by the Pacific salmons in the South Kuril region in summer.

Species of Salmon	1991	1992	1993	1994	1995	1996
			1 area			
Pink salmon	99,7	24,06	10,38	30,74	19,63	23,85
Chum salmon	7,86	11,47	4,84	9,38	9,55	14,28
Other salmon	0,16	+	+	0,53	+	0,25
All salmon	**107,72**	**35,53**	**15,22**	**40,65**	**29,18**	**38,38**
			2 area			
Pink salmon	32,73	17,73	8,29	30,91	15,65	23,25
Chum salmon	16,41	11,3	13,93	17,8	19,44	25,74
Other salmon	0,92	0,68	0,5	+	0,06	0,48
All salmon	**50,06**	**29,71**	**22,72**	**48,71**	**35,15**	**49,47**
			3 area			
Pink salmon	8,4	4,36	1,7	4,98	4,76	3,86
Chum salmon	16,02	11,85	12,08	13,88	14,2	17,83
Other salmon	?	+	0,67	+	0,92	+
All salmon	**24,42**	**16,21**	**14,45**	**18,86**	**19,88**	**21,69**

Table 8. Seasonal consumption of the food hydrobionts (th. t) by the Pacific salmons in the South Kuril region in summer.

Food	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**
			1 area			
Zooplankton food	69,0	32,37	13,6	36,11	22,49	15,6
Nekton food	38,72	3,16	1,62	4,54	6,69	22,78
All food	**107,72**	**35,53**	**15,22**	**40,65**	**29,18**	**38,38**
			2 area			
Zooplankton food	42,83	27,38	21,48	37,52	34,37	8,0
Nekton food	7,23	2,33	1,24	11,19	0,78	41,47
All food	**50,06**	**29,71**	**22,72**	**48,71**	**35,15**	**49,47**
			3 area			
Zooplankton food	14,32	13,71	13,32	16,6	16,47	19,52
Nekton food	10,1	2,5	1,13	2,26	3,41	2,17
All food	**24,42**	**16,21**	**14,45**	**18,86**	**19,88**	**21,69**