NPAFC
Doc. 766
Rev. ___

Survey of juvenile salmon along the eastern Sakhalin and southern Kuril islands (southern Okhotsk Sea) performed in late June – early August 2003 at the research vessel "Dmitry Peskov"

S.A. Kovalenko, A.O. Shubin, D.Yu. Stominok, D.Yu. Arkashov, I.A. Nemchinova, M.G. Dolgikh*, V.N. Chastikov, O.V. Kusailo, A.M. Kozlyakovsky

Sakhalin Research Institute of Fisheries and Oceanography
196, Komsomolskaya St., Yuzhno-Sakhalinsk, 693023, Russia

*** Russian Federal Research Institute of Fisheries and Oceanography (VNIRO)**

Submitted to the

NORTH PACIFIC ANADROMOUS FISH COMMISSION

by the

Russian Federation

September 2004

THIS PAPER MAY BE CITED IN THE FOLLOWING MANNER:
S.A. Kovalenko, A.O. Shubin, D.Yu. Stominok, D.Yu. Arkashov, I.A. Nemchinova, M.G. Dolgikh*, V.N. Chastikov, O.V. Kusailo, A.M. Kozlyakovsky. 2004. Survey of juvenile salmon along the eastern Sakhalin and southern Kuril islands (southern Okhotsk Sea) performed in late June – Early August 2003 at the research vessel "Dmitry Peskov" (NPAFC Doc. 766). Sakhalin Research Institute of Fisheries and Oceanography 196, Komsomolskaya St., Yuzhno-Sakhalinsk, 693023, Russia. E-mail: koval@sakhniro.ru

ABSTRACT

Investigating a distribution and habitat conditions of juvenile salmon along the eastern Sakhalin shore, on the area of the Okhotsk Sea deepwater depression, and along the southern Kuril Islands from the Okhotsk Sea side has been conducted since June 27 through August 7, 2003. A mid-water trawl of 54.4/192 m was used for fishing juveniles, and CTD sondes AST-1000 and Minipack for hydrologic investigations. A total of 177 trawl operations have been performed by the developed scheme of stations. In total, 18 juvenile pink, 158 juvenile chum, 6 juvenile masu, and 4 juvenile coho salmon have been sampled during the research cruise. Maps-schemes indicating the points of the juvenile salmon capture, data on their size-weight indices and feeding, thermohaline characteristic of the juveniles habitat, composition of non-salmonid fishes from the upper epipelagic zone of the southern Okhotsk Sea in a summer period are given in this report.

INTRODUCTION

Wild and hatchery-reared pink salmon form the base of the eastern Sakhalin juvenile salmon yield; the second place is occupied by chum salmon being reared mainly at hatcheries. Masu salmon reproduce at Sakhalin only naturally, and coho salmon both in natural and artificial ways; a juvenile abundance of these species is not high. On the southern Kuril Islands (Iturup and Kunashir), the juvenile salmon yield is formed by the hatchery-reared and wild pink and chum salmon. In 2003, a total catch of the eastern Sakhalin juvenile pink salmon was 422 million fish, including the Aniva Bay (207), southeastern Sakhalin (101), Terpeniya Bay (83), northeastern Sakhalin (31); on the southern Kuril Islands the catch was 754 million fish. A total catch of the eastern Sakhalin juvenile chum salmon was 172 million fish, including the Aniva Bay (17), southeastern Sakhalin (76), Terpeniya Bay (52), northeastern Sakhalin (27); on the southern Kuril Islands the catch was 81 million fish.

The eastern Sakhalin pink salmon fry do not stay nearby the estuaries of the native rivers after entering a sea, but immediately leave a shore and inhabit in the conditions of the open sea (Gritzenko, 1987; Shershnev et al., 1982; Shubin, 1994, Shubin et al., 1996, Ivankov et al., 1999). In September, together with juveniles from the other regions they form dense aggregations in the northeastern part of the Okhotsk Sea (Shuntov, 1989; Karpenko et al., 1998), and in October – November in its southern part (Shuntov, 1989, 1994). A life of the eastern Sakhalin juvenile pink salmon since June through August (a period of their moving from a shore and distributing over the shelf area) is not studied enough up to the present time. The reason is that both in June and July the researchers failed to find any dense aggregations neither along the shore nor in the open sea (Shershnev et al., 1982; Shuntov 1989, 1994; Shubin, 1994, Shubin et al., 1996; Shuntov et al., 1995; Ueno, Shimizu, 1996; Ueno, 1997). The juvenile pink salmon of the Iturup Island from the Okhotsk Sea side (southern Kuril Islands) behave in a different way. In June and July, they do not move far from a shore and form aggregations on the inner bays area of this island limited by the isobaths of 20-30 m (Kaev, Chupakhin, 2002).

The tasks of the SakhNIRO cruise along the eastern Sakhalin shore and along the southern Kuril Islands from the Okhotsk Sea side included studying the habitat conditions and distribution of juvenile pink salmon and other salmon species in the early sea period of their life, and estimating the ichthyosenosis composition of the upper epipelagial.

MATERIAL AND METHODS

The researches have been conducted since June 27 through August 7, 2003 aboard the SakhNIRO research vessel "Dmitry Peskov". The region of works was a southern part of the Okhotsk Sea on the shelf area and depths slope of the eastern Sakhalin, southern Kuril Islands and deepwater depression. A mid-water trawl (54.4/192 m) was used as a fishing gear (Guidance for marine investigation…, 1997). The counting works have been conducted according to the developed scheme of stations. We began to work in the La Perouse Strait (9 stations during June 27-28), then in Aniva Bay (17 stations during June 29 - July 1), along southeastern Sakhalin (22 stations during July 2-5), on the area of deepwater depression (11 stations during July 7-8 and 19), along Iturup Island and northern extremity of Kunashir Island (37 stations during July 9-18), along northeastern Sakhalin (76 stations during July 22 – August 5), and abeam Terpeniya Bay (5 stations during August 7). A total of 177 trawl stations have been performed (Fig. 1). Over the inside shelf area (up to the isobath of 50 m), 26% of the total number of stations were performed (all of them off the isobath of 30 m to the sea), 33% over the mid-shelf (isobaths 50-100 m), 16% over the outside shelf (isobaths 100-200 m), and 25% over the depths slope (isobaths more than 200 m). Usually, trawl operations were carried out in daylight since 8 a.m. to 20 p.m. by Sakhalin time. Six stations (№ 39, 52, 95, 133, 173, and 177) were performed at night.

A net part of the trawl consisted of the net set with mesh sizes of 800-400-200-100-60-30-12-6 mm, and codend of 4.5 mm. In order to take the head line out to the 0-m horizon, the trawl was equipped with the hydrodynamic panel of 4.25 m length and 1 m width. A V-shape trawl board of 4.0 m^2 was used for horizontal opening. During trawling, a front part of the trawl was located at a distance of about 375 m from the ship stern; the length of wires varied from 150 to 350 m, commonly making up 270 m. A tow speed varied from 3.9 to 5.4 knots, commonly 4.4 knots. A vertical trawl opening was about 28 m, horizontal about 42 m. At each trawling a head line was taken out to the 0-m horizon. In half an hour (a duration of one trawl haul) an area of 0.17 km^2, was swept; a volume of water filtered was 0.05 km^3.

A total of 18 juvenile pink, 158 juvenile chum, 6 juvenile masu, and 4 juvenile coho salmon have been caught during the cruise. Fork length and body weight were measured when performing biological analysis. A length was measured up to 0.1 cm. The sea balance produced by the firm «Marel» was used for fish weighing to within 1g. Juvenile salmon stomachs were fixed with the 4% formalin and processed individually according to the standard methods (Guidance for investigation…, 1974; Lubny-Gertsyk, 1953; Chislenko, 1968; Chuchukalo, Napazakov, 1999; Mikulich, Rodionov, 1975). In order to estimate a significance of individual species for the juvenile salmon feeding, the following indices were calculated: total index of fullness ($^0/_{000}$), percentage composition of food by weight, frequency of food objects, and coefficient of abundance determined as ***B x F,*** where ***B*** is a mean relative biomass (%), and ***F*** a frequency of this species (Paliy, 1961). The stomachs of the following salmon were examined: pink (18), chum (158), masu (6), and coho (4).

The sea parameters were measured at each station using the CTD sondes AST-1000 or Minipack. In addition, 5 standard oceanologic transects were performed (Fig. 1). Sounding at trawl and standard transect stations was conducted between 0 and 500 m depth (at shallow stations up to the bottom) with the 1-m discreteness.

The following abbreviations are accepted below: SST – sea surface temperature; CPUE - catch per unit effort.

RESULTS

Oceanologic conditions. A spatial structure of the temperature and salinity fields was characterized by a series of standard stable vorticities of anticyclonic and cyclonic orientation. In the first case, these are the vortexes in Aniva Bay, eastward of Cape Terpeniya, and on the line of Cape Elizabeth about 144°30 E, and in the second case, those appearing on the depths slope. A developed upwelling was observed in the northeastern Sakhalin shelf zone (Lunsky, Nyisky, and Piltun bays). It was also observed in the southwestern part of Aniva Bay (Fig. 2). Standard oceanologic transects, performed over the eastern Sakhalin shelf (Fig. 3-4), showed the existence of the salinity positive anomaly in the 0-50 m layer at transect II, water temperature positive anomaly in the 0-50 m layer at transect IV, and the weakened Amur River runoff by the data of sounding at transect V (Fig. 1B).

The isotherm 0°C was located at the depth of 25-30 m, lifting to the surface in the upwelling regions and deepening a little in the southern and offshore regions up to 40 m. The mean thickness of the upper warmed water layer was 20 m. To the south of 49°N, the upper 20-25 m layer with the isotherm 3ºC along the lower boundary was the most favorable for the juvenile salmon inhabiting. The environment conditions over the northeastern Sakhalin shelf were less favorable for juveniles (a thickness of water layer was 7-15 m with the temperature more than 3°C along its lower boundary). Due to these peculiarities of the upper epipelagial warming, all the layer of the possible juvenile salmon inhabitation has been fished.

Catches and distribution of juvenile salmon. Catches of juvenile salmon were the most diverse by species over the eastern Sakhalin shelf and depths slope, and on the western periphery of the deepwater depression to the south of 49º N. Chum salmon (*Oncorhynchus keta)* formed the base of catches in this region (25 ind.), pink salmon (*O. gorbuscha)* occupied the second place (8 ind.), masu (*O. masou)* (4 ind.) and coho salmon (*O. kisutch)* (1 ind.) followed it. Over the eastern Sakhalin shelf and depths slope to the north of 49º N, only juvenile coho (3 ind.) and masu salmon (2 ind.) were caught. Juvenile salmon were not found over the deepwater part of the Okhotsk Sea eastward of 145°30 E up to the southern Kuril Islands. Juvenile chum and pink salmon were found from catches along the southern Kuril Islands. Pink salmon (10 ind.) were caught in the Prostor Bay (Iturup Island), and chum salmon in the Prostor Bay (39 ind.) and along the northwestern part of Kunashir Island on the area adjoining to the Yekaterina Strait (94 ind.). In the Prostor Bay, the maximum catches of juvenile salmon have been recorded abeam the mouth of Reidovaya River, where a hatchery is located. Several chum and pink juveniles were caught in the open part of the Prostor Bay. No juvenile salmon were met in the outside part of the Kurilsky Bay; along with that, several chum juveniles were caught at a distance of 20-30 nautical miles from the Iturup Island (Fig. 5).

Juvenile pink salmon. Juvenile pink salmon were not frequent; they were observed only at 7 stations, and their total catch constituted only 18 ind. In the southwestern part of the Okhotsk Sea, pink juveniles were recorded at 4 stations over the southeastern Sakhalin shelf (frequency 8%) under SST 10-11°C (Fig. 5). CPUE did not exceed 3 ind./trawl. No pink juveniles occurred in catches both over the northeastern Sakhalin shelf and depths slope, and over the deepwater depression. Along the southern Kuril Islands, juvenile pink salmon were fished at 3 stations (frequency 8.1%); all fish were caught in the Prostor Bay (Iturup Island). Two stations were located over the shelf (40-116 m) and one station over the depths slope (1000 m). The maximum CPUE (5 ind./trawl) was recorded over the depths slope, where SST was higher (8.4°C) than near the shore (5.6°C). Thus, we failed to find any aggregations of juvenile pink salmon both over the shelf and depths slope of the eastern Sakhalin and southern Kuril Islands, and over the deepwater depression.

The length and weight of juvenile pink salmon in the southwestern part of the Okhotsk Sea ranged within 6.6-8.7 cm and 2-5 g, respectively; the mean fish length was 7.8 cm, body weight 3.5

g (Table 1, Fig. 6). All juveniles were found in the trawl codend. Fish were smaller along the southern Kuril Islands; their lengths ranged from 5.6 to 7.8 cm, and weights from 1 to 3 g, averaged 6.7 cm and 1.9 g, respectively. All juveniles were found in the front part of the trawl bag.

Stomachs of all the caught pink juveniles contained food. The average fullness was $379.2^{o}/_{ooo}$, under the range of 5.7 to $1825^{o}/_{ooo.}$ The stomach fullness over the southeastern Sakhalin shelf was significantly lower ($37.78^{o}/_{ooo}$) than in the Prostor Bay ($720.64^{o}/_{ooo}$). A total of 17 species of planktonic invertebrates, fish larvae, and air insects have been found in the juvenile pink salmon stomachs. Great differences both by a species composition and dominating groups were observed in the study regions. Only 6 species of food objects belonging to different zooplankton groups: *Themisto japonica, Limacina helicina* (species of the open waters); *Thysanoessa raschii*, Decapoda, zoea (neritic forms) were recorded in fish diet along the southeastern Sakhalin shore. Hyperiidea (*Themisto japonica)* and immature euphausiacea made up the base of stomach contents. In the Prostor Bay (Iturup Island) a diet was much diverse (13 species); five forms made up the base of food bolus. Euphausiacea (*Th. raschii)* and their juveniles dominated by the coefficient of abundance, and juvenile hyperiidea by frequency.

Juvenile chum salmon. Juvenile chum salmon were much frequent than pink salmon. They were observed at 22 stations, and their total catch constituted 158 ind. All stations with chum salmon findings were located to the south of 49° N. In the southwestern part of the Okhotsk Sea, chum juveniles were met in the Aniva Bay, La Perouse Strait, over the southeastern Sakhalin shelf and depths slope, and along the western periphery of the deepwater depression under SST between 10.6 and 13°C (Fig. 5). Their frequency was 5.9% in the Aniva Bay, 22.2% in the La Perouse Strait, 18.2% along the southeastern Sakhalin, and 42.8% over the western periphery of the deepwater depression. By the resulting stations, the average CPUE constituted 2.0 ind./trawl over the continental slope, 1.3 ind./trawl over the inside part of the shelf area. Along the southern Kuril Islands, a frequency of juvenile chum salmon was 24.3%. Their aggregations were observed in the Prostor Bay (Iturup Island) and along the northwestern part of Kunashir Island on the area adjoining to the Yekaterina Strait. In the Prostor Bay, chum juveniles were distributed along the shelf zone to the northern part of Iturup Island. The aggregations have been found over the inside and mid parts of the shelf area (to the 100-m isobath) on the line of Reidovaya River, where a hatchery is located. Juveniles were also met above the depths more than 200 m. The major juvenile chum salmon were caught at SST of about 6°C in the Prostor Bay. Over the northern shelf area of Kunashir Island the sea surface was warmed to 11°C.

Body lengths and weights of fish caught in the Aniva Bay, La Perouse Strait, and along the southeastern Sakhalin were similar to those caught near the Kunashir Island; their mean lengths were 10.9 and 10.4 cm, and mean weights 10.8 and 8.7 g (Table 1, Fig. 7). The largest juveniles were caught eastward of Cape Terpeniya (station № 49, 47°21 N and 144°59 E); a length and weight of specimens varied from 15.5 to 20.3 cm and from 36 to 70 g, respectively. The smallest juveniles were caught in the Prostor Bay (Iturup Island); their indices are clearly seen in figures showing the distribution of body lengths and weights (Fig. 7). The scales of the Prostor Bay juvenile chum salmon from 6.6 to 7.8 cm long had 5-7 (average 6) sclerities. The number of sclerities from fish 8.7-12.6 cm long, caught in other regions, ranged between 8 and 16, averaged 11.6.

Chum juveniles fed intensively; stomach fullness was more than 1 for all the specimens. The mean index of fullness was 178.15 $^{o}/_{ooo}$, ranging by sites from 38.84 $^{o}/_{ooo}$ to 333.06 $^{o}/_{ooo}$. The minimum index of fullness was recorded for fish caught over the western periphery of the deepwater depression (38.84 $^{o}/_{ooo}$), the maximum in the Prostor Bay (333.06 $^{o}/_{ooo}$). A total of 34 forms of marine invertebrates, eggs, fish larvae, and air insects from 10 large taxonomic groups belonging to different faunistic complexes have been identified from the juvenile chum salmon stomachs (Table 2 and 3). A group of crustaceans was the most diverse. It consisted of 12 copepods species, 2 amphipods species, 7 euphausids species, and 3 larval forms of decapods. Fish were presented by the larvae from 3 families: Stichaeidae, Scorpaenidae, and Cottidae.

In the Aniva Bay, La Perouse Strait, and over the southeastern Sakhalin shelf and depths slope, a total of 14 species of food objects different by their ecological characteristics (land insects, coastal, neritic, epipelagic, and eurybathic species) have been identified in the juvenile chum salmon diet. The following five preferable food components with the abundance coefficient > 100 (by decreasing): euphausid *Euphausia pacifica, Thysanoessa longipes*, amphipod *Themisto japonica*, fish larvae, and copepod *Neocalanus plumchrus* were distinguished from the total number. Amphipods (Hyperiidea) prevailed by the proportion in food bolus, and fish larvae by frequency (Table 2 and 3).

On the area of western periphery of the deepwater depression, the juvenile chum salmon diet was less diverse: 7 forms, mainly, the interzonal species common for the Okhotsk Sea open waters. Fish juveniles (indefinite remains) and euphausids *Euphausia pacifica, Thysanoessa inermis, Euphausiacea gen. sp.* prevailed in stomachs by the abundance coefficient (Table 2 and 3).

A total of 19 species of food components were identified in chum juveniles of the Prostor Bay; euphausids with the dominating species from the genus *Thysanoessa* (most probably *Th. longipes*) and copepods from the genus *Neocalanus* dominated by the abundance coefficient. From the area adjoining to the Yekaterina Strait, a total of 20 species of food components were identified. Four groups of food objects prevailed in feeding (abundance coefficient > 100): euphausids (*Thysanoessa longipes),* amphipods *(Primno macropa* and *Themisto japonica)*, larval decapods, and copepods (Calanoida gen. sp.) belonging, most probably, to the genus *Neocalanus* (Table 2 and 3).

Pteropods, chaetognaths, and tunicates were related to the secondary food in all the surveyed regions.

Juvenile masu salmon. Juveniles of this species were met only at 6 stations (6 ind.), which were performed in the southwestern part of the Okhotsk Sea (in the Aniva Bay and over the eastern Sakhalin shelf and depths slope area) under SST between 6.2 and 12°C (Fig. 5). Body lengths and weights of masu juveniles caught in the Aniva Bay and over the southeastern Sakhalin shelf and depths slope varied within 13.5-16.5 cm and 25-51 g, respectively, averaged 15.1 cm and 37.5 g. A sea zone of the scales growth included 13 sclerities for masu salmon 15.9 cm long and 44 g weigh, caught in Aniva Bay. Over the northeastern Sakhalin shelf, masu juveniles had the larger size-weight indices: a length from 14.1 to 19.4 cm, and body weight from 28 to 84 g, averaged 16.8 cm and 56 g.

The mean index of stomach fullness was 136.1 $^{o}/_{ooo}$ with the maximum at the very north site (450 $^{o}/_{ooo}$) and minimum near Cape Svobodniy (6.6 $^{o}/_{ooo}$). In the Aniva Bay, above the depths to 50 m, only planktonic invertebrates *Thysanoessa raschii* and *Themisto japonica* were found in stomachs of juvenile masu salmon. Along the southeastern Sakhalin shore, larval fish and planktonic larval decapods appeared in the masu diet, and the neritic species *Thysanoessa raschii* was replaced by the interzonal widely-distributed *Euphausia pacifica*. Along the northeastern Sakhalin shore, on the line of Chayvo Bay, a portion of the neritic euphausid species *Thysanoessa raschii* and larval sand lance increased in stomachs; farther to the north, a food bolus consisted only of the juvenile sand lance. On the average, larval fish and euphausids prevailed in the diet by frequency, relative weight, and abundance coefficient.

Juvenile coho salmon. Juvenile coho salmon were the least frequent being observed only at 4 stations (Fig. 5). One specimen was caught over the depths slope of southeastern Sakhalin under SST 12.6°C; its length was 21 cm, weight 108 g (age 1.0+), and 9 sclerities in the sea zone of growth. Three other specimens were caught over the northeastern Sakhalin shelf and depths slope under SST between 7.4 and 9.2°C. The length of one of them was 16.6 cm, weight 218 g (age 2.0+), and 7 sclerities in the sea zone of growth. The two other individuals were 15.5 and 16.1 cm long and 35 and 39 g weigh.

A total of 10 forms of food objects from different taxonomic groups, including air insects, fish, planktonic and benthic invertebrates, have been identified from the coho salmon stomachs. The base of the food bolus (86.6%) was formed by 5 fish species. Within the 100-m isobath, juvenile fish from the neritic and near-bottom complexes, including walleye pollock juveniles, prevailed in the coho diet. With the increase in sea depth, the species from the planktonic shelf complex have been appearing in the food bolus, and escaping from the diet at the depth more than 1 km.

Maturing salmon and other fish species. In addition to juvenile salmon, a total of 782 maturing pink salmon and 18 maturing chum salmon were caught. The maturing pink and chum salmon were observed both along the Sakhalin shores and along the southern Kuril Islands. However, they were the most frequent over the northeastern Sakhalin shelf. In total, including the maturing salmon, 39 fish species from 20 families has been found from catches (Table 4). In the Aniva Bay, La Perouse Strait, and along the southeastern Sakhalin shore, the ichthyosenosis of the upper pelagial was presented by 30 species from 19 families; over the northeastern Sakhalin shelf and depths slope – 30 species from 15 families; over the deepwater depression – 14 species from 11 families; along the southern Kuril Islands – 20 species from 14 families.

In the southwestern part of the sea (southward of 49º N), the base of abundance and biomass was formed by the juvenile arabesque greenling (*Pleurogrammus azonus*), mature and juvenile capelin (*Mallotus villosus catervarius)*, juvenile herring (*Clupea pallasii*), and northern smoothtongue (*Leuroglossus shmidti*) caught at night over the deepwater part of the sea (Table 4, Fig. 8 and 9). There, the most frequent were juvenile Bering wolffish (*Anarchhichas orientalis*) and sculpins from the genera *Hemilepidotus* and *Hemitripterus,* and in the La Perouse Strait these were Japanese anchovy (*Engraulis japonicus*) and Pacific spiny lumpsucker (*Eumicrotremus orbis*). Over the northeastern Sakhalin shelf and depths slope, the base of catches was made by mature walleye pollock (*Theragra chalcogramma*), herring, maturing pink salmon, and sand lance (*Ammodytes hexapterus*). The mature capelin, juvenile sculpins from the genus *Hemilepidotus,* and butterfly sculpin (*Melletes papillio*) were often met. The northern smoothtongue dominated from catches at the night stations over the depths slope. Along the southern Kuril Islands, the base of abundance and biomass was formed by the juvenile arabesque greenling, maturing pink and chum salmon, and juvenile and larval walleye pollock. On the whole, a composition of the fish community from the upper pelagic zone and abundance indices of the mass nekton species appeared to be close to those being observed earlier in the southern part of the Okhotsk Sea in the summer period (Shuntov et al., 1993; Radchenko et al., 1997; Radchenko et al., 2002).

DISCUSSION

According to the popular idea, juveniles of the Asiatic pink salmon after entering a sea spend two or even three months (June – August) on the inside and mid parts of the shelf area within the regions of reproduction. Juveniles begin leaving for the outside shelf area and open waters in late July – August, and their mass re-distribution takes place in September (Birman, 1985; Shuntov, 1994; Karpenko, 1998; Karpenko et al., 1998; Kaev, Chupakhin, 2002). Taking into account a high pink salmon abundance on the shelf area of the eastern Sakhalin (hundreds of million, at the minimum), it could be expected that the pink salmon CPUE would be formed of tens or even hundreds of specimens when using the mean properly sized trawls as 54.4/192. But in reality this is not so. In late June – early July 2003, a total of 48 stations have been performed in the Aniva Bay, La Perouse Strait, and over the southeastern Sakhalin shelf and depths slope; the mean CPUE of juvenile pink salmon was only 0.2 ind./trawl. On the northeastern Sakhalin shelf and depths slope, a total of 76 stations have been performed in late July – early August; no juvenile pink salmon were observed from catches. We remind that since late May through early July 2003, a total of 422 million of pink fry have migrated downstream the eastern Sakhalin rivers. The same picture we observed in the preceding year. In late June – early July 2002, a total of 29 stations were performed in the Aniva Bay, La Perouse Strait, and over the southeastern Sakhalin shelf and depths slope; the mean CPUE of juvenile pink salmon was 1.1 ind./trawl. Over the northeastern Sakhalin shelf and depths slope, 76 stations were performed in the second half of July; the mean CPUE of juvenile pink salmon was 0.9 ind./trawl (Shubin et al., 2003). At the same time, the total harvest of the juvenile pink salmon from the eastern Sakhalin rivers constituted 1,684 million ind. in 2002. Thus, by the 2002 and 2003 data, CPUE of pink juveniles over the eastern Sakhalin shelf and depths slope is quite discordant to the value of their harvest from the rivers of this region. The observed CPUE values might be connected either with the inefficiency of fishing gear or with the low density of aggregations due to their dispersion over the eastern Sakhalin shelf. In the southern part of the Okhotsk Sea in summer period, the smallest pink juveniles (length 4.9-9.4 cm, weight 0.7-3.0 g) are being caught with the purse seine, and the largest fish (length 11.1-14.7 cm, weight 14.0-30.0 g) with the drift nets (Ueno et al., 1992; Ueno, Shimizu, 1996a). The size-weight indices of juvenile pink salmon from the catches of the mean properly-sized mid-water rope trawls occupy an intermediate position (Ueno et al., 1997; Shubin et al., 2003); this may be connected with the filtering of some part of specimens less than 8-10 cm long through the net part of a trawl. Thus, in 2003, during sorting the trawl catches at R/V “Dmitry Peskov”, 91% of specimens among 32 pink and chum juveniles less than 7.2 cm were collected from the front part of the trawl bag. All juvenile salmon more than 7.5 cm long were taken from the trawl codend. In addition, we need to note that in the southwestern part of the Okhotsk Sea, chum juveniles caught were 3 times more than pink ones, and masu and coho juveniles almost as many as pink salmon. All the pink salmon juveniles were less than 9 cm long, and masu and coho salmon more than 9 cm long. The trawl account of juvenile salmon in the southern part of the Okhotsk Sea in summer period using the mid-water rope trawls constantly shows the low CPUE estimates (Shuntov, 1989, 1994; Ueno et al., 1997). At the same time, the trawl account shows the high CPUE estimates in the autumn period. Thus, in November 2003, we have conducted the counting works in the southeastern part of the Okhotsk Sea using the idem mid-water rope trawl of 54.4/192 m. CPUE of the juvenile pink salmon varied from

116 to 364 ind./trawl, chum juveniles from 12 to 209 ind./trawl. Pink juveniles were from 19 to 31 cm long, chum from 16 to 33 cm. Another reason for a low CPUE of juvenile pink salmon on the eastern Sakhalin shelf could be connected with their dispersion over the shelf area after entering a sea. The eastern Sakhalin coastline is straight and open without any bays and bights cut deep inland, and coastal islands divided by narrow straits. Due to this, there are no areas in the coastal zone where juvenile pink salmon could stay and form dense aggregations. If we compare other habitat conditions, for example in the straits of the southeastern Alaska coastal archipelago, we can note that the juvenile pink salmon CPUE in June-July is rather high. This is connected both with peculiarities of the southeastern Alaska coastline and with larger sizes of juveniles in late June and July (on the average 9.0 cm and 12.0 cm, respectively) (Orsi et al., 2002).

In late June, the size-weight indices of juvenile pink salmon are from 2.6 to 6.4 cm and from 0.5 to 2.4 g on the inside shelf area of the southeastern Sakhalin (Shubin et al., 1996). The length and weight of pink juveniles caught in late June – early July 2002 and 2003 along the southern Sakhalin shore were greater (6.5-11.0 cm and 2-9 g, respectively). Judging from these indices, a great part of pink juveniles migrated to the sea as early as May; so, by the origin they might be both from the southern Sakhalin rivers and from Hokkaido.

Juvenile chum salmon caught in the southwestern part of the Okhotsk Sea, judging from their great size-weight indices (9.2-21.5 cm), have originated from the rivers of Japan, where they are released from hatcheries earlier compared to Sakhalin. The largest specimens, migrating to the sea accordingly earlier than other fish, moved northward farther in the Okhotsk Sea. In July, the aggregations of juvenile chum salmon from 8 to 22 cm long are common over the eastern Sakhalin shelf and depths slope southward of 49° N. (Shuntov, 1989; Shuntov et al., 1995; Shubin et al., 2003). Evidently, the aggregations of juvenile chum salmon on the shelf area of the northern Kunashir Island are also formed by those originated from Japan. Taking into account the size-weight indices of juvenile pink and chum salmon caught in the Prostor Bay, undoubtedly, that they have originated from the rivers of Iturup Island.

The size indices of juvenile masu salmon caught in July 2003 along the eastern Sakhalin shore were equal to those in the preceding year (13.5-19.4 cm and 13.5-21.0 cm, respectively). In mid-summer they are actually being observed in the southern part of the Okhotsk Sea; their length is from 14.7 to 31 cm (Shuntov et al., 1993; Shuntov et al., 1995; Ueno, Shimizu, 1996; Ueno, 1997), which is greater compared to our catches in 2002 and 2003. Most probable, the masu specimens caught near the eastern Sakhalin shore are of the native origin. The same is right in respect of the juvenile coho salmon, which occur in July in the southern part of the Okhotsk Sea only near the eastern Sakhalin shore (Radchenko et al., 2002).

REFERENCES

Birman I.B. 1985. Pacific salmon ocean life and stock dynamics. Agropromizdat, Moscow 208 p. (in Russian).

Gritsenko O.F. 1981. On the population structure of pink salmon *Oncorhynchus gorbuscha* (Walbaum). Vopr. Ichtiologii. 21:787-799. (in Russian).

Ivankov V.N., Andreeva V.V., Tyapkina N.V., Rukhlov F.N., Fadeeva N.P. 1999. Biology and feeding base of juvenile Pacific salmons during the early period of ocean life. Vladivostok. Far Eastern State University Press. 260 p. (in Russian).

Kaev A.M., Chupakhin V.M. 2002. Early sea period of pink salmon *Oncorhynchus gorbuscha* and chum salmon *O. keta* in Iturup Island. Transactions of SakhNIRO. 4:116-132. (in Russian).

Karpenko V.I., Erokhin V.G., Smorodin V.P. 1998. Abundance and biology of Kamchatkan salmon during the initial year ocean residence. NPAFC Bull. No. 1:352-366.

Karpenko V.I. 1998. The early sea life of Pacific salmons. Moscow. VNIRO. 166 p. (in Russian)

Guidance for marine investigation of Pacific Salmon. 1997. Petropavlovsk-Kamchatski: KamchatNIRO. 64 p. (in Russian).

Guidance for investigation of fish diet and food preference in natural environment. 1974. Nauka, Moscow. 254 p. (in Russian).

Chuchukalo V.I., Napazakov V.V. 1999. Addendum to the Guidance for determining diurnal dietary intake and digestion rate of predatory and benthivorous fish. Izv. TINRO. 126:160-171. (in Russian).

Mikilich A.V., Rodionov N.A. 1975. Weight parameter of some species of zooplankton in the Sea of Japan. Hydrobiological studies in the Sea of Japan and Pacific Ocean. Proceedings of Pacific Oceonagraphic Institute, Academy of Sience, USSR. Vladivostok: 9:75-88. (in Russian).

Chislenko L.L. 1968. Nomographic chart for determining aquatic species weight by size and shape. Nauka, Leningrad. 106 p. (in Russian).

Lubny-Gertsyk E.A. 1953. Weight parameter of main zooplankton species in Pacific Ocean and Bering Sea. Lecture Report, Academy of Science USSR. Vol. 91, No. 6:949-952. (in Russian).

Orsi J.A., Fergusson E.A., Herd W.R., Mortensen D.G., Sturdevant M.V., Wertheimer A.C., Wing B.L. 2002. Survey of juvenile salmon in the marine waters of southeastern Alaska, May-September 2001. NPAFC Doc. 630. 51 p.

Paliy V.F. 1961. Quantitative indices when processing the faunistic materials. Zoological Journal. 40:3-6. (In Russian).

Radchenko V.I., Mel'nikov I.V., Volkov A.F., Semenchenko A.Yu., Glebov I.I., Mikheev A.A. 1997. Environmental conditions and composition of plankton and nekton in epipelagic layer of the southern Sea of Okhotsk and adjacent Pacific waters in summer. Biologiya morya. 23: 15-25. (in Russian).

Radchenko V.I., Kantakov G.A., Shubin A.O., Stominok D.Yu., Phephilov Yu.V., Malakhova Yu.A., Dolgikh M.G. 2002. Ichthyocenosis and physical conditions of upper epipelagy off shore south-east of Sakhalin during downstream migration of juvenile salmon. Proceedings SakhNIRO. Yuzhno-Sakhalinsk: 4:70-92. (in Russian).

Shershnev A.P., Chupakhin V.M., Rudnev V.A. 1982. Some features of the ecology of young Sakhalin and Iturup pink salmon *Oncorhynchus gorbuscha (Walbaum) (Salmonidae)* during marine period of life. Vopr.Ichthyologii 22: 441-448. (in Russian).

Shubin A.O. 1994. Peculiarities of the early sea life period for pink and chum salmon from the different areas of reproduction and its role in the formation of generations' numbers in the southeastern part of Sakhalin Island. "Taxonomy, biology, and biotechnics of salmonid fishes propagation". Materials of V All-Russian conference. Sankt-Peterburg. P. 225-228 (in Russian).

Shubin A.O., Fedotova N.A., Senchenko I.A. 1996. Distribution, food supply and feeding of pink salmon juveniles in southeastern Sakhalin littoral waters. In: Fishery researches in Sakhalin-Kuril region and adjoining areas. Transactions of SakhNIRO. V. 1. Yuzhno-Sakhalinsk. 1:21-33 (in Russian).

Shubin A.O., Radchenko V.I., Stominok D.Y., Dolgikh M.G., Kantakov G.A., Pischalnik V.M., Romanov A.A., Chastikov V.N. 2003. Distribution of juvenile salmon along the eastern Sakhalin coast in late June-July 2002 by the R/V «Dmitry Peskov» cruise data. NPAFC Doc. 668. 24 p.

Shuntov V.P. 1989. Distribution of juvenile Pacific salmon from the genus *Oncorhynchus* in the Okhotsk Sea and adjacent waters of the Pacific Ocean. Vopr. Ichthyologii. 29: 239-248 (in Russian).

Shuntov V.P., Radchenko V.I., Lapko V.V., Poltev Yu.N. 1993. Distribution of salmon in Sakhalin-Kuril waters during anadromous migrations. Vopr. Ichthyologii 33: 348-358 (in Russian).

Shuntov V.P. 1994. New data on marine life of Asian pink salmon. Izv. TINRO. 116:3-41. (in Russian).

Shuntov V.P., Lapko V.V., Balanov A.A., Startsev A.V. 1995. Interannual changes in anadromous migrations of salmons in the Sakhalin-Kurile region. Biologiya morya. 21:116-124 (in Russian).

Ueno Y., Shimizu I., Shubin A.O. 1992. Summary of Japan-Russian cooperative salmon research aboard the research vessel «Wakashio-maru» in 1992. Report on the Research of Salmon Resources in the North Pacific Ocean in 1992. Salmon Report Series 36:47-52

Ueno Y., Shimizu I. 1996a. Summary of Japan-Russian cooperative juvenile salmon research aboard the research vessel «Wakashio-maru» in 1995. Report on the Research of Salmon Resources in the North Pacific Ocean in 1995. Salmon Report Series 41:66-72

Ueno Y., Shimizu I. 1996b. Summer distribution and migration routes of juvenile chum salmon (*Oncorhynchus keta*) originating from river in Japan. Bull. Nat. Res. Inst. Far Seas Fish. No 33:139-147

Ueno Y. 1997. Distribution and biological characteristics of juvenile salmon in the Sea of Okhotsk in the early-summer of 1997. NPAFC Doc. 267. 18 p.

Table 1. Size-weight indices of juvenile pink and chum salmon in the southern part of the Okhotsk Sea in late June – early August 2003 by the regions of fishery

Region	Date	N, ind.	Fork Length (cm)		Weight (g)	
			Lim	M±s	Lim	M±s
Pink						
Aniva Bay, La Perouse Strait, southeastern Sakhalin	June 27 – July 05	8	6.6-8.7	7.84±0.27	2-5	3.50±0.40
Prostor Bay	July 10-11, 17-18	10	5.6-7.8	6.70±0.24	1-3	1.85±0.27
Chum						
Aniva Bay, La Perouse Strait, southeastern Sakhalin	June 27 – July 05	17	9.2-12.0	10.92±0.19	6-15	10.82±0.59
Abissal area	7-8, 19 July	8	11.3-21.5	15.54±1.49	11-91	38.88±10.82
Prostor Bay	July 10-11, 17-18	39	5.9-7.8	6.86±0.07	1-3	2.26±0.08
Yekaterina Strait area	July 15-16	94	8.2-12.6	10.43±0.10	4-16	8.68±0.26

Table 2. Abundance coefficient of food groups of the juvenile chum salmon by the regions of fishery

Group	Southeastern Sakhalin shelf and depths slope	Western periphery of the deepwater depression	Prostor Bay	Yekaterina Strait
Euphausiacea	1095.26	2507.93	6078.11	3219.99
Pisces	631.97	3391.32	0.39	63.50
Amphipoda	837.17	117.53	2.87	2098.75
Calanoida	140.77	9.28	451.17	258.00
Decapoda	0.07	0.00	8.19	5.19
Tunicata	0.00	0.00	0.00	301.65
Insecta	25.07	0.00	0.00	0.00
Chaetognatha	0.00	0.00	0.00	0.37

Table 3. Basic indices of the juvenile chum salmon diet by the regions of fishery

Food components	Aniva Bay – southeastern Sakhalin shelf and depths slope			Western periphery of the deepwater depression			Prostor Bay (Iturup Island)			Yekaterina Strait		
	Proportion in a food bolus, %	Frequency, %	Coeff. of abund.	Proportion in a food bolus, %	Frequency, %	Coeff. of abund.	Proportion in a food bolus, %	Frequency, %	Coeff. of abund.	Proportion in a food bolus, %	Frequency, %	Coeff. of abund.
Calanus sp.	0	0	0	0	0	0	0.04	33.33	1.37	0	0	0
Eucalanus bungii	0	0	0	0	0	0	0.10	33.33	3.47	0	0	0
Neocalanus cristatus	0	0	0	0	0	0	0.05	33.33	1.63	0.16	20	3.21
Neocalanus plumchrus	8.27	14.29	118.17	0	0	0	0.004	33.33	0.12	1.51	60	90.71
Neocalanus sp.	0	0	0	0.278	33.33	9.28	5.13	66.67	342.17	0.11	20	2.12
Pseudocalanus sp.	0	0	0	0	0	0	0.22	33.33	7.22	0.001	20	0.02
Clausocalanus sp	0	0	0	0	0	0	0	0	0	0.12	20	2.34
Metridia pacifica	0.89	14.29	12.70	0	0	0	2.57	33.33	85.62	0.11	20	2.23
Metridia sp.	0.55	14.29	7.84	0	0	0	0.02	33.33	0.73	0	0	0
Centropages abdominalis	0	0	0	0	0	0	0	0	0	0.01	20	0.29
Calanoida gen. sp.	0.14	14.29	2.07	0	0	0	0.27	33.33	8.86	7.85	20	157.08
Ostracoda gen. sp.	0.29	14.29	4.08	0	0	0	0	0	0	0	0	0
Limacina helicina	0.19	28.57	5.53	0	0	0	0	0	0	0.29	40	11.80
Primno macropa	0.68	28.57	19.47	2.20	33.33	73.46	0.09	33.33	2.87	20.87	100	2086.95
Themisto japonica	28.62	28.57	817.70	0.66	66.67	44.07	0.07	33.33	2.31	12.76	20	255.14
Euphausia pacifica	20.88	28.57	596.56	29.25	66.67	1950.05	0	0	0	1.92	20	38.35
Thysanoessa longipes	13.10	28.57	374.40	0	0	0	16.56	66.67	1104.25	34.28	80	2742.48
Thysanoessa raschii	0	0	0	0	0	0	0.09	33.33	3.16	0	0	0
Thysanoessa inermis	6.29	14.29	89.81	3.62	33.33	120.62	0	0	0	0	0	0
Thysanoessa sp.	2.41	14.29	34.50	0	0	0	74.53	66.67	4968.40	3.07	60	184.02
Euphausiacea gen. sp.	0	0	0	13.12	33.33	437.25	0	0	0	0.26	20	5.19
Chionocetes opilio, zoea	0	0	0	0	0	0	0.22	33.33	7.30	0	0	0
Decapoda gen. sp., zoea	0	14.29	0.07	0	0	0	0.03	33.33	0.89	0	0	0
Decapoda gen. sp., megalopa	0	0	0	0	0	0	0	0	0	14.75	20	294.99
Oikopleura vanhoeffeni	0	0	0	0	0	0	0	0	0	0.31	20	6.29
Oikopleura sp.	0	0	0	0	0	0	0	0	0	0.02	20	0.37
Chaetognatha gen. sp.	0	0	0	0	0	0	0.01	33.33	0.39	0	0	0
Pisces, *Sebastes sp.*	0	0	0	0	0	0	0	0	0	0.01	20	0.29
Pisces, Cottidae gen. sp.	0	0	0	0	0	0	0	0	0	1.58	40	63.21
Pisces gen. sp., larvae	14.75	42.86	631.97	50.87	66.67	3391.32	0.04	33.33	1.37	0	0	0
Insecta	1.75	14.29	25.07	0	0	0	0.10	33.33	3.47	0	0	0

Table 4. Species composition of the community, fish frequency (%) and their biomass (%) in early summer 2003 by the regions of fishery

Fish species	La Perouse Strait	Aniva Bay	Southeastern Sakhalin area	Abissal area	Southern Kuril area	Norheastern Sakhalin area
Petromyzonidae						
Lethenteron japonicum	11.1/0.002	11.7/0.005	4.5/0.019			6.5/0.003
Lamnidae						
Lamna ditropis		5.9/15.9		9.1/37.0		1.3/2.68
Clupeidae						
Clupea pallasii	44.4/10.04	76.47/6.2	45.5/7.82			44.7/32.78
Sardinops sagax			4.5/0.012			
Engraulidae						
Engraulis japonicus	33.3/0.89	23.5/2.7	36.4/7.54	18.2/0.02	10.8/0.07	
Osmeridae						
Mallotus villosus catervarius	44.4/19.80	94.1/73.2	50.0/44.11		29.7/0.28	56.5/1.48
*Mallotus villosus catervarius (*l)*			4.5/0.004			2.6/0.00
Salmonidae						
Oncorhynchus gorbuscha		5.9/0.20		72.7/12.7	21.6/16.3	55.3/13.76
O. gorbuscha (ju)**			18.2/0.011		8.1/0.03	
O. keta				9.1/0.94	5.4/5.8	5.4/5.8
O. keta(ju)	22.2/0.11	5.9/0.001	18.2/0.028	45.5/0.078	24.3/0.74	
O. tshawytscha						1.32/0.06
O. masou (ju)		5.9/0.005	13.6/0.04			2.6/0.002
O. kisutch (ju)				9.1/0.02		3.95/0.004
Salvelinus leucomaenis						1.32/0.005
Bathylagidae						
*Bathylagus okhotensis^*			4.5/0.002	18.2/0.18		1.32/0.074
*Leuroglossus schmidti^*			4.5/28.4	18.2/18.5		1.32/0.37
Myctophidae						
*Stenobrachius leucopsarus^*				9.1/0.002		
Zoarcidae						
Bothrocarina microcephala			4.5/0.15			
Stichaeidae						
Stichaeidae sp. (l)			9/0.0		8.1/0.002	
Lumpenus macilatus(l)		5.9/0.01	18.2/0.03			
Gadidae						
Theragra chalcogramma			4.5/0.292		21.6/10.7	44.74/39.83
Theragra chalcogramma(l*)*				18.2/0.002	40.5/0.06	1.3/0.000
Eleginus gracilus	22.2/0.011				2.7/0.1	
Gadus macrocephalus					2.7/2.9	

(Table 4, continue)

Gasterosteidae *Gasterosteus aculeatus*	33.3/0.04	17.6/0.001	4.5/0.004			
Scorpaenidae *Sebastes minor*		11.8/0.006	9/0.05	9.1/0.02	2.7/0.06	1.3/0.001
Sebastes glaucus						2.6/0.015
Sebastes minor (ju)					13.5/0.003	
Ammodytidae *Ammodytes hexapterus* (l)					24.3/0.3	
Ammodytes hexapterus			9/0.03		2.7/0.01	23.6/8.18
Anarchichadidae *Anarchichas orientalis*						1.3/0.012
Anarchichas orientalis (ju)	77.7/4.9	100/0.37	63.6/0.41	45.5/0.19	2.7/0.001	7.8/0.004
Hexagrammidae *Pleurogrammus azonus*	77.7/26.3	100/0.69	68.2/9.71	81.8/30.3	43.2/64.9	9.2/0.072
P. monopterigius					2.7/0.0	
Cottidae *Myoxocephalus jaok*			31.8/0.012		5.4/0.002	
Hemilepidotus sp.	66.6/0.18	23.5/0.03	45.5/0.06		62.2/0.07	19.7/0.001
Melletes papillio						14.4/0.071
Hemitripteridae *Nautichthys pribilovius*						1.32/0.000
Hemitripterus villosus	100/8.29	100/0.46	50/0.08		8.1/0.002	2.63/0.000
Cyclopteridae *Eumicrotremus orbis*	77.8/29.4	47/0.09	36.4/1.24	9.1/0.005		
Eumicrotremus pacificus		5.9/0.04				
Cyclopterus lindbergi		11.8/0.007				
Aptocyclus ventricosus					2.7/0.8	
Pleuronectidae *Limanda sakhalinensis*						1.3/0.000
Reinchardtius hippoglossoides (l)					8.1/0.002	1.3/0.000

*(l)** –larvae
*(ju)*** - juveniles
^ - at the night stations, calculation from the total number of stations

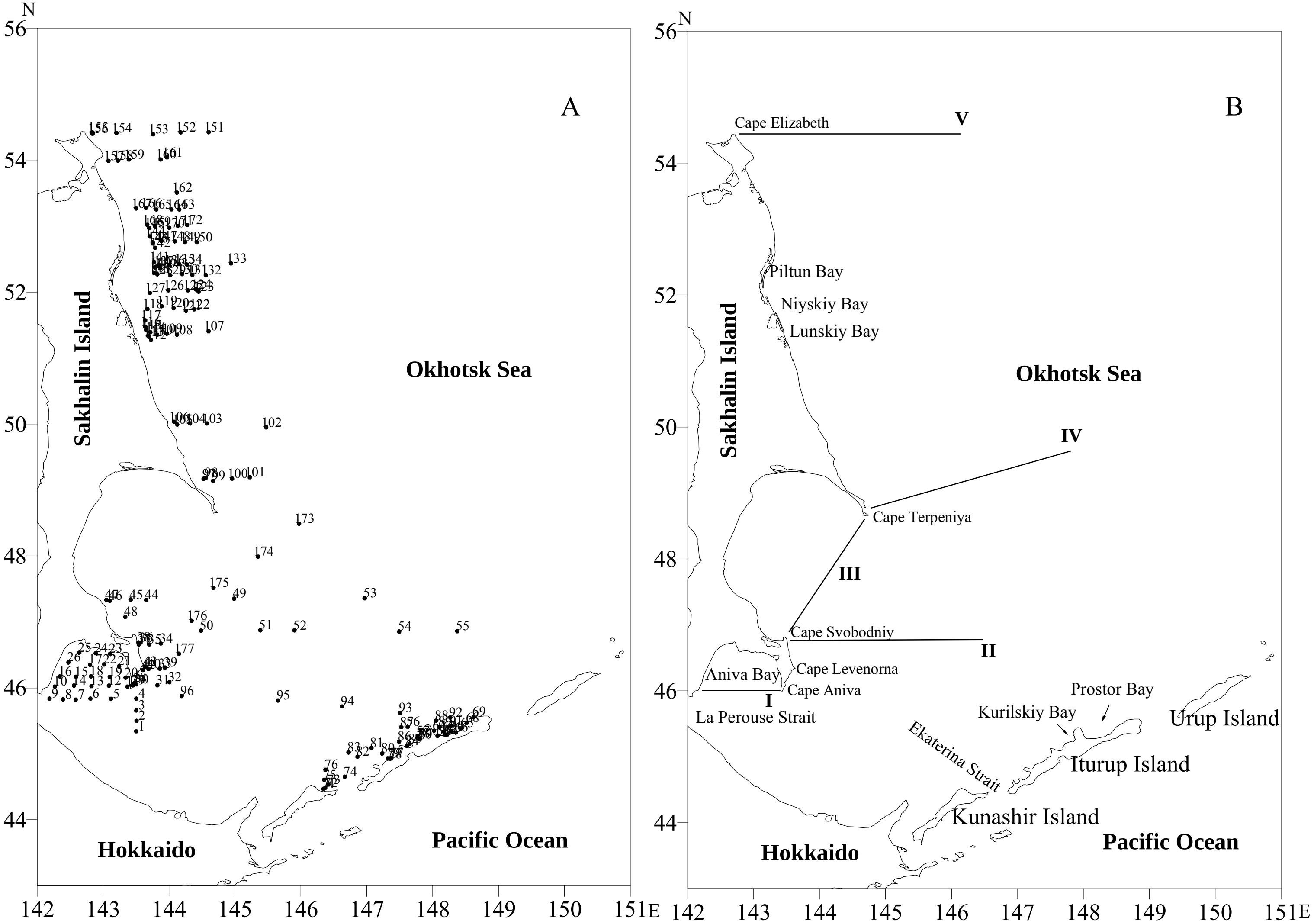

Fig. 1. Scheme of trawl stations (A) and hydrological transects (B) during the cruise in late June – early August 2003.

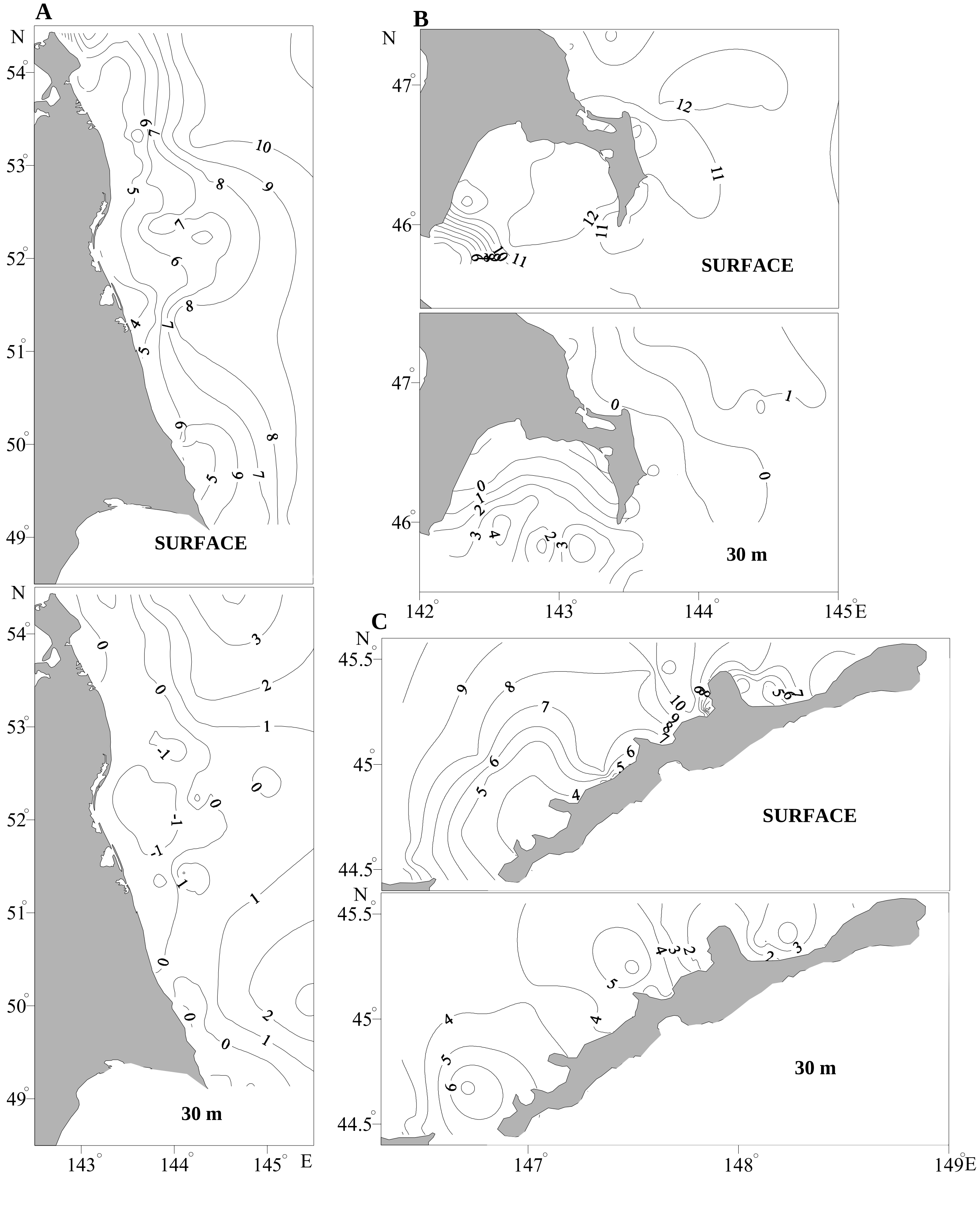

Fig. 2. Distribution of temperatures at the surface and at 30 m along the northeastern Sakhalin shore (A), in Aniva Bay and along the southeastern Sakhalin shore (B), along the southern Kuril Islands (C)

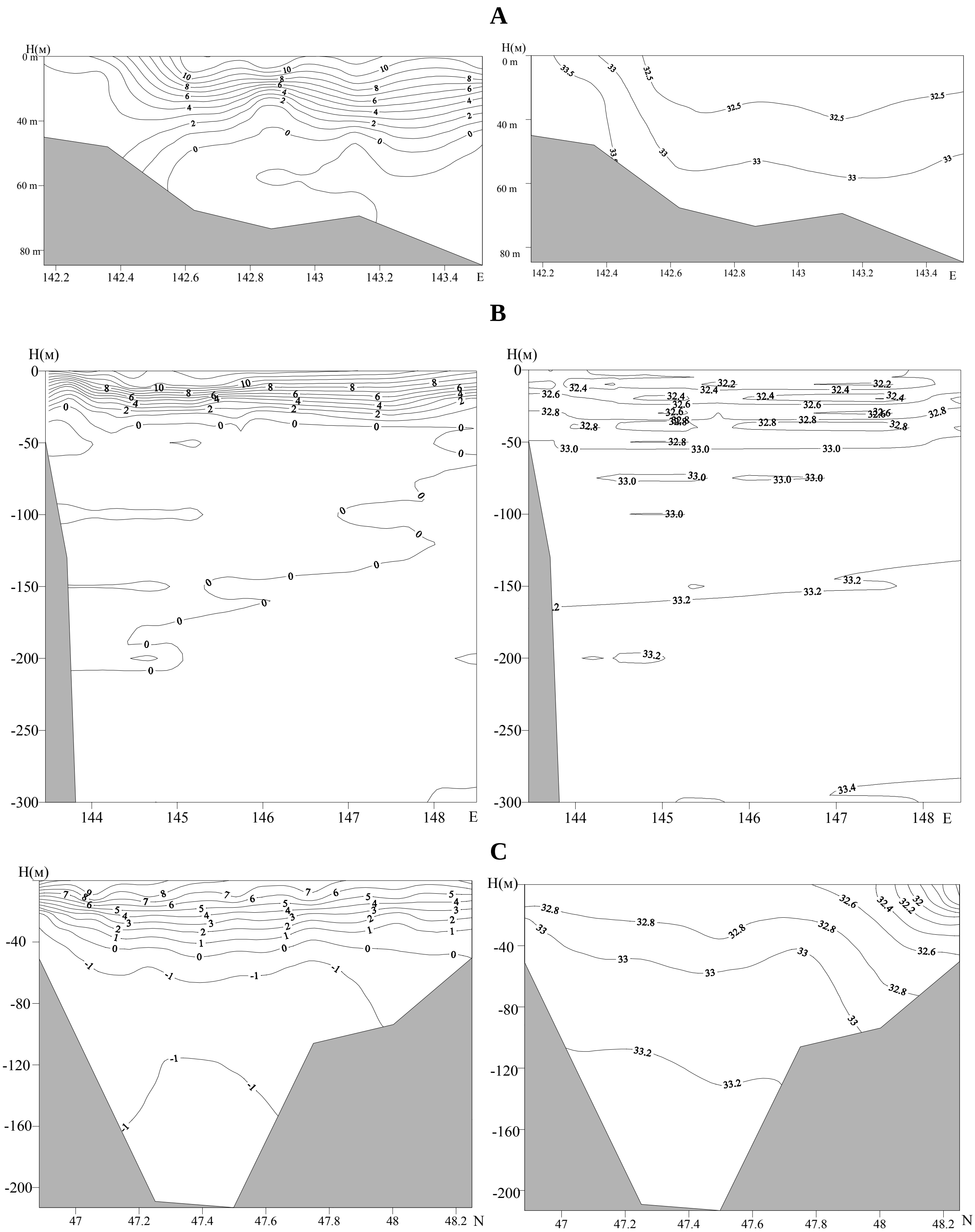

Fig. 3. Vertical profiles of temperature (left) and salinity (right) by transects I (A), II (B) and III (C). (The scheme of transects in Fig. 1B).

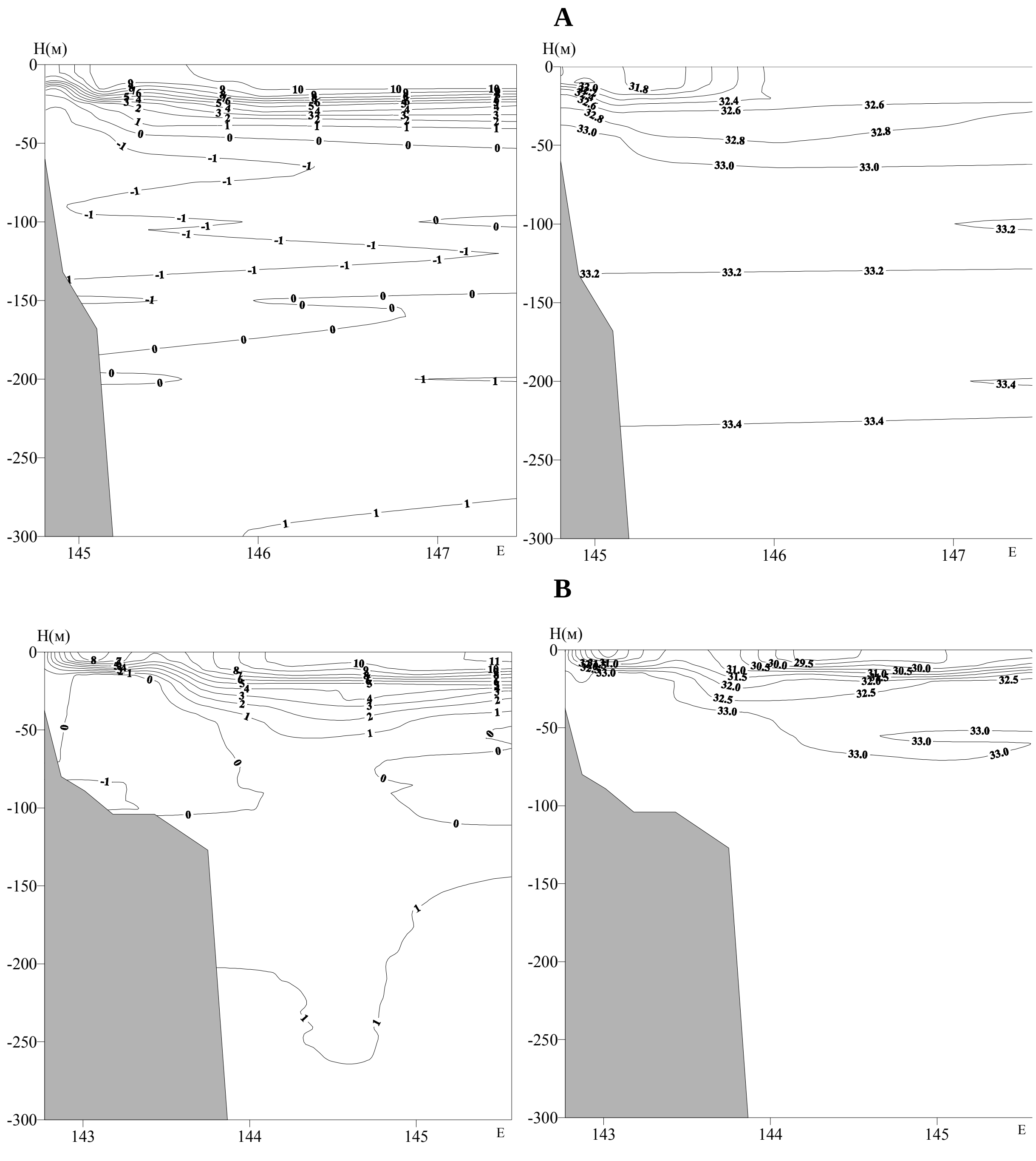

Fig. 4. Vertical profiles of temperature (left) and salinity (right) by transects IV (A) and V (B). (The scheme of transects in Fig. 1B).

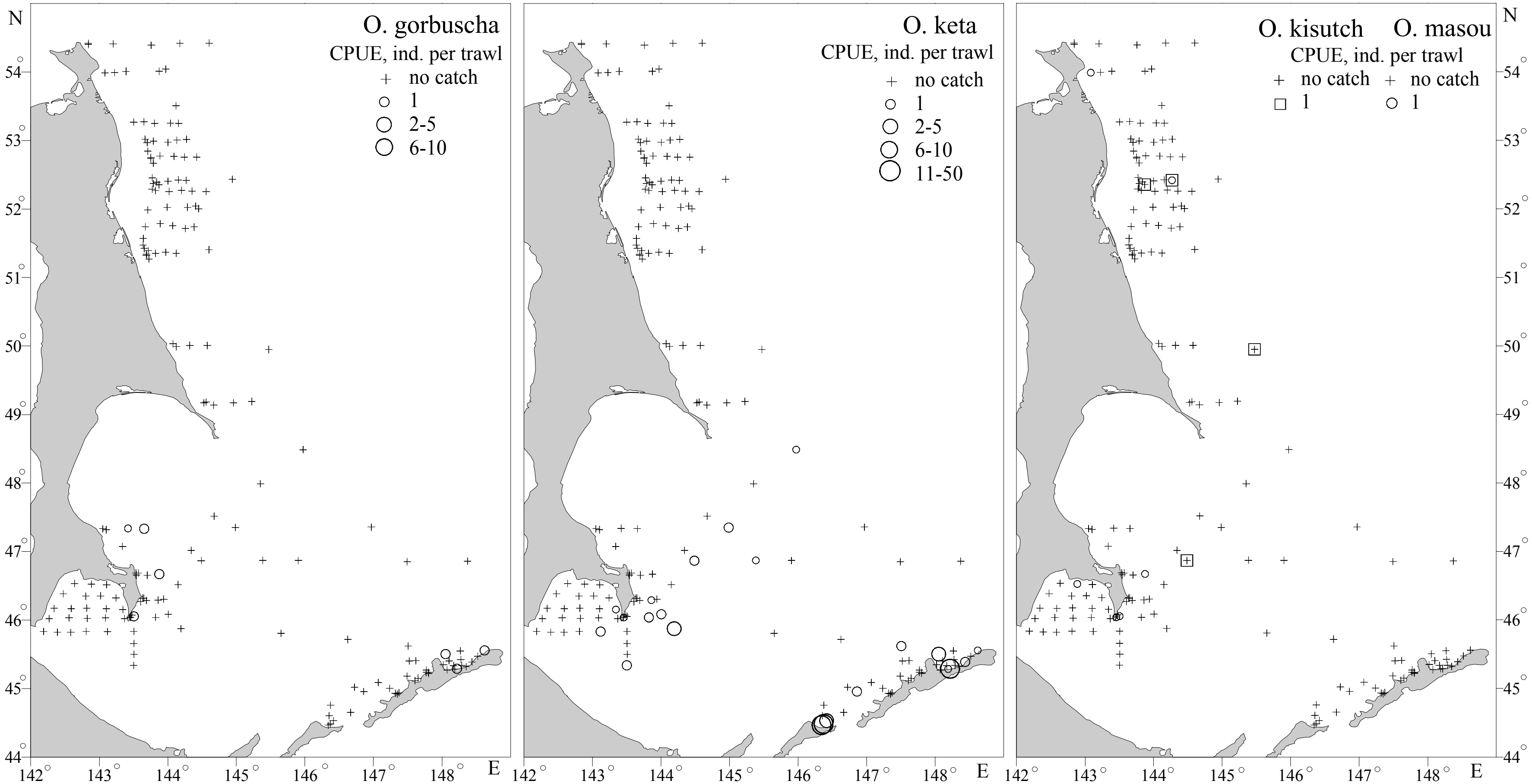

Fig. 5. Distribution and CPUE of juvenile pink, chum, coho and masu salmon in the southern Okhotsk Sea in late June – early August 2003

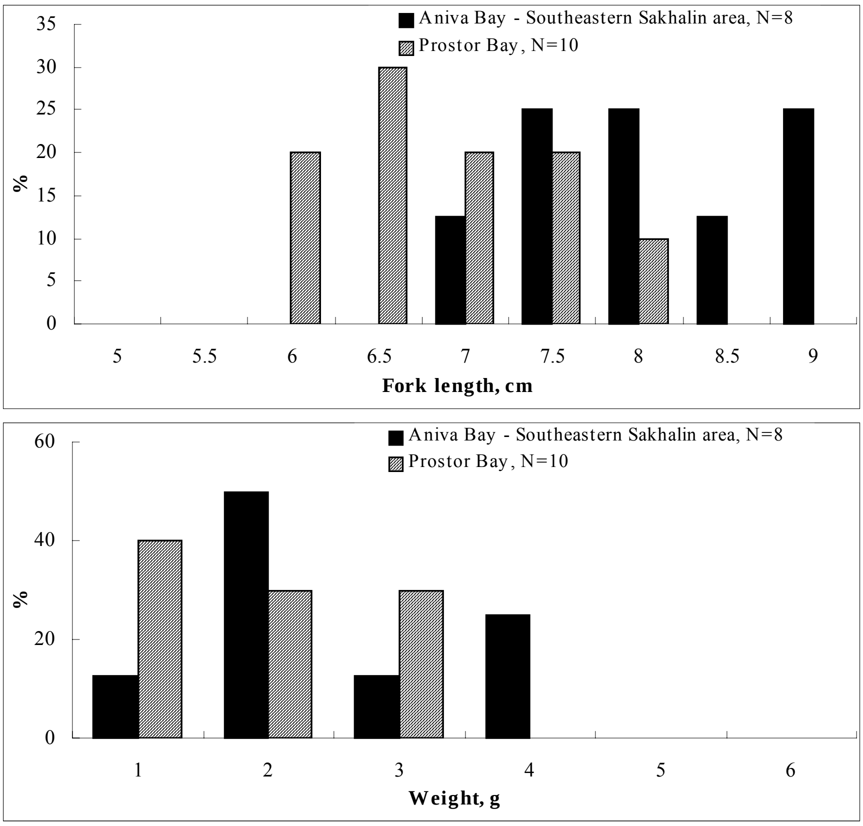

Fig. 6. Length and weight composition of juvenile pink salmon catches in early summer 2003

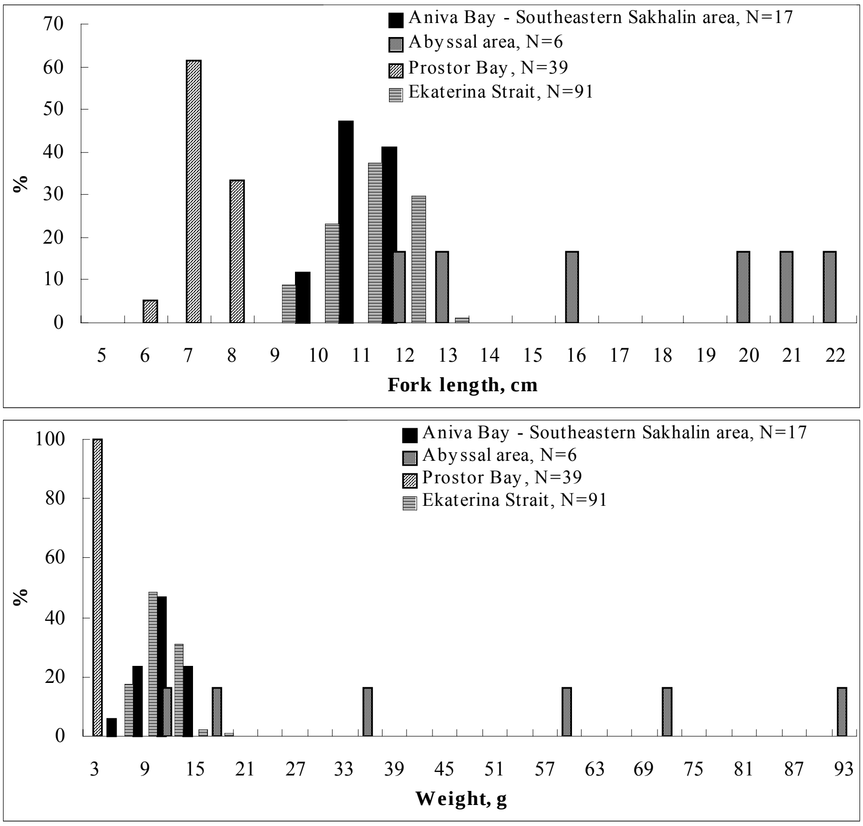

Fig. 7. Length and weight composition of juvenile chum salmon catches in early summer 2003

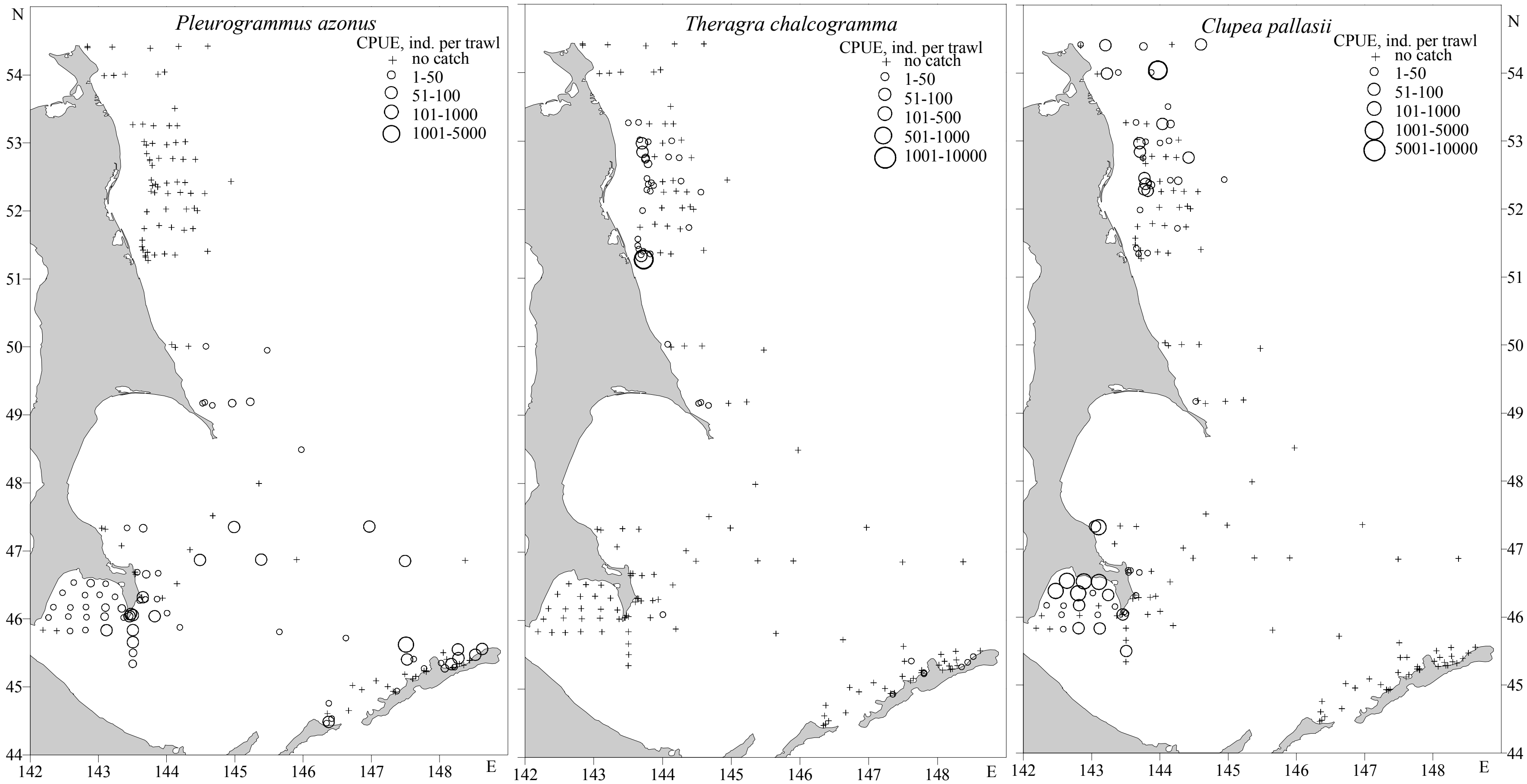

Fig. 8. Distribution and CPUE of *Pleurogrammus azonus*, *Theragra chalcogramma* and *Clupea pallasii* in the southern Okhotsk Sea in early summer 2003

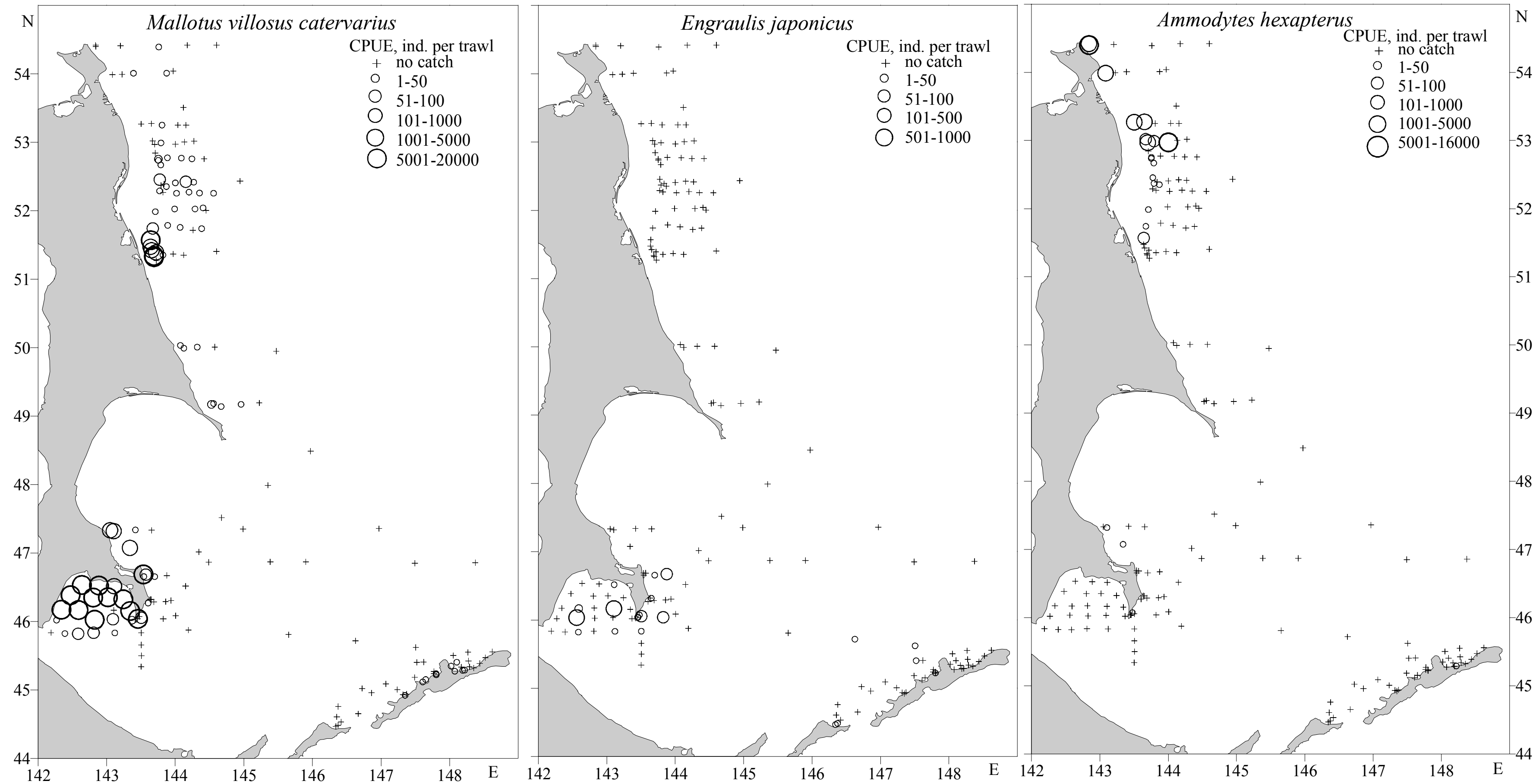

Fig. 9. Distribution and CPUE of *Mallotus villosus catervarius, Engraulis japonicus* and *Ammodytes hexapterus* in the southern Okhotsk Sea in early summer 2003