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Differences of major fish species abundance estimates in the epipelagic layer of the Russian Far Eastern seas based on data of daytime and nighttime trawlings

by

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Differences of major fish species abundance estimates in the epipelagic layer of the Russian Far Eastern seas based on data of daytime and nighttime trawlings

ABSTRACT

The methods of TINRO-center abundance estimates for Pacific salmon, Pacific saury and juveniles of Atka mackerel and arabesque greenling both daytime and nighttime trawlings are used. No fishing power correction factors are used in order to bring daytime and nighttime trawlings data into the common dataset. In the study presented, based on the original data collected by TINRO-center during complex epipelagic surveys in Okhotsk, Bering and Japan Seas and adjacent Pacific waters in 1991-2002, the CPUEs of above-mentioned species are analyzed for daytime and nighttime trawlings. During the comparison of nighttime and daytime trawlings results it was found, that for the most species studied the presence in daytime trawlings catches was more frequent compared with nighttime catches. Also for the most surveys studied, between nighttime and daytime trawlings the statistically significant differences in relative abundance estimates were observed. For all the species studied the CPUEs decreased in nighttime trawlings compared with daytime. Only immature chinook salmon was an exception since no statistically significant differences were observed for this species. Most likely, that the nighttime migration of the investigated species closer to the surface results in their greater avoidance of trawl. To obtain correct abundance estimates and get a picture of CPUEs spatial distribution we need to account for diel differences in catches of investigated species.

INTRODUCTION

According to the TINRO-center methods of abundance estimates for Pacific salmon, Pacific saury and juveniles of Atka mackerel and arabesque greenling both daytime and nighttime trawlings are used. No fishing power correction factors are used in order to bring daytime and nighttime trawlings data into the common dataset. It is considered that the daytime has no influence on the amount of catch per unit effort for these species. Therefore no differences in abundance estimates are expected. In cases if we do have differences this is due to the random error. TINRO-center's methods of complex epipelagic surveys are based on trawlings which are conducted round-the-clock. Such a round-the-clock trawlings enable us to conduct surveys in a shorter time periods. On the other hand in order to incorporate TINRO-Center's surveys data into the single dataset with the data from other scientific institutions we have to take a round-the-clock manner of trawlings into account. Also in order to estimate species abundance correctly we have to account for diel changes the level of

catches. The purpose of this study was to compare CPUE values for daytime and nighttime trawlings based on the original data collected at TINRO-center complex epipelagic surveys.

MATERIALS AND METHODS

The original data collected by RV "TINRO", "Professor Kaganovsky", "Professor Kizevetter", "Professor Levanidov" and "Professor Soldatov" during complex epipelagic surveys in Okhotsk, Bering and Japan Seas and adjacent Pacific waters in 1991-2002, the CPUEs of above-mentioned species are analyzed for daytime and nighttime trawlings. All of the epipelagic surveys, which contained at least one catch of investigated species and its size-age groups (juveniles, immature, mature), were considered. The particular emphasis was given to data on Pacific salmon. It is well known (Birman, 1985; Shuntov et al., 1993a; Shuntov et al., 1993b; Ogura, 1994) that Pacific salmon dwell mostly in the upper 30-50 meters layer, which is effectively fished by the trawls used by TINRO-center.

The trawling surveys of upper epipelagic layer in the spring, summer, fall and winter period were conducted using the standard midwater rope trawls (trawl types: PT/TM 80/396, PT/TM 108/528 and PT/TM 119/450). In order to achieve the required parameters of research vessel trawling system the trawling course was adjusted according to weather and hydrological conditions. Usually the trawl was towed for one hour.

The analysis was performed for juvenile Pacific salmon (pink salmon – *Oncorhynchus gorbuscha*, chum salmon – *O. keta*, sockeye salmon – *O. nerka*, coho salmon – *O. kisutch*, masu salmon – *O. masou*), mature pink salmon, immature chinook salmon - *O. tschawytscha* (fork length – 43.5–93.0 cm) and mature coho salmon (47.5–77.5 cm). Most of the n.0+ Pacific salmon from the investigated trawlings were shorter than 30 cm (pink salmon - 9.9-28.9 cm, chum salmon - 7.7-29.4 cm, sockeye salmon - 15.6-29.8 cm, coho salmon - 13.8-33.2 cm, masu salmon - 16.1-33.0 cm). The juvenile arabesque greenling (*Pleurogrammus azonus*) had fork length of 9.7–22.0 cm and juvenile Atka mackerel (*P. monopterygius*) - 4.0-21.5 cm. All of the epipelagic surveys, which contained at least one catch of investigated species and its size-age groups (juveniles, immature, mature), were considered. The separate datasets were formed for particular survey's working area (Okhotsk, Bering and Japan Seas, Pacific Ocean).

In order to classify trawlings in two groups (daytime and nighttime trawlings) the NOAA Sunset/Sunrise Calculator provided at National Oceanographic and Atmospheric Administration website (www.srrb.noaa.gov/highlights/sunrise/sunrise.html) was used. Survey periods, number of trawlings and major technical characteristics of trawlings are provided at Table 1. Only trawlings with the following technical characteristics were selected

for analysis: trawling velocity is more or equal 4 knots; length of warps is more or equal 350 m. In addition to these requirements one of the following selection criteria was used:

1) headrope depth during the trawling is less or equal 25 m, depth at trawling location is more or equal 500 m; segregation of trawlings into the daytime and nighttime trawlings was done with the help NOAA Calculator.

2) headrope depth during the trawling is less or equal 25 m, depth at trawling location is more or equal 500 m; trawlings that contained mesopelagic fish species were considered nighttime trawlings and all others - daytime trawlings

3) headrope depth during the trawling is equal 25 m (headrope was located directly at the surface), depth at trawling location is more or equal 500 m; segregation of trawlings into the daytime and nighttime trawlings was done with the help NOAA Calculator.

3) headrope depth during the trawling is less or equal 25 m, no restrictions on depth at trawling location are imposed; segregation of trawlings into the daytime and nighttime trawlings was done with the help NOAA Calculator.

4) headrope depth during the trawling is equal 0 m (headrope was located directly at the surface), no restrictions on depth at trawling location are imposed; segregation of trawlings into the daytime and nighttime trawlings was done with the help NOAA Calculator.

The preliminary study has shown that almost all of the trawlings, which were classified as a daytime trawlings with the help NOAA Calculator, did not contain any mesopelagic fish species (Table 1). This speaks in favor that our classification of trawlings (daytime and nighttime) was correct.

No statistically significant differences between the major technical characteristics of trawlings (velocity, length of warps, horizontal and vertical spread of trawl). For each station the abundance and the biomass of all the nekton representatives per specified unit of area (individuals/km^2 and kg/km^2) was calculated using the following formula:

$$N(B) = \frac{n(m)}{1.852 \cdot v \cdot t \cdot 0.001 \cdot a \cdot k},$$

where N is abundance of particular species (individuals/km^2),

B is biomass (kg/km^2),

n is actual number of particular species caught (individuals),

m is weight of particular species in the catch (kgs),

1.852 - number of kilometers in one nautical mile,

v is a speed of trawl towing (knots),

t is duration of the trawling (hrs),

a is a horizontal spread of the trawl (m),

k is a fishing efficiency coefficient

For the mature salmon and immature species with body length exceeding 30 cm, k was set at 0.3, for the salmon shorter than 30 cm k was set to be 0.4, for the Pacific saury - 0.1 and the juveniles of Atka mackerel and arabesque greenling - 0.2.

The average values of relative abundance were calculated separately for daytime and nighttime trawlings of particular survey's working area (Okhotsk, Bering and Japan Seas, Pacific Ocean). The ratios of these values (daytime CPUEs/nighttime CPUEs) were estimated as a fishing power correction factors for particular species. Similar approach was employed previously when calculating fishing power differences for various trawls (Wilderbuer et al., 1998; von Szalay, Brown, 2001).

The Shapiro-Wilk W test showed that CPUEs were not normally distributed. Due to this nonparametric Mann-Whitney U test was used to test the differences in daytime and nighttime CPUEs. Similar statistical procedures were used previously in studies on diurnal variation in the salmon catches in drift gillnets (Eriksen, Marshall, 1997).

RESULTS AND DISCUSSION

Summary data on relative abundance estimates are presented in Tables 1and 2. The particular emphasis was given to results obtained for the first type of trawlings selection (trawlings with headrope depth during the trawling less or equal 25 m, depth at trawling location is more or equal 500 mand segregation of trawlings into the daytime and nighttime trawlings was done with the help NOAA Calculator). The results obtained for the other 3 types of trawlings selection were quite similar and provide additional support of our results.

During the comparison of nighttime and daytime trawlings results it was found, that for the most species studied the presence in daytime trawlings catches was more frequent compared with nighttime catches (Table 1, 2). Also for the most surveys studied, between nighttime and daytime trawlings the statistically significant differences in abundance estimates were observed (Table 3). For all the species studied (.0+ pink salmon, .0+ chum salmon, n.0+ sockeye salmon, n.0+ coho salmon and n.0+ masu salmon, mature pink and coho salmon, Pacific saury and juveniles of Atka mackerel and arabesque greenling) the CPUEs decreased in nighttime trawlings compared with daytime (Table 1, 2). Only immature chinook salmon was an exception since no statistically significant differences were observed for this species (Table 3). In general, for the majority of the investigated surveys (each survey consisted of series of trawlings), the steady and statistically significant decrease of CPUEs was observed at nighttime trawlings. Also at nighttime trawlings the investigated species

appeared in catches more rarely as compared with daytime (Table 2). Some species at several surveys were caught only during the daytime and did not appear in night catches (Table 1).

The results, obtained from the trawlings classification based on mesopelagic fish species presence/absence (the 2nd type of trawlings selection), also have shown the decrease of CPUEs at nighttime (Table 1, 2). This fact is well correlated with the abrupt decrease of CPUEs of mesopelagic fish species during daytime. The results, obtained from the 3rd and 4th types of trawlings selection, have shown that decrease of Pacific salmon and other investigated species CPUEs at nighttime was typical shelf areas as well (no restrictions on depth at trawling location were imposed during selection of trawlings).

We checked our assumption that the lesser nighttime CPUEs values were observed for all types of trawls used in surveys. This was done by selecting trawlings that were conducted by means of particular trawl type. In cases, when the quantity of trawlings was sufficient, the significant differences were observed. For the trawl PT/TM 108/528, which was used most frequently, the differences were significant for most species (Table 3): juvenile pink salmon ($P=0.03$), mature pink salmon ($P<0.005$), n.0+ coho salmon ($P<0.005$), mature coho salmon ($P<0.005$), n.0+ sockeye salmon ($P=0.02$), juvenile arabesque greenling ($P=0.03$) and juvenile Atka mackerel ($P<0.005$). Also, the examination of Figures1 and 2 of respective CPUEs values for every survey show a clear decrease of CPUEs at nighttime for all types of trawl.

Evidently, the decrease of CPUEs at nighttime is due to the diurnal vertical migrations and behavior of investigated species. Most likely, that the nighttime migration of the investigated species closer to the surface results in their greater avoidance of trawl. We consider that during nighttime the maximum horizontal spread of trawl becomes more distant from the major concentrations of fish. This results in smaller CPUEs. Such explanation agrees quite well with the data from literature on diurnal vertical migrations of Pacific salmon. The decrease of CPUEs at nighttime can not be a result of species migration to the deeper water layers. There were some observations of significant depth of chinook salmon presence (Ogura, 1994; Radchenko, Glebov, 1998; Murphy, Heard, 2001). It has been reported for Pacific salmon species that the average depth of presence is lesser for the nighttime period (Ogura, Ishida, 1992; Ishida et al., 1998; Wada, Ueno, 1999; Walker et al., 2000; Walker et al., 2001; Friedland et al., 2001). On the other hand, no clear tendency for chinook salmon to migrate closer to the sea surface during the nighttime has been reported (Ogura, 1994; Murphy, Heard, 2001).

During the epipelagic trawling at TINRO-center surveys the hydrodynamic plate, which is mounted on the headrope, creates turbidity at the surface. This may frighten away the investigated species. Also, the research vessel itself will frighten away mostly the fishes,

which are located closer to the surface, as compared with the fishes, which are located deeper.

The results we received testify for significant diurnal variation in CPUEs of investigated species. In the light of this we can conclude that there is necessity to introduce species-specific fishing power correction factors in order to bring daytime and nighttime trawlings data into the common dataset. The fishing power correction factors which were obtained as the result of this study were determined as mean CPUEs ratios ($CPUE_{daytime}/CPUE_{nighttime}$). The fishing power correction factors for all investigated species were more than 1, which reflects lesser CPUEs of Pacific salmon, Pacific saury and juveniles of Atka mackerel and arabesque greenling at nighttime at the all surveys, vessels, trawl types and regions which we studied. The fishing power correction factors for pink and chum salmon juveniles rather close - 1.3 and 1.7, respectively (Table 2). The fishing power correction factors for n.0+ sockeye and coho salmon were highest among salmon species - 14.6 and 5.8, respectively. Similarly the mature coho salmon had greater fishing power correction factor (4.9) than mature pink salmon (1.7). For masu salmon the intermediate values of fishing power correction factor - 2.5 were noted. The values of fishing power correction factors for Pacific saury and juveniles of Atka mackerel and arabesque greenling were higher (8.3-78.9), than those for Pacific salmon. In order to utilize adequate fishing power correction factors the further studies in this area are needed. To obtain correct abundance estimates and get a picture of CPUEs spatial distribution we need to account for diel differences in catches of investigated species. Otherwise, the there is danger of obtaining incorrectly low estimates of species abundance due to the underestimated CPUEs values at nighttime trawlings. We consider the exclusion of nighttime trawlings during abundance calculation highly undesirable. Such an approach may distort the overall picture of catches spatial distribution. On the other hand the round-the-clock manner of trawling enables to estimate mesopelagic species abundance as well as overall species composition of epipelagic community.

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Table 1.

Survey periods, number of trawlings, major technical characteristics of trawlings and species abundance estimates

Species	Size-age group	Research Vessel	Sea	Type of trawl	Time of the day	Beginning of survey	End of survey	N	V, knots	L	VS	HS	DH	D	ind/hr$_{meso}$	%	ind/km^2 25-500	%$_{meso}$	ind/km^2 ms	ind/km^2 25-0	ind/km^2 0-0
O. gorbuscha	.0+	Pr. Soldatov	Okh	108/528	day	July 2, 1993	August 14, 1993	43	5	264	45	45	2	2190	0	7	31	9	26	25	2
					night	July 2, 1993	August 14, 1993	21	5	265	45	45	2	1894	3294	0	0	0	0	0	0
		Pr. Kaganovsky	Okh	108/528	day	July 15, 1992	August 12, 1992	23	5	312	40	50	1	839	0	4	0	3	0	0	1
					night	July 14, 1992	August 12, 1992	8	5	312	40	50	2	975	7241	0	0	0	0	0	0
				80/396, 108/528	day	August 14, 1999	October 27, 1999	24	5	252	30	48	1	1950	0	63	2040	63	3523	1748	1883
					night	August 13, 1999	October 27, 1999	30	4	246	34	43	0	1743	853	67	863	64	721	681	785
				80/396, 108/528	day	September 4, 2000	November 10, 2000	15	4	246	39	33	1	1496	0	87	3328	92	3426	2081	3819
					night	October 7, 2000	November 11, 2000	26	5	253	38	32	1	2085	7080	92	2337	91	1573	1599	2581
		Pr. Kizevetter	Okh	108/528	day	July 31, 1996	August 23, 1996	24	5	344	42	51	0	2301	0	4	1	4	1	122	131
					night	July 31, 1996	August 23, 1996	11	5	341	41	51	0	1931	3594	9	2	13	2	2	2
		Pr. Levanidov	Okh	108/528	day	July 11, 1991	August 13, 1991	13	5	291	40	49	3	925	0	8	5	7	4	3	4
					night	July 21, 1991	August 13, 1991	4	5	285	40	49	0	925	13081	0	0	0	0	1	1
			Pac	108/528	day	March 12, 1992	April 5, 1992	16	5	330	39	51	18	5248	0	25	54	25	60	54	
					night	March 11, 1992	April 12, 1992	23	5	306	40	50	6	5213	0	22	38			38	3
				108/528	day	November 10, 1994	January 13, 1995	18	4	280	50	44	1	5044	0	67	525	59	786	437	506
					night	November 9, 1994	January 13, 1995	33	4	282	50	45	0	4546	449	76	1046	73	652	997	1025
			Okh	108/528	day	November 23, 1995	December 28, 1995	6	4	350	45	50	0	2260	0	100	4365	100	3425	3273	4365
					night	November 22, 1995	December 27, 1995	8	4	336	45	49	0	2825	672	100	4186	100	3571	3044	3720
				108/528	day	July 28, 1996	September 14, 1996	21	5	325	42	50	0	1024	0	10	2	8	1	1	1
					night	July 28, 1996	September 15, 1996	9	5	325	42	50	1	1272	2100	0	0	0	0	0	0
				119/450	day	July 10, 1997	August 29, 1997	11	5	323	40	46	5	1895	0	18	8	20	80	56	76
					night	July 11, 1997	August 27, 1997	7	5	266	40	43	2	1391	12831	0	0	0	0	22	24
		TINRO	Pac	108/528	day	May 21, 1991	June 21, 1991	10	5	335	50	47	19	5340	0	0	0	7	9	0	
					night	February 21, 1991	June 20, 1991	50	5	328	50	47	4	5382	0	10	12	0	0	12	6
			Okh	108/528	day	July 21, 1993	August 16, 1993	15	5	293	48	46	1	1846	0	13	62	10	46	40	42
					night	July 21, 1993	August 16, 1993	11	5	275	48	45	0	2253	1952	9	1	9	1	0	0
				108/528	day	August 10, 1994	October 13, 1994	24	5	331	50	48	0	1755	0	42	667	42	562	558	586
					night	August 12, 1994	October 13, 1994	20	5	321	50	47	0	1493	8603	60	382	50	288	215	221
				108/528	day	August 26, 1998	October 30, 1998	22	5	244	38	46	1	2113	0	41	1252	46	1506	1059	1037
					night	August 27, 1998	November 1, 1998	23	5	245	39	46	1	1978	8118	61	879	58	806	652	832
				80/396	day	August 20, 2001	November 8, 2001	27	5	254	39	32	0	2149	0	52	2363	47	1684	1679	1934
					night	August 21, 2001	November 9, 2001	32	5	248	41	31	0	1903	1193	59	2931	65	3233	2132	2469
			Ber	80/396	day	September 3, 2002	October 14, 2002	27	5	274	38	33	0	3145	0	44	2060	43	1599	1466	1547
					night	September 2, 2002	October 14, 2002	20	5	273	38	33	0	3022	8011	40	560	32	448	325	335
			Okh	80/396	day	October 19, 2002	October 30, 2002	7	5	276	38	33	0	1760	0	100	2943	100	3858	2943	2943
					night	October 18, 2002	October 27, 2002	11	5	271	37	33	0	1779	309	91	1494	90	768	1494	1494
		Total	Total	Total	day	Total	Total	346	5	296	42	45	3	2404	0	36	1095	38	1144	864	1180
					night			347	5	288	42	44	1	2367	4410	37	818		710	623	750

Table 1 continued.

Species	Size-age group	Research Vessel	Sea	Type of trawl	Time of the day	Beginning of survey	End of survey	N	V, knots	L	VS	HS	DH	D	ind/hr$_{meso}$	%	ind/km^2 25-500	%$_{meso}$	ind/km^2 ms	ind/km^2 25-0	ind/km^2 0-0
O. gorbuscha	mature	Pr. Soldatov	Okh	108/528	day	July 2, 1993	August 14, 1993	43	5	264	45	45	2	2190	0	79	100	81	109	107	129
					night	July 2, 1993	August 14, 1993	21	5	265	45	45	2	1894	3294	86	97	86	108	90	149
		Pr. Kaganovsky	Pac	108/528	day	June 18, 1991	July 24, 1991	19	5	330	45	49	3	3343	0	95	280	100	269	270	113
					night	July 4, 1991	July 24, 1991	4	5	338	45	49	1	4468	28	100	81	67	87	71	
			Ber	108/528	day	June 25, 1991	July 3, 1991	10	5	320	45	48	8	2785	0	80	480	86	537	324	105
					night	June 26, 1991	July 3, 1991	4	5	288	45	46	6	3348	4	100	690	100	120	552	
			Okh	108/528	day	July 16, 1991	August 11, 1991	26	4	335	45	49	1	1795	0	96	654	94	601	489	574
					night	July 17, 1991	August 11, 1991	10	5	350	45	50	1	2148	216	80	111	85	96	85	
				108/528	day	July 15, 1992	August 12, 1992	23	5	312	40	50	1	839	0	96	98	86	92	115	82
					night	July 14, 1992	August 12, 1992	8	5	312	40	50	2	975	7241	75	60	100	49	53	37
				108/528	day	July 11, 1995	August 29, 1995	35	5	212	45	41	0	2058	0	94	474	90	385	450	450
					night	July 11, 1995	August 29, 1995	19	5	212	45	41	0	2074	1959	68	119	70	114	116	116
			Pac	108/528	day	July 27, 1995	August 27, 1995	18	5	202	45	41	0	4068	0	100	307	95	268	275	275
					night	July 29, 1995	August 27, 1995	12	5	203	45	41	0	3333	2248	75	110	82	103	232	232
			Okh	80/396, 108/528	day	August 14, 1999	October 27, 1999	24	5	252	30	48	1	1950	0	46	16	37	13	23	24
					night	August 13, 1999	October 27, 1999	30	4	246	34	43	0	1743	853	13	3	16	3	4	5
		Pr. Kizevetter	Pac	108/528	day	June 16, 1993	July 30, 1993	18	5	248	52	42	1	3983	0	56	109	50	159	137	168
					night	July 7, 1993	July 29, 1993	8	5	250	52	43	0	4663	1453	63	50	71	57	40	44
			Ber	108/528	day	June 18, 1993	July 6, 1993	21	5	261	52	43	1	2858	0	81	134	72	119	97	108
					night	June 21, 1993	July 7, 1993	4	5	255	52	43	1	2300	27	50	35	75	44	20	35
			Okh	108/528	day	July 15, 1993	August 2, 1993	11	5	250	52	43	1	2185	0	82	208	77	181	177	199
					night	July 15, 1993	August 3, 1993	8	5	253	52	43	0	1951	2114	100	230	100	230	230	230
				108/528	day	July 31, 1996	August 23, 1996	24	5	344	42	51	0	2301	0	96	269	96	372	247	260
					night	July 31, 1996	August 23, 1996	11	5	341	41	51	0	1931	3594	91	178	94	181	168	174
		Pr. Levanidov	Pac	108/528	day	July 5, 1991	August 10, 1991	25	5	301	40	50	1	3952	0	88	486	84	455	526	531
					night	July 9, 1991	August 8, 1991	11	5	291	40	49	0	4646	10316	82	224	77	256	187	193
			Okh	108/528	day	July 11, 1991	August 13, 1991	13	5	291	40	49	3	925	0	69	370	73	409	232	305
					night	July 21, 1991	August 13, 1991	4	5	285	40	49	0	925	13081	75	409	67	272	229	229
			Pac	108/528	day	March 12, 1992	April 5, 1992	16	5	330	39	51	18	5248	0	63	527	56	270	527	
					night	March 11, 1992	April 12, 1992	23	5	306	40	50	6	5213	0	57	56			56	91
			Ber	108/528	day	July 4, 1992	July 15, 1992	17	5	343	37	53	1	2874	0	53	14	56	14	23	24
					night	July 11, 1992	July 14, 1992	3	5	343	37	53	0	3055	115	67	5	50	4	8	8
			Okh	108/528	day	July 8, 1994	August 11, 1994	16	5	312	50	47	1	899	0	88	659	87	474	1443	1618
					night	July 18, 1994	August 12, 1994	8	5	308	50	46	0	797	21743	88	527	89	627	209	244
			Ber	108/528	day	June 19, 1995	July 9, 1995	28	5	316	50	47	0	2842	0	71	178	71	169	122	125
					night	June 20, 1995	July 7, 1995	14	5	311	50	46	0	3099	550	86	153	90	139	134	140
			Okh	108/528	day	July 19, 1995	August 1, 1995	5	5	330	50	47	0	2840	0	100	595	100	595	427	409
					night	July 20, 1995	August 2, 1995	5	5	340	50	48	0	2218	2085	100	423	100	423	335	335
				108/528	day	July 28, 1996	September 14, 1996	21	5	325	42	50	0	1024	0	76	157	73	166	396	396
					night	July 28, 1996	September 15, 1996	9	5	325	42	50	1	1272	2100	89	183	89	92	134	132
			Okh	119/450	day	July 10, 1997	August 29, 1997	11	5	323	40	46	5	1895	0	64	81	73	72	40	51
					night	July 11, 1997	August 27, 1997	7	5	266	40	43	2	1391	12831	71	80	71	80	18	16

Table 1 continued.

Species	Size-age group	Research Vessel	Sea	Type of trawl	Time of the day	Beginning of survey	End of survey	N	V, knots	L	VS	HS	DH	D	ind/hr$_{meso}$	%	ind/km^2 25-500	%$_{meso}$	ind/km^2 ms	ind/km^2 25-0	ind/km^2 0-0
O. gorbuscha	mature	TINRO	Pac	108/528	day	May 21, 1991	June 21, 1991	10	5	335	50	47	19	5340	0	90	354	51	195	354	
					night	February 21, 1991	June 20, 1991	50	5	328	50	47	4	5382	0	46	157	100	7	157	163
		TINRO	Pac	108/528	day	June 27, 1993	August 3, 1993	44	5	296	48	46	1	3914	0	91	186	87	168	187	196
					night	July 4, 1993	August 4, 1993	22	5	281	48	46	0	4380	4096	68	87	77	86	86	86
			Okh	108/528	day	July 21, 1993	August 16, 1993	15	5	293	48	46	1	1846	0	73	82	70	79	82	86
					night	July 21, 1993	August 16, 1993	11	5	275	48	45	0	2253	1952	82	49	82	49	36	36
				108/528	day	August 10, 1994	October 13, 1994	24	5	331	50	48	0	1755	0	71	258	67	238	186	196
					night	August 12, 1994	October 13, 1994	20	5	321	50	47	0	1493	8603	45	203	55	222	113	116
			Okh	108/528	day	July 2, 1995	August 15, 1995	36	5	278	50	45	0	1680	0	83	239	84	187	149	149
					night	July 10, 1995	August 13, 1995	8	5	303	50	46	0	2153	8401	75	71	75	72	21	21
			Pac	108/528	day	July 15, 1995	July 29, 1995	19	5	290	50	46	0	4320	0	100	459	96	405	528	528
					night	July 17, 1995	July 29, 1995	8	5	265	50	44	0	4226	10938	100	157	100	148	222	222
			Okh	108/528	day	August 26, 1998	October 30, 1998	22	5	244	38	46	1	2113	0	50	142	46	121	121	145
					night	August 27, 1998	November 1, 1998	23	5	245	39	46	1	1978	8118	43	33	42	32	25	15
				80/396	day	August 18, 2000	August 30, 2000	12	5	301	31	35	1	2473	0	100	168	93	153	130	131
					night	August 19, 2000	August 31, 2000	8	5	294	30	35	0	1898	2206	100	190	90	332	162	162
				80/396	day	May 21, 1991	November 8, 2001	27	5	254	39	32	0	2149	0	48	63	40	89	49	56
					night	February 21, 1991	November 9, 2001	32	5	248	41	31	0	1903	1193	25	8	26	11	38	44
		Total	Total	Total	day	Total	Total	633	5	294	44	46	2	2615	0	79	189	76	245	274	265
					night			405	5	288	45	46	1	2637	4379	73	249		139	128	121
O. keta	.0+	Pr. Soldatov	Okh	108/528	day	July 2, 1993	August 14, 1993	43	5	264	45	45	2	2190	0	30	66	28	69	54	85
					night	July 2, 1993	August 14, 1993	21	5	265	45	45	2	1894	3294	19	2	18	2	2	1
		Pr. Kaganovsky	Okh	108/528	day	July 16, 1991	August 11, 1991	26	4	335	45	49	1	1795	0	19	27	15	21	18	48
					night	July 17, 1991	August 11, 1991	10	5	350	45	50	1	2148	216	20	2	15	2	1	
				108/528	day	July 11, 1995	August 29, 1995	35	5	212	45	41	0	2058	0	11	12	8	9	11	11
					night	July 11, 1995	August 29, 1995	19	5	212	45	41	0	2074	1959	0	0	0	0	0	0
				80/396, 108/528	day	August 14, 1999	October 27, 1999	24	5	252	30	48	1	1950	0	58	1253	58	1220	1074	1157
					night	August 13, 1999	October 27, 1999	30	4	246	34	43	0	1743	853	63	396	68	413	312	360
				80/396, 108/528	day	September 4, 2000	November 10, 2000	15	4	246	39	33	1	1496	0	87	1062	92	864	665	1208
					night	October 7, 2000	November 11, 2000	26	5	253	38	32	1	2085	7080	92	1055	91	1123	722	1206
		Pr. Kizevetter	Okh	108/528	day	July 15, 1993	August 2, 1993	11	5	250	52	43	1	2185	0	27	34	23	29	29	34
					night	July 15, 1993	August 3, 1993	8	5	253	52	43	0	1951	2114	0	0	0	0	0	0
				108/528	day	July 31, 1996	August 23, 1996	24	5	344	42	51	0	2301	0	29	50	25	43	71	77
					night	July 31, 1996	August 23, 1996	11	5	341	41	51	0	1931	3594	18	1	19	1	2	2
		Pr. Levanidov	Pac	108/528	day	March 12, 1992	April 5, 1992	16	5	330	39	51	18	5248	0	31	6	10	2	6	
					night	March 11, 1992	April 12, 1992	23	5	306	40	50	6	5213	0	0	0			0	0
			Okh	108/528	day	December 2, 1994	January 26, 1995	16	4	270	50	44	3	2666	0	50	731	53	1432	655	775
					night	November 27, 1994	January 27, 1995	33	4	276	50	44	0	2810	22	55	1206	50	61	1206	1206
			Ber	108/528	day	June 19, 1995	July 9, 1995	28	5	316	50	47	0	2842	0	4	0	3	0	0	0
					night	June 20, 1995	July 7, 1995	14	5	311	50	46	0	3099	550	0	0	0	0	0	0
			Okh	108/528	day	July 19, 1995	August 1, 1995	5	5	330	50	47	0	2840	0	40	60	40	60	33	22
					night	July 20, 1995	August 2, 1995	5	5	340	50	48	0	2218	2085	0	0	0	0	0	0

Table 1 continued.

Species	Size-age group	Research Vessel	Sea	Type of trawl	Time of the day	Beginning of survey	End of survey	N	V, knots	L	VS	HS	DH	D	ind/hr meso	%	ind/km² 25-500	%meso	ind/km² ms	ind/km² 25-0	ind/km² 0-0
O. keta	.0+	Pr. Levanidov	Okh	108/528	day	November 23, 1995	December 28, 1995	6	4	350	45	50	0	2260	0	83	2473	75	1877	1855	2473
					night	November 22, 1995	December 27, 1995	8	4	336	45	49	0	2825	672	88	1351	90	1133	983	1201
		Pr. Levanidov	Okh	108/528	day	July 28, 1996	September 14, 1996	21	5	325	42	50	0	1024	0	14	10	12	8	5	5
					night	July 28, 1996	September 15, 1996	9	5	325	42	50	1	1272	2100	11	1	11	1	1	1
				119/450	day	July 10, 1997	August 29, 1997	11	5	323	40	46	5	1895	0	9	1	20	19	8	9
					night	July 11, 1997	August 27, 1997	7	5	266	40	43	2	1391	12831	0	0	0	0	6	6
		TINRO	Pac	108/528	day	May 21, 1991	June 21, 1991	10	5	335	50	47	19	5340	0	0	0	4	2	0	
					night	February 21, 1991	June 20, 1991	50	5	328	50	47	4	5382	0	6	3	0	0	3	3
			Okh	108/528	day	July 21, 1993	August 16, 1993	15	5	293	48	46	1	1846	0	13	16	20	15	11	11
					night	July 21, 1993	August 16, 1993	11	5	275	48	45	0	2253	1952	18	3	18	3	2	2
				108/528	day	August 10, 1994	October 13, 1994	24	5	331	50	48	0	1755	0	42	264	42	235	193	194
					night	August 12, 1994	October 13, 1994	20	5	321	50	47	0	1493	8603	60	144	50	83	85	87
				108/528	day	July 2, 1995	August 15, 1995	36	5	278	50	45	0	1680	0	11	2	7	1	1	1
					night	July 10, 1995	August 13, 1995	8	5	303	50	46	0	2153	8401	0	0	0	0	0	0
				108/528	day	August 26, 1998	October 30, 1998	22	5	244	38	46	1	2113	0	45	941	50	898	800	852
					night	August 27, 1998	November 1, 1998	23	5	245	39	46	1	1978	8118	57	209	54	178	155	149
				80/396	day	August 18, 2000	August 30, 2000	12	5	301	31	35	1	2473	0	17	8	14	7	6	3
					night	August 19, 2000	August 31, 2000	8	5	294	30	35	0	1898	2206	25	4	20	3	3	3
				80/396	day	August 20, 2001	November 8, 2001	27	5	254	39	32	0	2149	0	70	1242	62	843	883	1016
					night	August 21, 2001	November 9, 2001	32	5	248	41	31	0	1903	1193	56	869	61	878	632	732
			Ber	80/396	day	September 3, 2002	October 14, 2002	27	5	274	38	33	0	3145	0	30	18	24	42	30	32
					night	September 2, 2002	October 14, 2002	20	5	273	38	33	0	3022	8011	25	22	20	18	41	42
			Okh	80/396	day	October 19, 2002	October 30, 2002	7	5	276	38	33	0	1760	0	100	1950	100	1922	1950	1950
					night	October 18, 2002	October 27, 2002	11	5	271	37	33	0	1779	309	91	885	90	619	885	885
		Total	Total	Total	day	Total	Total	461	4	259	38	39	2	2116	0	32	339	30	370	321	415
					night			407	4	255	38	38	1	2097	2929	27	326		181	194	235
O. kisutch	n.0+	Pr. Levanidov	Okh	108/528	day	July 28, 1996	September 14, 1996	21	5	325	42	50	0	1024	0	14	13	12	11	27	27
					night	July 28, 1996	September 15, 1996	9	5	325	42	50	1	1272	2100	0	0	0	0	7	7
				80/396	day	July 10, 1997	August 29, 1997	11	5	323	40	46	5	1895	0	18	40	13	29	32	30
					night	July 11, 1997	August 27, 1997	7	5	266	40	43	2	1391	12831	0	0	0	0	9	10
		TINRO	Pac	108/528	day	May 21, 1991	June 21, 1991	10	5	335	50	47	19	5340	0	10	1	1	0	1	
					night	February 21, 1991	June 20, 1991	50	5	328	50	47	4	5382	0	0	0	0	0	0	0
				108/528	day	November 6, 1993	January 4, 1994	6	5	300	50	45	7	5083	0	0	0	8	1	2	0
					night	November 7, 1993	January 6, 1994	24	5	226	50	41	0	4997	53	8	1	7	1	1	1
			Okh	108/528	day	August 10, 1994	October 13, 1994	24	5	331	50	48	0	1755	0	13	18	12	18	14	14
					night	August 12, 1994	October 13, 1994	20	5	321	50	47	0	1493	8603	0	0	0	0	0	0
				108/528	day	August 26, 1998	October 30, 1998	22	5	244	38	46	1	2113	0	27	30	31	27	73	4
					night	August 27, 1998	November 1, 1998	23	5	245	39	46	1	1978	8118	4	1	8	1	0	1
				119/450	day	August 20, 2001	November 8, 2001	27	5	254	39	32	0	2149	0	7	31	7	19	23	27
					night	August 21, 2001	November 9, 2001	32	5	248	41	31	0	1903	1193	16	4	16	4	3	3
			Ber	119/450	day	September 3, 2002	October 14, 2002	27	5	274	38	33	0	3145	0	44	17	43	15	12	13
					night	September 2, 2002	October 14, 2002	20	5	273	38	33	0	3022	8011	25	5	24	6	3	3
		Total	Total	Total	day	Total	Total	148	4	265	39	38	4	2501	0	15	17	14	13	20	14
					night			185	4	248	39	38	1	2382	4546	6	1	6	1	3	3

Table 1 continued.

Species	Size-age group	Research Vessel	Sea	Type of trawl	Time of the day	Beginning of survey	End of survey	N	V, knots	L	VS	HS	DH	D	ind/hr meso	%	ind/km² 25-500	%meso	ind/km² ms	ind/km² 25-0	ind/km² 0-0
O. kisutch	mature	Pr. Kaganovsky	Pac	108/528	day	June 18, 1991	July 24, 1991	19	5	330	45	49	3	3343	0	26	4	30	4	4	1
					night	July 4, 1991	July 24, 1991	4	5	338	45	49	1	4468	28	25	2	0	0	1	
			Okh	108/528	day	July 15, 1992	August 12, 1992	23	5	312	40	50	1	839	0	39	8	41	8	12	16
					night	July 14, 1992	August 12, 1992	8	5	312	40	50	2	975	7241	38	6	0	0	10	0
		Pr. Kizevetter	Pac	108/528	day	November 12, 1991	December 16, 1991	8	5	178	50	37	5	4510	0	38	25	31	17	25	10
					night	November 12, 1991	December 15, 1991	21	5	175	50	37	5	4643	994	14	2	16	3	2	0
				108/528	day	June 16, 1993	July 30, 1993	18	5	248	52	42	1	3983	0	39	8	36	7	7	8
					night	July 7, 1993	July 29, 1993	8	5	250	52	43	0	4663	1453	0	0	0	0	0	0
		Pr. Levanidov	Pac	108/528	day	July 5, 1991	August 10, 1991	25	5	301	40	50	1	3952	0	28	6	35	6	4	5
					night	July 9, 1991	August 8, 1991	11	5	291	40	49	0	4646	10316	9	1	8	1	2	3
				108/528	day	July 3, 1992	August 7, 1992	8	5	345	37	54	0	4532	0	75	39	78	37	41	41
					night	July 30, 1992	August 5, 1992	2	5	325	37	52	0	5267	4548	0	0	0	0	0	0
			Okh	108/528	day	July 8, 1994	August 11, 1994	16	5	312	50	47	1	899	0	19	3	17	3	2	2
					night	July 18, 1994	August 12, 1994	8	5	308	50	46	0	797	21743	13	2	0	0	1	1
			Pac	108/528	day	June 29, 1995	July 28, 1995	12	5	325	51	47	0	5092	0	17	1	11	1	1	1
					night	July 10, 1995	July 29, 1995	4	5	341	50	48	1	4375	5840	0	0	0	0	0	0
			Okh	108/528	day	July 28, 1996	September 14, 1996	21	5	325	42	50	0	1024	0	19	2	31	6	14	14
					night	July 28, 1996	September 15, 1996	9	5	325	42	50	1	1272	2100	11	1	22	2	8	8
				80/396	day	July 10, 1997	August 29, 1997	11	5	323	40	46	5	1895	0	9	1	7	1	1	1
					night	July 11, 1997	August 27, 1997	7	5	266	40	43	2	1391	12831	29	3	29	3	1	1
		TINRO	Pac	108/528	day	May 21, 1991	June 21, 1991	10	5	335	50	47	19	5340	0	0	0	3	1	0	
					night	February 21, 1991	June 20, 1991	50	5	328	50	47	4	5382	0	2	0	0	0	0	0
				108/528	day	June 27, 1993	August 3, 1993	44	5	296	48	46	1	3914	0	34	4	31	4	4	4
					night	July 4, 1993	August 4, 1993	22	5	281	48	46	0	4380	4096	14	2	17	2	2	2
			Okh	108/528	day	August 10, 1994	October 13, 1994	24	5	331	50	48	0	1755	0	4	0	9	1	0	0
					night	August 12, 1994	October 13, 1994	20	5	321	50	47	0	1493	8603	0	0	0	0	0	0
				108/528	day	August 26, 1998	October 30, 1998	22	5	244	38	46	1	2113	0	9	1	8	1	1	1
					night	August 27, 1998	November 1, 1998	23	5	245	39	46	1	1978	8118	17	2	17	2	1	1
		Total	Total	Total	day	Total	Total	261	4	280	42	44	3	2879	0	24	7	25	6	8	8
					night			197	4	274	42	44	1	3049	5861	11	1	7	1	2	1
O. masu	n.0+	Pr. Levanidov	Okh	108/528	day	July 8, 1994	August 11, 1994	16	5	312	50	47	1	899	0	13	3	13	3	1	1
					night	July 18, 1994	August 12, 1994	8	5	308	50	46	0	797	21743	0	0	0	0	0	0
				108/528	day	July 28, 1996	September 14, 1996	21	5	325	42	50	0	1024	0	5	0	4	0	1	1
					night	July 28, 1996	September 15, 1996	9	5	325	42	50	1	1272	2100	0	0	0	0	0	0
				80/396	day	July 10, 1997	August 29, 1997	11	5	323	40	46	5	1895	0	9	1	20	2	1	2
					night	July 11, 1997	August 27, 1997	7	5	266	40	43	2	1391	12831	14	2	14	2	1	1
		TINRO	Okh	108/528	day	August 10, 1994	October 13, 1994	24	5	331	50	48	0	1755	0	8	1	15	2	1	1
					night	August 12, 1994	October 13, 1994	20	5	321	50	47	0	1493	8603	5	0	0	0	0	0
				108/528	day	August 26, 1998	October 30, 1998	22	5	244	38	46	1	2113	0	23	4	19	3	5	4
					night	August 27, 1998	November 1, 1998	23	5	245	39	46	1	1978	8118	17	2	21	2	1	2
		Total	Total	Total	day	Total	Total	94	5	307	44	47	1	1537	0	11	2	14	2	2	2
					night			67	5	293	44	46	1	1386	10679	7	1	7	1	0	1

Table 1 continued.

Species	Size-age group	Research Vessel	Sea	Type of trawl	Time of the day	Beginning of survey	End of survey	N	V, knots	L	VS	HS	DH	D	ind/hr meso	%	ind/km² 5-500	% meso	ind/km² ms	ind/km² 25-0	ind/km² 0-0
O. nerka	n.0+	Pr. Kizevetter	Ber	108/528	day	June 18, 1993	July 6, 1993	21	5	261	52	43	1	2858	0	10	2	8	1	1	1
					night	June 21, 1993	July 7, 1993	4	5	255	52	43	1	2300	27	0	0	0	0	0	0
		Pr. Levanidov		108/528	day	June 19, 1995	July 9, 1995	28	5	316	50	47	0	2842	0	4	0	3	0	0	0
					night	June 20, 1995	July 7, 1995	14	5	311	50	46	0	3099	550	0	0	0	0	0	0
		TINRO	Pac	108/528	day	June 27, 1993	August 3, 1993	44	5	296	48	46	1	3914	0	7	10	7	8	9	6
					night	July 4, 1993	August 4, 1993	22	5	281	48	46	0	4380	4096	0	0	0	0	0	0
			Okh	108/528	day	August 10, 1994	October 13, 1994	24	5	331	50	48	0	1755	0	8	2	6	2	2	2
					night	August 12, 1994	October 13, 1994	20	5	321	50	47	0	1493	8603	0	0	0	0	0	0
				108/528	day	August 26, 1998	October 30, 1998	22	5	244	38	46	1	2113	0	5	0	4	0	29	0
					night	August 27, 1998	November 1, 1998	23	5	245	39	46	1	1978	8118	0	0	0	0	0	0
				119/450	day	August 20, 2001	November 8, 2001	27	5	254	39	32	0	2149	0	15	167	11	101	119	137
					night	August 21, 2001	November 9, 2001	32	5	248	41	31	0	1903	1193	9	23	6	23	17	20
			Ber	119/450	day	September 3, 2002	October 14, 2002	27	5	274	38	33	0	3145	0	33	33	32	26	37	39
					night	September 2, 2002	October 14, 2002	20	5	273	38	33	0	3022	8011	25	14	20	11	12	13
		Total	Total	Total	day	Total	Total	193	4	220	35	33	0	2086	0	9	24	8	15	22	21
					night			135	4	215	35	32	0	2019	3400	4	4	3	4	3	4
O. tschawytscha	immature	Pr. Kaganovsky	Pac	108/528	day	June 18, 1991	July 24, 1991	19	5	330	45	49	3	3343	0	5	0	5	0	1	0
					night	July 4, 1991	July 24, 1991	4	5	338	45	49	1	4468	28	0	0	0	0	9	
			Okh	108/528	day	July 15, 1992	August 12, 1992	23	5	312	40	50	1	839	0	17	1	24	2	1	1
					night	July 14, 1992	August 12, 1992	8	5	312	40	50	2	975	7241	50	4	33	3	2	0
		Pr. Kizevetter	Pac	108/528	day	November 12, 1991	December 16, 1991	8	5	178	50	37	5	4510	0	63	21	56	17	21	5
					night	November 12, 1991	December 15, 1991	21	5	175	50	37	5	4643	994	62	11	68	13	10	5
			Ber	108/528	day	November 27, 1991	December 5, 1991	4	5	175	50	37	6	3793	0	50	31	33	20	31	
					night	November 26, 1991	December 5, 1991	13	5	179	50	37	7	2830	150	15	7	18	8	6	0
			Pac	108/528	day	June 16, 1993	July 30, 1993	18	5	248	52	42	1	3983	0	6	0	5	0	1	1
					night	July 7, 1993	July 29, 1993	8	5	250	52	43	0	4663	1453	0	0	0	0	0	0
			Ber	108/528	day	June 18, 1993	July 6, 1993	21	5	261	52	43	1	2858	0	24	7	20	6	5	6
					night	June 21, 1993	July 7, 1993	4	5	255	52	43	1	2300	27	25	10	25	10	5	10
		Pr. Levanidov	Pac	108/528	day	July 5, 1991	August 10, 1991	25	5	301	40	50	1	3952	0	20	1	19	2	3	3
					night	July 9, 1991	August 8, 1991	11	5	291	40	49	0	4646	10316	0	0	0	0	1	1
				108/528	day	March 12, 1992	April 5, 1992	16	5	330	39	51	18	5248	0	13	1	4	0	1	
					night	March 11, 1992	April 12, 1992	23	5	306	40	50	6	5213	0	0	0			0	0
				108/528	day	July 3, 1992	August 7, 1992	8	5	345	37	54	0	4532	0	25	4	22	4	5	5
					night	July 30, 1992	August 5, 1992	2	5	325	37	52	0	5267	4548	50	3	50	3	2	2
			Ber	108/528	day	July 4, 1992	July 15, 1992	17	5	343	37	53	1	2874	0	6	0	11	1	0	0
					night	July 11, 1992	July 14, 1992	3	5	343	37	53	0	3055	115	67	5	50	4	2	2
			Okh	108/528	day	July 8, 1994	August 11, 1994	16	5	312	50	47	1	899	0	13	1	13	1	1	1
					night	July 18, 1994	August 12, 1994	8	5	308	50	46	0	797	21743	25	4	22	3	2	2
			Ber	108/528	day	June 19, 1995	July 9, 1995	28	5	316	50	47	0	2842	0	39	7	37	6	5	5
					night	June 20, 1995	July 7, 1995	14	5	311	50	46	0	3099	550	21	4	20	5	4	4
			Okh	80/396	day	July 10, 1997	August 29, 1997	11	5	323	40	46	5	1895	0	27	6	27	6	3	4
					night	July 11, 1997	August 27, 1997	7	5	266	40	43	2	1391	12831	29	4	29	4	1	2

Table 1 continued.

Species	Size-age group	Research Vessel	Sea	Type of trawl	Time of the day	Beginning of survey	End of survey	N	V, knots	L	VS	HS	DH	D	ind/hr meso	%	ind/km² 25-500	%meso	ind/km² ms	ind/km² 25-0	ind/km² 0-0
O. tschawytscha	immature	TINRO	Pac	108/528	day	May 21, 1991	June 21, 1991	10	5	335	50	47	19	5340	0	0	0	1	0	0	
					night	February 21, 1991	June 20, 1991	50	5	328	50	47	4	5382	0	2	0	0	0	0	0
				108/528	day	June 27, 1993	August 3, 1993	44	5	296	48	46	1	3914	0	9	1	13	1	1	1
					night	July 4, 1993	August 4, 1993	22	5	281	48	46	0	4380	4096	14	1	10	1	1	1
				108/528	day	November 6, 1993	January 4, 1994	6	5	300	50	45	7	5083	0	0	0	0	0	0	0
					night	November 7, 1993	January 6, 1994	24	5	226	50	41	0	4997	53	4	0	7	1	0	0
			Ber	108/528	day	November 11, 1993	December 3, 1993	3	5	283	50	43	4	2877	0	0	0	0	0	0	0
					night	November 11, 1993	December 3, 1993	12	5	271	50	44	0	3136	31	8	1	13	1	0	1
			Okh	108/528	day	August 10, 1994	October 13, 1994	24	5	331	50	48	0	1755	0	13	1	15	1	1	1
					night	August 12, 1994	October 13, 1994	20	5	321	50	47	0	1493	8603	5	0	5	0	1	1
				108/528	day	August 26, 1998	October 30, 1998	22	5	244	38	46	1	2113	0	14	1	12	1	1	0
					night	August 27, 1998	November 1, 1998	23	5	245	39	46	1	1978	8118	9	1	8	1	1	0
				119/450	day	August 20, 2001	November 8, 2001	27	5	254	39	32	0	2149	0	7	1	7	1	1	1
					night	August 21, 2001	November 9, 2001	32	5	248	41	31	0	1903	1193	0	0	0	0	0	0
			Ber	119/450	day	September 3, 2002	October 14, 2002	27	5	274	38	33	0	3145	0	48	22	54	21	17	18
					night	September 2, 2002	October 14, 2002	20	5	273	38	33	0	3022	8011	55	26	56	21	16	16
		Total	Total	Total	day	Total	Total	377	5	290	45	45	4	3235	0	19	5	18	4	5	3
					night			329	5	279	45	44	1	3316	4290	21	4		4	3	2
P. azonus	juveniles	Pr. Soldatov	Okh	108/528	day	July 2, 1993	August 14, 1993	43	5	264	45	45	2	2190	0	37	1017	38	956	811	1311
					night	July 2, 1993	August 14, 1993	21	5	265	45	45	2	1894	3294	14	9	27	684	62	4
		Pr. Kaganovsky	Okh	108/528	day	July 11, 1995	August 29, 1995	35	5	212	45	41	0	2058	0	17	10844	19	8285	9988	9988
					night	July 11, 1995	August 29, 1995	19	5	212	45	41	0	2074	1959	16	334	9	252	288	288
				80/396, 108/528	day	August 14, 1999	October 27, 1999	24	5	252	30	48	1	1950	0	71	10542	71	6937	9036	9731
					night	August 13, 1999	October 27, 1999	30	4	246	34	43	0	1743	853	37	69	36	69	662	763
		Pr. Kizevetter	Okh	108/528	day	July 31, 1996	August 23, 1996	24	5	344	42	51	0	2301	0	63	4145	57	3683	3686	3955
					night	July 31, 1996	August 23, 1996	11	5	341	41	51	0	1931	3594	36	234	44	427	206	224
		Pr. Levanidov	Okh	119/450	day	July 10, 1997	August 29, 1997	11	5	323	40	46	5	1895	0	82	34541	87	32731	14666	18717
					night	July 11, 1997	August 27, 1997	7	5	266	40	43	2	1391	12831	29	295	29	295	139	152
		TINRO	Pac	108/528	day	June 27, 1993	August 3, 1993	44	5	296	48	46	1	3914	0	5	1	4	1	102	117
					night	July 4, 1993	August 4, 1993	22	5	281	48	46	0	4380	4096	9	6	10	6	7	7
			Okh	108/528	day	July 2, 1995	August 15, 1995	36	5	278	50	45	0	1680	0	25	478	29	412	239	239
					night	July 10, 1995	August 13, 1995	8	5	303	50	46	0	2153	8401	0	0	0	0	2	2
				108/528	day	August 26, 1998	October 30, 1998	22	5	244	38	46	1	2113	0	41	321	42	286	273	399
					night	August 27, 1998	November 1, 1998	23	5	245	39	46	1	1978	8118	35	82	33	79	61	18
				80/396	day	August 18, 2000	August 30, 2000	12	5	301	31	35	1	2473	0	58	1157	57	1345	817	868
					night	August 19, 2000	August 31, 2000	8	5	294	30	35	0	1898	2206	63	249	50	199	199	199
				80/396	day	August 20, 2001	November 8, 2001	27	5	254	39	32	0	2149	0	48	3893	44	2379	4737	5455
					night	August 21, 2001	November 9, 2001	32	5	248	41	31	0	1903	1193	31	82	29	132	67	77
		Total	Total	Total	day	Total	Total	278	5	277	41	44	1	2272	0	45	6694	45	5701	4436	5078
					night			181	5	270	41	43	0	2134	4654	27	136	27	214	169	173

Table 1 finished.

Species	Size-age group	Research Vessel	Sea	Type of trawl	Time of the day	Beginning of survey	End of survey	N	V, knots	L	VS	HS	DH	D	ind/hr$_{meso}$	%	ind/km$^2_{25-500}$	%$_{meso}$	ind/km$^2_{ms}$	ind/km$^2_{25-0}$	ind/km$^2_{0-0}$
P. monopterigius	juveniles	Pr. Soldatov	Okh	108/528	day	July 2, 1993	August 14, 1993	43	5	264	45	45	2	2190	0	5	64	4	52	51	0
					night	July 2, 1993	August 14, 1993	21	5	265	45	45	2	1894	3294	0	0	0	0	0	0
		Pr. Kaganovsky	Okh	108/528	day	July 15, 1992	August 12, 1992	23	5	312	40	50	1	839	0	22	1850	24	1506	1026	1911
					night	July 14, 1992	August 12, 1992	8	5	312	40	50	2	975	7241	50	154	33	21	54	0
				108/528	day	July 11, 1995	August 29, 1995	35	5	212	45	41	0	2058	0	23	15736	19	11697	14494	14494
					night	July 11, 1995	August 29, 1995	19	5	212	45	41	0	2074	1959	0	0	0	0	0	0
				80/396, 108/528	day	August 14, 1999	October 27, 1999	24	5	252	30	48	1	1950	0	21	27	13	17	23	25
					night	August 13, 1999	October 27, 1999	30	4	246	34	43	0	1743	853	3	3	4	3	2	3
		Pr. Kizevetter	Ber	108/528	day	June 18, 1993	July 6, 1993	21	5	261	52	43	1	2858	0	29	2205	28	3018	1597	1853
					night	June 21, 1993	July 7, 1993	4	5	255	52	43	1	2300	27	50	8490	25	1205	4851	8490
		TINRO	Pac	108/528	day	June 27, 1993	August 3, 1993	44	5	296	48	46	1	3914	0	23	1684	22	1381	1544	1690
					night	July 4, 1993	August 4, 1993	22	5	281	48	46	0	4380	4096	0	0	7	2	0	0
			Okh	108/528	day	August 26, 1998	October 30, 1998	22	5	244	38	46	1	2113	0	5	1	4	0	0	1
					night	August 27, 1998	November 1, 1998	23	5	245	39	46	1	1978	8118	0	0	0	0	0	0
				80/396	day	August 20, 2001	November 8, 2001	27	5	254	39	32	0	2149	0	15	3	11	24	2	2
					night	August 21, 2001	November 9, 2001	32	5	248	41	31	0	1903	1193	6	32	3	1	23	27
			Ber	80/396	day	September 3, 2002	October 14, 2002	27	5	274	38	33	0	3145	0	78	93725	78	90233	66598	70298
					night	September 2, 2002	October 14, 2002	20	5	273	38	33	0	3022	8011	40	3991	48	5590	2282	2349
		Total	Total	Total	day	Total	Total	266	5	263	42	43	1	2357	0	24	12811	23	11992	9482	10030
					night			179	5	260	42	42	1	2252	3866	17	1408	13	758	801	1207
C. saira	mature	Pr. Kaganovsky	Pac	108/528	day	July 27, 1995	August 27, 1995	18	5	202	45	41	0	4068	0	17	3485	14	2851	2727	2727
					night	July 29, 1995	August 27, 1995	12	5	203	45	41	0	3333	2248	17	37	18	28	45	45
			Okh	80/396, 108/528	day	August 14, 1999	October 27, 1999	24	5	252	30	48	1	1950	0	21	1409	13	890	1208	1300
					night	August 13, 1999	October 27, 1999	30	4	246	34	43	0	1743	853	3	1	4	2	11	13
		Pr. Levanidov	Jap	119/450	day	September 1, 1997	September 14, 1997	10	5	320	40	46	3	2373	0	50	907	47	304	829	1134
					night	September 1, 1997	September 15, 1997	29	5	288	40	44	0	2665	0	41	135			129	129
		TINRO	Pac	108/528	day	August 20, 1994	September 7, 1994	9	5	346	50	48	2	3684	0	44	2484	27	1491	1865	996
					night	August 19, 1994	September 6, 1994	9	5	350	50	49	0	3143	6385	22	12	30	13	44	33
			Jap	108/528	day	September 28, 1995	November 14, 1995	21	4	247	48	43	0	2864	0	29	347	15	114	202	227
					night	September 28, 1995	November 20, 1995	41	4	241	48	42	0	2646	0	7	5			3	4
		Total	Total	Total	day	Total	Total	82	5	273	43	45	1	2988	0	32	1726	23	1130	1366	1277
					night			121	5	266	43	44	0	2706	1897	18	38		14	47	45

Designations. Okh - Okhotsk Sea, Ber - Bering Sea, Jap - Japan Sea, Pac - Pacific Ocean; N - overall number of trawlings for particular survey. The averaged values for the following characteristics - L - length of warps; V$ - verical spread, m; HS - horizontal spread, m; DH - depth of trawl headrope, m; D - depth at trawling location, m; ind/hr$_{meso}$ - overall CPUE of mesopelagic fish species (individuals/hour of trawling); % - species occurrence frequency in catches (only trawlings with trawl headrope depth <= 25 m and depth at trawling location >= 500 m were used, segregation of trawlings into the daytime and nighttime trawlings was done with the help NOAA Calculator); ind/km$^2_{25-500}$ - relative abundance - individuals/km^2 (only trawlings with trawl headrope depth <= 25 m and depth at trawling location >= 500 m were used, segregation of trawlings into the daytime and nighttime trawlings was done with the help NOAA Calculator); %$_{meso}$ - species occurrence frequency in catches (only trawlings with trawl headrope depth <= 25 m and depth at trawling location >= 500 m were used, trawlings that contained mesopelagic fish species were considered nighttime trawlings and all others - daytime trawlings); ind/km$^2_{meso}$ - only trawlings with trawl headrope depth <= 25 m and depth at trawling location >= 500 m were used, trawlings that contained mesopelagic fish species were considered nighttime trawlings and all others - daytime trawlings; ind/km$^2_{25-0}$ - only trawlings with trawl headrope depth <= 25 m were used no restrictions on depth at trawling location; ind/km$^2_{0-0}$ - only trawlings with trawl headrope depth = 0 m were used (no restrictions on depth at trawling location. The major technical characteristics of trawlings are given for only trawlings with trawl headrope depth <= 25 m and depth at trawling location >= 500 m were used (segregation of trawlings into the daytime and nighttime trawlings was done with the help NOAA Calculator)

Table 2.

Ratios of species occurrence frequencies of between daytime and nighttime trawlings (%d/%n) and average values of fishing power correction factors for all surveys studied (CPUEd/n)

Species	Size-age group	%d/%n $_{25\text{-}500}$	%d/%n $_{meso}$	CPUEd/n $_{25\text{-}500}$	CPUEd/n $_{meso}$	CPUEd/n $_{25\text{-}0}$	CPUEd/n $_{0\text{-}0}$
O. gorbuscha	.0+	1.0	1.0	1.3	1.6	1.4	1.6
	mature	1.1	1.0	1.7	1.8	2.2	2.2
O. keta	.0+	1.2	1.1	1.7	2.0	1.7	1.8
O. kisutch	n.0+	2.5	2.3	14.6	10.3	7.9	5.1
	mature	2.1	3.4	4.9	8.0	4.1	6.8
O. masou	n.0+	1.6	2.0	2.5	2.6	4.4	2.7
O. nerka	n.0+	2.4	2.7	5.8	4.0	6.7	5.7
P. azonus	juveniles	1.7	1.7	49.3	26.6	26.2	29.3
P. monopterygius	juveniles	1.5	1.7	9.1	15.8	11.8	8.3
C. saira	mature	1.8	1.3	45.2	78.9	29.4	28.6

Designations. %d/%n $_{25\text{-}500}$ - ratios of species occurrence frequencies between daytime and nighttime trawlings (only trawlings with trawl headrope depth <= 25 m and depth at trawling location >= 500 m were used, segregation of trawlings into the daytime and nighttime trawlings was done with the help NOAA Calculator); %d/%n_{meso} - ratios of species occurrence frequencies between daytime and nighttime trawlings (only trawlings with trawl headrope depth <= 25 m and depth at trawling location >= 500 m were used; trawlings that contained mesopelagic fish species were considered nighttime trawlings and all others - daytime trawlings); CPUEd/$n_{25\text{-}500}$ - average values of fishing power correction factors for all surveys studied (only trawlings with trawl headrope depth <= 25 m and depth at trawling location >= 500 m were used, segregation of trawlings into the daytime and nighttime trawlings was done with the help NOAA Calculator); CPUEd/n_{meso} - only trawlings with trawl headrope depth <= 25 m and depth at trawling location >= 500 m were used, trawlings that contained mesopelagic fish species were considered nighttime trawlings and all others - daytime trawlings; CPUEd/$n_{25\text{-}0}$ - only trawlings with trawl headrope depth <= 25 m were used (no restrictions on depth at trawling location), segregation of trawlings into the daytime and nighttime trawlings was done with the help NOAA Calculator; CPUEd/$n_{0\text{-}0}$ - only trawlings with trawl headrope depth = 0 m were used (no restrictions on depth at trawling location), segregation of trawlings into the daytime and nighttime trawlings was done with the help NOAA Calculator.

Table 3.

Mann-Whitney probabilities of equal day/night CPUEs for the surveys' joint datasets

Species	Size-age group	$P_{25\text{-}500}$	P_{meso}	$P_{25\text{-}0}$	$P_{0\text{-}0}$	$P_{PT\ 108/528}$ **	$P_{PT\ 80/396}$ **
O. gorbuscha	.0+	**0.01***	**0.00***	**0.02***	0.07	**0.03***	
	mature	**0.00***	**0.00***	**0.00***	**0.00***	**0.00***	**0.00***
O. keta	.0+	0.29	**0.01***	0.90	0.59		
O. kisutch	n.0+	**0.00***	0.28	**0.00***	**0.00***	**0.00***	
	mature	**0.00***	**0.00***	**0.00***	**0.00***	**0.00***	
O. masou	n.0+	0.55	0.28	**0.02***	0.08		
O. nerka	n.0+	0.09	**0.05***	**0.03***	0.08	**0.02***	
O. tschawytscha	immature	0.29	0.20	0.17	**0.02***		
P. azonus	juveniles	**0.00***	**0.00***	**0.00***	**0.00***	**0.03***	**0.03***
P. monopterygius	juveniles	**0.00***	**0.00***	**0.00***	**0.00***	**0.00***	**0.00***
C. saira	mature	**0.02***	0.09	0.14	0.17		

Designations. P<0.05 are marked by *; ** - only P<0.05 are provided for these columns (only trawlings done by the PT 108/528 and PT 80/396 trawls were used for comparisons); $P_{25\text{-}500}$ - null-hypothesis probabilities (only trawlings with trawl headrope depth <= 25 m and depth at trawling location >= 500 m were used, segregation of trawlings into the daytime and nighttime trawlings was done with the help NOAA Calculator); P_{meso} - only trawlings with trawl headrope depth <= 25 m and depth at trawling location >= 500 m were used; trawlings that contained mesopelagic fish species were considered nighttime trawlings and all others - daytime trawlings); $P_{25\text{-}0}$ - only trawlings with trawl headrope depth <= 25 m were used (no restrictions on depth at trawling location), segregation of trawlings into the daytime and nighttime trawlings was done with the help NOAA Calculator; $P_{0\text{-}0}$ - only trawlings with trawl headrope depth = 0 m were used (no restrictions on depth at trawling location), segregation of trawlings into the daytime and nighttime trawlings was done with the help NOAA Calculator. P=0.00 designates P<0.005.

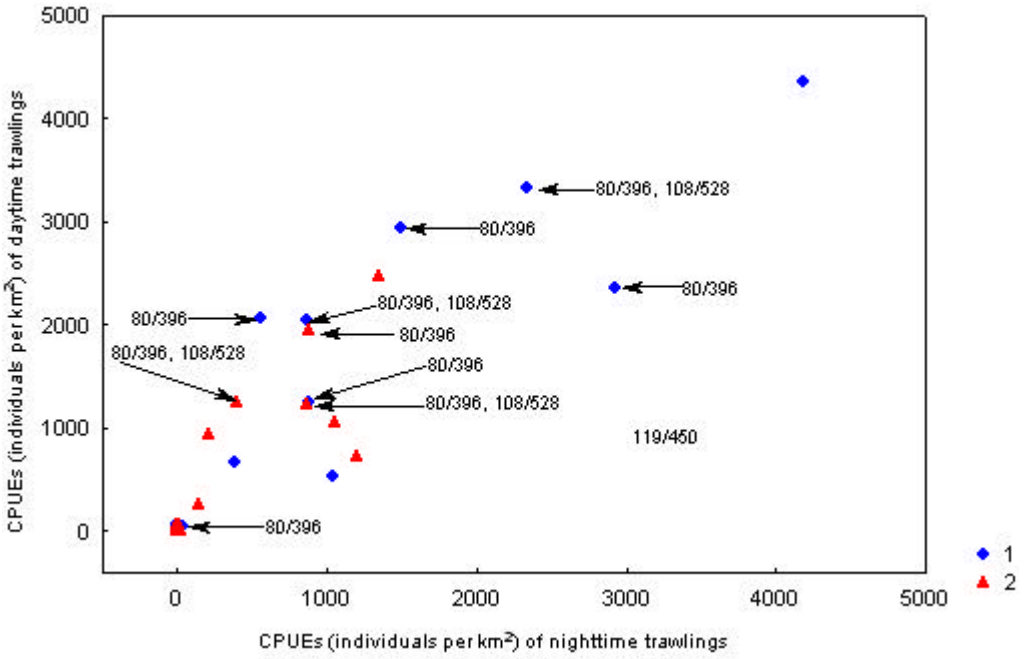

Figure 1. Juvenile pink (1) and chum (2) salmon CPUEs (individuals per km^2) ratios of daytime (vertical axis) and nighttime (horizontal axis) trawlings. Ratios plotted for every survey. Numbers designate trawl type for particular survey (except for the most common trawl - PT 108/528)

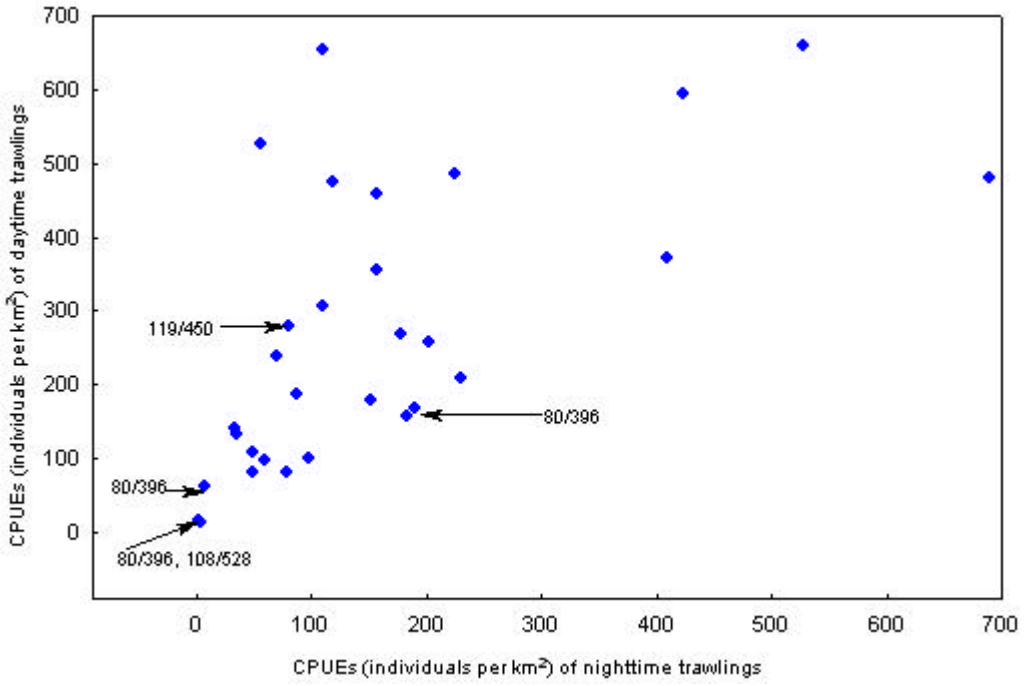

Figure 2. Mature pink salmon CPUEs (individuals per km^2) ratios of daytime (vertical axis) and nighttime (horizontal axis) trawlings. Ratios plotted for every survey. Numbers designate trawl type for particular survey (except for the most common trawl - PT 108/528)