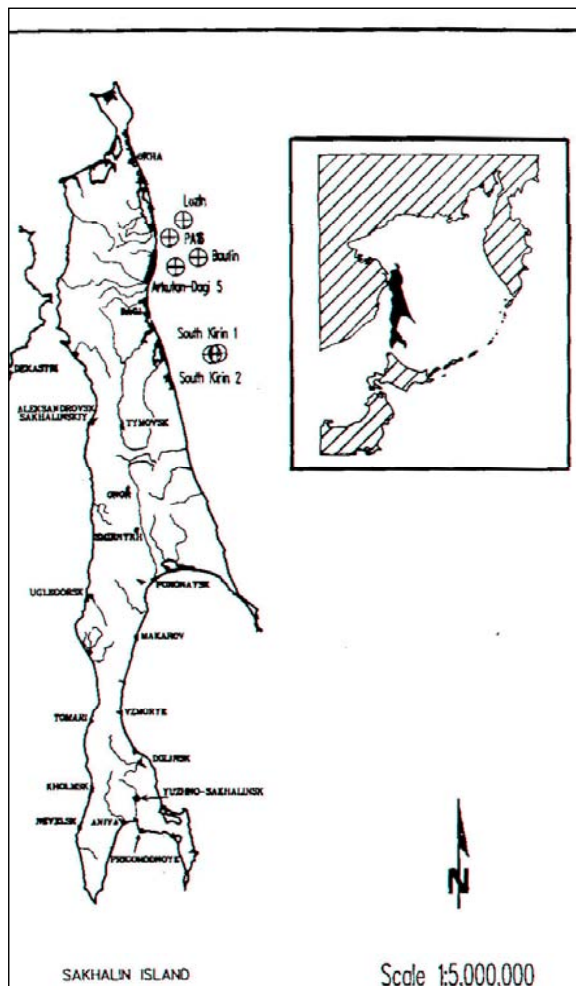


***LONG-TERM VARIABILITY OF PELAGIC FISH SPECIES COMPOSITION
NEAR THE SAKHALIN (SEA of OKHOTSK): DISTRIBUTION,
FLUCTUATIONS IN ABUNDANCE, FISHERY***

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Pelagic fish species composition

Sakhalin Island

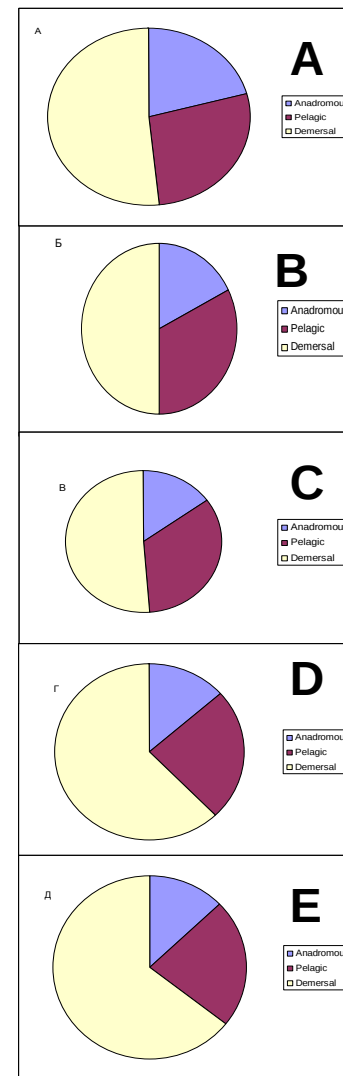


Species composition (+, species present; -, species absent) of pelagic and demersal planktivorous fish in different areas off Sakhalin Island (adapted from Lindberg, 1959; Borets, 1997).

Species	North western Sakhalin	South-western Sakhalin	Aniva Bay, La Perouse Strait	South-eastern Sakhalin	North-eastern Sakhalin
PELAGIC FISH					
<i>Clupea harengus</i>	+	+	+	+	+
<i>Sardinops sagax</i>	+	+	+	+	+
<i>Engraulis japonicus</i>	+	+	+	+	+
<i>Oncorhynchus keta</i> (juv.)	+	+	+	+	+
<i>Oncorhynchus gorbuscha</i>	+	+	+	+	+
<i>Oncorhynchus mazou</i> (juv.)	-	-	-	+	+
<i>Oncorhynchus tshawytscha</i> (juv.)	+	+	+	+	+
<i>Osmerus dentex</i>	+	+	+	+	+
<i>Hypomesus japonicus</i>	+	+	+	+	+
<i>Mallotus villosus</i>	-	-	-	+	+
<i>Leuroglossus schmidti</i>	+	+	+	+	-
<i>Salangichthys microdon</i>	+	+	+	+	-
<i>Cololabis saira</i>	+	+	+	+	+
<i>Theragra chalcogramma</i>	+	+	+	+	+
<i>Gasterosteus aculeatus</i>	+	+	+	+	-
<i>Arctoscopus japonicus</i>	-	+	+	-	-
<i>Scomber japonicus</i>	-	+	+	+	+
<i>Pleurogrammus azonus</i> (juv.)	-	+	+	+	+
DEMERSAL FISH*					
<i>Gadus macrocephalus</i> (juv.)	-	+	+	+	+
<i>Eleginus graciosus</i> (juv.)	-	+	+	+	+
<i>Lumpenella longirostris</i>	+	+	+	+	+
<i>Lumpenus sagitta</i>	+	+	+	+	+
<i>Leptoclinus maculatus</i>	+	+	+	+	+
<i>Ammodytes hexapterus</i>	-	+	+	-	-
<i>Hypoptichus dybowskii</i>	+	+	+	+	+
<i>Hexagrammus octogrammus</i> (juv.)	+	+	+	+	+
<i>Hexagrammus lagocephalus</i> (juv.)	+	+	+	+	+
<i>Blepsias cirrhosus</i>	+	+	+	+	+
<i>Hemirhamphus villosus</i>	-	+	+	+	+
<i>Hemilepidotus gilberti</i> (juv.)	-	+	-	+	+
<i>Melletes papilio</i>	-	-	+	+	+
<i>Podothecus acipenserinus</i>	+	+	+	+	-
<i>Podothecus gilberti</i>	+	+	+	+	-
<i>Eumicrotremus pacificus</i>	+	+	+	+	+
<i>Hippoglossoides elassodon</i>	+	+	+	+	+
<i>Limanda sakhalinensis</i>	-	-	-	-	-
Total planktivorous species	27	32	33	34	29
Pelagic	15	16	16	17	14
Demersal	12	16	17	17	15
Number of planktivorous species with biomass >10 000 t	5	6	7-8	8	7
Number of planktivorous species with biomass >100 000 t	2	3	5	6	5

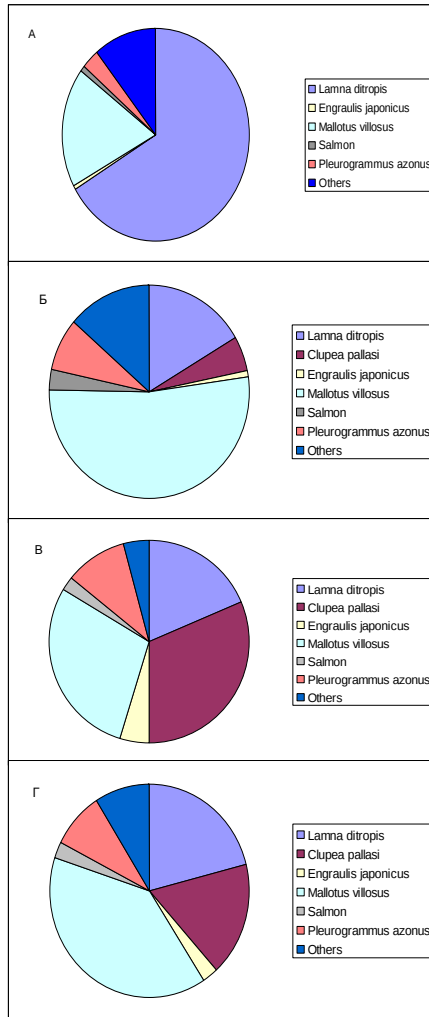
Species composition (+, species present; -, species absent) of pelagic and demersal planktivorous fish in different areas off Sakhalin Island (adapted from Lindberg, 1959; Borets, 1997).

Proportion of pelagic, anadromous and demersal species in the epipelagic fish communities in different regions of eastern S a k h a l i n :
1947-1997 - northeastern Sakhalin (A), southeastern Sakhalin (B), Aniva Bay (C); 2002-2004 - Aniva Bay (D); 2005- Aniva Bay (E)

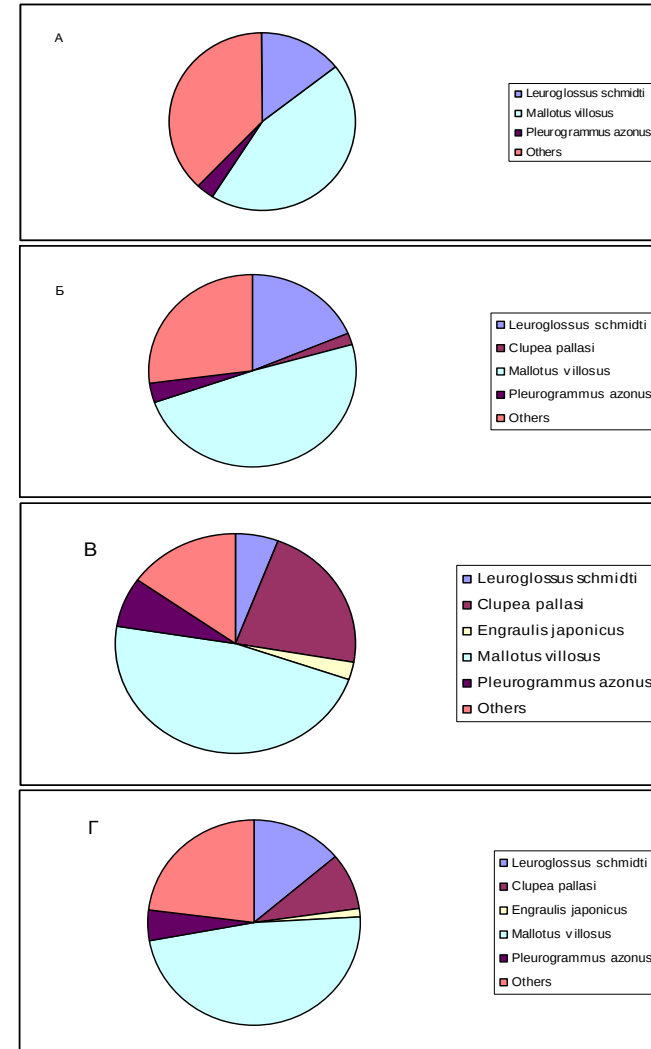


Biomass and abundance proportion of pelagic fish species in the Aniva Bay upper epipelagic zone and adjoining areas of the Sea of Okhotsk: A – 2002; B – 2003; C – 2004; D- 2002-2004

Biomass



Abundance



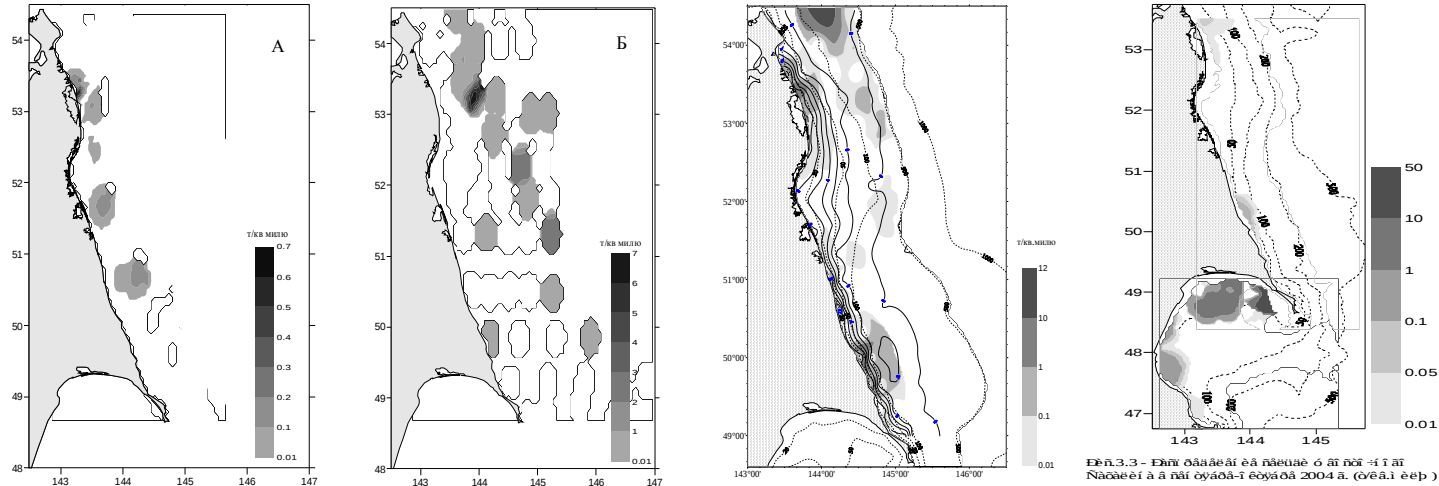
Data of south-latitude fishes occurred near the Okhotsk Sea coast of Sakhalin Island in

different years

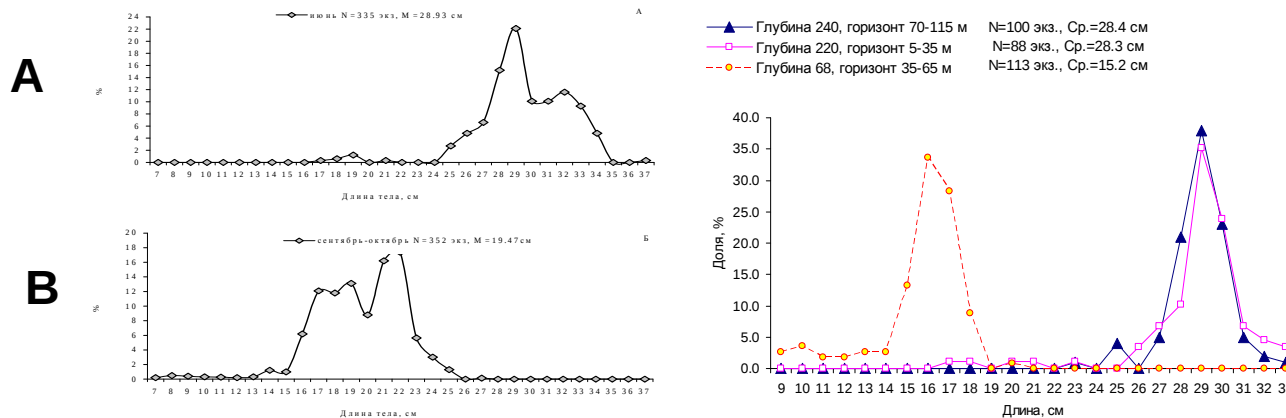
Fish species		Aniva Bay		Eastern Sakhalin	
English name	Latin name	1947-1949 (Lindberg,1959)	2000-2008	1947-1949 (Lindberg,1959)	2000-2008
Salmon shark	<i>Lamna ditropis</i>	+	+ (2002-2005; 2007)	+	+ (2002-2004; 2008)
White shark	<i>Carcharodon carcharias</i>	–	+ (2007)	–	–
Pacific sardine	<i>Sardinops melanostictus</i>	?	+ (2006-2007)	?	+ (2001-2004)
Japanese anchovy	<i>Engraulis japonicus</i>	–	+ (2003-2008)	–	+ (2000-2004; 2008)
Pacific saury	<i>Cololabis saira</i>	+	–	+	+ (2000-2001)
Green gar	<i>Strongilura anastomella</i>	–	+ (2008)	–	–
Rockfish	<i>Sebastes schlegeli</i>	+	+ (2006)	–	–
Rockfish	<i>Sebastes wakiyai</i>	–	+ (2001)	–	–
Common dolphin-fish	<i>Coryphaena hippurus</i>	–	+ (2000)	–	+ (2004)
Chub mackerel	<i>Scomber japonicus</i>	+	+ (2000)	–	+ (2008)
Swell fishes puffers	<i>Takifugu porphyreus</i>	+	+ (2003; 2008)	–	–

Distribution of pelagic fishes

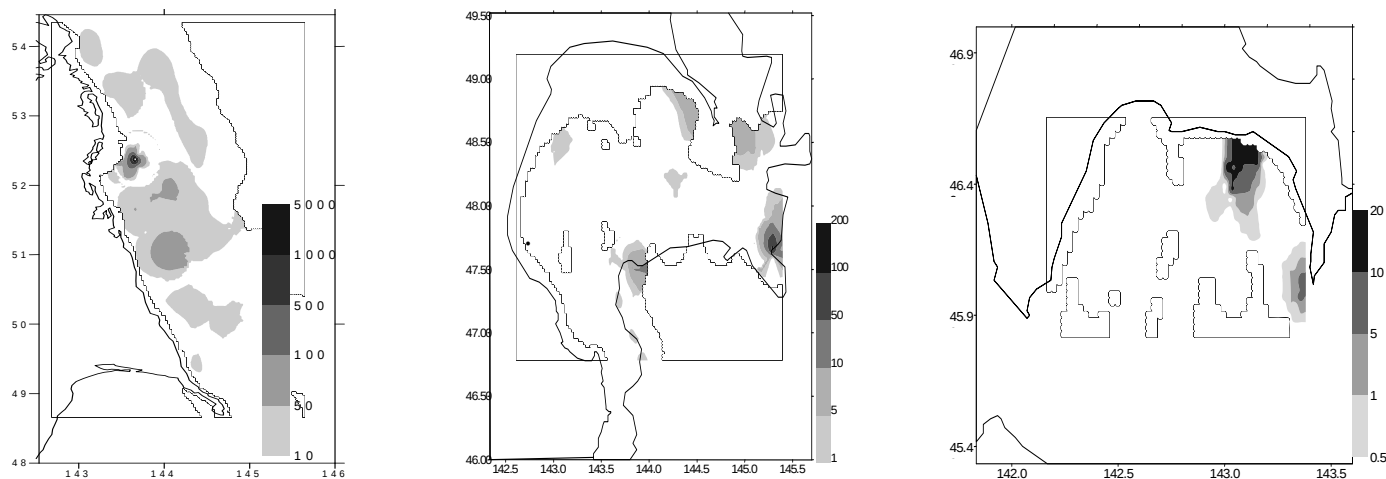
Distribution of herring along the eastern Sakhalin coast (from left to right: October 2002; July 2002; August 2003; September-October 2004)



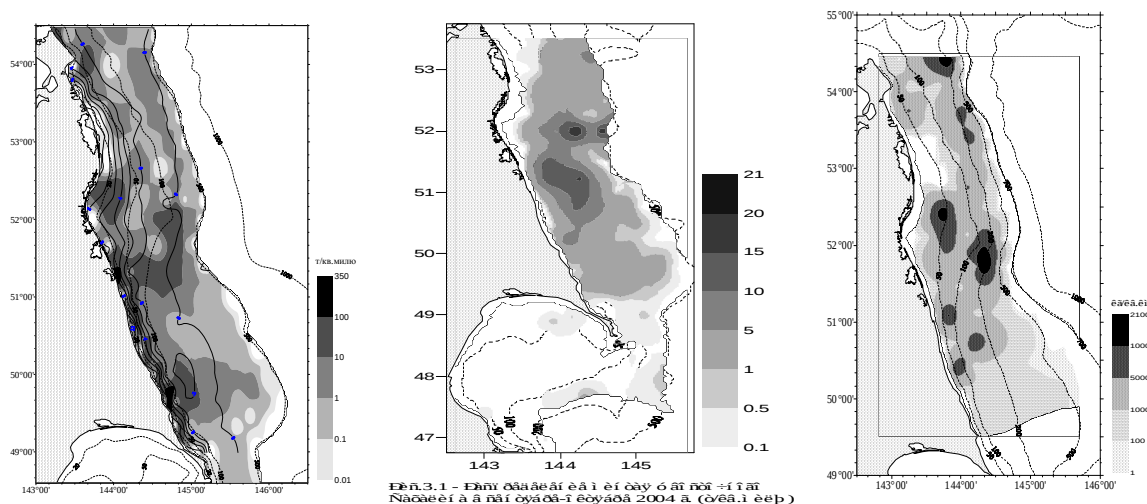
Length-size composition of herring trawl catches near northeastern Sakhalin: Left – July 2002 (A); October 2002 (B); right – June 2007



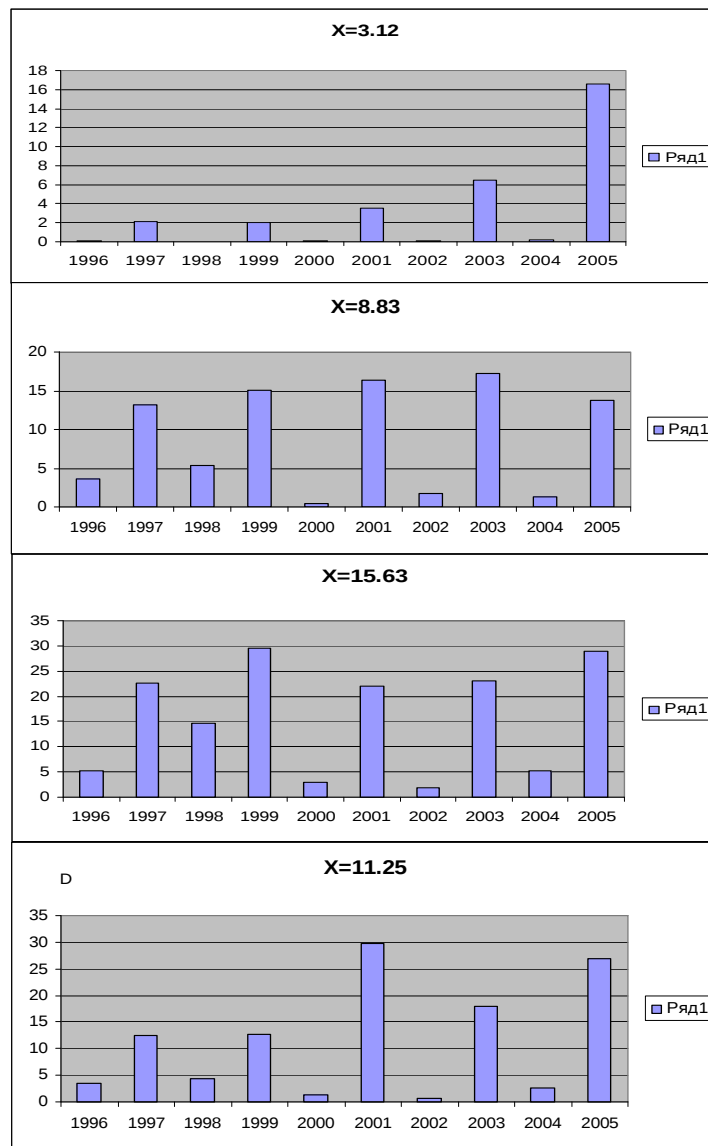
Distribution of walleye pollock near the eastern Sakhalin coast in 2002 (from left to right: northeastern Sakhalin, September-October; southeastern Sakhalin and Aniva Bay, August-September).



Distribution of walleye pollock near the northeastern Sakhalin coast (from left to right: August 2003, October 2004 and 2005)



Dynamics of abundance index of pink salmon in different regions of eastern Sakhalin in 1996-2005 (top-down: northeastern Sakhalin; Terpeniya Bay; southeastern Sakhalin; Aniva Bay).



Distribution of capelin near the eastern Sakhalin coast (from left to right: pelagic trawl survey - June-July 2002, June-August 2003; bottom trawl survey - September-October 2004)

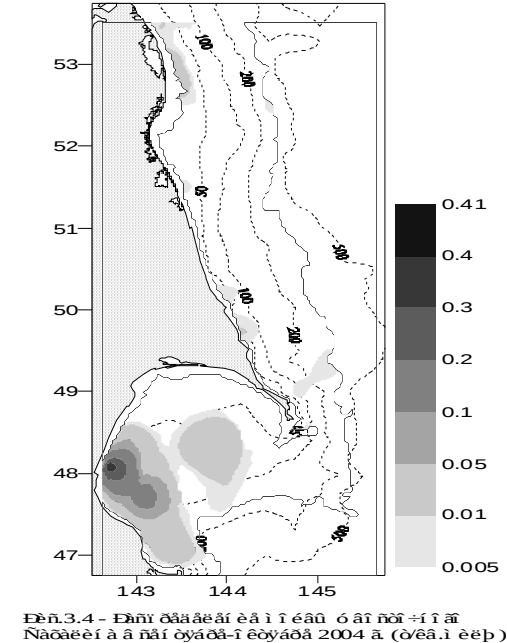
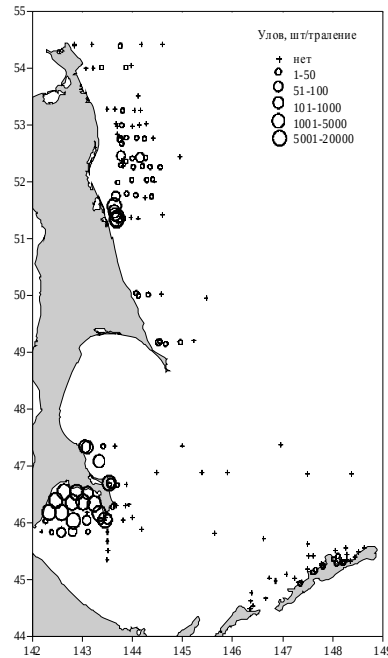
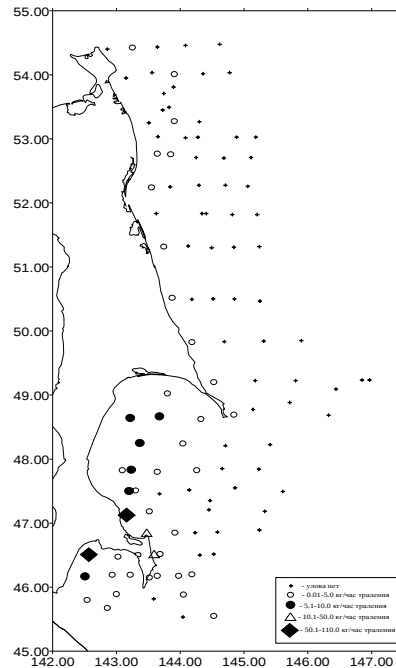
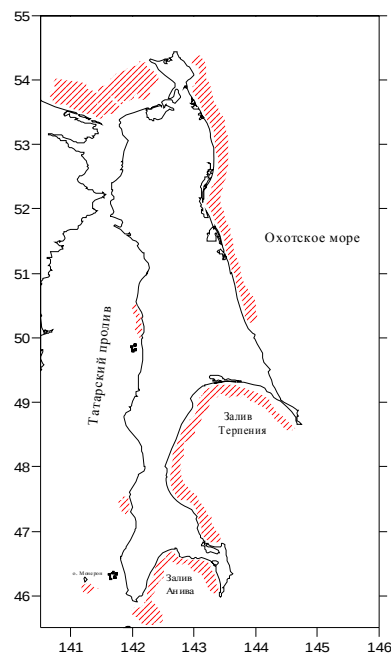
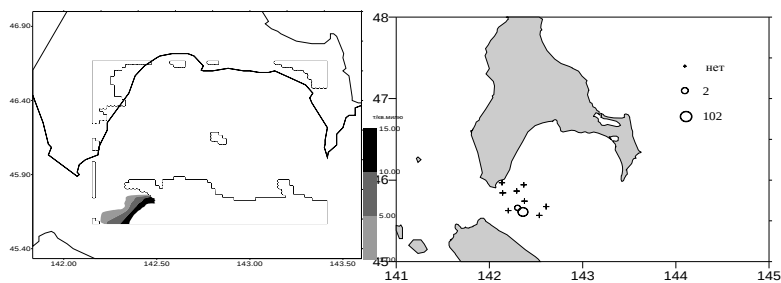


Рис.3.4 - Распределение колюшки в районе восточного побережья Сахалина в сентябре-октябре 2004 г. (данные БТ)

Distribution of sand-lance in shelf waters of Sakhalin Island

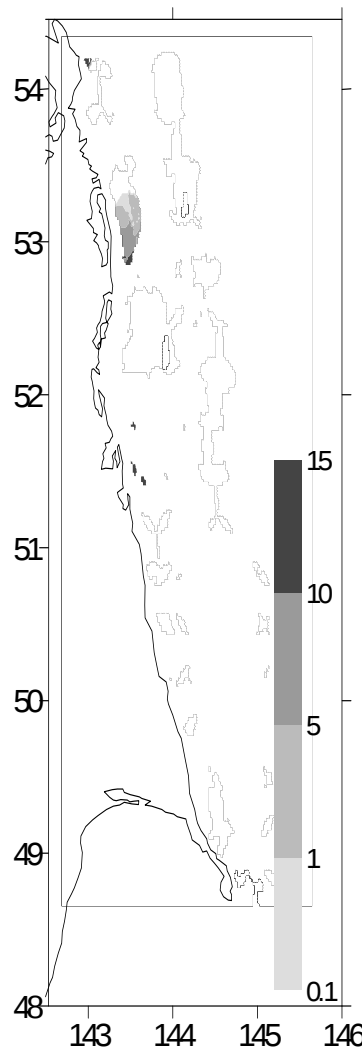


Distribution of sand-lance in Aniva Bay and La Perouse Strait in June 2004 (left fig.) and 2006 (bottom trawl survey)

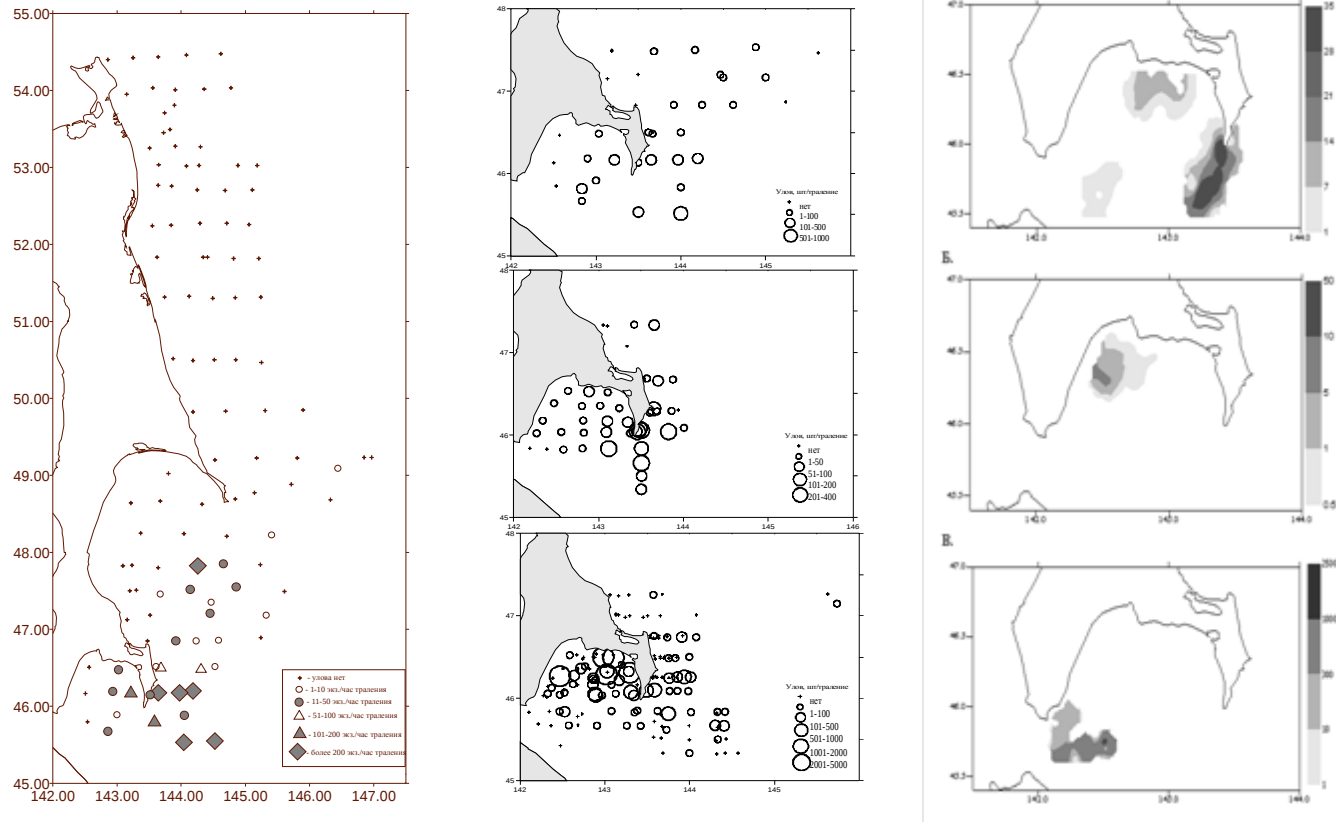


Distribution of sand-lance near the northeastern Sakhalin coast in September-October 2002 (bottom trawl survey)

Photo of sand-lance from pelagic trawl catches near the northeastern Sakhalin coast in July 2002

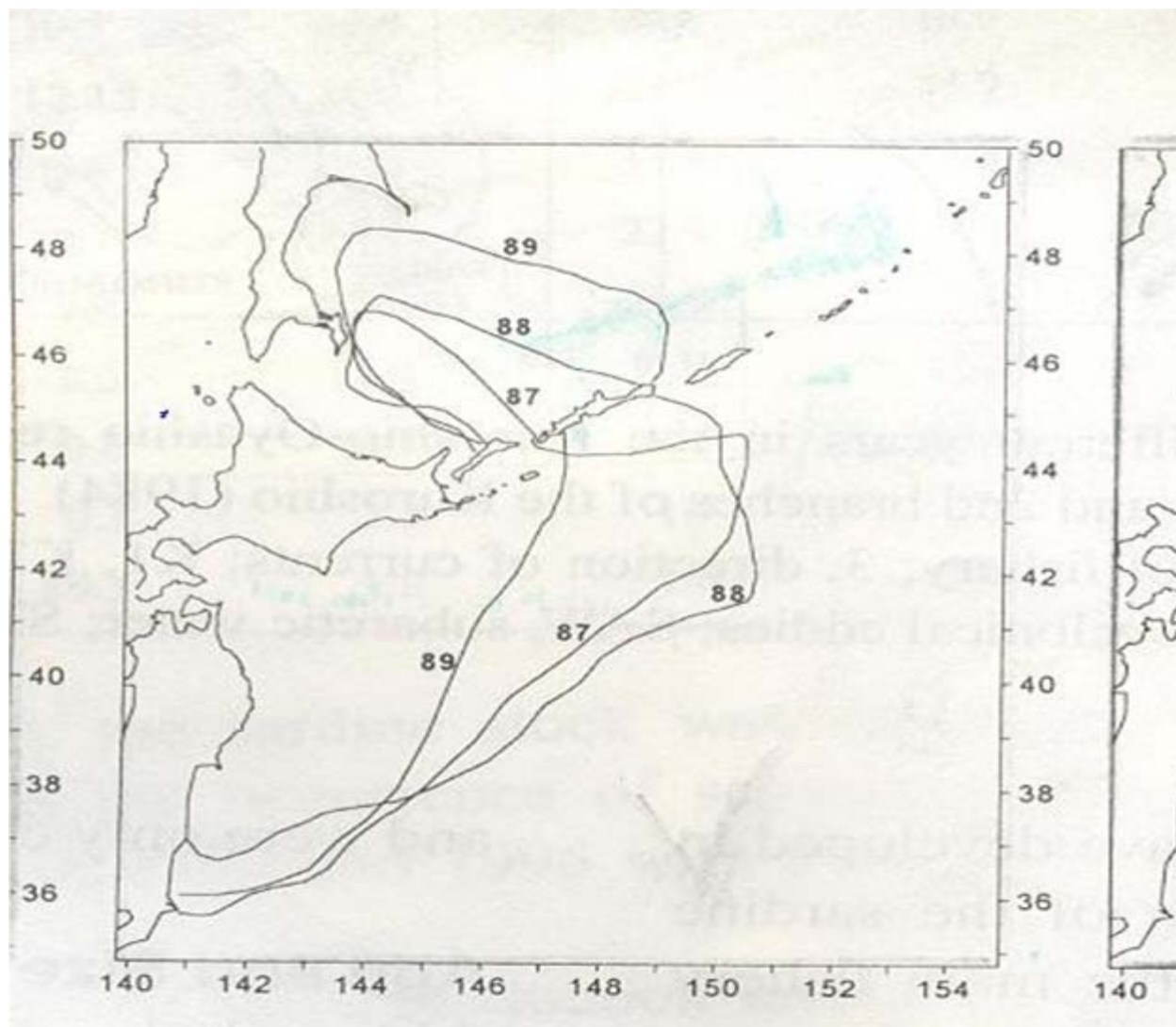


Distribution of arabesque greenling in Aniva Bay and adjoining waters (pelagic trawl survey: left panel - June-July 2002, central panel - June-July 2002-2004; bottom trawl survey: right panel (top-down) – October-November 2000, August-September 2002, August 2005)

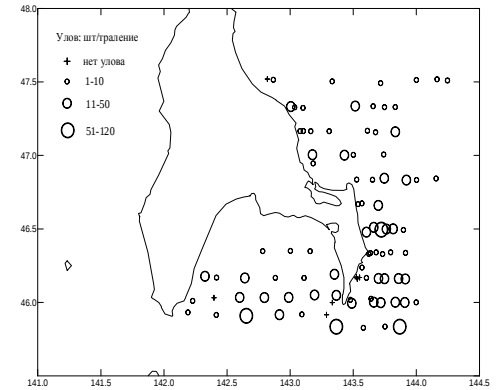
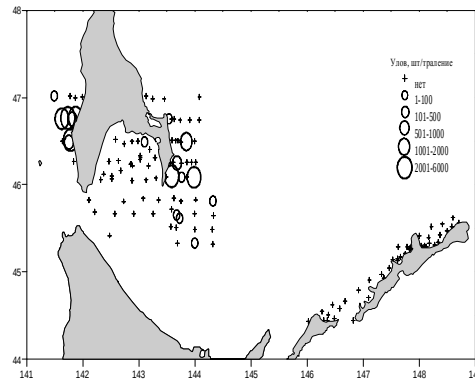
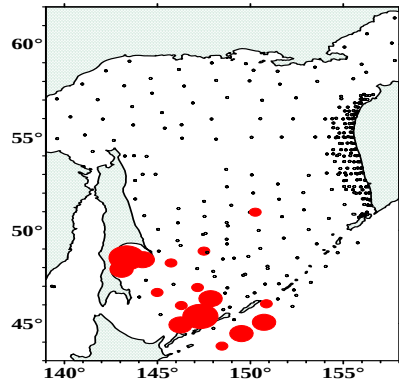


“Aniva Bay and La Perouse Strait are the only region where arabesque greenling demersal aggregations were found in the Okhotsk Sea waters of Sakhalin Island, including aggregations of adult fishes (2005)”

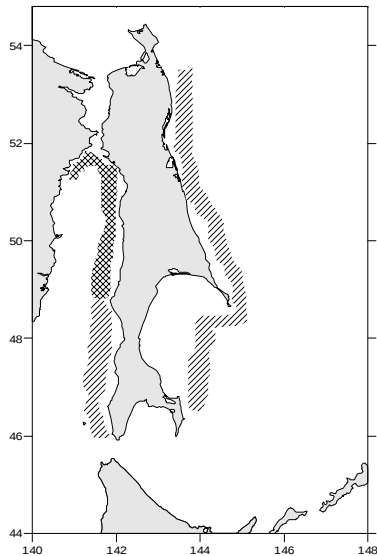
Boundaries of maximal distribution of the fishing congestions of the sardine during 1987-1989 (Zhigalin, Belayev, 1999)



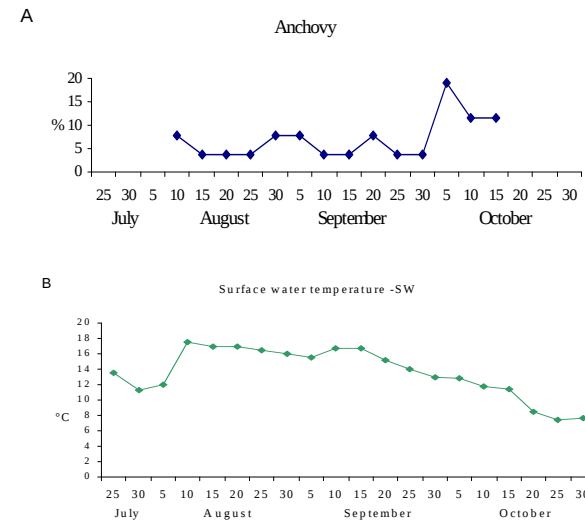
Distribution of Japanese anchovy catches in the Sea of Okhotsk (from left to right: summer1999, Merzlaykov,Temnykh, 2002; summer 2004 and summer 2008)



Distribution of Japanese anchovy near the Sakhalin coast in summer-autumn 2002

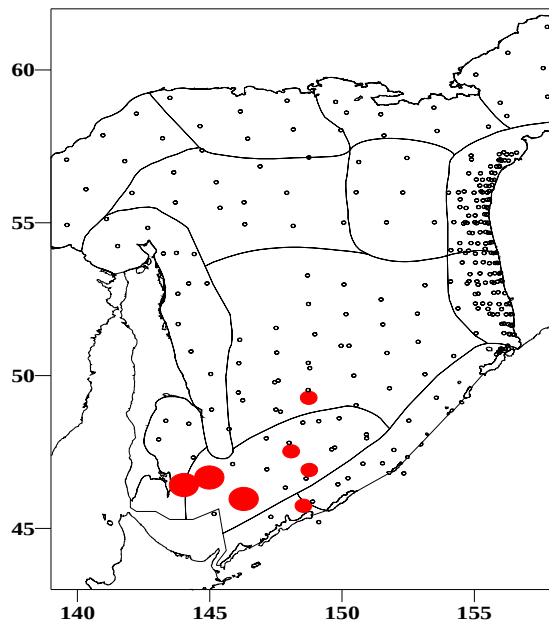


Dynamics of Japanese anchovy frequency and water surface temperature in a zone of deep waters near southeastern Sakhalin in 1999



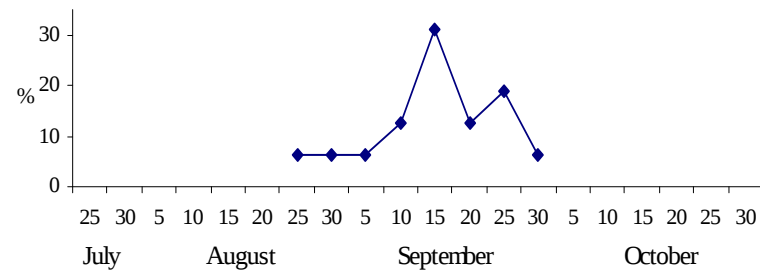
Left Fig. Distribution of saury catches (thousand ind./sq. km) in the Sea of Okhotsk in summer-autumn 1999 (from Merzlyakov, Temnykh, 2002)

Right Fig. Dynamics of Pacific saury frequency and water surface temperature in a zone of deep waters near the southeastern Sakhalin in 1999



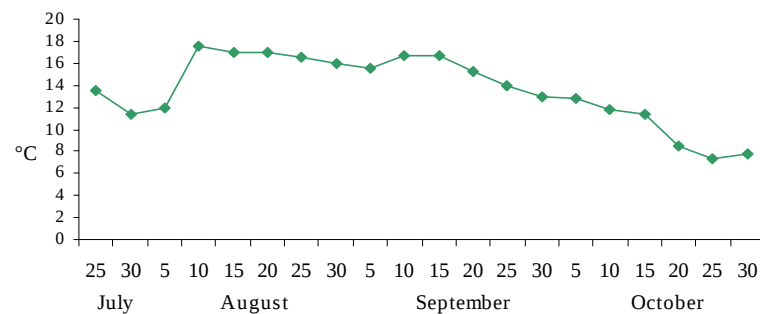
A

Pacific saury



B

Surface water temperature -SW

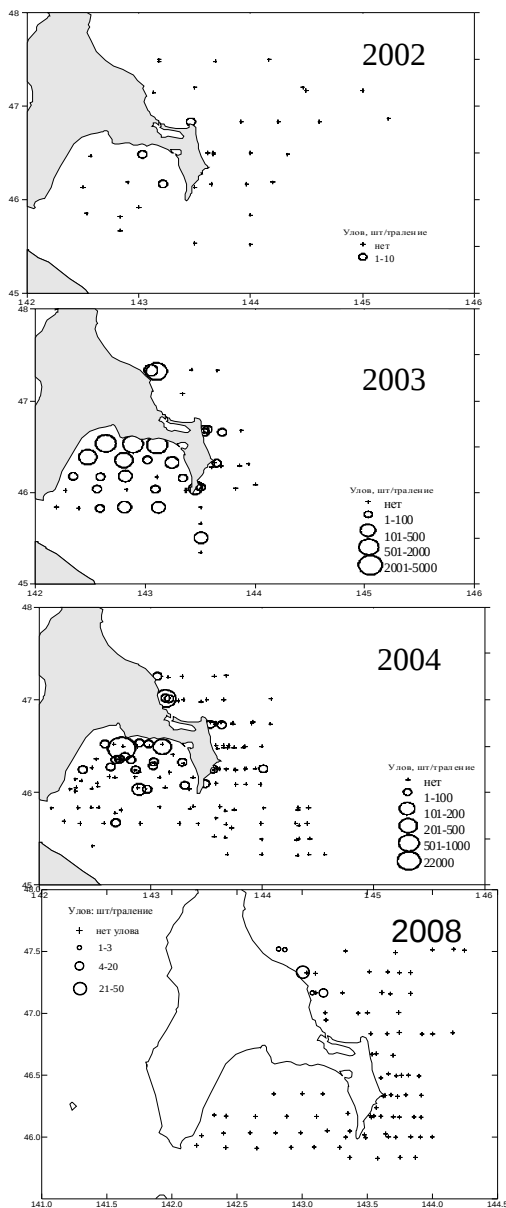


South-latitude fish found in the Sea of Okhotsk (north boundaries) near Sakhalin Island in different decades

Species	1930-1939	1940-1949	1950-1959	1980-1989	1990-1999	2000-2008	Source
Pacific sardine	52°00'		46°40'	48°40'	48°40'	53°20'	Taranets, 1937; Druzhinin,Darda,1963; Zhigalin, Belayev,1999; Velikanov,2006
Japanese anchovy	46°40'		49°00'		53°00'	54°20'	Darda,1968;Velikanov, 2001;2004;2006; Mukhametova, 2004
Pacific saury		49°00'			47°00'	50°00'	Lindberg,1959; Velikanov,2003;2006; Filatov,2005
Daggertooth					47°38'		Own data, 1996
Common dolphin-fish					46°30'	47°18'	Poltev, Sergeenko, 2001; Nazarkin,Gudkov,2006
Longnose lancetfish				46°50'	46°39'		Ilinskiy, 1998; Velikanov, 2003
White shark						46°35'	Own data, 2007
Swell fishes puffers						46°30'	Velikanov, Stominok, 2004
Chub mackerel		46°00' - 46°30'				46°21'	Lindberg,1959; Velikanov,Stominok, 2004; Own data, 2008

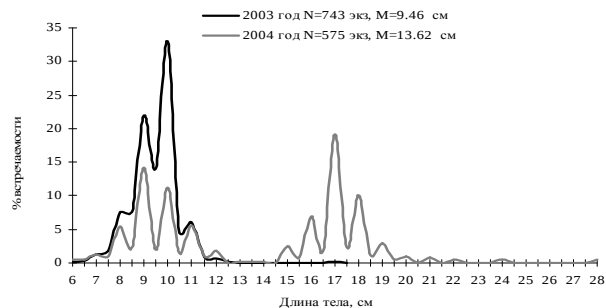


Changing of spawning ground productivity

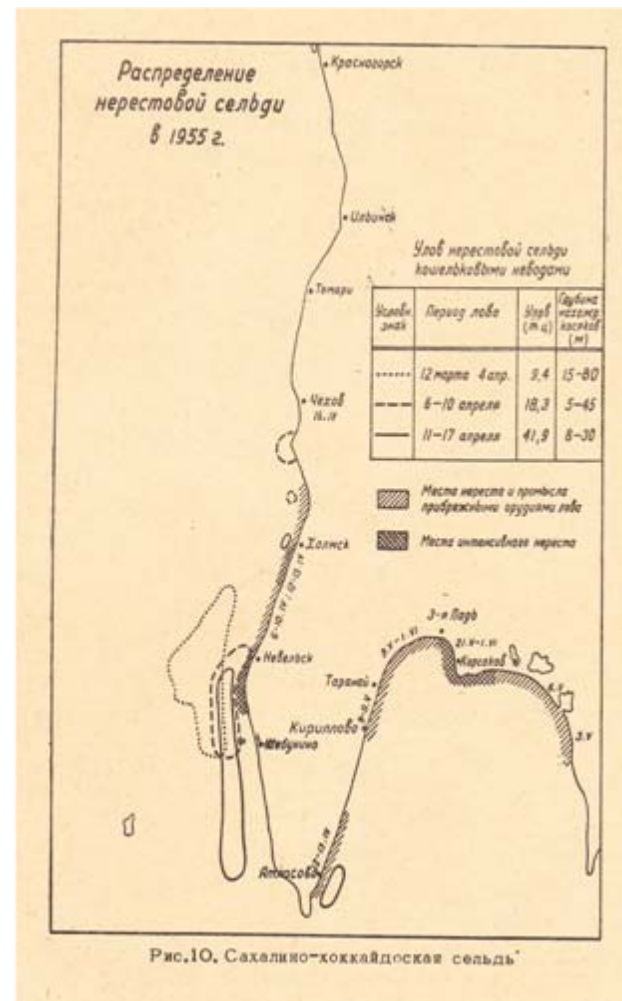


Distribution of juvenile herring in Aniva Bay and adjacent waters in June-July 2002-2004 and 2008

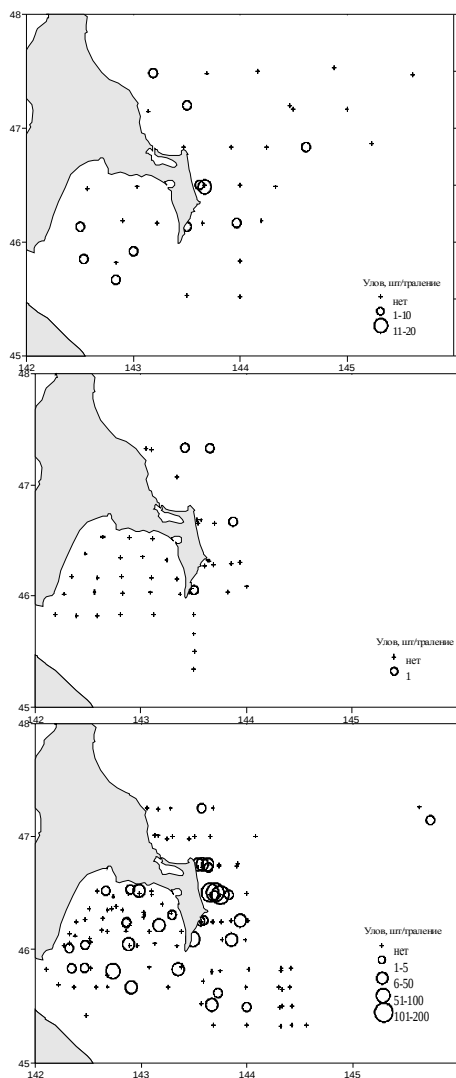
Length composition of herring from the pelagic trawl catches in Aniva Bay and adjacent waters in summer 2003-2004



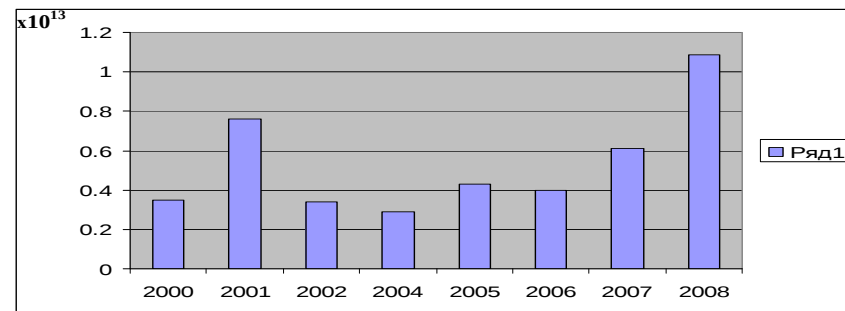
Location of herring spawning grounds near the southern coast of Sakhalin in 1955 (Rumyantsev et al,1958)



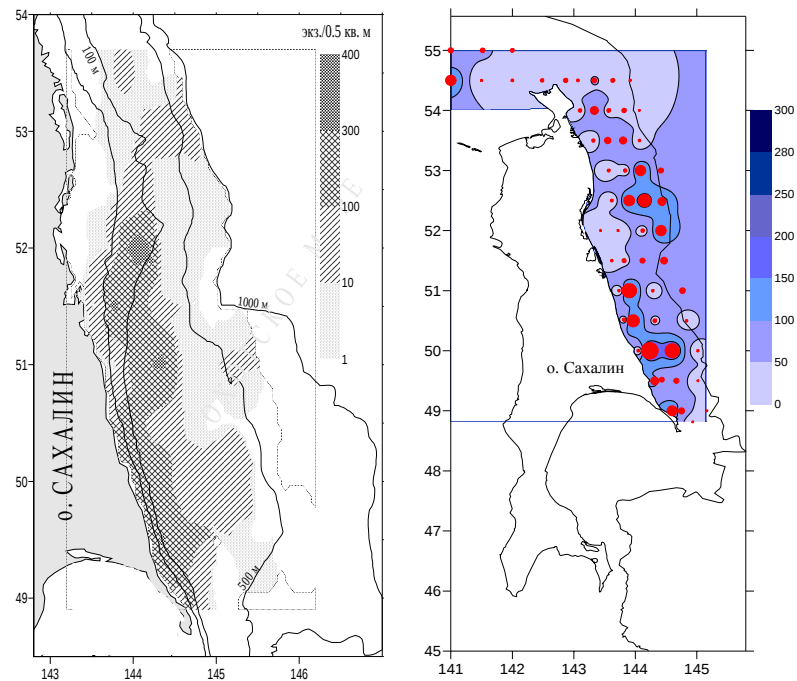
Distribution of juvenile walleye pollock in Aniva Bay and adjacent waters in June-July 2002-2004 (top-down)



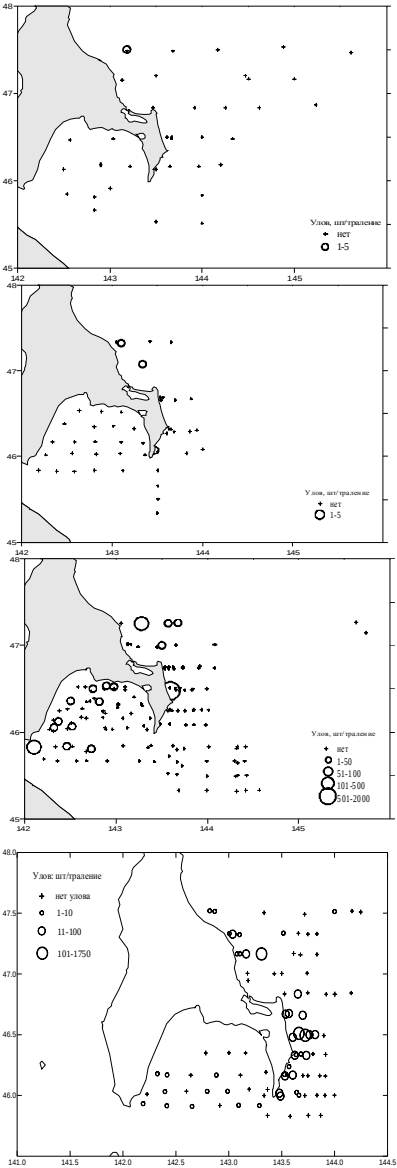
Dynamics of abundance index of walleye pollock floating eggs near the northeastern Sakhalin coast in 2000-2008



Spatial distribution of walleye pollock floating eggs near the northeastern Sakhalin coast in June 2007 (left) and early July 2008 (right)



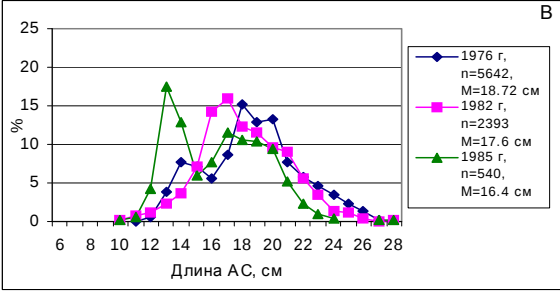
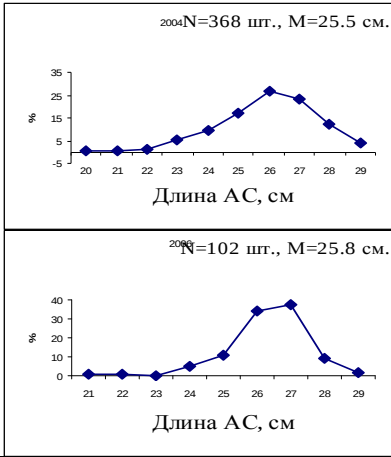
Distribution of juvenile sand-lance in Aniva Bay and adjacent waters in June-July 2002-2004 and in July 2008 (top-down)



Occurrence and pelagic trawl catches of juvenile sand-lance in Aniva Bay and adjacent waters in June-July 2002-2008

Year	2002	2003	2004	2005	2006	2007	2008
Occurrence, %	2.3	2.7	4.3	10.0	1.2	0.0	50.0
Catch, ind./trawl	1-5	1-5	1-20000	1-30	1-2	0.0	1-1750
Number of stations	37	48	145	80	81	91	91

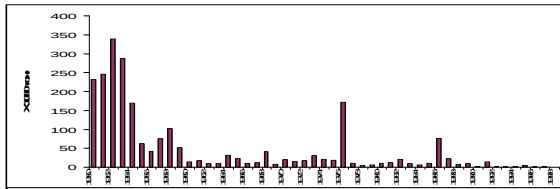
Length composition of the bottom trawl catches of sand-lance in the La Perouse Strait in June 2004 and 2006 (top) and in June-August 1976, 1982 and 1985 (bottom)



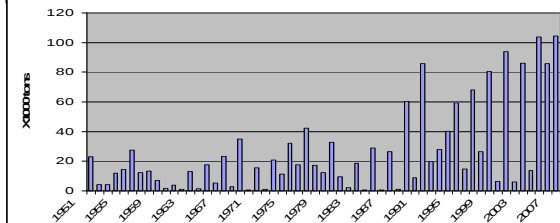
Data of capelin spawning area and eggs concentration in Aniva Bay and near southeastern Sakhalin in different years

Year	Aniva Bay		South-Eastern Sakhalin	
	Egg concentration ($\times 10^6$ egg/m ²)	Spawning area ($\times 10^6$ m ²)	Egg concentration ($\times 10^6$ egg/m ²)	Spawning area ($\times 10^6$ m ²)
1979	3,14 – 15,90	0.60		
1985	0.51-3.66			
1986			0.26 – 0.67	
1987	0.05- 1.28	0.50	0.08 -0,17	0.51
1988	0.01 – 2.10	0.71	0,01 – 8.77	0.89
1989			0.01 – 3.18	0.64
1985-1989	0.01 – 3.66	0.5-0.71	0.01 - 8,77	0.51-0.89
2000	0.004 – 0.145		0,30 – 0.70	0.50
2001	0.002 – 0.110		0,05 – 0,40	0.40
2002	0.049- 2.025	0.20	0.10 – 1,01	0.60
2003	0.009- 1.452	0.09	0.05 – 0.20	
2004	0.007 – 0.196	0.15	0,01 – 0,19	
2000-2004	0.002 – 2.025	0.09-0.20	0,01 – 1,01	0.40-0.60

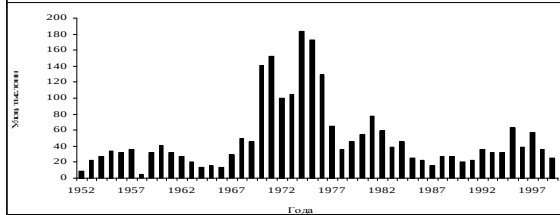
Herring



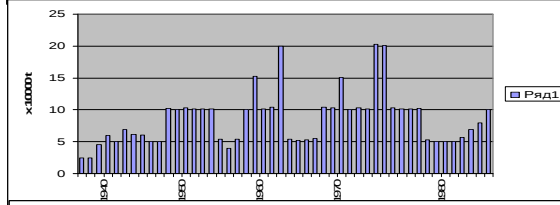
Pink salmon



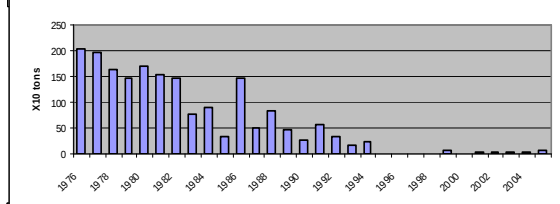
Sand-lance



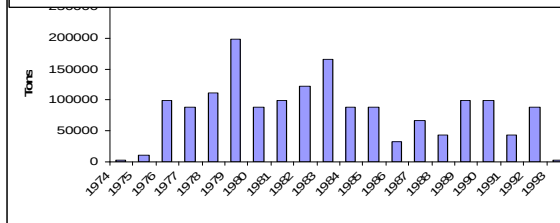
Arabesque greenling



Walleye pollock



Pacific sardine



Abundance and Fishery

In the 20th century total maximal annual catches of herring, Pacific sardine, sand-lance, walleye pollock and pink salmon reached 1,0 million tons near the eastern Sakhalin. Long-term abundance fluctuations of northern and southern boreal species were characterized by comparatively smooth changes, which had been observed during 50-60 years. The time periods when high abundant subtropical species appeared in the investigation area were shorter, not more than 10-20 years.

**Dynamics of different pelagic fish catches
in the southwestern part
of the Sea of Okhotsk in the second half of the
20th century**

Summary

- Essential changes in species composition, distribution, abundance and annual catches of pelagic fishes took place in the Sea of Okhotsk near the Sakhalin Island during 1950 – 2008.
- At present, walleye pollock, herring and sand-lance are mostly abundant in the northern part of the study area (49 - 54° N), whereas pink salmon, capelin, arabesque greenling and Japanese anchovy – in the southern part (46 - 49° N).
- The productivity of the southern spawning grounds for herring, walleye pollock, sand-lance and capelin declined significantly during the last 30 years, whereas the productivity of pink salmon spawning grounds in Sakhalin southern rivers increased.
- In 1990-2008 reproduction of Japanese anchovy and arabesque greenling was at the high level. Annually these species form feeding aggregations near the southeastern Sakhalin, but their spawning grounds are located far south of Sakhalin Island.
- In the 20th century total maximal annual catches of herring, Pacific sardine, sand-lance, walleye pollock and pink salmon reached 1,0 million tons near the eastern and southern Sakhalin.
- Long-term abundance and catches fluctuations of boreal and subtropical pelagic fishes have essential difference in the Sea of Okhotsk near Sakhalin Island. Boreal species were characterized by comparatively smooth changes, which had been observed during 50-60 years. The time period when high abundant subtropical species appeared in the investigation area was shorter, not more than 10-20 years
- A new wave of south-latitude fish migrations took place near the Eastern Sakhalin in 2000-2008; there were recorded almost 10 various species, including white shark, which was caught for the first time in Aniva Bay in 2007.
- All above-mentioned changes in the epipelagic fish communities are related with long-term changes in climate and oceanological regime.



•Thank you for attention