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by V. L. Kostarev

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THE OKHOTSK CHUM FISHING INDUSTRY

by V.L. Kostarev.

The national salmon industry began to develop in the Okhotsk region after the October Socialist Revolution. The first beginnings of the state fishing industry should be considered as the years 1923 - 24. At that time a mixed state and private company OKARO (Okhotsk-Kamchatka Joint-stock Company) was organized. Until that time the industry had been carried on by private owners, by the local population to satisfy domestic needs, and by Japanese fishing entrepreneurs working concessions.

*133

In pre-revolutionary times the number of concessions was never more than 11. At that time between 0.4 and 1.0 million chum a year were caught. In the period 1917-1924 the number of concessions grew significantly to between 28-51; the chum catch in those years varied from 1.2 to 3.8 million fish.

The Kamchatka Joint-stock Company (AKO) was founded in 1928, amalgamating the state owned fishing enterprises of the Kamchatka and Okhotsk coasts. In 1935 the Okhoto-Ayanski State Fishery Trust separated from AKO and was later reorganized into the Okhotsk Trust (Ivanis, 1963).

* Numbers in the right-hand margin indicate the corresponding pages in the original.

At the same time, besides the state-owned fishing industry, until 1943 there was a concessionary salmon industry. The number of concessions during that period did not exceed 38 and between 1925 and 1943 their chum catch came to from 0.5 to 2.6 million fish.

The total chum catch in the period 1925-1933 in the area of the Okhotsk industry fluctuated between 76.5 to 212.6 thousand centners (Kuznetsov, 1937); in the period 1934-1939 between 116.2 and 233.2 thousand centners (Pravdin, 1940); that is, over 15 years, in the period 1925-1939, the chum catch fluctuated by a factor of 3.

In the period of the Patriotic War, 1941-1945, the chum catch varied very little. The catches in those years fluctuated from 61 to 120 thousand centners making a yearly average of only 95 thousand centners.

Chum stocks began to be exploited most intensively with the introduction of fish-pump plants in 1947. In the years that followed, further mechanization of the labour-consuming processes continued (the construction of mechanized Borland-type fish passes, conveyors, etc.), and this affected the industry's fishing capacity.

Naturally, at that time chum stocks were more fully exploited and there was a greater range in the yearly catch fluctuations. Thus in the period 1948-1961, the annual chum catch varied from 76 to 318 thousand centners, that is, there were fluctuations of up to 400%, averaging out to 156 thousand centners annually. After 1961 the off-shore catch was cut sharply and in the period 1961-1967 averaged about 60 thousand centners, with fluctuations of from 26 to 85 thousand centners. During these years, in comparison with the preceding period, the off-shore catch of Okhotsk chum was cut by a factor of 2.6.

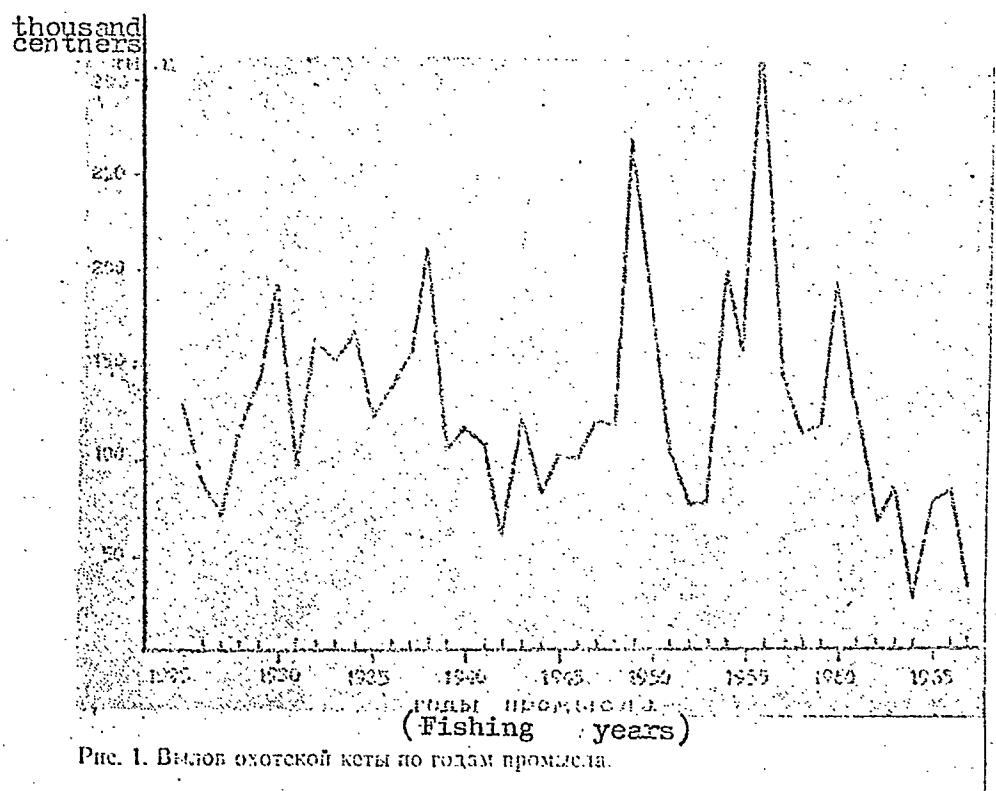


Рис. 1. Вывод охотской кеты по годам промысла.

Figure 1. Okhotsk chum catch by fishing years.

The considerable fluctuations in the yearly catches and their drop in later years were determined mainly by the condition of Okhotsk chum stocks and by great fluctuations in the size of the year-classes which make up the spawning population in any given year.

During the post-war period as a whole (1945-1967), the size of the chum catch by fishing year fluctuated in the range of 26 to 318 thousand (centners) or from 698 to 8788 thousand fish, which is more than a twelve-fold fluctuation. Fluctuations in the chum catch for the period 1925-1967 are shown in Figure 1, where the size of catches for 1925-1939 has been reduced on average by 10% in comparison with the findings of I.I.Kuznetsov (1937) and I.F. Pravdin (1940). (in the data of the above-mentioned authors the Tauiskii region and the River Yama are included, which according to statistics for subsequent years accounted for 10% of the combined catch of Okhotsk, Tauiskii and Yama chum). In order to get comparable data, and taking into account the impossibility of separating out today the catches of Tauiskii and Yama chum for the years 1925-1939, we thought it possible to extend the ten percent figure for the Tauiskii region and the River Yama to the above-mentioned years. In other words, excluding the chum catch in the rivers of the Tauiskii Gulf and the River Yama over the period 1925-1939, which averages

10% of the over-all catch of Okhotsk, Tauiskii and Yama chum, we get comparable data on the chum catch in the Okhotsk region for the whole period 1925-1967.

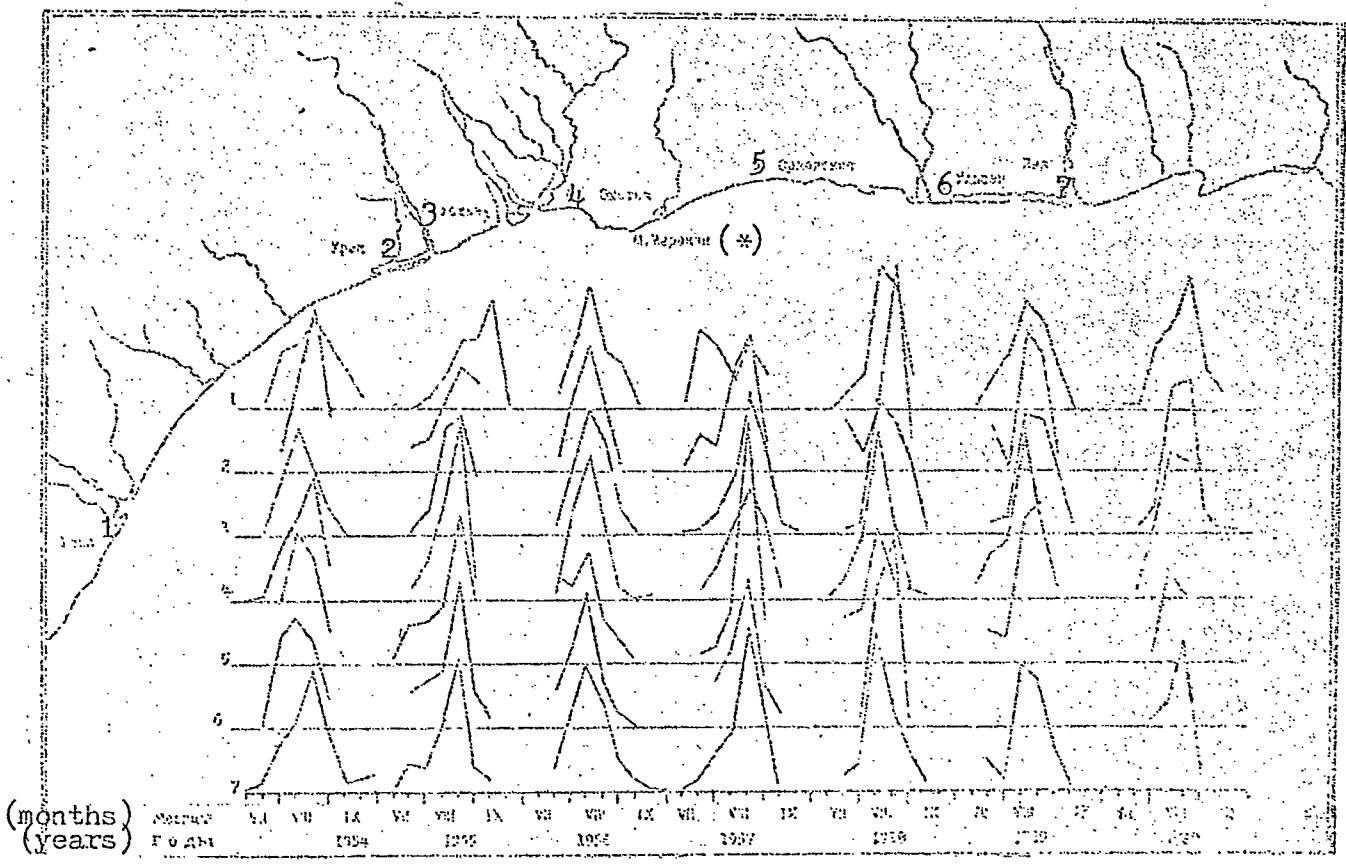
The first approaches of the chum to the shores of the north-western part of the Sea of Okhotsk and their entry into the rivers take place at the end of June. They occur in commercially exploitable numbers around the tenth of July. Their run into the rivers continues until the middle of September, but commercially they are caught until the end of August or the beginning of September. In view of the sharp thinning out of the run in the later period, fishing ceases to be commercially effective. The mass run lasts from the end of July to the middle of August (Figure 2). No significant differences occur in the times of the run in different areas of the Okhotsk coastline, which runs from 141° to 146° long. East.

136

Рис. 2. Динамика вылова кеты предприятиями Охотского рыбтреста в 1954-1960 гг. (1-7 - промышленные участки побережья и соответствующие им вылова кеты в течение каждого промышленного сезона).

Figure 2. The dynamics of the chum catch made by enterprises of the Okhotsk Fishery Trust in the period 1954 - 1960. (1-7 = commercially exploited areas of the coastline and their corresponding chum catches during each commercial season.)

135



- 1. Ul'ya
- 2. Uyak
- 3. illegible
- 4. Okhotsk
- 5. Orlovskii ? /not clear/
- 6. Ul'beya
- 7. Inya
- (*) Cape Marakan

The run of the Okhotsk chum compared with the Western Kamchatka chum takes place at exactly the same time, with the exception of the Southwest Kamchatka chum which is attributed to the autumn form (Abramov, 1943; Birman, 1964). Nor are any differences observed in the times of the mass run in individual years, although the duration of the runs varies somewhat depending on the size of the spawning populations. The rule in this case is: in years where the size of the spawning population is large, the duration of the run increases, and on the contrary, where the size of the spawning population is low, the general duration of the run is less.

The approaches of the chum toward the coast, their river migrations and their arrival at the spawning grounds take place while temperatures are gradually falling—an exception being the spawning grounds on the River Ulkhan. (Table 1)

TABLE 1. Water temperature during the chum run.

Ten-day period (A)	Month (B)	Sea (C)	River (D)	Spawning grounds (E)	
				River Meta (F)	River Ulkhan (G)
I	August (a)				
II	August				
III	August				
I	September (b)				
II	September				

Таблица 1. Температура воды в период хода охотской кеты

Декада (A)	Месяц (B)	Море (C)	Река (D)	Нерестилище (E)	
				р. Мета (F)	р. Улхан (G)
I	Август (a)	13,8	12,8	5,2	14,3
II	Август	14,1	12,1	3,6	14,0
III	Август	14,1	11,8	3,3	12,5
I	Сентябрь (b)	12,8	10,4	3,0	—
II	Сентябрь	11,6	6,8	2,5	—

In contrast to the chum of the Amur, where the run occurs from the colder waters of the Sea of Okhotsk into the warmer waters of the Amur estuary and into the Rivers Amur and Ussuri and then into the colder waters of the spawning rivers (Birman, 1952), the Okhotsk chum goes from the relatively warm waters of the Sea of Okhotsk into the colder waters of the rivers of the continental littoral and the still colder waters of the spawning grounds. As to the spawning grounds in the River Ulkhan, the chum run occurs there under conditions of relatively limited temperature change.

The salmon catch in the Okhotsk commercial fishing area is at present carried out with river drag seines in the lower reaches of the rivers and with fixed trap nets in sea fishing areas.

The Rivers Ul'ya, Urak, Okhota, Kukhtui, Ul'beya and Inya are the main salmon spawning rivers of the area; as regards both the commercial aspect and the replacement-reproduction of salmon stocks these rivers are not of equal importance.

The size of the chum catch (in percentages) in the above-mentioned rivers is set out in Table 2.

Table 2. The chum catch in the rivers of the north-western part of the Sea of Okhotsk (%).

(a) Names of the rivers					
1. Ul'ya	2. Urak	3. Okhota	4. Kukhtui	5. Ul'beya	6. Inya
9.7	1.0	61.9	14.3	2.0	11.1

Таблица 2. Вылов кеты в реках северо-западной части Охотского моря, в %

(a) Наименование рек					
1. Ульа	2. Урак	3. Охота	4. Кухтуй	5. Ульбея	6. Иня
9.7	1.0	61.9	14.3	2.0	11.1

Salmon fishing, including chum, is carried out by the fishing collectives of the Okhotsk region and by enterprises of the Okhotsk Fishery Trust. Over the last 20 years, the share of the state and of the collective sectors in the catch has changed fundamentally. While at the end of the 1940's the state catch represented about 50% of the overall salmon catch, in the middle of the '50's its share had fallen to 30%, in the early '60's it was 15%, and in recent years it has sunk to less than 10%. The enlarging of the role played by the collective sector in the salmon industry is linked with Government policy aimed at strengthening the economy and the standard of local regional collectives. 137

The amount of fishing gear varies according to fishing years. And the ratio of fixed trap nets to seines also varies. During the period from 1953 to 1967, the number of trap nets fluctuated from 30 to 65, that is, more than doubled, averaging over these years 46 nets. During the same period the number of seines changed by a factor of 5.8, the numbers fluctuating from 17 to 98 nets and averaging over these years 54 nets. The difference in the number of trap and seine nets in the period 1953-1967 averages altogether only 8 nets; however, in individual years this figure was higher. In the period 1953-1961, seines predominated significantly. The predominance of seines reached on average 20 nets, and in individual years was as high as 33 nets. After 1961, in connection with restrictions on river

salmon fishing, the number of seine nets was sharply reduced. Along with this reduction in the number of seine nets, there was also a reduction in the number of trap nets. This was due to the drop in numbers of the salmon spawning population. The reduction of stocks and the restriction of river fishing led to the predominance of sea trap nets in the period 1962-1967 in the salmon industry of the Okhotsk commercial fishing area, in contrast to the preceding period (1953-1961). In the first years this predominance was not significant but in 1965-1967 it was double, although the overall quantity of both types decreased considerably. Thus, while in 1953-1961 the number of trap nets averaged 52. During 1962-1967 this was reduced to 35, that is by a third. Over these same years the number of seines was reduced by almost two-thirds - from 70 nets in 1953-1961, to 26 nets in 1962-67.

Chum catches using trap nets, as well as salmon catches in general, are significantly higher in most commercial seasons than are catches using seines (Table 3). Therefore, regardless of the significant predominance (1953-1961) of seine nets in the chum industry, the greater part of the fish were caught in sea fishing areas, and in 1962-1967 sea catches annually exceeded river catches. In 1953-1961 about 62% of the total chum catch came from trap nets and in 1962-1967, 70%. For the whole period from 1953 to 1967, 63.3% of the total chum catch for these years came from sea trap nets.

The average chum catch by fishing year for one type of fishing gear fluctuated considerably. Moreover, greater fluctuations in the average catch occurred with trap nets and in the period 1953-1967 reached a factor of 7.4, from 397 to 2920 centners, the average catch for these years being 1597 centners. In the period 1953-1967, the average chum catch using seine nets varied from 455 to 1880 centners or by a factor of 4.1, with an average catch for this period of 904 centners.

Fluctuations in the average chum catch using one type of fishing gear depend mainly on the size of the chum spawning population and partly on the numbers of other types of salmon (especially pink salmon).

Chum catches expressed in percentages of the total salmon catch are cited in Table 3. These figures show that in some years other types of salmon make up a significant part of the catch, but in individual years chum predominate. These circumstances cannot help but influence the fishing rate for chum spawning populations and, in the final analysis, also the size of the chum catch for one type of fishing gear.

TABLE 3. Summary figures on Okhotsk chum commercial fishing 1953-1966

(A) Commer- cial Year	(B) Fixed-trap nets					(J) Seine nets					(R) Total salmon catch thousand centners	(S) Chum among them thousand centners	(T) Chum catch as % total catch
	No of nets (C)	(D) Average catch per net (centners)		(G) Total chum catch		No of nets (K)	(L) Average catch per net (centners)		(O) Total chum catch				
		(E) all species salmon	(F) chum among them	(H) thou- sand centners	(I) %		(M) all species salmon	(N) chum among them	(P) thou- sand centners	(Q) %			

Таблица 3. Сводные данные о промысле охотской кеты в 1953-1966 гг.

(A) Год промысла	(B) Ставные невода					(J) Закладные невода					(R) Общий улов лосо- сей, тыс. ц	(S) В т. ч. ке- ты, тыс. ц	(T) Улов ке- ты в % от общего улова
	количе- ство нево- дов (C)	(D) Средний улов одного невода, ц		(G) Общий улов кеты		количе- ство нево- дов (K)	(L) Средний улов одного невода, ц		(O) Общий улов кеты				
		(E) всех видов лосося	(F) в т. ч. кеты	(H) тыс. ц	(I) %		(M) всех видов лосося	(N) в т. ч. кеты	(P) тыс. ц	(Q) %			
1953	43	1988	750	32,4	40,5	58	2183	820	47,5	50,5	212,1	79,9	37,7
1954	53	2245	2140	113,6	57,6	73	1192	1140	83,4	42,4	206,0	197,0	95,6
1955	65	2507	1969	81,3	52,0	93	1539	770	75,2	48,0	312,0	157,0	50,3
1956	64	2342	2770	177,3	55,6	75	1914	1880	141,0	44,4	327,9	318,3	97,1
1957	55	3223	1450	79,8	55,0	64	2237	1015	65,2	45,0	321,0	145,0	45,2
1958	49	1302	1135	56,4	49,5	65	939	890	57,6	50,5	125,8	114,0	90,6
1959	42	1899	1510	63,5	54,0	70	966	770	54,0	46,0	144,4	117,5	80,0
1960	49	3072	2920	143,0	75,4	71	694	660	46,9	24,6	199,7	189,9	95,1
1961	47	2015	1760	83,8	64,2	57	867	820	46,7	35,8	138,0	130,5	94,6
1962	36	998	850	30,6	51,2	33	1058	885	29,2	48,2	70,0	59,8	85,4
1963	30	3559	1800	56,6	69,6	32	1375	770	24,6	30,4	144,8	81,2	56,1
1964	34	582	397	13,5	51,5	28	664	455	12,7	48,5	38,4	26,2	68,2
1965	42	2478	1550	65,2	82,7	19	1115	729	13,6	17,3	125,3	78,3	62,9
1966	34	1996	1900	66,7	78,6	17	1067	1060	18,1	21,4	86,0	84,8	93,6

The conditions under which the industry is carried on have a definite influence on the efficiency of the fishing among spawning populations of salmon, including the chum.

In salmon fishing with sea trap nets, wind conditions which hamper successful carrying out of the work are an adverse factor. Since coastal areas where fishing with fixed trap nets is carried out are open to gales with winds of over force 4, work on the nets is impeded and sometimes stops; in heavy, prolonged gales fishing gear is taken in. In some years in heavy gales some of the nets are damaged and repairs are carried out after the gale is over.

Analysis of weather conditions for the fishing season of the years 1953-1967 shows that the amount of wasted fishing time due to gales at the end of July and in August fluctuated between 3.8 and 17.5 days. The amount of wasted fishing time in the commercial chum season in the third ten-day period of July and in August expressed in deviations from the long-term average index for this factor is cited in Table 4. These figures show that in the period of the mass chum run into the rivers (the first 20 days of August) in some years stormy days constituted more than half of all the fishing time. In the first ten-day period of August the number of stormy days varied from 0.5 to 5.8, in the second ten-day period, from 0 to 5.2 days.

How the size of the average chum catch per trap net depends on weather conditions can be seen by comparing the figures of Tables 3 and 4.

TABLE 4. The amount of wasted fishing time (days) in the commercial chum fishing season 1953-1967 (in deviations from the long-term average, data of the hydrometeorological service).

(A) Commercial year	(B) Month and ten-day period				(E) for the season
	(C) July		(D) August		
	III	I	II	III	
	Месяц, декада				
Год промысла	июль	август		За сезон	
	III	I	II	III	
1955	0.2	1.8	-1.6	0.0	0.4
1954	-2.2	-1.9	-2.6	-0.8	-7.5
1955	-2.5	-0.7	-2.4	-1.5	-7.1
1956	-1.0	-2.2	-0.8	0.2	-3.8
1957	0.2	0.5	-0.4	0.5	0.8
1958	2.2	0.0	1.2	0.2	3.6
1959	2.5	0.3	-1.1	0.5	2.2
1960	-0.8	-1.9	-1.1	1.0	-2.8
1961	-1.0	-0.9	-0.1	-0.5	-2.5
1962	-0.5	0.1	-0.1	-0.2	-0.7
1963	0.0	-1.2	0.9	0.2	-0.1
1964	2.5	2.1	1.4	0.2	6.2
1965	-0.8	1.3	1.2	1.0	2.7
1966	0.2	-0.7	2.6	2.2	4.3
1967	0.2	3.1	-0.1	0.5	3.7

The figures in these tables show that in years where the number of gales in the commercial chum season is near to the longterm average (+ a day) the catches from one fixed trap net are on average 1360 centners. In years when the number of gales exceeded the longterm average (+2.2; +4.3 days), the catch per trap net was on average about 1200 centners, and in years where the number of gales was below the average (-2.5; -7.5 days), the catch from a trap net reached on average 2170 centners. Along with the characteristics of the figures cited, one must also take into account both the size of the chum spawning population and the numbers of other species of salmon which are caught at the same time as the chum.

In commercial salmon fishing with drag seines in the lower reaches of rivers, the water level of the rivers at the period when the fish are running in them is of considerable importance. Where the river level is low the catch rate among spawning salmon populations increases considerably. A rise in the water level of the rivers and flood waters, arising from a high level of precipitation greatly hampers, and sometimes renders impossible, salmon fishing with seines. At such periods the fishing sites prove to be

TABLE 5. The amount of precipitation in the middle reaches of the Okhota River (deviations from the average longterm figures for the period 1945-1967).

Year (A)	(B) Month & ten-day period					(E) For the season
	(C) July		(D) August			
	II	III	I	II	III	

Таблица 5. Количество выпадающих осадков с средних течений р. Охота в 1953-1967 гг. (в отклонениях от средних многолетних показателей периода 1945-1967 гг.)

Год: (A)	(B) Месяц, декада					(E) За сезон
	(C) июль		(D) август			
	II	III	I	II	III	
1953	64.8	19.1	17.5	-7.2	-7.8	88.9
1954	-24.9	-23.7	14.5	-3.5	19.6	-18.0
1955	-3.1	9.3	28.2	-14.2	-14.2	6.0
1956	-19.5	-8.3	-18.9	-13.0	-4.5	-25.2
1957	3.1	12.5	-13.2	-9.7	-11.2	-18.3
1958	3.8	2.0	-19.6	-4.2	-19.3	-25.3
1959	-35.2	140.5	-5.3	-13.0	-15.4	71.9
1960	32.0	17.5	-15.4	-7.9	5.6	31.9
1961	56.0	-25.1	-0.5	16.8	-14.1	33.1
1962	-29.7	-22.4	11.0	-4.3	-12.3	-57.7
1963	-62.4	-25.2	-22.3	-10.6	8.6	-101.9
1964	-26.8	-24.1	47.9	6.1	16.7	29.8
1965	21.2	-13.7	-22.3	28.4	4.1	17.7
1966	-14.2	96.7	7.5	36.3	-9.2	47.1
1967	0.0	-26.4	68.2	-7.4	-11.1	29.3

flooded and fishing takes place in random areas little suited to fishing. The catch rate at such periods falls sharply. To a great extent this concerns chum which in their run into the rivers and their migrations along them keep to the main channel, unlike pink salmon who move along the river-bank areas of the channel.

Since we have not got the figures on the flow rate and the water levels in the rivers of the north-west part of the Sea of Okhotsk at our disposal, we must use figures on the amount of precipitation for the period when the salmon spawners make their run into the rivers.

The material in Table 5 shows that in some commercial fishing periods deviations in the amount of precipitation from the longterm average reach significant proportions. Naturally this cannot help but be reflected in the efficiency of the functioning of the seines in river-mouth areas.

In some years the actual amount of precipitation is five times the longterm average and in other years there is absolutely no precipitation at all. All this creates great fluctuations in riverwater levels and in some years facilitates a higher commercial catch rate and in other years greatly hampers the catching of the fish running into the rivers. Comparison of the figures in Tables 3 and 5 confirms the above. Along with this it is also necessary to take into account the size of the chum spawning population and the number of salmon of other species caught with the chum.

The features dealt with, of commercial fishing in rivers and in sea fishing areas, determine to a considerable extent the yearly ratio between chum catch and spawning escapement. For the last 7 fishing years the percentage of the chum removal from the spawning population varied by a factor of 2.5. Figures for the commercial removal of chum for 1961-1967 are given in Table 6. On average the removal percentage for these years came to 57.8%

The figures cited on the commercial removal of Okhotsk chum in coastal waters (Table 6) are very near to such figures for other areas. Thus V.Y. Levanidov (1964) cites figures on the commercial removal of Amur summer chum, noting, that on average in commercial years 50-55% of the population of summer chum are caught. And for the Amur pink salmon he cites a commercial removal coefficient of 60%. R.S. Semko (1954) cites Azbelov's figures on the commercial exploitation of a population of sockeye in the basin of the River Ozemaya. In the period 1941-1947, the coefficient of the commercial removal of sockeye in this region varied from 30 to 63%.

TABLE 6. The ratio between chum catch and spawning escapement
in the period 1961-1967

(A) Designation	(B) Commercial year							(C) Seven year average
	1961	1962	1963	1964	1965	1966	1967	
1. Catch (million fish)								
2. Escapement to the spawning grounds (million fish)*								
3. Size of spawning population (million fish)								
4. Percentage of removals of fish from the spawning population.								

* the number of chum spawners having passed through to the spawning grounds in the period 1961-1967 was determined by aerovisual survey using methods of the Kamchatka branch of the Pacific Fisheries and Oceanography Research Institute (Ostroumov, 1962).

Таблица 6. Соотношение вылова и пропуска кеты на нерестилища в 1961—1967 гг.

Наименование	Год промысла							Среднее за 7 лет
	1961	1962	1963	1964	1965	1966	1967	
Улов (млн. шт.)	3,765	1,546	2,190	0,698	2,270	2,402	0,808	1,954
Пропуск на нерести- лища (млн. шт.)*	2,000	1,230	0,725	0,800	1,130	2,376	1,736	1,428
Численность нерес- ткового стада (млн. шт.)	5,765	2,776	2,915	1,498	3,400	4,778	2,544	3,382
Процент изъятия рыб из нерестово- го стада	65,3	55,7	75,1	46,6	66,8	50,3	31,8	57,8

* Количество производителей кеты, прошедших на нерестилища в 1961—1967 гг. определено методом аэровизуального учета по методике Камчатского отделения ТИИРО (Остругов, 1962).

Hunter (1959) quotes a 50% coefficient of commercial removal for British Columbia chum, and Neave (1953) assumes a mortality rate for the pink salmon under coastal fishing conditions of 60%.

In order to compare figures on the commercial removal of chum for the period 1961-1967 in the rivers of the Okhotsk region, obtained with the help of an aerovisual survey and from the commercial figures on the chum catch, we quote information on commercial removal for the period 1956-1960, obtained by calculation using data from censuses and commercial catch figures (Table 7).

TABLE 7.

	1956	1957	1958	1959	1960
Percentage of fish removed from the spawning population процент вылова из нерестового стада	74.8	53.2	72.7	59.0	77.2

The high removal rates in 1956, 1958 and 1960 were obtained because in those years commercial fishing was mainly only for chum. In 1956 chum provided 97.1% of the total salmon catch, in 1958, 90.6%, in 1960, 95.1% (Table 3). Commercial conditions for those years also facilitated a high removal of fish from the spawning population. Thus, in 1956, gale weather was 3.8 days below the average (Table 4); conditions were favourable for fishing with fixed trap nets, as the level of the water in the rivers was low; in the chum commercial fishing period precipitation was 25.2 mm below average (Table 5); conditions were also favourable for commercial chum fishing with seines. A similar pattern is seen for 1958 and 1960.

As far as 1957 and 1959 are concerned, along with the chum, a great many pink salmon were caught. In 1957, chum provided only 45.2% of the total salmon catch, and in 1959, 80% (Tab 3). Moreover, commercial conditions in those years did not favour further stepping up of fishing operations. (Tables 4 & 5)

V.Y. Levaniidov (1964) and a number of other authors, points out that a commercial removal of 60%, and even somewhat higher, does not cause a fall in stocks.

It seems to us that in this case replacement-reproduction conditions acquire a decisive importance. Thus, in 1961, the commercial removal of Okhotsk chum by off-shore fishing came to 65.3% (about 5.8 million chum were running), the total return of the 1961 chum year-class was about 7.6 million fish. At the same time, in the next chum generation of the 1962 spawning, the commercial removal rate was 55.7%; with the size of the spawning population near 2.8 million fish, the return to off-shore waters of this generation of chum was 2.5 million fish.

The examples cited show that under favourable replacement-reproduction conditions a large (65.3%) commercial removal of fish from the spawning

population may not cause a fall in stocks but on the contrary in some years the new year-class may be numerically superior to the parent generation. Under insufficiently favourable replacement-reproduction conditions, as was seen for the chum year-class of the 1962 spawning, even a lower removal rate (10% down from 1961), not only did not bring about a numerical increase in the new generation but a certain reduction occurred.

From what has been said, however, it does not follow that given favourable replacement conditions commercial removal of fish can be increased inordinately. Thus, in 1956, the chum spawning population was 11.75 million fish from which about 8.8 million fish (74.8%) were commercially removed. Despite exceptionally favourable replacement conditions in the winter of 1956-1957, the number of progeny returning to off-shore waters scarcely reached 9.7 million fish.

A large removal of fish has a particularly harmful effect in years when the numbers of the spawning population are low and conditions for replacement are unfavourable. The 1958 chum year-class may serve as an example: the size of the spawning population was estimated at 4.2 million fish and the removal rate was 72.8%. The result was a total progeny return of only 0.65 million fish. A similar pattern was observed for the 1960 spawning year-class when the commercial removal rate was 77.2% and the total return of the progeny of this year-class was only 0.90 million fish, the parent generation having numbered 8.14 million chum.

From what we have seen it follows that in years when the numbers of the chum spawning population are low, the commercial removal rate should not exceed 50%.

In view of the fact that in recent years stocks of chum have been sharply reduced, until they are replenished it will be necessary to restrict sea fishing considerably and to limit off-shore catches strictly. These measures can promote an increase in the numbers of spawners at the spawning grounds and a rise in the rate of natural replacement.

CONCLUSIONS

1. Analysis of data on the commercial fishing of Okhotsk chum shows that in individual years, depending on the numbers of the spawning population and the numbers of other species of salmon, and also on commercial conditions, the percentage of chum removals from the spawning population in the period 1956-1967 fluctuated from 31.8 to 77.2, that is, by a factor of almost 2.5.

2. In commercial chum fishing using seine nets in river fishing sectors, the water level of the rivers during the salmon run is of decisive importance to catch efficiency; and in commercial fishing with fixed trap nets in sea fishing sectors, gales are important.

3. Under favourable replacement-reproduction conditions (spawning, egg and fry development), a commercial removal rate of 65% does not bring about a fall in the numbers of the new generation, but under unfavourable reproduction-replacement conditions a commercial removal rate of 40% does not ensure that the numbers of the new generation will maintain a level even near the numbers of the parent population.

4. The River Okhota is the main chum river of the continental coast of the north-west part of the Sea of Okhotsk. The Okhota provides 62% of the total chum catch and is of great importance in the replacement-reproduction of chum stocks.

5. The approach of the chum to the shore and their run into the rivers extends from the end of June to the middle of September. The mass run is from the end of July to the middle of August.

6. The numbers of the spawning populations and the size of catches per yearly run are subject to great fluctuations. In the post-war period (1945-1967) the chum catch fluctuated from 698 to 8788 thousand fish, that is by a factor of more than 12. Catches according to commercial fishing effort are also subject to sharp fluctuations. In the period 1953-1967, the average chum catch using fixed trap nets varied from 397 to 2929 centners, that is by a factor of 7.4, and with seine nets from 455 to 1880 centners or by a factor of 4.1.

7. In connection with the sharp drop in numbers of chum spawning populations and with the drop in chum stocks, considerable restriction of commercial sea fishing and also a strict limit on off-shore fishing are necessary. These measures will promote an increase in the numbers of spawners in the spawning grounds and a rise in the rate of natural replacement-reproduction.

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