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History of the Fishery and Summary Statistics of the Sockeye Salmon, *Oncorhynchus nerka*, Runs to the Chignik Lakes, Alaska, 1888-1966

Michael L. Dahlberg

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Juanita M. Kreps, Secretary
National Oceanic and Atmospheric Administration
Richard A. Frank, Administrator
National Marine Fisheries Service
Terry L. Leitzell, Assistant Administrator for Fisheries

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MICHAEL L. DAHLBERG[1]

ABSTRACT

Annual runs of sockeye salmon to the Chignik Lakes, Alaska, decreased from an average of 1.9 million during the period 1922-39 to an average of 0.9 million during the period 1949-66. In order to study the dynamics of the runs' historic catch, escapement and age structure data were compiled by spawning stock and brood year. The history of fishing and management of the runs from inception of the fishery until 1966 is described. The high seas and coastal distributions of Chignik sockeye salmon indicated significant interception by the fishery in only one area other than the Chignik Bay and Chignik Lagoon; the fishery at Cape Igvak started in the mid-1960's. Results of the study were used to construct parent-progeny relationships that formed the basis for a management strategy to restore the runs to their former level of abundance.

INTRODUCTION

One approach to restoring sockeye salmon stocks[2] to their former levels of abundance is to precisely regulate the harvest of each major race (Royce 1964). According to Royce (1960), such a course requires that the management agency 1) can define and recognize each major race[3] of salmon, 2) has accurate statistics on catch and escapement, 3) can forecast the returns[4] accurately, 4) knows the number of spawners needed for maintenance, and 5) is aware of the gear and time needed to harvest the desired number of salmon. The management agency does not have all this knowledge for any race of salmon in Alaska, but information has become available on the stocks of one sockeye salmon-producing system of western Alaska, the Chignik River system, from which it can formulate a management strategy based on precise regulation of the harvest.

In this paper, historic catch and escapement statistics are presented for each of the two major stocks of sockeye salmon in the Chignik River system. Current statistics have been routinely published and are later cited.

Sockeye Salmon Research at Chignik, Alaska

The potential of the Chignik watershed for controlled studies of the life history of sockeye salmon was recognized early in the development of salmon research in Alaska (Gilbert and O'Malley 1921). Parallel studies of the life history of sockeye salmon were started by the U.S. Bureau of Fisheries at Karluk in 1921 and at Chignik in 1922 with the main purpose of ascertaining "what relation exists between spawning colonies of varying size and the number of progeny that they furnish" (Gilbert 1929). The Karluk and Chignik Rivers were selected because it was believed the fishery operated solely on fish bound for these particular watersheds.

In 1928 the complexities of the life cycle and dynamics of the sockeye salmon populations of Chignik were brought to light, and intensive study of the freshwater life history of the Chignik sockeye salmon began (Higgins 1930). Considerable progress was made in determining the pattern of the life history of Chignik sockeye salmon and the relationship between the numbers of spawners and returning progeny (Holmes 1934). However, in 1934 research was drastically reduced because of budget restrictions, and the only activity was collection of scales for later study (Higgins 1936). A fish-counting weir was first erected in Chignik River in 1922 to estimate the escapement. The counting weir was not maintained in 1938, from 1940 through 1948, and in 1951. Each year since 1952 a weir has been in operation to count the escapement; because of turbid water and lack of adequate sites, counting towers used in the Bristol Bay district are not feasible at Chignik.

Tagging studies were conducted at Chignik by the Fisheries Research Institute (FRI), University of Washington, in 1949 and 1952, and a research program funded by the Chignik salmon canning industry began in 1955. From 1955 to 1960 the research program consisted of studies of the age composition of the runs, annual enumeration of smolts, and an investigation of predation on juvenile salmon by Dolly Varden, *Salvelinus malma*,

[1] Northwest and Alaska Fisheries Center Auke Bay Laboratory, National Marine Fisheries Service, NOAA, P.O. Box 155, Auke Bay, AK 99821.

[2] Stock refers to each aggregation that can be managed separately (Ricker 1966); run, as defined by Mathews (1966), signifies the total number of mature sockeye salmon entering the watershed in 1 yr (catch plus escapement).

[3] Race, the same as stock, see above.

[4] Returns refers to the total number of mature progeny produced by one spawning, regardless of the time of return.

and coho salmon, *Oncorhynchus kisutch*, (Roos[5, 6, 7], 1959, 1960). Beginning in 1961 the FRI intensified ecological studies of the nursery lakes. Results of those studies have been reported by Narver (1966), Phinney (1970), Parr (1972), and Burgner and Marshall[8]. Dahlberg (1973) analyzed the historical records of the fishery and reported on the dynamics of the sockeye salmon returns to Chignik from the inception of the fishery through 1966. Although all five species of Pacific salmon found in North America occur at Chignik, sockeye salmon are the most abundant and commercially important species. This report treats only sockeye salmon at Chignik. Narver (1966) and Parr (1972) described the life histories of fishes associated with sockeye salmon in the Chignik lakes.

The Watershed

The Chignik watershed is located on the Alaska Peninsula approximately halfway between the tip of the Alaska Peninsula and Kodiak Island (Fig. 1). Black and Chignik Lakes drain into the Pacific Ocean and form a natural northwest-southeast pass through the Aleutian Mountain Range. The watershed covers an area of approximately 1,520 km^2 including two lakes of 63.8 km^2 total surface area. Atwood (1911) and Knappen (1929) discussed in detail the geology of the region and briefly described the geography and vegetation; Murie (1959) detailed the fauna of the Alaska Peninsula.

Because the lakes are important as rearing areas for juvenile sockeye salmon, they have been closely studied; a complete description of the two lakes is presented by Narver (1966). Black Lake is shallow (44% of the area is <2 m deep), warms rapidly in the spring, and is usually turbid (typical Secchi disk reading is <1 m) throughout the summer. Chignik Lake, although smaller in area than Black Lake, is six times greater in volume and generally clearer. Although the lakes are different physically (Table 1), together they show a marked contrast in biological activity when compared with 24 other sockeye salmon-producing lakes in western Alaska (Burgner et al. 1969). The Chignik system ranked second in number of spawners per unit of lake surface area, first in rate of photosynthetic activity (area and volume), first in content of chlorophyl *a* per unit of lake volume, and second in content of total dissolved solids, and generally showed high concentrations of trace elements. Black Lake and Chignik Lake had the highest standing crops of phytoplankton among the lakes compared.

The lakes are connected by Black River (12 km long), which flows south along the edge of the Aleutian Mountain Range. Two major spawning tributaries enter Black River. West Fork, entering from the west, drains the northeast slope of Mount Veniaminoff (Fig. 1), a volcano which erupted as recently as 1956 (Roos see footnote 7). Chiaktuak Creek enters from the east and drains a valley parallel to Chignik Lake. Bearskin Creek also enters Black River but is of minor importance as a spawning stream; small numbers of spawners are found occasionally in the upper reaches (Phinney 1970).

The lower lake is drained by Chignik River (7.2 km long), which is normally influenced by tidal action for nearly one-half its length. The highest spring tides affect the river up to the lake outlet.

[5] Roos, J. F. 1959. Report on Chignik adult red salmon studies, 1958. Unpubl. manuscr., 12 p. Fish. Res. Inst., Univ. Washington, Seattle.

[6] Roos, J. F. 1959. Red salmon tagging at Chignik, Alaska during 1959. Unpubl. manuscr., 9 p. Fish. Res. Inst., Univ. Washington, Seattle.

[7] Roos, J. F. 1960. Life history of red salmon, *Oncorhynchus nerka* (Walbaum), at Chignik, Alaska. Unpubl. manuscr., 56 p. Fish. Res. Inst., Univ. Washington, Seattle.

[8] Burgner, R. L., and S. L. Marshall. 1974. Optimum escapement studies of Chignik sockeye salmon. Anadromous Fish Project Final Report for period ending June 30, 1973. Report No. FRI-UW-7401. Fish. Res. Inst., Univ. Washington, Seattle, 91 p.

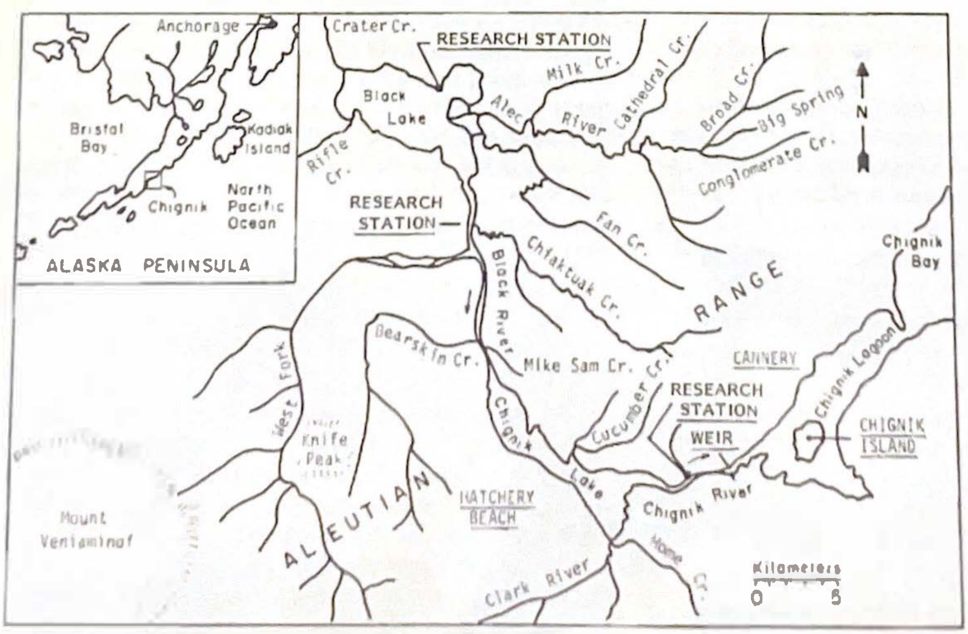

Figure 1.—Map of the Chignik River watershed with inset of western Alaska.

Table 1.—Morphometric measurements of Chignik and Black Lakes and Chignik Lagoon (from Dahlberg 1973).

Source	Altitude (m)	Depth (m)		Water area (km²)	Volume (km³)	Shoreline		Flow at outlet	
		Mean	Maximum			Length (km)	Development	(m³/s)	Date
Black Lake	15	3	6	41.1	0.10	27.0	1.19	17.0	25 June 1963
Chignik Lake	5	29	64	22.7	0.64	27.7	1.64	79.5	23 June 1963
	—	—	—	—	—	—	—	35.8	13 Aug. 1963
Total	—	—	—	63.8	0.74	—	—	—	—
Chignik Lagoon	—	3	15	41.8	0.13	46.7	2.04	—	—

Chignik Lagoon (12 km long) is a nearly enclosed estuary having a sandy or muddy, flat bottom with scattered patches of algae and extensive areas of eel grass (*Zostera*). Water covers about 42 km² at high tide, and about half that at low tide. Low and high tide salinities range from 10 to 17‰ in the upper lagoon and from 30 to 32‰ at the sand spit near the outlet. The importance of the estuary as a secondary rearing area for juvenile sockeye salmon has been investigated by Phinney (1968); large catches of postsmolt sockeye salmon have been taken by beach seine and surface trawl in the lagoon during June and July (Narver and Dahlberg 1965; Phinney 1968).

The Climate

The climate of the region is strongly maritime because the Alaska Peninsula is a comparatively small body of land between two large water masses, the North Pacific Ocean and the Bering Sea. The weather conditions reported by Atwood (1911) and Knappen (1929) remain typical. The summers are short and cool; although there may be many days of wet weather, the rainfall is seldom excessive. A great many overcast days occur. Violent winds often exceeding 161 km/h (100 mph) have been recorded. Winter temperatures are more moderate than those in Bristol Bay; recording thermometers left in cabins over the winters of 1961-67 showed a low of −27°C (−17°F). Ice breakup on the lakes occurs in April or May, much earlier than in the lakes of the Bristol Bay district. Long-term weather records are not available for the immediate area; Kodiak Island (270 km to the northeast) is the nearest location with extensive weather records, although some data are available from nearby Port Heiden on the north side of the peninsula.

History of the Commercial Fishery

Cannery operations.—Commercial exploitation of Chignik sockeye salmon began in 1888 when the Fishermen's Packing Company of Astoria, Oreg., sent a crew to Chignik Bay to prospect for fish; they returned in the fall with 2,160 barrels of salted salmon. In 1889 canning operations were started in plants of the Fishermen's Packing Company, Chignik Bay Company of San Francisco, and the Shumagin Packing Company from Portland, Oreg. (Moser 1899). Operating agreements between the companies proved so successful in 1890 and 1891 that they joined the pool of canneries of the Alaska Packing Association in 1892. In 1893 they all became members of the Alaska Packers Association, and only one cannery was operated as a result of increased operation efficiency (Moser 1899).

The ease with which fish were captured at Chignik attracted more investment into the fishery; in 1896 Hume Brothers and Hume, and the Pacific Steam Whaling Company each built a cannery (Cobb 1930). In 1901 these companies became part of the Pacific Packing and Navigation Company, which in turn became part of the Northwestern Fisheries Company in 1905. In 1910 the Columbia River Packers Association built yet another cannery in the area. Competition was intense until 1914 when the three companies then operating—Alaska Packers Association (APA), Columbia River Packers Association (CRPA), and Northwestern Fisheries Company (NFC)—agreed to an equal division of the catch (Rich and Ball 1930).

Industry relationships remained static until 1926 when H. W. Crosby operated a floating salmon cannery, Salmon King, for one season. In 1932 Crosby returned and built a land-based cannery; the same year, CRPA, NFC, and APA made a combined pack at the APA cannery. The following season, 1933, Pacific American Fisheries (PAF) acquired the Northwestern Fisheries Company, and the PAF, APA, and CRPA combined canning operations. The APA acquired the Chignik interests of PAF and CRPA during the ensuing years and continues to operate their cannery at Chignik (Pacific Fisherman Yearbook 1915-67; National Fisherman Yearbook 1968, 1969; Pacific Packers Report 1970-76).

Crosby changed the name of his operation to Chignik Lagoon Packing Company in 1936, and after two other changes gave it the name Chignik Fisheries Company in 1947. Beginning in 1953, APA and Chignik Fisheries Company entered into an agreement to can all fish in the APA cannery; the cannery of the Chignik Fisheries Company serves as a base of supply and operations for its fishing fleet (Roos see footnote 7). In 1968, Columbia-Wards Company purchased the Chignik Fisheries cannery and has continued operations under the same arrangements with the APA (Pacific Packers Report 1976).

Fishing gear.—Pile traps (Scudder 1970) were the principal fishing gear, and beach seines took a small part of the catch before 1900. The water at Chignik was too clear and the channel too narrow for effective gillnetting (Moser 1899). The number of units of gear operated in proaches are studded with traps, some with leads 3,500 feet long, and sometimes so interlaced that at a distance the channel appears completely blocked, and it hardly seems possible for a fish to pass." Dahlberg (1968) presented figures showing the location of traps fished in Chignik Lagoon during 1899 and 1902.

Because there is some question as to the effectiveness of the older types of gear, I calculated fishing effort from the data on gear (Table 2) and catch data. The unit of effort chosen was the trap-day, i.e., the number of traps fished, which yields the total trap days in season i. Total trap catch in season i divided by total trap days within season i yields catch per unit of effort.[9]

The fishing effort from 1905 to 1909 was low and the catch of sockeye salmon per unit of effort (CPUE) was exceedingly high (Fig. 4). The sharp drop in the CPUE

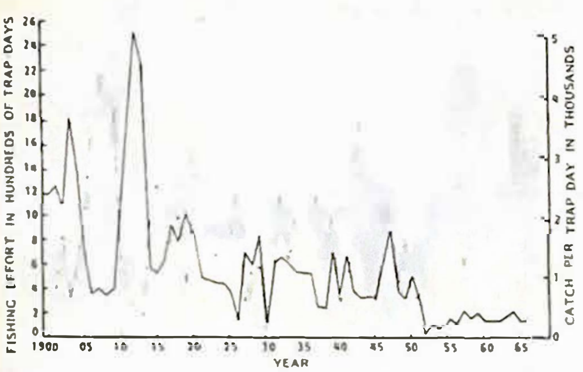

Figure 4.—Trends in fishing effort (solid line) and catch (dotted line) of sockeye salmon per unit of effort at Chignik, 1900-66.

and the concomitant rise in units of gear between 1909 and 1913 indicate "keen competition" between companies during this period (Rich and Ball 1930). The agreement in 1914 to equally divide the catch among the three companies brought about much more efficient conduct of the fishery; however, its intensity was to no extent reduced in later years (Rich and Ball 1930), e.g., in 1922 more than 75% of the run was harvested (Alaska Fishery and Fur-Seal Industries 1922).[10] While it appears from Figure 4 that the CPUE may have risen during the period 1950-65, this may be due to a change in the efficiency or catchability of the newer gear. With the introduction of powered seine blocks, synthetic fiber nets, and modern seine boats in recent years, one would expect greater efficiency per unit of gear.

Fishing regulations.—There was little, if any, enforcement of fishery regulations in the Chignik fishery before 1922. There were no statutory regulations prior to 1895, only a weekly closure of 30 h for the period 1895-1906, and one of 36 h for 1907-40 (Table 2). Cooley (1963) pointed out that starting in 1892 the U.S. Fish Commission had funds to support only one inspector and an assistant for the enforcement of fishing regulations in the entire territory of Alaska. They were forced to depend on industry transportation to make their rounds during the 3-mo season.

A fish-counting weir was first established in Chignik River in 1922 by the U.S. Bureau of Fisheries. The weir has not been installed every year since that time, but a management agent has been on duty to check the fishing area during closed periods. However, inspection of Figure 2 shows that until 1925 there had never been <40 days of fishing during the season. In 1924, with the passage of the White Act,[11] which required 50% escapement in streams where counting weirs were maintained, the fishery was subjected to periodic closures by the management agent. In 1925 it was required that the minimum annual escapement at Chignik be set at 1 million fish (Rich and Ball 1930). This requirement was met nearly every year until 1938. Management of the Chignik fishery was based mainly on the rule of 50% escapement and 50% catch under the White Act until the time of its repeal in 1957.[12] In recent years target escapements estimated from spawner-return relationships have been used as management guidelines to secure adequate spawning densities (Dahlberg 1973).

Catch trend.—The general trend of catch declining not long after the inception of the fishery is typical of many other salmon fisheries in Alaska (Fig. 5). Catches

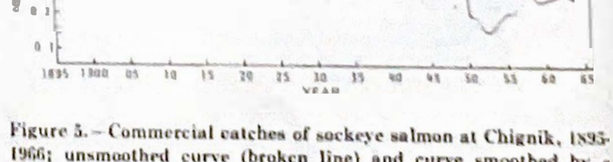

Figure 5.—Commercial catches of sockeye salmon at Chignik, 1895-1966; unsmoothed curve (broken line) and curve smoothed by a moving average of 5 (solid line).

[9] Since beach seines gradually replaced traps over the years (Fig. 3, Table 2), I chose to convert the effort by gill nets and seines to trap effort in order to make all the fishing effort data comparable between years. I calculated relative fishing powers, by gear type, from the percentage of the catch of each type of gear and the number of units of each type of gear operating concurrently. I found that on the average, one trap was the equivalent of 5.9 beach seines or 26.2 gill nets. These figures are to be used with caution since the selectivity of trap sites and the efficiency of beach seines used during the period 1940 to 1954 and those used in the 1970's are probably not the same. However, these relative fishing powers can be used for gross comparisons of fishing effort.

[10] The data for 1917 to 1950 were taken from the publication series Alaska Fishery and Fur-Seal Industries. This series was published annually as appendices to the Report of Commission of Fisheries until 1940. Beginning in that year, they were published in the U.S. Fish and Wildlife Service's Statistical Digest Series.

[11] Public Law 204, 68th Congress, 1924 (Cooley 1963).

[12] Public Law 296, 85th Congress, 1957.

gradually increased as the fishery developed, leveled off until the White Act took effect in 1924 at which time they decreased, remained at an intermediate level for several years (1925-48), and then dropped sharply after 1949 to a low level. The catch data for the Nushagak district of Bristol Bay (Mathisen 1971), show a unique similarity in trend (Fig. 6) except for the timing of the fall from initial high production. The decline of sockeye salmon production in the Nushagak district preceded that at Chignik by a few years. It is noteworthy that these two independent sockeye salmon systems exhibit the same historical development and both show a decline in return per spawner.

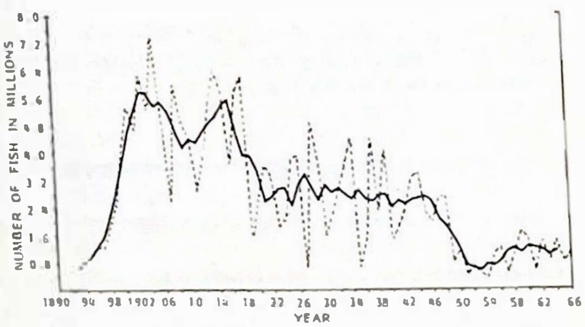

Figure 6.—Commercial catches of sockeye salmon in the Nushagak district, Bristol Bay, 1893-1966 (after Mathisen 1967); unsmoothed curve (broken line) and curve smoothed by a moving average of 5 (solid line).

CATCHES AND ESCAPEMENTS OF THE CHIGNIK SOCKEYE SALMON RUNS, 1888-1966

Catch and escapement, age and size composition, sex ratio, timing of the run, and distribution of the escapement on the spawning grounds are among the important required statistics for setting management regulations for the establishment and maintenance of maximum sustained yield.

Catches and Escapements

Escapement records began accumulating after erection of a weir in Chignik River in 1922. Catch statistics have been recorded from the beginning of the fishery in 1888; more detailed records have been kept since the Chignik canners joined the Alaska Packers Association in 1893 (Moser 1899). The long-term changes in abundance of Chignik sockeye salmon have been about twofold (Table 3).

Catch records.—Several sources of information were used to compile a complete record of the annual catches of Chignik sockeye salmon since 1888 (Moser 1899, 1902; Rich and Ball 1929, 1930; Alaska Fishery and Fur-Seal Industries 1917-50; Kasahara 1963; Pacific Fisherman Yearbook 1915-67; Pacific Salmon Inter-Agency Council 1966; Roos[13], see footnotes 5, 7; Calkins[14]). The two most valuable sources were 1) annual reports of the Chignik cannery superintendents, Alaska Packers Association, over the years 1895-1955; and 2) various reports of the management agents for the U.S. Bureau of Fisheries (1922-39), the U.S. Fish and Wildlife Service (1940-59), and the Alaska Department of Fish and Game (1960-66) (microfilms of these documents are on file in the archives of the FRI). I resolved inconsistencies in the reports compiled and issued by various agencies and individuals by cross-checking several sources; in the event of a major disagreement, I accepted the daily catch figures compiled by either the management agency or canning industry. Many arithmetical errors were discovered in the historical records; in these instances, I used the summation of the daily catch figures (Dahlberg[15]). Catch records were complete for all the years covered in this study (1888-1966).

Escapement records.—Daily weir counts were used to compile annual escapement records for those years in which a weir was operated in the Chignik River. The counting weir was not maintained in Chignik River during 1938, from 1940 through 1948, and in 1951. Moreover, in some years (1924, 1931, 1933) the weir was

[13] Roos, J. F. 1957. Report on Chignik adult red salmon studies, 1955-1956. Unpubl. manuscr., 58 p. Fish. Res. Inst., Univ. Washington, Seattle.

[14] Calkins, T. P. 1958. Report on Chignik adult red salmon studies, 1957. Unpubl. manuscr., 59 p. Fish. Res. Inst., Univ. Washington, Seattle.

[15] Dahlberg, M. L. 1967. Chignik catch escapement analysis. Fish. Res. Inst., Comput. Program FRD 295, Univ. Washington, Seattle, 4 p.

Table 3.—Long-term changes in abundance of Chignik sockeye salmon (Dahlberg 1968).

	Chignik Lake				Black Lake				Total run			
	Catch 1,000's	Escapement 1,000's	Total 1,000's	Rate of exploitation[1]	Catch 1,000's	Escapement 1,000's	Total 1,000's	Rate of exploitation[1]	Catch 1,000's	Escapement 1,000's	Total 1,000's	Rate of exploitation[1]
Mean 1922-39	504	563	1,067	0.472	290	497	787	0.368	794	1,060	1,854	0.428
Mean 1949-66	240	326	566	0.423	145	201	346	0.419	385	527	912	0.422
Percent change[2]	−52.5	−42.1	−47.0	−10.4	−49.8	−59.5	−55.9	+13.9	−51.5	−50.2	−50.8	−3.8

[1] Rate of exploitation as defined by Ricker (1958:20).
[2] Expressed as a percentage of the mean for the period 1922-39.

Table 10.—Summary of estimated catches and escapements of Chignik sockeye salmon by stock, 1922-66 (Dahlberg 1968).

Year	Catch: Chignik Lake	Catch: Black Lake	Catch: Total	Escapement: Chignik Lake	Escapement: Black Lake	Escapement: Total	Total run: Chignik Lake	Total run: Black Lake	Total run: Total
1922	900,823	346,011	1,246,834	352,807	86,421	439,228	1,253,630	432,432	1,686,062
1923	562,316	80,556	642,872	213,781	4,642	218,423	776,097	85,198	861,295
1924	767,424	110,937	878,361	910,521	121,983	1,032,504	1,677,945	232,920	1,910,865
1925	436,985	260,999	697,984	677,566	386,364	1,063,930	1,114,551	647,363	1,761,914
1926	173,161	242,054	415,215	695,314	289,009	984,323	868,475	531,063	1,399,538
1927	303,401	137,566	440,967	429,525	857,881	1,287,406	732,926	995,447	1,728,373
1928	774,667	8,595	783,262	1,020,520	507,353	1,527,873	1,795,187	515,948	2,311,135
1929	689,123	359,861	1,048,984	914,307	995,832	1,910,139	1,603,430	1,355,693	2,959,123
1930	27,306	888	28,194	359,405	92,955	452,360	386,711	93,843	480,554
1931	503,584	206,256	709,840	631,986	96,201	728,187	1,135,570	302,457	1,438,027
1932	871,112	704,130	1,575,242	1,113,859	2,151,734	3,265,593	1,984,971	2,855,864	4,840,835
1933	345,469	249,452	594,921	310,088	223,913	534,001	655,557	473,365	1,128,922
1934	525,294	583,048	1,108,342	447,642	866,890	1,314,532	972,936	1,449,938	2,422,874
1935	409,893	209,449	619,342	462,469	194,636	657,105	872,362	404,085	1,276,447
1936	453,914	526,811	980,725	376,838	548,039	924,877	830,752	1,074,850	1,905,602
1937	422,254	207,064	629,318	406,618	205,613	612,231	828,872	412,677	1,241,549
1938	260,879	150,111	410,990	305,827	175,972	481,799	566,706	326,083	892,789
1939	652,780	827,580	1,480,360	512,754	1,142,852	1,655,606	1,165,534	1,970,432	3,135,966
1940	116,336	134,098	250,434	152,957	176,307	329,264	269,293	310,405	579,698
1941	383,764	270,145	653,909	531,904	374,420	906,324	915,668	644,565	1,560,233
1942	354,518	303,987	658,505	516,621	442,981	959,602	871,139	746,968	1,618,107
1943	788,636	459,182	1,247,818	1,205,418	701,859	1,907,277	1,994,054	1,161,041	3,155,095
1944	219,545	182,431	401,976	351,212	291,844	643,056	570,757	474,275	1,045,032
1945	90,563	130,390	220,953	151,326	217,882	369,208	241,889	348,272	590,161
1946	424,682	444,337	869,019	739,884	774,130	1,514,014	1,164,566	1,218,467	2,383,033
1947	768,694	1,316,128	2,084,822	1,393,990	2,386,733	3,780,723	2,162,684	3,702,861	5,865,545
1948	166,244	204,085	370,329	313,319	384,637	697,956	479,563	588,722	1,068,285
1949	418,156	124,390	542,546	574,715	213,269	787,984	992,871	337,659	1,330,530
1950	318,450	34,742	353,192	861,070	206,270	1,067,340	1,179,520	241,012	1,420,532
1951	143,521	115,494	259,015	490,899	125,126	616,025	634,420	240,620	875,040
1952	20,393	106,675	127,068	260,540	34,155	294,695	280,933	140,830	421,763
1953	109,450	185,738	295,188	221,408	168,375	389,783	330,858	354,113	684,971
1954	19,232	72,334	91,566	277,912	184,953	462,865	297,144	257,287	554,431
1955	168,987	179,539	348,526	201,409	256,757	458,166	370,396	436,296	806,692
1956	421,251	246,442	667,693	483,024	289,096	772,120	904,275	535,538	1,439,813
1957	224,757	77,423	302,180	328,779	192,479	521,258	553,536	269,902	823,438
1958	179,949	141,180	321,129	212,594	120,862	333,456	392,543	262,042	654,585
1959	251,547	165,000	416,547	308,645	112,226	420,871	560,192	277,226	837,418
1960	418,356	274,048	692,404	357,230	251,567	608,797	775,586	525,615	1,301,201
1961	278,609	53,852	332,461	254,970	140,714	395,684	533,579	194,566	728,145
1962	292,528	71,562	364,090	324,860	167,602	492,462	617,388	239,164	856,552
1963	323,080	80,258	403,338	200,314	332,536	532,850	523,394	412,794	936,188
1964	427,940	128,950	556,890	166,625	137,073	303,698	594,565	266,023	860,588
1965	152,521	477,032	629,553	163,151	307,192	470,343	315,672	784,224	1,099,896
1966	143,098	79,696	222,794	183,525	383,545	567,070	326,623	463,241	789,864

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Table 11.—Selected ratios of catch and escapement statistics for Chignik Lake, Black Lake, and total runs, 1922-66.

Year	Chignik Lake: Catch/ escape- ment	Chignik Lake: Escape- ment/ catch	Chignik Lake: Rate of exploi- tation	Chignik Lake: Escape- ment (prop)	Black Lake: Catch/ escape- ment	Black Lake: Escape- ment/ catch	Black Lake: Rate of exploi- tation	Black Lake: Escape- ment (prop)	Total run: Catch/ escape- ment	Total run: Escape- ment/ catch	Total run: Rate of exploi- tation	Total run: Escape- ment (prop)
1922	2.553	0.391	0.718	0.281	4.003	0.249	0.800	0.199	2.[illegible]	0.352	0.739	0.260
1923	2.630	0.380	0.724	0.275	17.353	0.057	0.945	0.054	2.943	0.339	0.746	0.253
1924	0.842	1.186	0.457	0.542	0.909	1.099	0.476	0.523	0.850	1.175	0.459	0.540
1925	0.644	1.550	0.392	0.607	0.675	1.480	0.403	0.596	0.656	1.524	0.396	0.603
1926	0.249	4.015	0.199	0.800	0.837	1.193	0.455	0.544	0.421	2.370	0.296	0.700
1927	0.706	1.415	0.413	0.586	0.160	6.216	0.138	0.861	0.342	2.919	0.255	0.744
1928	0.759	1.317	0.431	0.568	0.016	59.038	0.016	0.983	0.512	1.950	0.338	0.661
1929	0.753	1.326	0.429	0.570	0.361	2.767	0.265	0.734	0.549	1.820	0.354	0.645
1930	0.075	13.162	0.070	0.929	0.009	104.679	0.009	0.990	0.062	16.044	0.058	0.941
1931	0.796	1.254	0.443	0.556	2.144	0.466	0.681	0.318	0.974	1.025	0.493	0.506
1932	0.782	1.278	0.438	0.561	0.327	3.055	0.246	0.753	0.482	2.073	0.325	0.674
1933	1.114	0.897	0.526	0.473	1.114	0.897	0.526	0.473	1.114	0.897	0.526	0.473
1934	1.173	0.852	0.539	0.460	0.672	1.486	0.402	0.597	0.843	1.186	0.457	0.542
1935	0.886	1.128	0.469	0.530	1.076	0.929	0.518	0.481	0.942	1.060	0.485	0.514
1936	1.204	0.830	0.546	0.453	0.961	1.040	0.490	0.509	1.060	0.943	0.514	0.485
1937	1.038	0.962	0.509	0.490	1.007	0.992	0.501	0.498	1.027	0.972	0.506	0.493
1938	0.853	1.172	0.460	0.539	0.853	1.172	0.460	0.539	0.853	1.172	0.460	0.539
1939	1.273	0.785	0.560	0.439	0.724	1.380	0.420	0.580	0.894	1.118	0.472	0.527
1940	0.760	1.314	0.432	0.567	0.760	1.314	0.432	0.567	0.760	1.314	0.432	0.567
1941	0.721	1.386	0.419	0.580	0.721	1.386	0.419	0.580	0.721	1.386	0.419	0.580
1942	0.686	1.457	0.406	0.593	0.686	1.457	0.406	0.593	0.686	1.457	0.406	0.593
1943	0.654	1.528	0.395	0.604	0.654	1.528	0.395	0.604	0.654	1.528	0.395	0.604
1944	0.625	1.599	0.384	0.615	0.625	1.599	0.384	0.615	0.625	1.599	0.384	0.615
1945	0.598	1.670	0.374	0.625	0.598	1.671	0.374	0.625	0.598	1.670	0.374	0.625
1946	0.573	1.742	0.364	0.635	0.573	1.742	0.364	0.635	0.573	1.742	0.364	0.635
1947	0.551	1.813	0.355	0.644	0.551	1.813	0.355	0.644	0.551	1.813	0.355	0.644
1948	0.530	1.884	0.346	0.653	0.530	1.884	0.346	0.653	0.530	1.884	0.346	0.653
1949	0.727	1.374	0.421	0.578	0.583	1.714	0.368	0.631	0.688	1.452	0.407	0.592
1950	0.369	2.703	0.269	0.730	0.168	5.937	0.144	0.855	0.330	3.021	0.248	0.751
1951	0.292	3.420	0.226	0.773	0.923	1.083	0.479	0.520	0.420	2.378	0.296	0.704
1952	0.078	12.775	0.072	0.927	3.123	0.320	0.757	0.242	0.431	2.319	0.301	0.698
1953	0.494	2.022	0.330	0.669	1.103	0.906	0.524	0.475	0.757	1.320	0.430	0.569
1954	0.069	14.450	0.064	0.935	0.391	2.556	0.281	0.718	0.197	5.054	0.165	0.834
1955	0.839	1.191	0.456	0.543	0.699	1.430	0.411	0.588	0.760	1.314	0.432	0.567
1956	0.872	1.146	0.465	0.534	0.852	1.173	0.460	0.539	0.864	1.156	0.463	0.536
1957	0.683	1.462	0.406	0.593	0.402	2.486	0.286	0.713	0.579	1.724	0.366	0.633
1958	0.846	1.181	0.458	0.541	1.168	0.856	0.538	0.461	0.963	1.038	0.490	0.509
1959	0.815	1.226	0.449	0.550	1.470	0.680	0.595	0.404	0.989	1.010	0.497	0.502
1960	1.171	0.853	0.539	0.460	1.089	0.917	0.521	0.478	1.137	0.879	0.532	0.467
1961	1.092	0.915	0.522	0.477	0.382	2.612	0.276	0.723	0.840	1.190	0.456	0.543
1962	0.900	1.110	0.473	0.526	0.426	2.342	0.299	0.700	0.739	1.352	0.425	0.574
1963	1.612	0.620	0.617	0.382	0.241	4.143	0.194	0.805	0.756	1.321	0.430	0.569
1964	2.568	0.389	0.719	0.280	0.940	1.062	0.484	0.515	1.833	0.545	0.647	0.352
1965	0.934	1.069	0.483	0.516	1.552	0.643	0.608	0.391	1.338	0.747	0.572	0.427
1966	0.779	1.282	0.438	0.561	0.207	4.812	0.172	0.827	0.392	2.545	0.282	0.717
1922-1939:												
Mean	1.018	1.683	0.463	0.537	1.844	10.456	0.431	0.569	0.965	2.163	0.438	0.561
95% confidence limits												
Upper	1.340	3.334	0.538	0.613	3.822	23.966	0.551	0.689	1.340	3.918	0.518	0.641
Lower	0.696	0.132	0.387	0.461	−0.132	−3.053	0.311	0.448	0.589	0.409	0.358	0.481
1949-1966:												
Mean	0.841	2.733	0.411	0.588	0.873	1.982	0.411	0.588	0.779	1.687	0.413	0.586
95% confidence limits												
Upper	1.127	4.738	0.495	0.671	1.223	2.763	0.495	0.672	0.974	2.220	0.473	0.646
Lower	0.555	0.727	0.328	0.504	0.523	1.201	0.327	0.504	0.583	1.153	0.353	0.526
Combined:												
Mean	0.930	2.308	0.437	0.562	1.359	6.219	0.421	0.578	0.872	1.925	0.426	0.574
95% confidence limits												
Upper	1.136	3.492	0.491	0.616	2.326	12.802	0.490	0.648	1.075	2.799	0.473	0.621
Lower	0.721	1.125	0.383	0.508	0.391	−0.364	0.351	0.509	0.668	1.051	0.378	0.526