



ABUNDANCE OF CENTRAL ALASKAN
CHINOOK SALMON

by

Donald E. Rogers

Submitted to

International North Pacific Fisheries Commission
by the
United States National Section

Fisheries Research Institute
College of Ocean and Fishery Sciences
University of Washington
Seattle, Washington 98195

October 1985

This paper may be cited in the following manner:

Rogers, D. E. 1985. Abundance of central Alaskan chinook salmon. (Document submitted to the annual meeting of the INPFC, Tokyo, Japan, November 1985). 14 pp. Fisheries Research Institute, University of Washington, Seattle.

INTRODUCTION

Chinook salmon (Oncorhynchus tshawytscha) are the least abundant of the Pacific salmon; however, because they are the heaviest of the species at maturity, they are particularly sought by North American commercial fishermen primarily for the fresh/frozen market and by sport fishermen for recreation. Along the coast of North America the largest stocks of chinook salmon (with annual runs of over 100,000 fish) occur in the large river systems, e.g., the Sacramento, Columbia and Fraser rivers to the south and the Nushagak, Kuskokwim and Yukon rivers to the north (Bering Sea).

In recent years, the annual coastal runs (catch + escapement) to the southern region (southeastern Alaska to California) have averaged about 4 million fish and the average coastal runs to the north (Bering Sea) have averaged about 1 million fish (Rogers and Salo 1985, Myers et al. 1984). The annual runs to the coastal waters of the upper Gulf of Alaska from the Bering River to Unimak Island (central Alaska) have not been estimated, but based on the historical commercial catches in that area, they were generally believed to be much smaller than the western Alaskan and Kamchatkan stocks which were known to contribute significantly to the Japanese high seas salmon fisheries.

In 1984 a study of the origins of chinook salmon caught by the Japanese high seas salmon fisheries was completed (Myers et al. 1984). This study, which was based on scale pattern analysis, indicated that chinook salmon stocks from central Alaska contributed more fish to the high seas fishery than the stocks from Kamchatka and nearly as many as the stocks from western Alaska. It was estimated that during 1978-1983 the high seas fisheries caught an annual average of 130,000 chinook salmon of central Alaskan origin, nearly twice the average commercial catch in the coastal waters of central Alaska. This was a quite unexpected result that naturally caused a great concern among

the coastal fishermen. Either the high seas fishery was exploiting the stocks from central Alaska at a very high rate or the stock group was much more abundant than the inshore catches would indicate.

The purpose of this report is to estimate the abundance (catch + escapement) of chinook salmon in central Alaska from historical catch statistics and recent estimates of escapements provided by the Alaska Department of Fish and Game (ADF&G). These estimates should provide one basis for determining the likelihood that the central Alaskan stocks have contributed an average of over 100,000 chinook salmon annually to the high seas fisheries since 1964.

THE COASTAL FISHERIES

Chinook salmon are the first species to return to coastal waters of Alaska. The runs occur primarily in June but extend through August. Within central Alaska the coastal fisheries on chinook salmon were historically on the Copper River stock and the complex of stocks in Cook Inlet. Chinook salmon were caught incidentally to other species in the other fishing districts in central Alaska (Table 1).

Prior to 1964 the largest commercial catches of chinook salmon were made in Cook Inlet with a peak production during the late 1940's to early 1950's. At that time the Cook Inlet fishery was the largest producer of chinook salmon north of southeastern Alaska. The largest annual catches were in 1950 (163,000) and 1951 (188,000). Catches declined sharply after that and commercial fishing in June was prohibited in Cook Inlet after 1963 when it was apparent that stock abundance was depressed. This closure of commercial fishing has remained in effect through 1985, even though the catches of other

salmon in Cook Inlet increased dramatically in the late 1970's (Table 2) and there was a general increase in the abundance of all species throughout western and central Alaska beginning about 1978 (Rogers 1984).

The reason for the present closure of directed commercial fishing on chinook salmon in Cook Inlet is that a substantial sport fishery has developed which presently harvests more chinook salmon than those incidentally caught by commercial fishermen (Table 3). The sport fishermen believe that a directed commercial fishery on chinook salmon would adversely affect their catch.

There is a small subsistence fishery on the west side of upper Cook Inlet that targets on chinook salmon bound for the Susitna River which is by far the largest river system draining into Cook Inlet. The sport fishery is concentrated along the Kenai Peninsula (east side) in the middle and lower area where there are several smaller systems that also produce chinook salmon. Since 1976 the combined commercial, sport and subsistence catches of chinook salmon in Cook Inlet have averaged about 41,000 fish annually or less than one-half of the commercial catches during the historical peak of the fishery.

ESCAPEMENT ESTIMATES

The method commonly used in Alaska to estimate the relative escapement of chinook salmon is by aerial surveys of the spawning grounds. The surveys are timed to coincide with the peak in the time of spawning. The surveys usually include most of the known major spawning concentrations but even so they usually account for a minority of the escapement to the river system, e.g., surveys of chinook salmon in the Nushagak river system are believed to account for only 20 percent of the escapement (Bill et al. 1985). The annual survey counts for that river are thus multiplied by a factor of about five to

estimate the escapements.

Aerial surveys have been conducted for the Copper River since 1966 and the annual survey counts multiplied by a factor of 3.9 to estimate the escapements to that river system (Table 4). The Copper River runs gradually increased in abundance during the 1970's and then greatly increased in 1982. The catches in 1982 and 1983 were the largest in the history of the fishery. It is noteworthy that the stock increased in abundance from rather modest escapements since the fish tend to return four to six years after spawning, and that the stock is apparently able to sustain a rather high rate of exploitation.

In Cook Inlet, aerial surveys have been conducted on the Susitna River since 1976 (Barrett et al. 1985). The peak survey counts for those areas that were consistently surveyed are given in Table 5. Counts were not available for 1980 and 1981 because water level was high and visibility was poor in those years. The aerial counts averaged 54,700 for the seven years that were surveyed.

The Susitna River escapements of chinook salmon were estimated from tagging at a point 80 miles upstream from the mouth (RM 80) and recovery on the spawning grounds in each of the last three years. The population estimates from the tagging experiments were for only those fish that migrated past RM 80; however, the aerial surveys indicate that the majority of the chinook salmon entering the Susitna River spawn below the point of tagging. I estimated the annual total escapement to the Susitna River for each of the years with tagging by expanding the tagging estimate by the ratio of the survey counts above RM 80 (upper river) to the total survey counts (Table 6). For the years without tagging estimates (1976-1979), I expanded the upper

river counts by the average ratio (1982-1984) of upper river survey count to tagging estimate and then the ratio of upper river survey count to total survey count.

The resultant estimates of chinook salmon escapements averaged 355,000 for the years with survey estimates. The escapement estimates are greatly dependent on the three tagging estimates and some biologists in the Alaska Department of Fish and Game believe that the tagging estimates are too high (C. Meacham, personal communication). Simpson (1984) compared mark-recapture estimates of salmon escapements with estimates made from weir counts and concluded that for sockeye salmon (no estimates were available for chinook salmon) the mark-recapture estimates averaged 22 percent above the estimates from weir counts which he assumed were unbiased. I recalculated the Susitna River escapements in Table 6 after dividing the tagging population estimates by 1.22. The resultant escapements then averaged 293,000, and this was about five times the average of the aerial survey counts which is quite close to the factor used to estimate the chinook salmon escapements to the Nushagak River.

REGIONAL STOCK ABUNDANCE

To estimate the annual runs of chinook salmon to central Alaska since 1976 I summed the catches (commercial, sport and subsistence; reported in INPFC Statistical Yearbooks through 1981 and provided by ADF&G after 1981), the escapements to the Copper River, the adjusted (for tagging bias) escapements to the Susitna River, and escapements to other rivers which were estimated as 25 percent of the catch excluding Copper River (Table 7). I believe the estimated average run of 400,000 is conservative. The actual average run could easily be 500,000 and is very unlikely to have been less

than 300,000. The catches of chinook salmon in central Alaska during 1976-1984 averaged 84,000, or just 21 percent of the estimated regional runs.

Myers et al. (1984) estimated that the high seas fishery caught an annual average of 147,000 chinook salmon of central Alaskan origin during 1975-1983, or 75 percent more than the coastal fisheries caught during 1976-1984. It seemed unreasonable that the central Alaskan stocks could sustain such an apparently high rate of exploitation; however, the recent estimates of the escapements to the Susitna River (certainly the largest stock in central Alaska) indicate that the estimates of the high seas catches are quite feasible.

After the closure of a June commercial fishery for chinook salmon in Cook Inlet in 1964, the Susitna stock probably increased (especially the spawning stock) and this provided a surplus of fish that could be harvested on the high seas while at the same time the escapements were still relatively large. The chinook stocks probably increased even more in recent years along with the increase in the abundance of other salmon which has been associated with an increase in coastal temperatures and a decrease in high seas salmon fishing.

LITERATURE CITED

- Barrett, B. M., F. M. Thompson, and S. N. Wick. 1985. Adult salmon investigations May–October 1984. Report No. 6. ADF&G Susitna Hydro Aquatic Studies. 337 p.
- Bill, D. L., W. A. Bucher, and R. B. Russell. 1985. Salmon spawning ground surveys in Bristol Bay, 1984. Bristol Bay Data Report No. 84-6. ADF&G. 61 p.
- Myers, K. W., D. E. Rogers, C. K. Harris, C. M. Knudsen, R. V. Walker, and N. D. Davis. 1984. Origins of chinook salmon in the area of the Japanese mothership and landbased driftnet salmon fisheries in 1975–1981. (Document submitted to annual meeting of the International North Pacific Fisheries Commission, Vancouver, Canada, November 1984). 208 p. University of Washington, Fisheries Research Institute, Seattle.
- Rogers, D. E. 1984. Trends in abundance of northeastern Pacific stocks of salmon. p. 100–127. In W. G. Percy (ed.). The Influence of Ocean Conditions on the Production of Salmonids in the North Pacific. Oregon State Univ. Press.
- Rogers, D. E., and E. O. Salo. 1985. Trends in natural and hatchery production of chinook salmon. p. 39–43. In C. J. Sindermann (ed.), Proceedings of the Eleventh U.S.–Japan Meeting on Aquaculture, Salmon Enhancement, Tokyo, Japan, October 19–20, 1982, NOAA Tech. Rep. NMFS 27.
- Simpson, K. 1984. The accuracy of mark–recapture estimates of escapements. p. 209–225. In P. E. K. Symons and M. Waldichuk (eds.). Proceedings of the Workshop on Stream Indexing for Salmon Escapement Estimation, West Vancouver, B.C., 2–3 February 1984. Can. Tech. Rep. Fish. Aquat. Sci. 1326.

Table 1. Annual commercial catches of chinook salmon in Central Alaska, in thousands of fish (+ = less than 1,000).

| Year | District | | | | | Central Alaska total | |
|-----------------|-----------------|---------|--------|-----------------|----------------------------|----------------------------|-----|
| | South Penin. | Chignik | Kodiak | Cook Inlet | PWS Copper ¹ | | |
| Annual average | | | | | | | |
| 1914-23 | 6 | 1 | 1 | 43 | 1 | 13 | 65 |
| 1924-33 | 10 | 1 | 2 | 63 | 3 | 30 | 109 |
| 1934-43 | 13 | 1 | 2 | 80 | 2 | 12 | 110 |
| 1944-53 | 7 | 1 | 1 | 106 | 1 | 16 | 132 |
| 1954-63 | 3 | 1 | 1 | 36 | 3 | 11 | 55 |
| 1964-73 | 2 | 1 | 1 | 10 ² | 2 | 15 | 31 |
| 1974 | 1 | + | 1 | 7 | 2 | 19 | 29 |
| 75 | + | 1 | + | 5 | 3 | 20 | 28 |
| 76 | 2 | 2 | 1 | 11 | 1 | 31 | 49 |
| 77 | 1 | 1 | 1 | 15 | 1 | 22 | 40 |
| 78 | 1 | 2 | 3 | 19 | 1 | 29 | 55 |
| 79 | 2 | 1 | 2 | 15 | 2 | 18 | 41 |
| 80 | 5 | 2 | 1 | 14 | + | 9 | 31 |
| 81 | 11 | 3 | 1 | 13 | + | 20 | 49 |
| 82 | 8 | 5 | 1 | 20 | + | 49 | 83 |
| 83 | 20 | 5 | 4 | 20 | + | 52 | 101 |
| 84 | 7 | 4 | 3 | 9 | + | 40 | 63 |
| 85 ³ | 6 | + | 5 | 24 | 1 | 42 | 78 |

¹Includes minor catches from Bering River.

²Directed commercial fishery (i.e., in June) prohibited after 1963.

³Preliminary catches from ADF&G.

Table 2. Annual commercial catches of salmon in Cook Inlet,
in thousands of fish.

| Year | Sockeye | Pink | Chum | Coho |
|-----------------|---------|------|-------|------|
| Annual average | | | | |
| 1914-23 | 1356 | 490 | 67 | 167 |
| 1924-33 | 1244 | 460 | 75 | 322 |
| 1934-43 | 1785 | 961 | 234 | 310 |
| 1944-53 | 1876 | 1167 | 365 | 340 |
| 1954-63 | 967 | 1614 | 704 | 220 |
| 1964-73 | 935 | 1363 | 728 | 224 |
| 1974 | 525 | 534 | 416 | 207 |
| 75 | 713 | 1400 | 973 | 234 |
| 76 | 1722 | 1393 | 521 | 212 |
| 77 | 2115 | 717 | 1306 | 194 |
| 78 | 2767 | 1942 | 626 | 225 |
| 79 | 964 | 1107 | 693 | 284 |
| 80 | 1620 | 2366 | 430 | 285 |
| 81 | 1522 | 1647 | 928 | 494 |
| 82 | 3148 | 1278 | 1524* | 766* |
| 83 | 5009* | 958 | 1280 | 511 |
| 84 | 2252 | 1235 | 736 | 431 |
| 85 | 4131 | 1318 | 744 | 626 |
| 1976-85 average | 2525 | 1536 | 827 | 382 |

*Largest historical catch.

Table 3. Subsistence and sport catches of chinook salmon in Central Alaska, in thousands of fish (+ = less than 1,000).

| Year | Cook Inlet | | Copper River | | All Central Alaska | | |
|------|------------|-------|--------------|-------|--------------------|-------|-------|
| | Subs. | Sport | Subs. | Sport | Subs. | Sport | Total |
| 1970 | + | 2 | + | 1 | 1 | 3 | 4 |
| 71 | + | 2 | 1 | 1 | 1 | 4 | 5 |
| 72 | + | 5 | 2 | 1 | 2 | 6 | 8 |
| 73 | 0 | 3 | 2 | 1 | 2 | 4 | 6 |
| 74 | + | 6 | 1 | 1 | 1 | 7 | 8 |
| 75 | + | 7 | 2 | 1 | 2 | 8 | 10 |
| 76 | + | 16 | 2 | + | 2 | 17 | 19 |
| 77 | + | 21 | 2 | + | 2 | 22 | 24 |
| 78 | + | 21 | 2 | 1 | 2 | 22 | 24 |
| 79 | + | 27 | 2 | 3 | 3 | 30 | 33 |
| 80 | 2 | 17 | 2 | 2 | 5 | 20 | 25 |
| 81 | 2 | 28 | 2 | 2 | 4 | 31 | 35 |
| 82 | 2 | 29 | 3 | 2 | 5 | 31 | 36 |
| 83 | 3 | 23 | 5 | 3 | 8 | 27 | 35 |
| 84 | 2 | -- | 2 | 2 | 4 | -- | -- |
| 85 | -- | | -- | -- | -- | -- | -- |

Table 4. Estimates of Copper River chinook salmon abundance, in thousands of fish.

| Year | Catches | | Total | Escape- ment ¹ | Total run | μ^2 |
|------|------------|---------------|-------|------------------------------|--------------|---------|
| | Commercial | Subs. + Sport | | | | |
| 1964 | 13 | 1 | 14 | -- | -- | |
| 65 | 15 | 2 | 17 | -- | -- | |
| 66 | 11 | 1 | 12 | 4 | 16 | 75 |
| 67 | 10 | 1 | 11 | 5 | 16 | 69 |
| 68 | 10 | 1 | 11 | 5 | 16 | 69 |
| 69 | 14 | 1 | 15 | 3 | 18 | 83 |
| 70 | 19 | 1 | 20 | 5 | 25 | 80 |
| 71 | 16 | 3 | 19 | 4 | 23 | 83 |
| 72 | 22 | 2 | 24 | 8 | 32 | 75 |
| 73 | 20 | 2 | 22 | 6 | 28 | 79 |
| 74 | 19 | 2 | 21 | 6 | 27 | 78 |
| 75 | 20 | 2 | 22 | 5 | 27 | 81 |
| 76 | 31 | 3 | 34 | 5 | 39 | 87 |
| 77 | 22 | 3 | 25 | 6 | 31 | 81 |
| 78 | 29 | 3 | 32 | 6 | 38 | 84 |
| 79 | 17 | 6 | 23 | 11 | 34 | 68 |
| 80 | 9 | 4 | 13 | 7 | 20 | 65 |
| 81 | 20 | 5 | 25 | 5 | 30 | 83 |
| 82 | 47 | 5 | 52 | 15 | 67 | 78 |
| 83 | 50 | 8 | 58 | 10 | 68 | 85 |
| 84 | 39 | 4 | 43 | 17 | 60 | 72 |
| 85 | 42 | -- | -- | -- | -- | |

¹Aerial survey counts multiplied by 3.9 provided by K. Roberson (ADF&G).

²Rate of exploitation, in percent.

Table 5. Chinook salmon escapement indices for the Susitna River, 1976-1984. Source: Table 12 in Barrett, et al. (1985).

| Year | Highest survey counts (in thousands) by sub-basin | | | | Total |
|------|---|---------------------------|---------------------------------|---------------------|-------|
| | Lower River ¹ | Yentna River ² | Talkeetna-Chulitna ³ | Middle ⁴ | |
| 1976 | 31.9 | 5.1 | 9.6 | 1.2 | 47.8 |
| 77 | 53.1 | 9.2 | 8.3 | 0.8 | 71.4 |
| 78 | 35.3 | 10.3 | 7.1 | 0.3 | 53.0 |
| 79 | 37.4 | 5.8 | (7.3) | 0.5 | 51.0 |
| 80 | -- | -- | -- | -- | -- |
| 81 | -- | -- | -- | 1.1 | -- |
| 82 | 21.2 | 6.7 | 5.5 | 2.3 | 35.7 |
| 83 | 28.2 | 17.1 | 7.9 | 4.3 | 57.5 |
| 84 | 28.0 | (17.1) | 14.7 | 6.9 | 66.7 |

¹Excludes Sucker and Wolverine creeks which were not surveyed in most years.

²Lake Creek and Talachulitna River only since other areas were not surveyed in most years. Lake Creek count for 1984 was estimated from the average ratio of Lake Creek count to Talachulitna River count.

³Chulitna River (Middle Fork), Clear Creek, and Prairie Creek only. The 1979 estimate from Clear Creek count and the average ratio of Clear Creek count to the total count in other years.

⁴Indian River and Portage Creek only since other areas were not surveyed in most years.

Table 6. Estimates of chinook salmon escapements to the Susitna River, in thousands of fish.

| Year | Peak index counts ¹ | | | Ratio: Total/Upper | Upper river population from tagging ² | Expanded total escapement ³ |
|------|--------------------------------|----------------|-------|-----------------------|--|--|
| | Lower river | Upper river | Total | | | |
| 1976 | 37 | 11 | 48 | 4.36 | -- | 312 |
| 77 | 62 | 9 | 71 | 7.89 | -- | 462 |
| 78 | 46 | 7 | 53 | 7.57 | -- | 344 |
| 79 | 43 | 8 | 51 | 6.37 | -- | 331 |
| 80 | -- | -- | -- | -- | -- | -- |
| 81 | -- | -- | -- | -- | -- | -- |
| 82 | 28 | 8 | 36 | 4.50 | 53 | 238 |
| 83 | 45 | 12 | 57 | 4.75 | 90 | 427 |
| 84 | 45 | 22 | 67 | 3.05 | 122 | 372 |

¹From Table 5.

²From Table 49 in Barrett, et al (1985).

³Total escapements for 1982-84 from tagging population estimate times ratio of total river index to upper river index and total escapements for 1976-79 from average ratio of upper river population to upper river index (1982-84, 6.5) times upper river index times ratio of total index to upper river index.

Table 7. Estimated runs of chinook salmon to central Alaska in thousands of fish.

| Year | Catches | | | Escapements | | | Total central Alaska run |
|-------|--------------|------------|-----------------|--------------|------------------|---------------------------|--------------------------|
| | Copper River | Cook Inlet | Other districts | Copper River | Susitna River | Other rivers ¹ | |
| 1976 | 34 | 27 | 6 | 5 | 259 | 8 | 339 |
| 77 | 25 | 36 | 4 | 6 | 383 | 10 | 464 |
| 78 | 32 | 40 | 7 | 6 | 286 | 12 | 383 |
| 79 | 23 | 42 | 7 | 11 | 275 | 12 | 370 |
| 80 | 13 | 33 | 8 | 7 | 293 ² | 10 | 364 |
| 81 | 25 | 43 | 15 | 5 | 293 ² | 14 | 395 |
| 82 | 52 | 51 | 14 | 15 | 194 | 16 | 342 |
| 83 | 58 | 46 | 29 | 10 | 352 | 19 | 514 |
| 84 | 43 | 36 | 13 | 17 | 305 | 12 | 426 |
| Means | 34 | 39 | 11 | 9 | 293 | 13 | 400 |

¹Estimated by 25% of the Cook Inlet and other district catch.

²Estimated by average escapement in other years.