

**Fishery Research Bulletin No. 91-02**

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**An Improved Procedure to Estimate Summer Chum  
Salmon Harvests in District 4 of the Yukon River,  
Alaska, as Applied to the 1989 Fishery**

by

**Gene J. Sandone**

June 1991

## **Fishery Research Bulletin**

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## ABSTRACT

An estimated 510,244 summer chum salmon *Oncorhynchus keta* were harvested during the 1989 summer commercial season in District 4 of the Yukon River Management Area. These fish were primarily used for roe production. Many of the resulting carcasses were used for subsistence sled dog food. Based on an estimated roe weight per female of 0.8959 lb, 316,222 females were used to produce the reported harvest of 283,305 lb of roe. Subdistrict 4A accounted for 95% of the District 4 harvest of roe, 78% of the summer chum sold in the round, and 95% of the estimated total numbers of summer chum salmon harvested. Average roe weight per female was greatest, 0.9845 lb, in Subdistrict 4A gill net harvests delivered to Anvik-area processors; the lightest roe weight per female, 0.8667 lb, was obtained from fish wheel harvests delivered to Nulato- or Galena-based processors. Fishermen sold approximately 62% of the Subdistrict 4A roe harvest to Nulato- or Galena-based processors. Salmon roe from fish wheel catches comprised 82% of the Subdistrict 4A salmon roe harvest. Less than 4% of the total estimated number of salmon harvested in District 4 during 1989 were sold in the round. An estimated 175,468 male chum salmon were harvested in District 4 but were not sold.

# TABLE OF CONTENTS

|                               |      |
|-------------------------------|------|
| LIST OF TABLES . . . . .      | vi   |
| LIST OF FIGURES . . . . .     | vii  |
| LIST OF APPENDICES . . . . .  | viii |
| INTRODUCTION . . . . .        | 1    |
| METHODS . . . . .             | 4    |
| Sampling Methods . . . . .    | 4    |
| Statistical Methods . . . . . | 6    |
| RESULTS . . . . .             | 7    |
| DISCUSSION . . . . .          | 10   |
| RECOMMENDATIONS . . . . .     | 12   |
| LITERATURE CITED . . . . .    | 12   |
| APPENDIX . . . . .            | 15   |

## LIST OF TABLES

| Table  | Page |
|--|------|
| 1. Summary of the processor-reported harvests of summer chum salmon by district, Upper Yukon Area, 1974–89 . . . . .   | 2    |
| 2. Summer chum salmon commercial harvest reported by processors, Yukon River District 4, 1974–1989. Adapted from Whitmore et al. 1990, Appendix Tables 6 and 17 . . . . .  | 3    |
| 3. Sample size, mean skein weight, and standard error of sampled individual summer chum salmon skeins by commercial fishing period, location, and gear type in the Yukon River Subdistrict 4A harvests of summer chum salmon, 1989 . . . . . | 6    |
| 4. Results of analysis of variance (ANOVA) conducted to test the hypothesis that there were no significant differences in mean skein weight with regards to location, gear type, and commercial fishing period . . . . .                     | 7    |
| 5. Estimated number of summer chum salmon harvested in the Yukon River Subdistrict 4A commercial harvest, June 21–August 1, 1989 . . . . .   | 9    |
| 6. Estimated number of summer chum salmon harvested in the Yukon River District 4 commercial harvest, June 21–August 1, 1989 . . . . .   | 9    |

## LIST OF FIGURES

| Figure  | Page |
|---|------|
| 1. Yukon River Management Area commercial fishing districts . . . . .   | 2    |
| 2. District 4, and associated statistical areas, of the Yukon River Management Area, 1989 . . . . .                                 | 4    |
| 3. Subdistrict 4A of the Yukon River Management Area. Underlined numbers represent river miles from the mouth . . . . .             | 5    |
| 4. Summer chum salmon roe harvest by location, gear type, and commercial fishing period, Yukon River Subdistrict 4A, 1989 . . . . . | 8    |

## LIST OF APPENDICES

| Appendix  | Page |
|---|------|
| A. Estimated number of summer chum salmon harvested by fishermen using fish wheels and delivering to processors located in Anvik, Yukon River Subdistrict 4A, June 21–August 1, 1989 . . . . .            | 15   |
| B. Estimated number of summer chum salmon harvested by fishermen using fish wheels and delivering to processors located in Galena or Nulato, Yukon River Subdistrict 4A, June 21–August 1, 1989 . . . . . | 15   |
| C. Estimated number of summer chum salmon harvested by fishermen using gill nets and delivering to processors located in Anvik, Yukon River Subdistrict 4A, June 21–August 1, 1989 . . . . .              | 16   |
| D. Estimated number of summer chum salmon harvested by fishermen using gill nets and delivering to processors located in Galena and Nulato, Yukon River Subdistrict 4A, June 21–August 1, 1989 . . . . .  | 16   |
| E. Estimated number of summer chum salmon harvested by fishermen using fish wheels, Yukon River Subdistrict 4B and 4C, June 21–August 1, 1989 . . . . .   | 17   |
| F. Estimated number of summer chum salmon harvested by fishermen using gill nets, Yukon River Subdistrict 4B and 4C, June 21–August 1, 1989 . . . . .   | 17   |



## INTRODUCTION

Prior to 1974, summer chum salmon *Oncorhynchus keta* in the Upper Yukon River, Alaska, were primarily taken under subsistence regulations and used mostly for sled dog food, although some small numbers (< 2,000) were also harvested commercially. The Yukon River Management Area is divided into six management districts (Figure 1). The Upper Yukon Management Area includes Districts 4–6. Most summer chum salmon in the Upper Yukon are taken in District 4, which consists of Subdistricts 4A, 4B, and 4C (ADF&G 1988) and extends from an Alaska Department of Fish and Game (ADF&G) regulatory marker at the mouth of an unnamed slough 0.75 mi downstream from Old Paradise Village to the western edge of the mouth of Illinois Creek near Kallands (Figure 2). Salmon are commercially harvested with set gill nets and fish wheels.

Poor statewide salmon returns in the early 1970s prompted the development of the District 4 commercial fishery for summer chum salmon. During this period commercial harvests of summer chum salmon increased throughout the Yukon River Area. District 4 fishermen had a record year in 1978 when 364,184 summer chum salmon were sold in-the-round (for flesh) and an undocumented (buyers not required to enumerate) number of salmon yielded 16,920 lb of roe (Table 1). During the early 1980s, however, buyers and processors operating in District 4 experienced limited in-the-round markets for summer chum salmon because of increased statewide salmon harvests and the relative poor quality of District 4 salmon flesh. The demand for salmon roe, however, continued to expand. As a result, summer chum salmon roe replaced in-round sales as the primary summer chum product from this area. The 1989 reported commercial summer chum salmon harvest for District 4 consisted of 18,554 salmon sold in the round and a record 283,305 lb of roe (Table 1), which were 38% and 34%, respectively, greater than the 1984–88 average.

Since 1980, 99% of the salmon roe harvest in the Yukon River drainage has been taken from District 4 (Table 1). The Subdistrict 4A summer chum roe harvest has ranged from 86% to 95% of the District 4 roe harvest during this time. The record Subdistrict 4A harvest of 270,039 lb of roe during the 1989 summer commercial fishing season accounted for 95% of the

District 4 harvest. In 1989 fish wheel catches accounted for approximately 97% of the reported Subdistrict 4A harvest of summer chum in the round and 82% of the salmon roe sales.

Although each salmon buyer is required to keep a record of each purchase of raw salmon roe, the total number of fish actually harvested is not included. From 1981 through 1987 the estimated number of female chum salmon harvested was based on the reported roe harvest and an assumed average roe weight of 1.0 lb per female. This estimate of average roe weight was based on a very small number of samples collected in Subdistrict 6B (Figure 1; Frederick Andersen, Alaska Department of Fish and Game, Fairbanks, personal communication). In 1988 number of females harvested was based on the results of a pilot study in District 4 which documented an average roe weight of 0.8970 lb per female (Robert Conrad, Alaska Department of Fish and Game, Anchorage, personal communication). From 1981 through 1985 estimates of the number of males harvested but not sold were based on the sex ratio from each season's sample taken in a test fish wheel operated near Stink Creek at river mile (RM) 419 (Figure 3). During this period, the percent females ranged from 56.6% in 1981 to 60.0% in 1984 (Whitmore et al. 1990). Estimates of the number of males harvested but not sold for 1986 through 1988 were based on the 1981–85 average season percentage of female salmon caught at the Stink Creek fish wheel: 57.9% (Whitmore et al. 1990).

The sex ratio of the summer chum salmon catch at the Stink Creek fish wheel was believed to a potentially biased estimate of the actual sex ratio of the harvest because a major portion of the harvest was taken downriver of the sample site. Additionally, because sex ratios may differ by tributary stock, sex ratio information from a single sampling site limits the statistical reliability of the estimate. Further, because the average roe weight of 1.0 lb per female used prior to 1988 was based on a small sample size, originated from another district, and was not repeated on an annual basis, the statistical reliability of harvest estimates of the number of females for these years is also limited. Therefore, annual estimates of the total num-

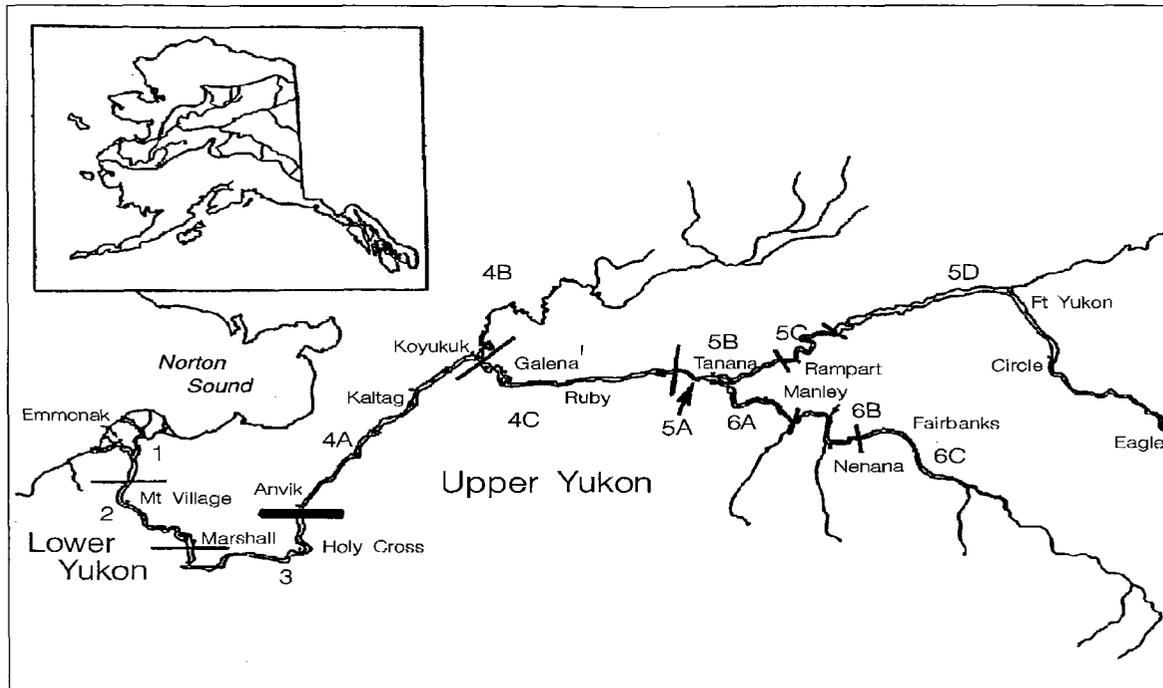


FIGURE 1.—Yukon River Management Area commercial fishing districts.

ber of fish harvested in the roe-directed fisheries prior to 1989 may be unreliable.

A more reliable estimate of the total numbers of fish harvested (both female and male) was needed to improve in-season management of summer chum

salmon and aid in the assessment of the status of the summer chum salmon stock. In-season accounting of the harvest would provide fishery managers with a critical component necessary for a more efficient execution of the fishery through emergency order open-

TABLE 1.—Summary of the processor-reported harvests of summer chum salmon by district, Upper Yukon Area, 1974-1989.

| Year                | District 4     |      |           |      | District 5     |      |                        |      | District 6     |      |                        |      | Upper Yukon Drainage |                               |
|---------------------|----------------|------|-----------|------|----------------|------|------------------------|------|----------------|------|------------------------|------|----------------------|-------------------------------|
|                     | In-Round Sales |      | Roe Sales |      | In-Round Sales |      | Roe Sales <sup>a</sup> |      | In-Round Sales |      | Roe Sales <sup>a</sup> |      | Total No. of Fish    | Total lbs of Roe <sup>a</sup> |
|                     | No.            | (%)  | (lbs)     | (%)  | No.            | (%)  | (lbs)                  | (%)  | No.            | (%)  | (lbs)                  | (%)  |                      |                               |
| 1974                | 27,866         | 58.0 | 27,636    | 34.3 | 6,831          | 14.2 | 14,613                 | 18.1 | 13,318         | 27.7 | 33,940                 | 42.1 | 48,015               | 80,531                        |
| 1975                | 165,054        | 85.6 | 32,748    | 45.8 | 12,997         | 6.7  | 14,787                 | 20.7 | 14,782         | 7.7  | 18,367                 | 25.7 | 192,833              | 71,426                        |
| 1976                | 211,331        | 96.6 | 38,532    | 56.1 | 774            | 0.4  | 11,303                 | 16.5 | 6,617          | 3.0  | 16,992                 | 24.7 | 218,722              | 68,657                        |
| 1977                | 169,541        | 96.8 | 29,640    | 46.7 | 1,274          | 0.7  | 10,497                 | 16.5 | 4,317          | 2.5  | 18,708                 | 29.5 | 175,132              | 63,430                        |
| 1978                | 364,184        | 90.2 | 16,920    | 65.7 | 4,892          | 1.2  | 605                    | 2.3  | 34,814         | 8.6  | 8,236                  | 32.0 | 403,890              | 25,761                        |
| 1979                | 169,430        | 86.2 | 35,317    | 87.8 | 8,608          | 4.4  | 1,009                  | 2.5  | 18,491         | 9.4  | 3,891                  | 9.7  | 196,529              | 40,217                        |
| 1980                | 147,560        | 80.3 | 135,814   | 97.6 | 456            | 0.2  | 0                      | 0.0  | 35,855         | 19.5 | 3,282                  | 2.4  | 183,871              | 139,096                       |
| 1981                | 59,718         | 63.9 | 187,032   | 98.9 | 1,236          | 1.3  | 49                     | 0.0  | 32,477         | 34.8 | 1,987                  | 1.1  | 93,431               | 189,068                       |
| 1982                | 3,647          | 14.3 | 151,281   | 99.0 | 213            | 0.8  | 21                     | 0.0  | 21,597         | 84.8 | 1,517                  | 1.0  | 25,457               | 152,819                       |
| 1983                | 6,672          | 21.5 | 148,125   | 98.8 | 42             | 0.1  | 1,856                  | 1.2  | 24,309         | 78.4 | 18                     | 0.0  | 31,023               | 149,999                       |
| 1984                | 1,009          | 1.7  | 166,842   | 99.8 | 645            | 1.1  | 47                     | 0.0  | 56,249         | 97.1 | 335                    | 0.2  | 57,903               | 167,224                       |
| 1985                | 12,007         | 15.1 | 247,085   | 99.4 | 700            | 0.9  | 0                      | 0.0  | 66,913         | 84.0 | 1,540                  | 0.6  | 79,620               | 248,625                       |
| 1986                | 300            | 0.6  | 269,509   | 99.2 | 690            | 1.3  | 0                      | 0.0  | 50,483         | 98.1 | 2,146                  | 0.8  | 51,473               | 271,655                       |
| 1987                | 29,991         | 73.2 | 121,474   | 99.6 | 362            | 0.9  | 44                     | 0.0  | 10,610         | 25.9 | 450                    | 0.4  | 40,963               | 121,968                       |
| 1988                | 24,051         | 37.1 | 254,526   | 99.2 | 722            | 1.1  | 363                    | 0.1  | 40,129         | 61.8 | 1,646                  | 0.6  | 64,902               | 256,535                       |
| 1989                | 18,554         | 30.5 | 283,305   | 98.2 | 154            | 0.3  | 373                    | 0.1  | 42,115         | 69.2 | 4,871                  | 1.7  | 60,823               | 288,549                       |
| Average (1984-1988) | 13,472         | 25.5 | 211,894   | 99.4 | 624            | 1.1  | 91                     | 0.0  | 44,877         | 73.4 | 1,223                  | 0.5  | 58,972               | 213,209                       |

<sup>a</sup>Processor records for roe extraction do not include a record of the number of females taken to produce the roe or the associated number of males discarded or otherwise commercially unutilized.

ings and closures, and would facilitate reliable in-season, as well as post-season, stock assessment.

Since 1967 commercial harvests of summer chum salmon in the Yukon River Area have generally increased. Total riverwide harvests ranged from less than 11,000 in 1967 to over 1.6 million in 1988. A poor summer chum salmon return to the Yukon River in 1987 prompted fishery managers to consider the summer chum salmon fishery as fully developed (i.e., no additional exploitation capabilities beyond spawning requirements). Throughout the development of the fishery and in 1988 and 1989, distribution of the summer chum salmon resource available for harvest reflected market demand and scheduled fishing time. As market demand for fresh-frozen chum salmon from the Lower Yukon Area increased, so did demand for salmon roe from District 4. This prompted resource allocation disputes between district fishermen, which intensified with the claim that many of the salmon carcasses produced as a byproduct of the roe fishery

were being wasted. Because fisheries managers scheduled fishing time, they were perceived by some of the public as making resource-allocation decisions. The neutral position that ADF&G must assume in the allocation process was being threatened. Therefore, ADF&G recognized that district allocation levels should be formalized through Alaska Board of Fisheries action. Because past guideline harvest ranges for other salmon species have been based on district-specific historical harvests, ADF&G recognized that the board needed accurate harvest estimates of summer chum salmon to formulate its resource allocation decisions.

The primary objective of this study was to provide a more reliable estimate of the total number of summer chum salmon harvested in salmon roe fisheries. This information would be used by the Alaska Board of Fisheries to facilitate allocation decisions and would aid in improving in-season management of the summer chum salmon resource and assessment of the

TABLE 2.—Summer chum salmon commercial harvest recorded by processors, Yukon River District 4, 1974-89. Adapted from Whitmore et al. 1990, Appendix Tables 6 and 17.

| Year | Subdistrict 4A             |                      | Subdistrict 4B <sup>a</sup> |                      | Subdistrict 4C <sup>a</sup> |                      | District 4 Total           |                      |   |
|------|----------------------------|----------------------|-----------------------------|----------------------|-----------------------------|----------------------|----------------------------|----------------------|---|
|      | In-Round<br>Sales<br>(no.) | Roe<br>Sales<br>(lb) | In-Round<br>Sales<br>(no.)  | Roe<br>Sales<br>(lb) | In-Round<br>Sales<br>(no.)  | Roe<br>Sales<br>(lb) | In-Round<br>Sales<br>(no.) | Roe<br>Sales<br>(lb) | Unsold<br>Males<br>(no.) <sup>c,d</sup> |
| 1974 | 1,200                      |                      | 28,500                      |                      |                             |                      | 27,866                     | 27,636 <sup>b</sup>  |   |
| 1975 | 105,600                    |                      |                             |                      |                             |                      | 165,054                    | 32,748 <sup>b</sup>  |   |
| 1976 | 178,300                    |                      | 33,031                      |                      |                             |                      | 211,331                    | 38,532 <sup>b</sup>  |   |
| 1977 | 148,700                    |                      |                             |                      |                             |                      | 169,541                    | 29,640 <sup>b</sup>  |   |
| 1978 | 309,484                    | 16,920               | 54,903                      | 0                    |                             |                      | 364,184                    | 16,920               | 0                                       |
| 1979 | 138,443                    | 35,117               | 29,789                      | 200                  | 4,046                       | 0                    | 169,430                    | 35,317               | 0                                       |
| 1980 | 120,398                    | 119,957              | 25,846                      | 14,385               | 2,346                       | 1,472                | 147,560                    | 135,814              | 0                                       |
| 1981 | 48,783                     | 160,757              | 8,332                       | 23,677               | 562                         | 2,598                | 59,718                     | 187,032              | 83,695                                  |
| 1982 | 1,032                      | 137,611              | 1,059                       | 12,550               | 1,556                       | 1,120                | 3,647                      | 151,281              | 102,791                                 |
| 1983 | 3,407                      | 130,013              | 3,265                       | 17,549               | 0                           | 563                  | 6,672                      | 148,125              | 100,591                                 |
| 1984 | 51                         | 148,519              | 659                         | 15,184               | 299                         | 3,139                | 1,009                      | 166,842              | 110,219                                 |
| 1985 | 5,130                      | 222,149              | 1,785                       | 19,306               | 5,092                       | 5,630                | 12,007                     | 247,085              | 168,391                                 |
| 1986 | 0                          | 236,820              | 241                         | 29,169               | 59                          | 3,520                | 300                        | 269,509              | 195,690                                 |
| 1987 | 29,314                     | 110,977              | 593                         | 9,956                | 84                          | 541                  | 29,991                     | 121,474              | 58,335                                  |
| 1988 | 19,070                     | 230,276              | 4,592                       | 21,766               | 389                         | 2,484                | 24,051                     | 254,526              | 182,270                                 |
| 1989 | 14,397                     | 270,039              | 2,940                       | 9,915                | 1,217                       | 3,351                | 18,554                     | 283,305              | 175,468                                 |

<sup>a</sup>From 1974 to 1978 the Subdistrict 4B boundaries included Subdistrict 4C.

<sup>b</sup>Commercially sold roe taken under subsistence regulations.

<sup>c</sup>Not reported by processors.

<sup>d</sup>Annual estimates of unsold males for 1981-85 were based on the percentage of females from each season's sample taken in a test fish wheel located near Stink Creek at RM 419, and the assumption that the average roe weight was 1.0 lb. From 1986-88 annual estimates of unsold males were based on the 1981-85 average season percentage of female salmon caught in the Stink Creek fish wheel, 57.9% and an assumed mean roe weight of 1.0 lb. The 1988 estimate was based on the 1981-85 average season percentage of female salmon caught in the Stink Creek fish wheel, 57.9% and a limited amount of commercial roe weight data collected near Galena. (See Whitmore et al. 1990 for further information). The 1989 estimate is based on this report.

status of the stock. An improved procedure to estimate the total harvest of the salmon roe fisheries was developed primarily for the 1989 fishery, continuation of the procedure in future years to be dependent on available funding.

## METHODS

### Sampling Methods

Estimation of the total number of summer chum salmon harvested in the roe fishery required that the quantity of salmon roe sold, mean salmon roe weight per female, and the sex ratio of the harvest be known. Roe weight and sex ratios samples were confined to the commercial harvests in Subdistrict 4A. This optimally allocated sampling resources because the vast majority of the total roe harvest has historically originated from this subdistrict (Table 2). Salmon skins

were individually weighed at processing sites. Sex ratio sampling was completed at various set net and fish wheel fishing sites. The quantity of the roe sold was obtained from fish tickets (last revision: March 1990).

Because of the large size of Subdistrict 4A, two field crews were employed to sample the harvest for sex ratio and the roe product information. Crews were based in roe processing locations near the boundaries of Subdistrict 4A. One field crew was based in the village of Anvik (RM 317) near the downstream boundary of the subdistrict and collected roe-weight data from harvests between RM 301 and RM 361 (Figure 3). The other crew was based in the village of Galena (RM 530) near the upstream boundary of the subdistrict and collected roe-weight data from harvests between RM 370 and RM 502 (Figure 3). Sex ratio information was collected on a more limited basis because the long distances between sample sites and the required travel time were restrictive. The

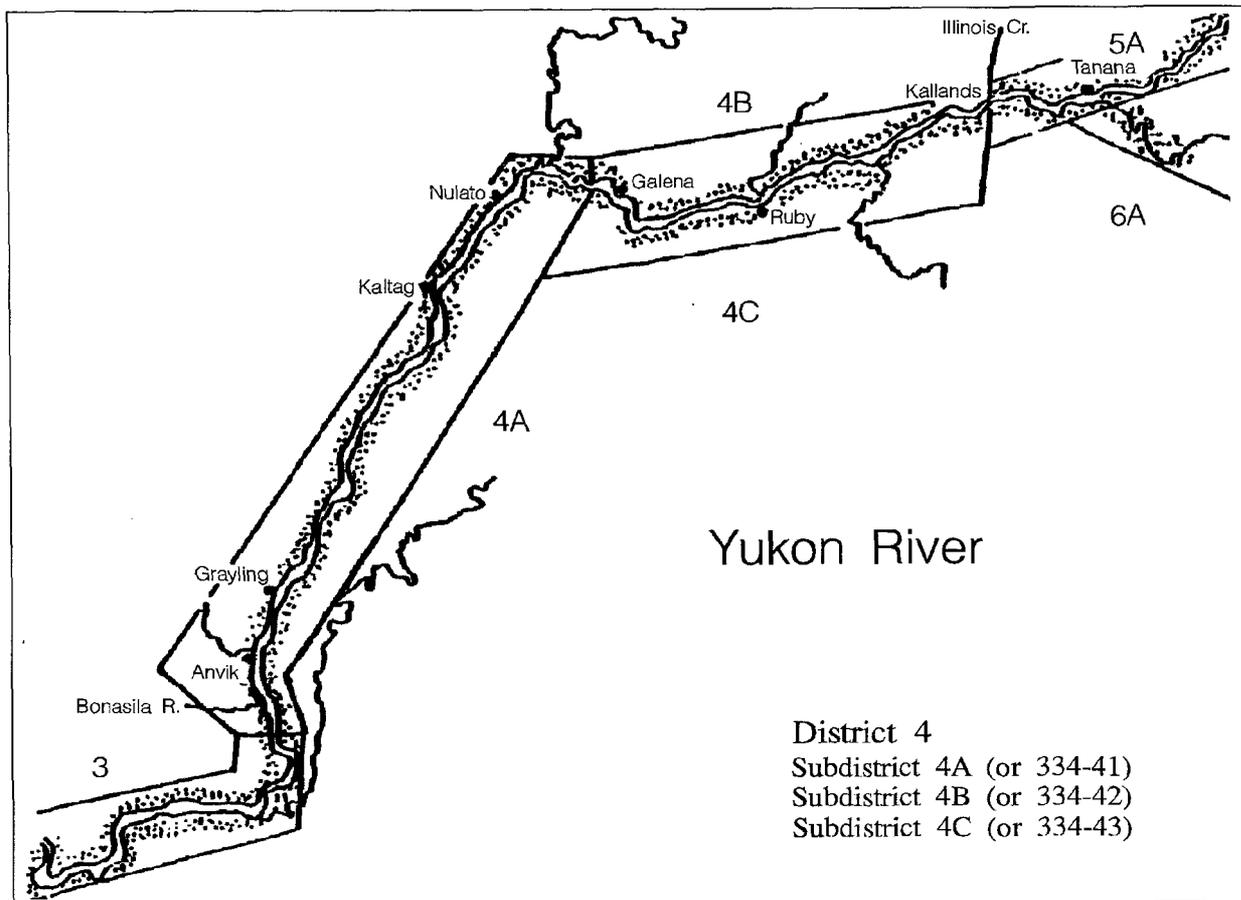


FIGURE 2.—District 4, and associated statistical areas, of the Yukon River Management Area, 1989.

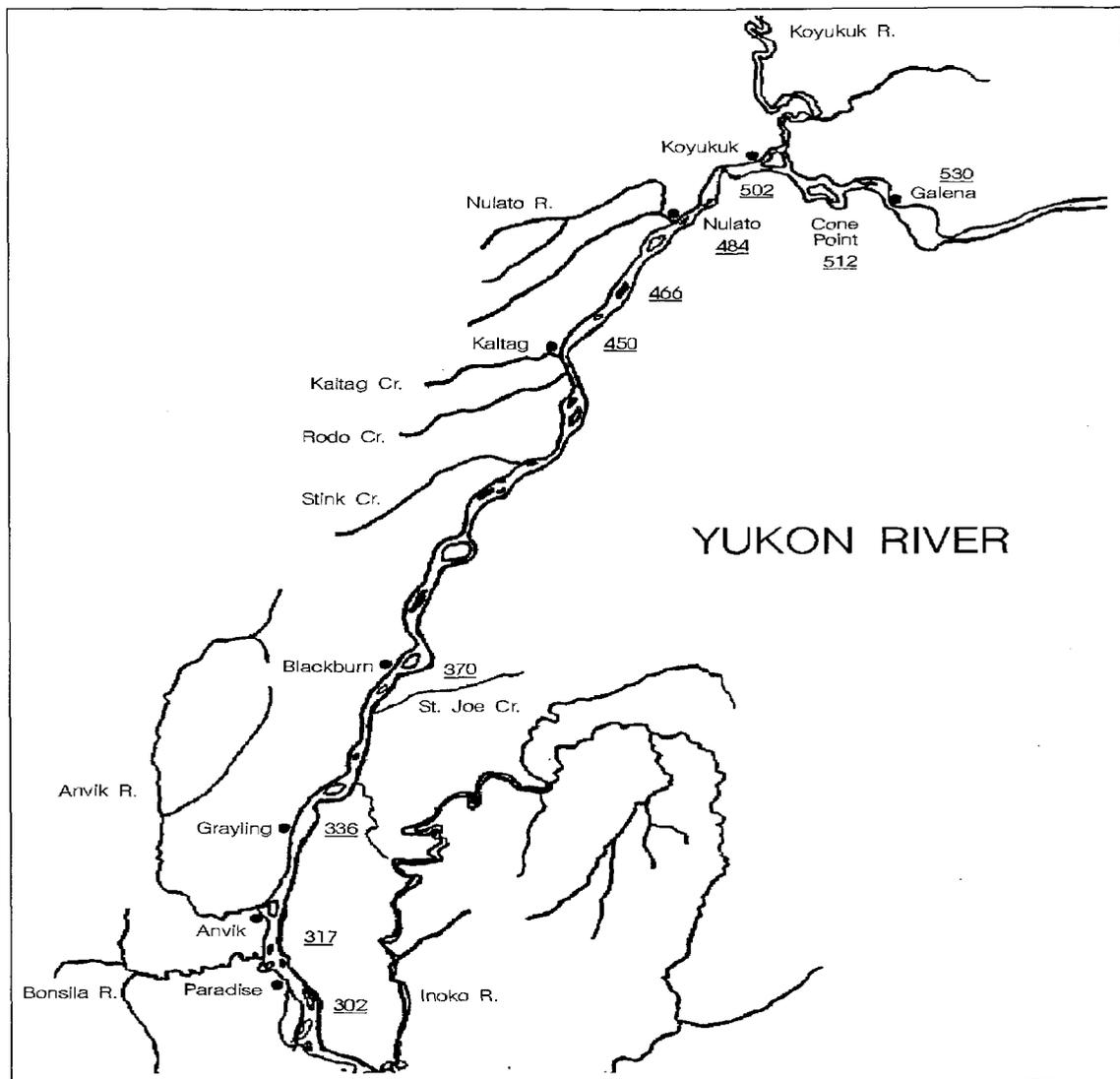


FIGURE 3.—Subdistrict 4A of the Yukon River Management Area. Underlined numbers represent river miles from the mouth.

Anvik crew collected sex ratio data at gill net and fish wheel sites between RM 302 and RM 339, and the Galena crew sampled between RM 466 and RM 502. Harvests within the 127 mi between RM 339 and RM 466 were not sampled for sex ratio information.

The 1989 summer commercial fishing season in Subdistrict 4A commenced on June 21 and was closed on August 1. Commercial fishing periods in Subdistrict 4A consisted of two 48-h periods per week. Twelve such periods were held during the summer season. Both fish wheels and gill nets were allowed to operate during each opening. Sampling was conducted during both days of each period. Sex-ratio data

were collected on the first day and skein weights were measured on the second day.

A sampling goal for each period was to determine the sex of at least 106 chum salmon at each of five geographically different fish wheel and gill net sites. Sex ratios by period were calculated based on the total number of salmon sexed from all sampling sites within each location and each gear type. Occasionally, during sampling at fish wheel sites within the Anvik area, female salmon were not enumerated when the fisherman returned all captured male salmon to the river alive. In these cases the number of female chum salmon assigned to this particular fish wheel sampling

TABLE 3.—Sample size, mean skein weight, and standard error of sampled individual summer chum salmon skeins by commercial fishing period, location, and gear type in the Yukon River Subdistrict 4A harvests of summer chum salmon, 1989.

| Fishing Period | Dates       | Fish Wheel  |                        |        |             |                        |        | Gill Net    |                        |        |             |                        |        |
|----------------|-------------|-------------|------------------------|--------|-------------|------------------------|--------|-------------|------------------------|--------|-------------|------------------------|--------|
|                |             | Anvik       |                        |        | Galena      |                        |        | Anvik       |                        |        | Galena      |                        |        |
|                |             | No. Sampled | Mean Skein Weight (lb) | SE     | No. Sampled | Mean Skein Weight (lb) | SE     | No. Sampled | Mean Skein Weight (lb) | SE     | No. Sampled | Mean Skein Weight (lb) | SE     |
| 1              | 06/21-06/23 | 230         | 0.4517                 | 0.0058 | 0           | -                      | -      | 0           | -                      | -      | 0           | -                      | -      |
| 2              | 06/25-06/27 | 165         | 0.4772                 | 0.0076 | 276         | 0.4366                 | 0.0136 | 0           | -                      | -      | 142         | 0.4602                 | 0.0094 |
| 3              | 06/28-06/30 | 749         | 0.4611                 | 0.0040 | 343         | 0.4867                 | 0.0148 | 0           | -                      | -      | 0           | -                      | -      |
| 4              | 07/02-07/04 | 445         | 0.4483                 | 0.0051 | 428         | 0.4352                 | 0.0135 | 173         | 0.4907                 | 0.0074 | 145         | 0.4662                 | 0.0103 |
| 5              | 07/05-07/07 | 763         | 0.4516                 | 0.0038 | 393         | 0.4381                 | 0.0114 | 145         | 0.4875                 | 0.0082 | 152         | 0.4551                 | 0.0084 |
| 6              | 07/09-07/11 | 536         | 0.4611                 | 0.0046 | 426         | 0.4487                 | 0.0219 | 129         | 0.4971                 | 0.0094 | 130         | 0.5006                 | 0.0089 |
| 7              | 07/12-07/14 | 703         | 0.4671                 | 0.0043 | 543         | 0.4324                 | 0.0112 | 85          | 0.4918                 | 0.0103 | 0           | -                      | -      |
| 8              | 07/16-07/18 | 523         | 0.4867                 | 0.0047 | 375         | 0.4273                 | 0.0099 | 51          | 0.5403                 | 0.0149 | 137         | 0.4584                 | 0.0107 |
| 9              | 07/19-07/21 | 173         | 0.4853                 | 0.0082 | 353         | 0.4031                 | 0.0104 | 127         | 0.4394                 | 0.0080 | 128         | 0.4607                 | 0.0082 |
| 10             | 07/23-07/25 | 377         | 0.4310                 | 0.0052 | 333         | 0.3590                 | 0.0089 | 0           | -                      | -      | 0           | -                      | -      |
| 11             | 07/26-07/28 | 0           | -                      | -      | 125         | 0.3527                 | 0.0085 | 0           | -                      | -      | 0           | -                      | -      |
| 12             | 07/30-08/01 | 0           | -                      | -      | 0           | -                      | -      | 0           | -                      | -      | 0           | -                      | -      |

site was calculated as the mean number of females sampled in the remaining Anvik-area fish wheel sampling sites for that period. This was done to determine the total harvest. In doing this, male chum salmon returned to the river alive were not included in the harvest totals.

Individual salmon skein weight, by date, gear type, location, and fisherman, was recorded to the nearest 1.0 g and converted to pounds prior to data analysis. Sampling was completed at the roe-processing sites in the villages of Anvik and Galena. The minimum sampling goal for obtaining skein weight information was set at 400 individual skeins per fishing period, or approximately 100 skeins sampled from four different locations for each crew.

### Statistical Methods

A factorial analysis of variance (ANOVA) using a general linear model (GLM) approach for unequal cell sizes (Freund and Littell 1981) was conducted to test the hypotheses that there were no differences in mean skein weight with regards to location, gear type, and commercial fishing period. These hypotheses were tested using a full factorial model,

$$MSW = L+G+P+(L)(G)+(L)(P)+(P)(G)+(L)(G)(P), \quad (1)$$

where:

*MSW* = mean skein weight,

*L* = location (Anvik or Galena),

*G* = gear type (fish wheel or gill net), and

*P* = fishing period.

Fishing periods which were not sampled completely by location and/or gear type, were not included in the analysis because results of such analyses are difficult to interpret (Freund and Littell 1981).

This analysis was conducted to determine the proper methodology in estimating the total number of salmon harvested. Non-significant hypothesis tests would indicate that estimates of mean skein weight could be based on pooled skein-weight data; significant hypothesis tests would indicate that pooling of data across levels of the factors involved in the significant model component was inappropriate. Sample strata were determined based on results of the hypothesis tests.

Type III sum of squares were employed in the analysis because this type of sum of squares is used in situations which require a comparison of main effects, even in the presence of interaction, and are unrelated to the cell frequencies (Freund and Littell 1981). Least-squares estimates of marginal means (LSMEANS; SAS 1985) were employed to allow comparisons of mean skein weights within the main effects. Tests for homogeneity of variance were con-

ducted (F-max test), and the variances were found to be homogenous for all planned ANOVA. Significance levels for all tests were set at 10%.

The number of females caught for roe ( $\hat{N}_{Fi}$ ) during any stratum,  $i$ , was estimated as

$$\hat{N}_{Fi} = \frac{R_i}{2\bar{X}_i} \quad (2)$$

where:

$R_i$  = the pounds of roe harvested during stratum  $i$ , and

$\bar{X}_i$  = the estimated mean weight of a single skein for stratum  $i$ .

$\hat{N}_{Fi}$  can be considered as a quotient with a constant ( $R_i / 2$ ) in the numerator and a variable ( $\bar{X}_i$ ) in the denominator. Its variance can be approximated using the delta method (Seber 1982):

$$\hat{V}(\hat{N}_{Fi}) = \left(\frac{R_i}{2}\right)^2 \frac{S^2(\bar{X}_i)}{(\bar{X}_i)^4} \quad (3)$$

where:

$$S^2(\bar{X}_i) = \frac{1}{n(n-1)} \sum (X_i - \bar{X}_i)^2 \quad (4)$$

the sample variance for the mean weight of single skeins from stratum  $i$ .

The number of males harvested ( $\hat{N}_{Mi}$ ) during any stratum was estimated as

$$\hat{N}_{Mi} = \hat{N}_{Fi} \left(\frac{\hat{q}_i}{\hat{p}_i}\right) \quad (5)$$

where:

$\hat{p}_i$  = the estimated proportion of females in the catch for stratum  $i$ , and

$\hat{q}_i$  = the estimated proportion of males in the catch for stratum  $i$ , or  $1 - \hat{p}_i$ .

Because  $\hat{N}_{Mi}$  is a product of two random variables, its variance can be estimated as

$$\hat{V}(\hat{N}_{Mi}) = (\hat{N}_{Fi})^2 \hat{V}\left(\frac{\hat{q}_i}{\hat{p}_i}\right) + \left(\frac{\hat{q}_i}{\hat{p}_i}\right)^2 \hat{V}(\hat{N}_{Fi}) - \hat{V}(\hat{N}_{Fi}) \hat{V}\left(\frac{\hat{q}_i}{\hat{p}_i}\right) \quad (6)$$

(Goodman 1960) where, defining  $n$  as the number of fish sampled,

$$\hat{V}\left(\frac{\hat{q}_i}{\hat{p}_i}\right) = \frac{1}{(\hat{p}_i)^4} \left(\frac{\hat{p}_i \hat{q}_i}{(n-1)}\right) \quad (7)$$

Variance estimates for strata totals were calculated as the sum of the variances for individual strata.

## RESULTS

The total of 9,803 individual salmon skeins were weighed during the 12 commercial fishing periods in Subdistrict 4A from June 21 to August 1, 1989. Skeins sampled from fish wheels numbered 8,259, and samples from gill nets numbered 1,544. In Anvik, 5,374 were weighed and 4,429 were weighed in Galena. Skeins from fish wheel-caught salmon were sampled

TABLE 4.—Results of analysis of variance (ANOVA) conducted to test the hypotheses that there were no significant differences in mean skein weight with regards to location, gear type, and commercial fishing period.

| Source               | DF | Type III Sum of Squares | Mean Square | F-Value | P <  F |
|----------------------|----|-------------------------|-------------|---------|--------|
| Location             | 1  | 162,262                 | 162,262     | 65.19   | 0.0001 |
| Gear                 | 1  | 180,520                 | 180,520     | 72.53   | 0.0001 |
| Period               | 4  | 96,484                  | 24,121      | 9.69    | 0.0001 |
| Location*Gear        | 1  | 8,356                   | 8,356       | 3.36    | 0.0670 |
| Location*Period      | 4  | 75,083                  | 18,771      | 7.54    | 0.0001 |
| Period*Gear          | 4  | 34,232                  | 8,558       | 3.44    | 0.0082 |
| Location*Gear*Period | 4  | 96,602                  | 24,151      | 9.70    | 0.0001 |

from 11 of the 12 fishing periods, while skeins from gill net-caught salmon were sampled in only eight. Complete sampling of both locations and both gear types occurred during only five commercial fishing periods (periods 4, 5, 6, 8, and 9). Mean skein weights and associated standard errors of all samples by gear type, location, and commercial fishing period are presented in Table 3.

ANOVA of mean skein weights by location, gear type, and period in Subdistrict 4A during the same commercial fishing period indicated significant differences ( $P < 0.1000$ ) due to all main effects (location, gear, and fishing period) and all interaction terms (Table 4). LSMEAN comparisons within the main effects of the model indicated that (1) mean weight of salmon skeins sampled in Anvik (0.4788 lb/skein) were significantly heavier than skeins sampled in Galena (0.4493 lb/skein;  $P < 0.0001$ ), (2) mean weight of skeins from gill net-caught salmon (0.4795 lb/skein) were significantly heavier than skeins from fish wheel-caught salmon (0.4484 lb/skein;  $P < 0.0001$ ), and (3) that mean weight of salmon skeins significantly differed by period ( $P < 0.0001$ ; Table 4). Mean skein weights for periods ranged from a low of 0.4471 lb/skein in period 9 to a high of 0.4782 lb/skein in

period 8. Of the 10 possible mean skein weight pairwise comparisons by period, only two were non-significant ( $P < 0.1000$ ). Mean weight of skeins harvested in period 4 (0.4601 lb/skein) was not significantly different from the mean weight of skeins harvested in period 5 (0.4581 lb/skein;  $P < 0.6939$ ) and mean weight of skeins harvested in period 6 (0.4769 lb/skein) was not significantly different from mean weight of skeins harvested in period 8 (0.4782 lb/skein;  $P < 0.8368$ ).

Significance of interaction terms were as follows: (L)(G),  $P < 0.0670$ ; (L)(P),  $P < 0.0001$ ; (P)(G),  $P < 0.0082$ ; and (L)(G)(P),  $P < 0.0001$  (Table 4). The significance of the interaction term (P)(G)(L),  $P < 0.0001$ , indicated that total pooling of the mean skein weight data across locations, gear types, and periods was inappropriate. Therefore, the estimate of the number of female salmon required to produce the reported commercial harvest of roe was calculated for each stratum defined as commercial fishing period by location by gear type (Appendices A–D). Salmon roe harvests were stratified by fishing period, gear type, and processor and then assigned to the Galena or Anvik location based on location of the processor (Figure 4). Salmon roe harvests sold at Nulato-based processors were included in the Galena totals. Associated estimates of the total numbers of female salmon harvested in Subdistrict 4A were then calculated by period, location, and gear type based on the stratified harvest and the associated mean skein weight for each stratum (Appendices A–D). However, if no samples were collected for a stratum, the mean of adjacent strata was used in the calculation of the total number of harvested female chum salmon.

The number of males harvested in conjunction with the roe-directed fishery was estimated by period, location, and gear type, or strata, (Appendices A–D) using stratum-specific estimates of sex ratio. However, if no sex ratio information was collected within a stratum, the mean of adjacent strata was used to calculate the total number of harvested male chum salmon. Sex ratio data were not collected from the Galena gill net harvest. Because the estimated sex ratios of the Anvik fish wheel (74%) and gill net harvests (70%) were very similar, while the sex ratio of the Galena fish wheel catch (59%) was dissimilar, it appears that harvest sex ratios were dependent more on location than on gear type (Appendix A–C). There-

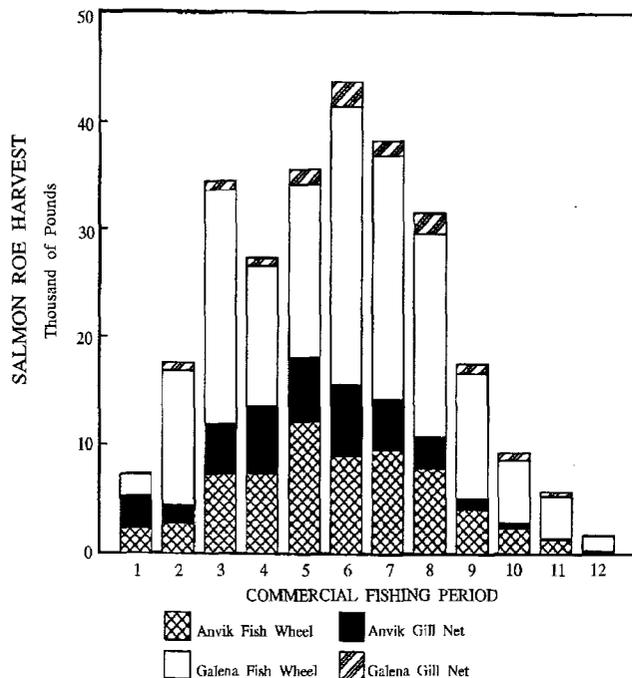


FIGURE 4.—Summer chum salmon roe harvest by location, gear type, and commercial fishing period, Yukon River Subdistrict 4A, 1989.

TABLE 5.—Estimated number of summer chum salmon harvested in the Yukon River Subdistrict 4A commercial harvest, June 21–August 1, 1989.

| Fishing<br>Period | Date      | Pounds of Roe<br>Harvested | Estimated No. of<br>Female Salmon<br>Harvested <sup>a</sup> |        | Prop. of<br>Females | Estimated No. of<br>Male Salmon<br>Harvested <sup>a</sup> |       | Estimated No. of<br>Total Salmon<br>Harvested <sup>a</sup> |        |
|-------------------|-----------|----------------------------|---|--------|---------------------|---|-------|--|--------|
|                   |           |                            | Number  | SE     |                     | Number  | SE    | Number   | SE     |
| 1                 | 6/21–6/23 | 7,351                      | 7,941   | 989    | 0.4647              | 9,149   | 1,099 | 17,090   | 1,478  |
| 2                 | 6/25–6/27 | 17,600                     | 19,629  | 3,859  | 0.3499              | 36,472  | 6,075 | 56,101   | 7,197  |
| 3                 | 6/28–6/30 | 34,429                     | 35,790  | 5,959  | 0.5560              | 28,577  | 2,671 | 64,367   | 6,530  |
| 4                 | 7/02–7/04 | 27,324                     | 30,285  | 4,644  | 0.6066              | 19,641  | 1,640 | 49,926   | 4,925  |
| 5                 | 7/05–7/07 | 35,474                     | 39,328  | 5,592  | 0.6278              | 23,316  | 2,342 | 62,644   | 6,063  |
| 6                 | 7/09–7/11 | 43,603                     | 47,343  | 9,837  | 0.7247              | 17,984  | 2,469 | 65,327   | 10,142 |
| 7                 | 7/12–7/14 | 38,213                     | 42,548  | 6,937  | 0.7074              | 17,603  | 2,052 | 60,151   | 7,234  |
| 8                 | 7/16–7/18 | 31,506                     | 34,872  | 5,490  | 0.6733              | 16,920  | 1,575 | 51,792   | 5,712  |
| 9                 | 7/19–7/21 | 17,620                     | 20,746  | 3,772  | 0.7575              | 6,642   | 868   | 27,388   | 3,870  |
| 10                | 7/23–7/25 | 9,424                      | 12,239  | 2,256  | 0.7561              | 3,948   | 466   | 16,187   | 2,304  |
| 11                | 7/26–7/28 | 5,771                      | 7,657   | 1,483  | 0.7594              | 2,426   | 313   | 10,083   | 1,516  |
| 12                | 7/30–8/01 | 1,724                      | 2,324   | 485    | 0.7437              | 801   | 115   | 3,125  | 499    |
| Totals            |           | 270,039                    | 300,702   | 17,349 | 0.6211              | 183,479   | 8,203 | 484,181  | 19,191 |

<sup>a</sup>Harvests included male fish sold in the round, females used for roe extraction (assume no females were sold for flesh), and males discarded or not commercially utilized.

fore, estimated sex ratios for the Galena fish wheel harvests by period were used to determine  $\hat{N}_{M_i}$  for each period of the Galena–area gill net harvest by period. Similarly, because sampling was not conducted in Subdistricts 4B and 4C, the appropriate data by gear type and associated with the Galena location were substituted in the calculations of the  $\hat{N}_{F_i}$  and  $\hat{N}_{M_i}$  for each period in these subdistricts. Total numbers of

female and male chum salmon harvested by fish wheel and gill net gear types from these two subdistricts (Appendices E and F) accounted for approximately 5% of the total District 4 harvest.

The total estimated Subdistrict 4A summer chum salmon harvest was 484,181 fish (SE 19,191), which accounted for approximately 95% of the total District 4 commercial catch. Estimated female chum salmon

TABLE 6.—Estimated number of summer chum salmon harvested in the Yukon River District 4 commercial harvest, June 21 - August 1, 1989.

| Fishing<br>Period | Date      | Pounds of Roe<br>Harvested | Estimated No. of<br>Female Salmon<br>Harvested <sup>a</sup> |        | Prop. of<br>Females | Estimated No. of<br>Male Salmon<br>Harvested <sup>a</sup> |       | Estimated No. of<br>Salmon<br>Harvested <sup>a</sup> |        |
|-------------------|-----------|----------------------------|---|--------|---------------------|---|-------|--|--------|
|                   |           |                            | Number  | SE     |                     | Number  | SE    | Number   | SE     |
| 1                 | 6/21–6/23 | 7,351                      | 7,941   | 989    | 0.4647              | 9,149   | 1,099 | 17,090   | 1,478  |
| 2                 | 6/25–6/27 | 18,344                     | 20,477  | 3,864  | 0.3486              | 38,265  | 6,084 | 58,742   | 7,207  |
| 3                 | 6/28–6/30 | 35,422                     | 36,814  | 5,964  | 0.5549              | 29,525  | 2,673 | 66,339   | 6,535  |
| 4                 | 7/02–7/04 | 29,666                     | 32,957  | 4,688  | 0.5986              | 22,096  | 1,659 | 55,053   | 4,973  |
| 5                 | 7/05–7/07 | 36,623                     | 40,629  | 5,598  | 0.6235              | 24,537  | 2,346 | 65,166   | 6,070  |
| 6                 | 7/09–7/11 | 45,106                     | 48,983  | 9,847  | 0.7232              | 18,748  | 2,472 | 67,731   | 10,152 |
| 7                 | 7/12–7/14 | 40,572                     | 45,238  | 6,961  | 0.7048              | 18,948  | 2,060 | 64,186   | 7,260  |
| 8                 | 7/16–7/18 | 33,550                     | 37,239  | 5,511  | 0.6719              | 17,185  | 1,581 | 55,424   | 5,733  |
| 9                 | 7/19–7/21 | 17,620                     | 20,746  | 3,772  | 0.7575              | 6,642   | 868   | 27,388   | 3,870  |
| 10                | 7/23–7/25 | 10,457                     | 13,664  | 2,285  | 0.7615              | 4,280   | 471   | 17,944   | 2,333  |
| 11                | 7/26–7/28 | 6,165                      | 8,212   | 1,490  | 0.7612              | 2,576   | 314   | 10,788   | 1,523  |
| 12                | 7/30–8/01 | 2,429                      | 3,322   | 550    | 0.7562              | 1,071   | 126   | 4,393  | 565    |
| Totals            |           | 283,305                    | 316,222   | 17,394 | 0.6197              | 194,022   | 8,219 | 510,244  | 19,239 |

<sup>a</sup>Harvests included male fish sold in the round, females used for roe extraction (assume no females were sold for flesh), and males discarded or not commercially utilized.

contribution to the harvest was approximately 62% (Table 5). Approximately 62% of the Subdistrict 4A roe harvest was sold to processors based in Nulato or Galena, and 82% of this harvest of roe was obtained from salmon captured by fish wheels.

Overall, estimated roe weight per female chum salmon harvested in District 4 was 0.8959 lb. Average skein weight per fish varied by location and gear type. Average weight of salmon skeins were heaviest from salmon harvested by gill net. Roe from salmon harvested by gill nets and delivered to Anvik processors averaged 0.9845 lb per female (Appendix C), and roe from gill net catches delivered to Galena processors averaged 0.9396 lb per female (Appendix D). Weight of skeins from fish wheel catches and delivered to Anvik and Galena processors averaged 0.9231 lb and 0.8667 lb per female, respectively (Appendices A and B).

The total commercial District 4 summer chum harvest was 510,244 fish (SE = 19,239). An estimated 316,222 female salmon (SE = 17,394) yielded the district harvest of 283,305 lb of salmon roe (Table 6). The associated total number of males harvested from the summer chum salmon run in District 4 was estimated at 194,022 (SE = 8,219), of which 175,468 (SE = 8,219) were not sold. This estimate is based on the assumption that the reported sales of summer chum salmon in the round consisted entirely of males because the extracted roe from the females would be worth more to the fisherman than the sale of the entire fish. The number of salmon sold in the round during the 1989 summer commercial fishing season in District 4 accounted for less than 4% of the estimated total number of summer chum salmon harvested and less than 10% of the males.

## DISCUSSION

The estimated total number of chum salmon harvested in District 4 during the 1989 summer commercial fishing season is approximately 4% greater than the estimate would have been for 1989 using 1.0 lb of roe per female and the 1981–85 mean sex ratio of 57.9% from the Stink Creek fish wheel catch. The estimated number of female chum salmon harvested during the 1989 harvest was approximately 12% greater, and the male component was about 6% less

than the estimated harvest using the fixed roe weight and sex ratio.

The small difference between the two estimates of total number of summer chum salmon harvested in District 4 is a product of relatively constant roe weights and sex ratios used in the calculations. It appears that skein weight of Yukon River summer chum salmon may be fairly constant from year to year. A pilot study conducted during the 1988 commercial fishery resulted in a roe weight of 0.8970 lb per harvested female summer chum salmon in District 4 (Robert Conrad, Alaska Department of Fish and Game, Anchorage, personal communication). The observed mean skein weight per female chum salmon for 1989 was nearly identical, 0.8959 lb. Additionally, the average length of a female summer chum salmon commercially harvested in District 1 has varied by no more than 3% from 1984 through 1989 in samples collected from harvests by fishermen using unrestricted and restricted mesh size not to exceed 6.0 in (Buklis and Wilcock 1985 and 1986; Buklis 1987; Wilcock 1989; Wilcock and Schneiderhan 1990; Daniel J. Schneiderhan; Alaska Department of Fish and Game, Anchorage, personal communication). Therefore, the annual differences in mean roe weight per female chum salmon should also be minimal.

Percentages of female chum salmon caught at the Stink Creek test fish wheel deviated by approximately 3 percentage points during the 6 years of project operation from 1981 to 1985 (mean = 57.9%; Whitmore et al. 1990) and were similar to the 1989 district estimate of 62%. These changes in the sex ratio have been larger and more important than the relatively minor changes in mean roe weight. Sex ratio of the harvest could change annually due to differences in the overall age-class composition of the run, contribution of the various tributary stocks to the harvest, and the commercial harvest strategies employed during the summer season in the Lower Yukon Area (Districts 1, 2 and 3).

Gill net harvests of summer chum salmon in the Lower Yukon Area, which averaged over 750,000 salmon during the 1980–89 period, may impact the summer chum salmon run entering District 4. From sex ratio data in Lower Yukon Area gill net harvests (Wilcock and Schneiderhan 1990), it appears that this fishery may inadvertently select for male summer chum salmon. If so, this fishery alters the sex ratio of

salmon escaping harvest and proceeding on to the upriver fisheries.

During the years the Anvik River chum salmon escapement has been monitored, the proportion of females has ranged from 39% in 1974 to 69% in 1982 (Sandone 1989). Because the Anvik River stock is the major summer chum salmon producer in the Yukon River drainage, accounting for an estimated 35% of the total drainage production of summer chum salmon (Buklis 1982), the sex ratio of salmon returning to this tributary plays an important role in determining the sex ratio of the harvest in the lower reaches of Subdistrict 4A. Additionally, 1988 escapement sex ratio data collected from the various tributary stocks show sex ratios variations among tributary stocks (Wilcock 1989). Because many of the summer chum salmon-producing tributaries are upstream of the Anvik River, the sex ratios of these tributary stocks will influence the sex composition, and therefore, the estimate of the total harvest of summer chum salmon above the Anvik River.

Prior to 1988 the annual estimate of the District 4 harvest of female summer chum salmon was based on an assumed mean roe weight of 1.0 lb/female. Both the 1988 pilot study and the present study indicated that actual mean roe weight may be closer to 0.90 lb. Using 0.90 lb of roe per female in the total harvest calculations prior to 1988 instead of 1.0 lb would result in an approximate 11% increase in harvest. However, in 1989 significant differences in mean roe weight were observed based on location and gear type. Because we are uncertain of the location of the historical harvest within Subdistrict 4A, the annual mean roe weight may have fluctuated depending on the location of harvest. Additionally, because harvest estimates prior to 1989 are based on potentially biased estimates of sex ratio, possibly exceeding the error induced by an incorrect assumption of roe weight, I believe that the 1989 roe weights should not be used to modify the historical harvest estimates of District 4 summer chum salmon.

In March 1990, the Alaska Board of Fisheries enacted the Yukon River Summer Chum Salmon Management Plan (5 AAC 05.362; ADF&G 1990). Based upon historical estimates of district harvests of summer chum salmon within the Yukon Management Area and information originating from this report, the Alaska Board of Fisheries set guideline harvest ranges

for summer chum salmon for all districts (ADF&G 1990). These district-specific guideline harvest ranges were designed to promote and maintain fishery stability throughout the Yukon Area by indicating the range of the harvest fishermen within a district could expect to catch. Additionally, the establishment of the guideline harvest ranges effectively relieved fisheries managers from making decisions perceived as being allocative.

With the exception of Subdistrict 4A, all guideline harvest ranges were set solely in number of salmon. The guideline harvest range assigned to Subdistrict 4A was set in fish numbers and equivalent roe poundage and provided for some combination of fish and pounds of roe. The guideline harvest range in equivalent roe poundage was equal to the harvest of the number of females required to produce the roe plus the number of males incidentally caught. The mean roe weight and the sex ratio used in these calculations (0.90 lb of roe per female and 60% female composition) were based on rounded values of the overall mean values presented in this report. Additionally, a "roe cap" was also established by the board, limiting the amount of roe sold by Subdistrict 4A fishermen.

Because of the difficulty in determining the total number of summer chum salmon harvested in Subdistrict 4A, the Alaska Board of Fisheries required that fish ticket reports include the total number of salmon caught by Commercial Fishery Entry Commission permit holders during commercial periods in Subdistrict 4A, in addition to the pounds of roe sold (ADF&G 1990). This regulation specifically stipulated that fish taken from commercial catches and used for subsistence purposes are to be reported in the commercial catch (ADF&G 1990). Although ADF&G has the authority to require reports of fish sold by number, pounds, and species, the board enacted this special regulation to inform the fishing public on reporting requirements and to explicitly convey the message that accurate reporting of the number of salmon harvested was mandatory.

Given the effects of location on the 1989 harvest within Subdistrict 4A and the board's request for more site-specific information of future harvests, this subdistrict was subdivided into three statistical areas prior to the 1990 fishing season. This was done to improve our knowledge of the location of the harvest with respect to chum salmon-producing tributaries and to

provide for possible implementation of area-specific harvest strategies within Subdistrict 4A.

## RECOMMENDATIONS

Although the Alaska Board of Fisheries required that the number of summer chum salmon harvested by Subdistrict 4A commercial fishermen be reported on fish tickets, harvests should still be sampled for average roe weight and sex ratio in order to verify fish ticket information. Although overall observed mean skein weights for Subdistrict 4A were stable during 1988 and 1989, the current sampling effort should continue in this subdistrict for one more year to determine if mean skein weight remains constant. However, the method of weighing skeins individually

should be discarded. Skeins should be weighed collectively in a container with the determination of the mean skein weight calculated by dividing the total skein weight by the number of skeins in the container. This more efficient method of collecting skein weight data would allow a more concentrated effort in the collection of sex ratio information of the harvest. Because roe weight of summer chum salmon is not expected to substantially deviate from 1988 and 1989 values, the majority of sampling funds should be directed toward obtaining accurate sex ratio information. If budget limitations demand further restrictions, sampling could be reduced to include only the mid-50% range of the harvest. At the very least, sampling the harvest for sex ratio near Anvik and Nulato or Galena should continue.

## LITERATURE CITED

- ADF&G (Alaska Department of Fish and Game) 1988. Arctic-Yukon-Kuskokwim Region commercial and subsistence fishing regulations, salmon and miscellaneous finfish, 1988-1989 edition. Division of Commercial Fisheries, Juneau.
- ADF&G (Alaska Department of Fish and Game) 1990. Arctic-Yukon-Kuskokwim Region commercial and subsistence fishing regulations, salmon and miscellaneous finfish, 1990-1991 edition. Division of Commercial Fisheries, Juneau.
- Buklis, L. S. 1982. Anvik River summer chum salmon stock biology. Alaska Department of Fish and Game, Division of Commercial Fisheries, Informational Leaflet 204, Juneau.
- Buklis, L. S. 1987. Age, sex, and size of Yukon River salmon catch and escapement, 1986. Alaska Department of Fish and Game, Commercial Fisheries Division, Technical Data Report 221, Anchorage.
- Buklis, L. S., and J. A. Wilcock. 1985. Age, sex, and size of Yukon River salmon catch and escapement, 1984. Alaska Department of Fish and Game, Commercial Fisheries Division, Technical Data Report 148, Anchorage.
- Buklis, L. S., and J. A. Wilcock. 1986. Age, sex, and size of Yukon River salmon catch and escapement, 1985. Alaska Department of Fish and Game, Commercial Fisheries Division, Technical Data Report 176, Anchorage.
- Freund, J. R., and R. C. Littell. 1981. SAS for linear models: a guide to the ANOVA and GLM procedures, SAS Institute, Cary, North Carolina.
- Goodman, L. A. 1960. On the exact variances of products. *Journal of the American Statistical Association* 55: 708-713.
- Sandone, G. J. 1989. Anvik and Andreafsky River Salmon Studies, 1988. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A89-03, Anchorage.
- SAS Institute Inc. 1985. SAS/STAT™ Guide for personal computers, version 6 edition. SAS Institute Inc., Cary, North Carolina.
- Seber, G. A. 1982. The estimation of animal abundance and related parameters. Charles Griffin and Company LTD., London, England.
- Whitmore, C., and six co-authors. 1990. Annual management report, 1988, Yukon Area. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A90-28, Anchorage.
- Wilcock, J. A. 1989. Age, sex, and size of Yukon River salmon catches and escapements, 1987. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Fishery Report 89-14, Juneau.
- Wilcock, J. A., and D. J. Schneiderhan. 1990. Age, sex, and size of Yukon River salmon catches and escapements, 1988. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Fishery Report 91-01, Juneau.

## **APPENDIX**



Appendix A.—Estimated number of summer chum salmon harvested by fishermen using fish wheels and delivering to processors located in Anvik, Yukon River Subdistrict 4A, June 21 - August 1, 1989.

| Fishing Period | Date      | Roe Harvested (lbs) | No. Skeins Weighed | Mean Weight/Skein (lb) | Estimated No. of Female Salmon Harvested <sup>a,b</sup> |       | No. Fish Sexed | Observed Prop. of Female Salmon |        | Estimated No. of Male Salmon Harvested <sup>b</sup> |       | Estimated Total No. of Salmon Harvested <sup>b</sup> |       |
|----------------|-----------|---------------------|--------------------|------------------------|---|-------|----------------|---------------------------------|--------|---|-------|--|-------|
|                |           |                     |                    |                        | No.   | SE    |                | Prop.                           | SE     | No.   | SE    | No.  | SE    |
| 1              | 6/21-6/23 | 2,271               | 230                | 0.4517                 | 2,514   | 493   | 148            | 0.5135                          | 0.0412 | 2,382   | 405   | 4,896  | 638   |
| 2              | 6/25-6/27 | 2,743               | 165                | 0.4772                 | 2,874   | 588   | 128            | 0.4375                          | 0.0440 | 3,695   | 663   | 6,569  | 886   |
| 3              | 6/28-6/30 | 7,317               | 749                | 0.4611                 | 7,935   | 1,907 | 296            | 0.6858                          | 0.0270 | 3,635   | 604   | 11,570   | 2,000 |
| 4              | 7/02-7/04 | 7,391               | 445                | 0.4483                 | 8,243   | 1,993 | 325            | 0.8923                          | 0.0172 | 995   | 258   | 9,238  | 2,010 |
| 5              | 7/05-7/07 | 12,135              | 763                | 0.4516                 | 13,436  | 3,107 | 234            | 0.7863                          | 0.0269 | 3,651   | 771   | 17,087   | 3,201 |
| 6              | 7/09-7/11 | 9,015               | 536                | 0.4611                 | 9,775   | 2,249 | 338            | 0.8462                          | 0.0197 | 1,777   | 392   | 11,552   | 2,283 |
| 7              | 7/12-7/14 | 9,687               | 703                | 0.4671                 | 10,368  | 2,542 | 340            | 0.7676                          | 0.0229 | 3,138   | 599   | 13,506   | 2,612 |
| 8              | 7/16-7/18 | 7,935               | 523                | 0.4867                 | 8,152   | 1,817 | 211            | 0.7204                          | 0.0310 | 3,164   | 599   | 11,316   | 1,913 |
| 9              | 7/19-7/21 | 4,123               | 173                | 0.4853                 | 4,248   | 944   | 106            | 0.7830                          | 0.0402 | 1,177   | 316   | 5,425  | 995   |
| 10             | 7/23-7/25 | 2,324               | 377                | 0.4310                 | 2,696   | 636   | 0              |                                 |        | 747   | 203   | 3,443  | 668   |
| 11             | 7/26-7/28 | 1,286               | 0                  | 0.4310                 | 1,492   | 352   | 0              |                                 |        | 413   | 112   | 1,905  | 369   |
| 12             | 7/30-8/01 | 159                 | 0                  | 0.4310                 | 184   | 44    | 0              |                                 |        | 51  | 14    | 235  | 46    |
| Totals         |           | 66,386              | 4,664              | 0.4615                 | 71,917  | 5,839 | 2,126          | 0.7434                          | 0.1172 | 24,825  | 1,629 | 96,742   | 6,062 |

<sup>a</sup>Calculations of the estimated number of female and male salmon removed when skein weight and/or sex ratio data were unavailable were based on the observed mean skein weight and/or proportion of females of the nearest adjacent period.

<sup>b</sup>Harvests include male salmon sold in the round, females used for roe extraction (assume no females were sold for flesh), and males discarded or not commercially utilized.

Appendix B.—Estimated number of summer chum salmon harvested by fishermen using fish wheels and delivering to processors located in Galena or Nulato, Yukon River Subdistrict 4A, June 21 - August 1, 1989.

| Fishing Period | Date      | Roe Harvested (lbs) | No. Skeins Weighed | Mean Weight/Skein (lb) | Estimated No. of Female Salmon Harvested <sup>a,b</sup> |        | No. Fish Sexed | Observed Prop. of Female Salmon |        | Estimated No. of Male Salmon Harvested <sup>b</sup> |       | Estimated Total No. of Salmon Harvested <sup>b</sup> |        |
|----------------|-----------|---------------------|--------------------|------------------------|---|--------|----------------|---------------------------------|--------|---|-------|--|--------|
|                |           |                     |                    |                        | No.   | SE     |                | Prop.                           | SE     | No.   | SE    | No.  | SE     |
| 1              | 6/21-6/23 | 1,940               | 0                  | 0.4366                 | 2,221   | 593    | 0              | -                               | -      | 4,696   | 942   | 6,917  | 1,113  |
| 2              | 6/25-6/27 | 12,411              | 276                | 0.4366                 | 14,212  | 3,793  | 109            | 0.3211                          | 0.0449 | 30,048  | 6,025 | 44,260   | 7,120  |
| 3              | 6/28-6/30 | 21,659              | 343                | 0.4867                 | 22,249  | 5,562  | 368            | 0.5190                          | 0.0261 | 20,618  | 2,506 | 42,867   | 6,100  |
| 4              | 7/02-7/04 | 13,007              | 428                | 0.4352                 | 14,945  | 3,995  | 518            | 0.5212                          | 0.0220 | 13,727  | 1,533 | 28,672   | 4,279  |
| 5              | 7/05-7/07 | 16,050              | 393                | 0.4381                 | 18,318  | 4,470  | 314            | 0.5159                          | 0.0282 | 17,187  | 2,191 | 35,505   | 4,978  |
| 6              | 7/09-7/11 | 25,732              | 426                | 0.4487                 | 28,676  | 9,458  | 472            | 0.6822                          | 0.0215 | 13,358  | 2,400 | 42,034   | 9,758  |
| 7              | 7/12-7/14 | 22,514              | 543                | 0.4324                 | 26,031  | 6,382  | 411            | 0.6667                          | 0.0233 | 13,015  | 1,939 | 39,046   | 6,670  |
| 8              | 7/16-7/18 | 18,808              | 375                | 0.4273                 | 22,008  | 5,124  | 827            | 0.6518                          | 0.0166 | 11,759  | 1,432 | 33,767   | 5,320  |
| 9              | 7/19-7/21 | 11,606              | 353                | 0.4031                 | 14,397  | 3,639  | 593            | 0.7572                          | 0.0176 | 4,617   | 794   | 19,014   | 3,725  |
| 10             | 7/23-7/25 | 5,886               | 333                | 0.3590                 | 8,198   | 2,156  | 698            | 0.8109                          | 0.0148 | 2,629   | 376   | 10,827   | 2,189  |
| 11             | 7/26-7/28 | 3,881               | 125                | 0.3527                 | 5,502   | 1,437  | 521            | 0.7869                          | 0.0180 | 1,765   | 286   | 7,267  | 1,465  |
| 12             | 7/30-8/01 | 1,300               | 0                  | 0.4366                 | 1,843   | 481    | 0              |                                 |        | 591   | 96    | 2,434  | 490    |
| Totals         |           | 154,794             | 3,595              | 0.4334                 | 178,600   | 16,070 | 4,831          | 0.5713                          | 0.0919 | 134,010   | 9,880 | 312,610  | 17,925 |

<sup>a</sup>Calculations of the estimated number of female and male salmon removed when skein weight and/or sex ratio data were unavailable were based on the observed mean skein weight and/or proportion of females of the nearest adjacent period.

<sup>b</sup>Harvests include male salmon sold in the round, females used for roe extraction (assume no females were sold for flesh), and males discarded or not commercially utilized.

Appendix C.—Estimated number of summer chum salmon harvested by fishermen using gill nets and delivering to processors located in Anvik, Yukon River Subdistrict 4A, June 21–August 1, 1989.

| Fishing Period | Date      | Roe Harvested (lbs) | No. Skeins Weighed | Mean Weight/Skein (lb) | Estimated No. of Female Salmon Harvested <sup>a,b</sup> |       | No. Fish Sexed | Observed Prop. of Female Salmon |        | Estimated No. of Male Salmon Harvested <sup>b</sup> |       | Estimated Total No. of Salmon Harvested <sup>b</sup> |       |
|----------------|-----------|---------------------|--------------------|------------------------|---|-------|----------------|---------------------------------|--------|---|-------|--|-------|
|                |           |                     |                    |                        | No.   | SE    |                | Prop.                           | SE     | No.   | SE    | No.  | SE    |
| 1              | 6/21-6/23 | 3,045               | 0                  | 0.4907                 | 3,103   | 619   | 0              | -                               | -      | 1,853   | 392   | 4,956  | 733   |
| 2              | 6/25-6/27 | 1,712               | 0                  | 0.4907                 | 1,745   | 348   | 107            | 0.6262                          | 0.0470 | 1,042   | 221   | 2,787  | 412   |
| 3              | 6/28-6/30 | 4,638               | 0                  | 0.4907                 | 4,726   | 942   | 115            | 0.5739                          | 0.0463 | 3,509   | 691   | 8,235  | 1,168 |
| 4              | 7/02-7/04 | 6,199               | 173                | 0.4907                 | 6,317   | 1,260 | 403            | 0.6005                          | 0.0244 | 4,203   | 517   | 10,520   | 1,362 |
| 5              | 7/05-7/07 | 5,935               | 145                | 0.4875                 | 6,087   | 1,234 | 245            | 0.8490                          | 0.0229 | 1,083   | 247   | 7,170  | 1,258 |
| 6              | 7/09-7/11 | 6,613               | 129                | 0.4971                 | 6,652   | 1,432 | 178            | 0.7865                          | 0.0308 | 1,806   | 403   | 8,458  | 1,488 |
| 7              | 7/12-7/14 | 4,576               | 85                 | 0.4918                 | 4,652   | 897   | 61             | 0.8689                          | 0.0436 | 702   | 283   | 5,354  | 941   |
| 8              | 7/16-7/18 | 2,920               | 51                 | 0.5403                 | 2,702   | 531   | 106            | 0.7453                          | 0.0425 | 923   | 226   | 3,625  | 577   |
| 9              | 7/19-7/21 | 927                 | 127                | 0.4394                 | 1,055   | 216   | 0              | -                               | -      | 513   | 144   | 1,568  | 260   |
| 10             | 7/23-7/25 | 525                 | 0                  | 0.4394                 | 597   | 122   | 20             | 0.6000                          | 0.1124 | 398   | 185   | 995  | 222   |
| 11             | 7/26-7/28 | 153                 | 0                  | 0.4394                 | 174   | 36    | 0              | -                               | -      | 116   | 54    | 290  | 65    |
| 12             | 7/30-8/01 | 176                 | 0                  | 0.4394                 | 200   | 41    | 0              | -                               | -      | 133   | 62    | 333  | 74    |
| Totals         |           | 37,419              | 710                | 0.4922                 | 38,010  | 2,767 | 1,235          | 0.7001                          | 0.2241 | 16,281  | 1,159 | 54,291   | 3,000 |

<sup>a</sup>Calculations of the estimated number of female and male salmon removed when skein weight and/or sex ratio data were unavailable were based on the mean skein weight and/or mean proportion of females of the two adjacent periods. When skein weight data and/or sex ratio data were unavailable for extreme periods, calculations of the number of salmon removed were based on the mean skein weight and/or proportion of females of the nearest adjacent period.

<sup>b</sup>Harvests include male salmon sold in the round, females used for roe extraction (assume no females were sold for flesh), and males discarded or not commercially utilized.

Appendix D.—Estimated number of summer chum salmon harvested by fishermen using gill nets and delivering to processors located in Galena or Nulato, Yukon River Subdistrict 4A, June 21 – August 1, 1989.

| Fishing Period | Date      | Roe Harvested (lbs) | No. Skeins Weighed | Mean Weight/Skein (lb) | Estimated No. of Female Salmon Harvested <sup>a,b</sup> |     | No. Fish Sexed | Observed Prop. of Female Salmon <sup>c</sup> |        | Estimated No. of Male Salmon Harvested <sup>b</sup> |     | Estimated Total No. of Salmon Harvested <sup>b</sup> |       |
|----------------|-----------|---------------------|--------------------|------------------------|---|-----|----------------|--|--------|---|-----|--|-------|
|                |           |                     |                    |                        | No.   | SE  |                | Prop.  | SE     | No.   | SE  | No.  | SE    |
| 1              | 6/21-6/23 | 95                  | 0                  | 0.4602                 | 103   | 25  | 0              | -  | -      | 218   | 44  | 321  | 51    |
| 2              | 6/25-6/27 | 734                 | 142                | 0.4602                 | 798   | 194 | 0              | 0.3211                                       | 0.0449 | 1,687   | 340 | 2,485  | 391   |
| 3              | 6/28-6/30 | 815                 | 0                  | 0.4632                 | 880   | 225 | 0              | 0.5190                                       | 0.0261 | 815   | 100 | 1,695  | 246   |
| 4              | 7/02-7/04 | 727                 | 145                | 0.4662                 | 780   | 208 | 0              | 0.5212                                       | 0.0220 | 716   | 80  | 1,496  | 223   |
| 5              | 7/05-7/07 | 1,354               | 152                | 0.4551                 | 1,487   | 339 | 0              | 0.5159                                       | 0.0282 | 1,395   | 175 | 2,882  | 382   |
| 6              | 7/09-7/11 | 2,243               | 130                | 0.5006                 | 2,240   | 452 | 0              | 0.6822                                       | 0.0215 | 1,043   | 141 | 3,283  | 473   |
| 7              | 7/12-7/14 | 1,436               | 0                  | 0.4795                 | 1,497   | 356 | 0              | 0.6667                                       | 0.0233 | 748   | 110 | 2,245  | 373   |
| 8              | 7/16-7/18 | 1,843               | 137                | 0.4584                 | 2,010   | 550 | 0              | 0.6518                                       | 0.0166 | 1,074   | 146 | 3,084  | 569   |
| 9              | 7/19-7/21 | 964                 | 128                | 0.4607                 | 1,046   | 210 | 0              | 0.7572                                       | 0.0176 | 335   | 50  | 1,381  | 216   |
| 10             | 7/23-7/25 | 689                 | 0                  | 0.4607                 | 748   | 150 | 0              | 0.8109                                       | 0.0148 | 174   | 28  | 922  | 153   |
| 11             | 7/26-7/28 | 451                 | 0                  | 0.4607                 | 489   | 98  | 0              | 0.7869                                       | 0.0180 | 132   | 22  | 621  | 100   |
| 12             | 7/30-8/01 | 89                  | 0                  | 0.4607                 | 97  | 19  | 0              | -  | -      | 26  | 4   | 123  | 19    |
| Totals         |           | 11,440              | 834                | 0.4698                 | 12,175  | 956 | 0              | 0.5928                                       | 0.0902 | 8,363   | 468 | 20,538   | 1,064 |

<sup>a</sup>Calculations of the estimated number of female and male salmon removed when skein weight and/or sex ratio data were unavailable were based on the mean skein weight and/or mean proportion of females of the two adjacent periods. When skein weight data and/or sex ratio data were unavailable for extreme periods, calculations of the number of salmon removed were based on the mean skein weight and/or proportion of females of the nearest adjacent period.

<sup>b</sup>Harvests include male salmon sold in the round, females used for roe extraction (assume no females were sold for flesh), and males discarded or not commercially utilized.

<sup>c</sup>Sex ratio data unavailable. Sex ratio data collected from the Galena-area fish wheel-caught salmon used to estimate number of male salmon removed by the gill net harvest delivered to the Galena- or Nulato-based processors.

Appendix E.—Estimated number of summer chum salmon harvested by fishermen using fish wheels, Yukon River Subdistricts 4B and 4C, June 21–August 1, 1989.

| Fishing Period | Date      | Roe Harvested (lbs) | No. Skeins Weighed | Mean Weight/Skein (lb) <sup>a</sup> | Estimated No. of Female Salmon Harvested <sup>b,c</sup> |       | No. Fish Sexed | Observed Prop. of Female Salmon <sup>a</sup> |        | Estimated No. of Male Salmon Harvested <sup>c</sup> |     | Estimated Total No. of Salmon Harvested <sup>c</sup> |       |
|----------------|-----------|---------------------|--------------------|-------------------------------------|---|-------|----------------|--|--------|---|-----|--|-------|
|                |           |                     |                    |                                     | No.   | SE    |                | Prop.  | SE     | No.   | SE  | No.  | SE    |
| 1              | 6/21-6/23 | 0                   | 0                  | 0.4366                              | 0   | 0     | 0              | 0.3211                                       | 0.0449 | 0   | 0   | 0  | 0     |
| 2              | 6/25-6/27 | 674                 | 0                  | 0.4366                              | 772   | 206   | 0              | 0.3211                                       | 0.0449 | 1,632   | 327 | 2,404  | 386   |
| 3              | 6/28-6/30 | 936                 | 0                  | 0.4867                              | 962   | 240   | 0              | 0.5190                                       | 0.0261 | 891   | 108 | 1,853  | 263   |
| 4              | 7/02-7/04 | 2,085               | 0                  | 0.4352                              | 2,396   | 640   | 0              | 0.5212                                       | 0.0220 | 2,201   | 246 | 4,597  | 686   |
| 5              | 7/05-7/07 | 922                 | 0                  | 0.4381                              | 1,052   | 257   | 0              | 0.5159                                       | 0.0282 | 987   | 126 | 2,039  | 286   |
| 6              | 7/09-7/11 | 1,198               | 0                  | 0.4487                              | 1,335   | 440   | 0              | 0.6822                                       | 0.0215 | 622   | 112 | 1,957  | 454   |
| 7              | 7/12-7/14 | 2,027               | 0                  | 0.4324                              | 2,344   | 575   | 0              | 0.6667                                       | 0.0233 | 1,172   | 175 | 3,516  | 601   |
| 8              | 7/16-7/18 | 1,732               | 0                  | 0.4273                              | 2,027   | 472   | 0              | 0.6518                                       | 0.0166 | 1,083   | 132 | 3,110  | 490   |
| 9              | 7/19-7/21 | 0                   | 0                  | 0.4031                              | 0   | 0     | 0              | 0.7572                                       | 0.0176 | 0   | 0   | 0  | 0     |
| 10             | 7/23-7/25 | 988                 | 0                  | 0.3590                              | 1,376   | 362   | 0              | 0.8109                                       | 0.0148 | 321   | 63  | 1,697  | 367   |
| 11             | 7/26-7/28 | 384                 | 0                  | 0.3527                              | 544   | 142   | 0              | 0.7869                                       | 0.0180 | 147   | 28  | 691  | 145   |
| 12             | 7/30-8/01 | 702                 | 0                  | 0.3527                              | 995   | 260   | 0              | 0.7869                                       | 0.0180 | 269   | 52  | 1,264  | 265   |
| Totals         |           | 11,648              | 0                  | 0.4220                              | 13,803  | 1,242 | 0              | 0.5968                                       | 0.0919 | 9,325   | 513 | 23,128   | 1,343 |

<sup>a</sup>Mean skein weight and sex ratio data unavailable. Mean skein weight and sex ratio data collected from the fish wheel harvest delivered to Galena- or Nulato-based processors substituted in the calculations of number of salmon removed.

<sup>b</sup>Calculations of the estimated number of female and male salmon removed when skein weight and/or sex ratio data were unavailable were based on the observed mean skein weight and/or proportion of females of the nearest adjacent period.

<sup>c</sup>Harvests include male salmon sold in the round, females used for roe extraction (assume no females were sold for flesh), and males discarded or not commercially utilized.

Appendix F.—Estimated number of summer chum salmon harvested by fishermen using gill nets, Yukon River Subdistricts 4B and 4C, June 21–August 1, 1989.

| Fishing Period | Date      | Roe Harvested (lbs) | No. Skeins Weighed | Mean Weight/Skein (g) <sup>a</sup> | Estimated No. of Female Salmon Harvested <sup>b,c</sup> |     | No. Fish Sexed | Observed Prop. of Female Salmon <sup>a</sup> |        | Estimated No. of Male Salmon Harvested <sup>c</sup> |    | Estimated Total No. of Salmon Harvested <sup>c</sup> |     |
|----------------|-----------|---------------------|--------------------|------------------------------------|---|-----|----------------|--|--------|---|----|--|-----|
|                |           |                     |                    |                                    | No.   | SE  |                | Prop.  | SE     | No.   | SE | No.  | SE  |
| 1              | 6/21-6/23 | 0                   | 0                  | 0.4602                             | 0   | 0   | 0              | -  | -      | 0   | 0  | 0  | 0   |
| 2              | 6/25-6/27 | 70                  | 0                  | 0.4602                             | 76  | 19  | 0              | 0.3211                                       | 0.0449 | 161   | 32 | 237  | 37  |
| 3              | 6/28-6/30 | 57                  | 0                  | 0.4632                             | 62  | 16  | 0              | 0.5190                                       | 0.0261 | 57  | 7  | 119  | 17  |
| 4              | 7/02-7/04 | 257                 | 0                  | 0.4662                             | 276   | 74  | 0              | 0.5212                                       | 0.0220 | 254   | 28 | 530  | 79  |
| 5              | 7/05-7/07 | 227                 | 0                  | 0.4551                             | 249   | 57  | 0              | 0.5159                                       | 0.0282 | 234   | 29 | 483  | 64  |
| 6              | 7/09-7/11 | 305                 | 0                  | 0.5006                             | 305   | 61  | 0              | 0.6822                                       | 0.0215 | 142   | 19 | 447  | 64  |
| 7              | 7/12-7/14 | 332                 | 0                  | 0.4795                             | 346   | 82  | 0              | 0.6667                                       | 0.0233 | 173   | 25 | 519  | 86  |
| 8              | 7/16-7/18 | 312                 | 0                  | 0.4584                             | 340   | 93  | 0              | 0.6518                                       | 0.0166 | 182   | 25 | 522  | 96  |
| 9              | 7/19-7/21 | 0                   | 0                  | 0.4607                             | 0   | 0   | 0              | 0.7572                                       | 0.0176 | 0   | 0  | 0  | 0   |
| 10             | 7/23-7/25 | 45                  | 0                  | 0.4607                             | 49  | 10  | 0              | 0.8109                                       | 0.0148 | 11  | 2  | 60   | 10  |
| 11             | 7/26-7/28 | 10                  | 0                  | 0.4607                             | 11  | 2   | 0              | 0.7869                                       | 0.0180 | 3   | 0  | 14   | 2   |
| 12             | 7/30-8/01 | 3                   | 0                  | 0.4607                             | 3   | 1   | 0              | -  | -      | 1   | 0  | 4  | 1   |
| Totals         |           | 1,618               | 834                | 213.8                              | 1,717   | 169 | 0              | 0.5850                                       | 0.0919 | 1,218   | 66 | 2,935  | 181 |

<sup>a</sup>Mean skein weight and sex ratio data unavailable. Mean skein weight and sex ratio data collected from the fish wheel harvest delivered to Galena- or Nulato-based processors substituted in the calculations of number of salmon removed.

<sup>b</sup>Calculations of the estimated number of female and male salmon removed when skein weight and/or sex ratio data were unavailable were based on the observed mean skein weight and/or proportion of females of the nearest adjacent period.

<sup>c</sup>Harvests include male salmon sold in the round, females used for roe extraction (assume no females were sold for flesh), and males discarded or not commercially utilized.