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# STEELHEAD *Oncorhynchus mykiss* CREEL CENSUS ON THE KLAWOCK RIVER, SOUTHEAST ALASKA, 1987-1988[1]

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ABSTRACT

Anglers were interviewed along the Klawock River between December 21, 1987 and June 19, 1988. Some 48% of the estimated 367 adult steelhead *Oncorhynchus mykiss* harvested were Klawock Lake Hatchery releases. Ninety percent of the anglers interviewed were residents of Prince of Wales Island and 88% of the angling effort was targeted on steelhead. The overall harvest rate was 0.10 steelhead per hour fished. Distinct fall and spring runs of steelhead were observed, with slack fishing occurring from February through mid-March. The peak fishing periods were from late December to mid-January and from late March to mid-April.

KEY WORDS: Southeast Alaska, Klawock River, Prince of Wales Island, steelhead, *Oncorhynchus mykiss*, recreational fishing, creel census, harvest.

## INTRODUCTION

Steelhead *Oncorhynchus mykiss* sport fishing effort and harvest are not thoroughly documented on Prince of Wales Island (PWI) in southern Southeast Alaska. Over 85 steelhead streams have been identified on the island, but the angling effort expended at any one location has not been previously determined via on-site creel census. The lack of such information, the need to manage specific steelhead systems, and a need to provide information on the PWI steelhead fishery to the public provided an impetus for a detailed fisherman creel census program on the island. The Klawock River was chosen because of these factors, plus the need to evaluate the contribution of the steelhead reared in the Klawock Lake Hatchery.

The local economy on PWI has been based primarily on the commercial fishing and timber industries for many years. As timber resources have declined in recent years, particularly on private lands, local businesses have looked toward increased tourism to take up the economic slack. Improvements are underway with regard to road condition and maintenance and to provide increased access to recreational fishing locations via trails and boat launches at the island's lakes.

Klawock River was chosen as the site to conduct an initial steelhead angler creel census program (Figure 1). Klawock River was known to be among the more heavily fished streams on the island. Its location on southwest PWI, near the island's largest communities of Craig and Klawock, coupled with good roadside access and an ongoing steelhead bio-enhancement program, made the Klawock River the preferred study stream.

The Klawock River is the outlet stream of Klawock Lake, PWI's largest impoundment. The stream measures 2.0 miles in length with an average width of about 120 ft. The Klawock River system supports coho *O. kisutch*, sockeye *O. nerka*, chum *O. keta*, and pink *O. gorbuscha* salmon, as well as cutthroat *O. clarki*, rainbow *O. mykiss*, and steelhead *O. mykiss* trout, and Dolly Varden char *Salvelinus malma*.

The Klawock River boasts both wild fall and spring runs of steelhead, as well as hatchery produced steelhead which return from the ocean as adults from October to June. The Klawock Lake Hatchery is located adjacent to upper Klawock River, just downstream from Klawock Lake. The hatchery has been operated by the Alaska Department of Fish and Game (ADF&G), Division of Fisheries Rehabilitation, Enhancement, and Development (F.R.E.D.) since 1978. From the steelhead program's inception at the Klawock Lake Hatchery (brood year 1979) through brood year 1986, hatchery steelhead releases into the Klawock River system have averaged approximately 21,000 smolt annually, with resultant projected adult returns averaging 600 fish per year.

The facility provides enhanced stocks of coho and sockeye salmon and steelhead, which are released as smolt or pre-smolt into the Klawock River system. Because of the steelhead enhancement in the Klawock River, sport fishermen are allowed a daily bag limit of two steelhead provided at least one has a clipped adipose fin (indicating hatchery origin), as evidenced by a healed scar. The daily bag limit is one steelhead in all other systems on PWI.

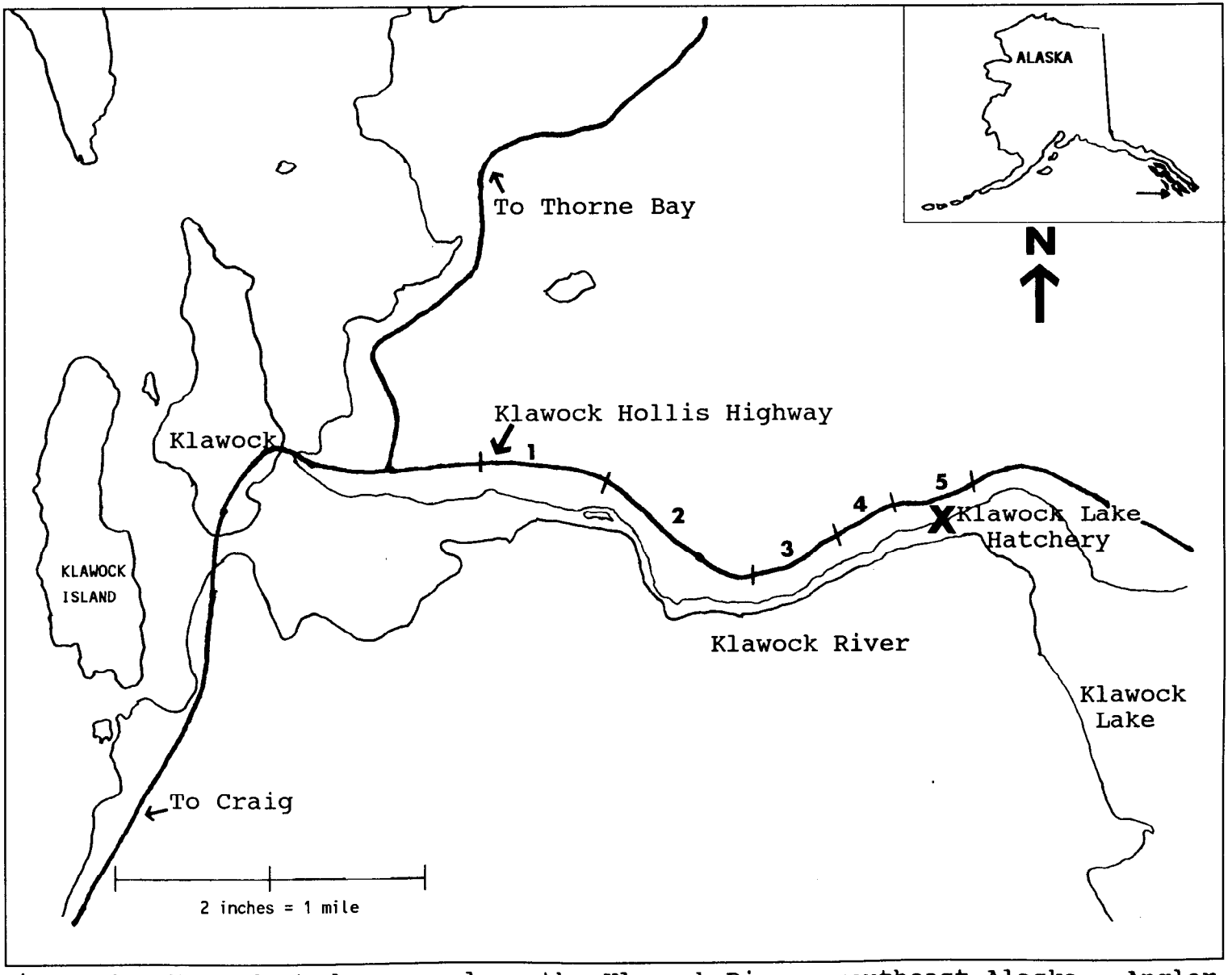


Figure 1. Map of study area along the Klawock River, southeast Alaska. Angler access areas are numbered above, and include the area between hash marks.

The objectives of this study were to:

1. Estimate the sport fishing effort for steelhead, harvest rates, and angler use patterns on the Klawock River by Prince of Wales Island resident and non-resident fishermen from December 21, 1987 through June 19, 1988.

2. Estimate the contribution of the Klawock Lake Hatchery steelhead program to the Klawock River steelhead sport fishery.

3. Determine the age structure of the Klawock River steelhead population.

## METHODS

The Klawock River steelhead creel census program was conducted from December 21, 1987 through June 19, 1988. The study period was subdivided into 13 bi-weekly strata (e.g., December 21-January 3). Within the bi-weekly strata, days were subdivided equally into weekday and weekend strata. Legal holidays were identified within the weekend strata. Additionally, each day was subdivided into early day and late day substrata. The sampling schedule was developed through incorporation of the following:

1. Within each week (i.e., Monday-Sunday), two weekend-holiday days were selected for sampling.

2. Two contiguous weekdays were randomly selected for "non-sampling" to provide weekly time off for staff. Two of the three remaining weekdays per week were randomly selected for sampling to ensure four days of sampling per week.

3. Throughout the study period, early day and late day substrata were alternated between sampling days.

4. One continuous sampling period occurred on each day selected for sampling. Daily sampling periods ranged from 4.0 to 6.75 hours per day, each corresponding to half the total daylight hours on a given day.

5. Within all bi-weekly strata, each of the five access areas was randomly selected for each sampling day.

A number of access areas situated along the Klawock-Hollis Highway provide for fisherman access to the Klawock River. The river was stratified into five distinct access areas which collectively encompassed the entire river length (Figure 1). River stratification was incorporated to ensure that the steelhead fishery was efficiently sampled.

Anglers were interviewed along the Klawock River after they had completed their fishing trip, generally upon returning to their vehicle. Each angler was asked a series of questions regarding their fishing trip to ascertain the following information: whether the fishing trip for the day was completed; guided/unguided; target species; terminal gear type used; hours fished (to the nearest half hour); number of fish of each species caught, kept, and/or released

(if any); and whether each steelhead caught had its adipose fin intact or clipped. Hatchery steelhead were distinguished by a clipped, healed adipose fin. Additionally, each angler was asked about their residency status. For the purpose of this study, a resident was an individual who currently resided on PWI but was not necessarily domiciled in Alaska for at least one year.

Standard age-weight-length (AWL) data were collected from each harvested steelhead which was sampled. Sampling was optional, based on angler cooperation. Because steelhead were the focus of this study, other species were not sampled. Consistent with ADF&G sport fishing regulations for the Klawock River, steelhead were distinguished from rainbow trout by length (i.e., steelhead exceeded 16 inches in total length). The length of each sampled steelhead was measured from mid-eye to the fork in the tail (MEFT), to the nearest millimeter (mm), using a cloth measuring tape. Weights were measured to the nearest pound using a Chatillon Model IN-12 spring-type hand scale. Cleaned and uncleaned steelhead weights were distinguished. Steelhead length and weight data collected were entered daily onto standard AWL forms, version 1.1, which were forwarded to RTS for computer data recording. Additionally, ten scales were collected from each steelhead sampled. Scale analysis for age composition was conducted by ADF&G Division of Commercial Fisheries staff in Ketchikan.

The head from each adipose fin-clipped steelhead encountered during the study was retained and identified with a uniquely numbered cinch tag. Pertinent biological and angler data for each fish were recorded on coded wire tag recovery forms. Heads and relevant recovery information were sent to the tag recovery laboratory operated by the F.R.E.D. Division in Juneau. Tags were then removed, decoded, and recovery information was entered into the tag lab's data base.

Data Analysis

The following equations were used for estimating the harvest and effort for the direct expansion completed-trip interview creel survey. These equations are valid for both the case when all completed trip anglers leaving the fishery are interviewed and the case when some anglers are missed (note: all completed trip anglers in the area and time stratum being sampled need to be counted). The first step involves the estimation of angler effort:

$\hat{E}_h$ = estimated angler-hours in the $h^{th}$ stratum of the fishery

$$= R_h \, (e_{h..} \div r_{h.}) \qquad [1]$$

$h$ = subscript denoting stratum (as defined by the combination of seasonal period, type of fishing day [i.e., weekday, weekend-holiday], and time-of-day [i.e., early versus late day]).

$R_h$ = total number of hours (available for fishing) in the $h^{th}$ stratum

$e_{h..}$ = total effort in hours expended by anglers interviewed within the $h^{th}$ stratum

$$= \sum_{i=1}^{n_h} \hat{e}_{hi\cdot} \qquad [2]$$

$i$ = subscript denoting period sampled within the $h^{th}$ stratum

$n_h$ = number of samples collected within the $h^{th}$ stratum

$\hat{e}_{hi\cdot}$ = estimated effort for the $i^{th}$ sample within the $h^{th}$ stratum

$$= O_i \bar{e}_{hi\cdot} \qquad [3]$$

$O_i$ = number of anglers counted in the $i^{th}$ sample within the $h^{th}$ stratum (including interviewed anglers and "missed" anglers)

$$= o_i + p_i \qquad [4]$$

$o_i$ = number of anglers interviewed during the $i^{th}$ sample

$p_i$ = number of anglers not interviewed (i.e., "missed") during the $i^{th}$ sample

$$\bar{e}_{hi\cdot} = \sum_{j=1}^{o_i} (e_{hij}) \div o_i \qquad [5]$$

$j$ = subscript denoting the angler interviewed during the $i^{th}$ period within the $h^{th}$ stratum

$e_{hij}$ = effort (in angler-hours) of the $j^{th}$ angler interviewed in the $i^{th}$ sample in the $h^{th}$ stratum

$r_{h\cdot}$ = total number of hours sampled in the $h^{th}$ stratum

$$= \sum_{i=1}^{n_h} r_{hi} \qquad [6]$$

$r_{hi}$ = hours sampled during the $i^{th}$ sample in the $h^{th}$ stratum

$\hat{V}_h(\hat{E}_h)$ = the variance estimate for the estimate of $E_h$, obtained by the standard formula for the estimation of the variance of a product of a constant and a variance of a random variable (Lehmann 1975, equation A.19, page 330)

$$= R_h^2 \hat{V}(e_{h\cdot\cdot} \div r_{h\cdot}) \qquad [7]$$

$\hat{V}(e_{h..} \div r_{h.})$ = the variance estimate for the effort rate (i.e., the ratio of $e_{h..}$ to $r_{h.}$), which is estimated approximately by the standard formula for the variance of the ratio of random variables (Jessen, 1978, equation 5.8, page 128, omitting the finite population correction factor)

$$\approx \{ (\bar{e}_{h..}) \div (\bar{r}_{h.}) \}^2 \{ (s_e^2 \div (\bar{e}_{h..})^2) + (s_r^2 \div (\bar{r}_{h.})^2) - [(2 \text{ cov}(e,r)) \div (\bar{e}_{h..}\bar{r}_{h.})] \} \quad [8]$$

$\bar{e}_{h..}$ = mean effort (in angler-hours) for the $n_h$ samples in the $h^{th}$ stratum

$$= e_{h..} \div n_h \quad [9]$$

$\bar{r}_{h.}$ = mean hours sampled for the $n_h$ samples in the $h^{th}$ stratum

$$= r_{h.} \div n_h \quad [10]$$

$s_e^2$ = variance estimate associated with estimating the effort component of the effort rate

$$= \{[(R_h - r_h) \div R_h][s^2_{B_e} \div n_h]\} + \{[r_h \div (R_h n_h)][s^2_{W_e} \div n_h]\} \quad [11]$$

$s^2_{B_e}$ = the between sample variance for effort

$$= \sum_{i=1}^{n_h} (e_{hi} - \bar{e}_{h..})^2 \div (n_h - 1) \quad [12]$$

$s^2_{W_e}$ = the within sample (between angler) variance for effort

$$= \sum_{i=1}^{n_h} \{[(O_i - o_i) \div O_i][O_i^2][1 \div o_i][\sum_{j=1}^{o_i} (e_{hij} - \bar{e}_{hi.})^2 \div (o_i - )]\} \quad [13]$$

$s_r^2$ = variance estimate associated with estimating the hours sampled component of the effort rate

$$= [(R_h - r_h) \div (R_h n_h)][\sum_{n=1}^{n_h} (r_{hi} - \bar{r}_{h.})^2 \div (n_h - 1)] \quad [14]$$

$\text{cov}(e,r)$ = covariance estimate between the effort and hours sampled components of the effort rate estimate

$$= [(R_h - r_h) \div (R_h n_h)][\sum_{i=1}^{n_h} [(\hat{e}_{hi\cdot} - \bar{e}_{h\cdot})(r_{hi} - \bar{r}_{h\cdot})] \div nh - 1)] \quad [15]$$

The final step in estimating the effort for the entire season involves combining the stratum estimates:

$\hat{E}$ = overall estimated effort

$$= \sum_{h=117}^{q} (E_h) \quad [16]$$

$q$ = number of strata

$\hat{V}(\hat{E})$ = estimated variance of E, assuming independence of the stratum estimates

$$= \sum_{h=1}^{q} (\hat{V}_h(\hat{E}_h)) \quad [17]$$

Harvest is estimated similarly by substituting the corresponding catch statistics in place of the effort statistics into equations 1-17 above.

Note that the approach as presented above, for variance estimation, is valid for a simple stratified random sampling design with only one stage of sample selection. Our use of this approach is not entirely correct, in that selection of time to sample (within a unique combination of stratum definitions) was not a simple random process; and the location to sample within access location stratum represents a second stage of sampling. Due to the complexities of the sample allocation process and due to the limitations of sampling density, we are not able to estimate the variance for the second stage (i.e., by using squared differences between sample means and means by location [and/or sample period]). However, the use of a single-stage sampling approach is conservative in that the resulting variance estimates will be larger than if a multi-stage estimator could be applied.

The contributions of hatchery steelhead to the Klawock River sport fishery were estimated according to the procedures outlined in Clark and Bernard (1987; equations 10 and 15, pages 22 and 24, respectively). Estimates were obtained separately as defined above. The overall contribution estimate and its related variance was calculated by summing the stratum estimates.

The contribution of hatchery steelhead to the Klawock River sport fishery was estimated by using estimates for the number of adipose fin-clipped steelhead

kept and for all steelhead kept. Standard procedures were used to calculate mean length and weight of harvested steelhead which were sampled.

Catch per unit effort (CPUE) in number of fish caught per angler hour was calculated for steelhead harvested and steelhead caught (i.e., kept plus released) by anglers who targeted on steelhead. Biweekly and seasonal steelhead angler hour and catch estimates for completed angler trips were used for these estimates.

Terminal gear types used by anglers were classified into four categories: spinners and spoons; flies; bait; and artificials. The percent use of each type was calculated from all completed trip and incomplete trip interviews for anglers who targeted on steelhead.

## RESULTS

During the study period, sport fishing effort on the Klawock River was primarily targeted toward steelhead. The total estimate for the Klawock River sport fishery from December 21, 1987 to June 19, 1988 was 4,217 angler-hours, with 95% confidence intervals (C.I.) from 2,787 to 5,645. An estimated 88% or 3,711 of the total angler-hours was targeted on steelhead, with 95% C.I. from 2,229 to 5,121 hours. The remaining 12% (506 angler-hours) was targeted on cutthroat and rainbow trout. Estimated biweekly angling effort during the study period is displayed in Figure 2. Based on angler interviews, all fishing effort which occurred on the Klawock River from program inception (i.e., December 21, 1987) through April 10, 1988 was directed toward steelhead. Peak steelhead angling effort occurred from January through mid-February and from mid-April through early May. From mid-May through June 19, the angling effort primarily targeted on cutthroat and rainbow trout.

Ninety percent of anglers interviewed were PWI residents, whereas the remaining ten percent of anglers interviewed were non-residents. The majority of non-residents were encountered from March to June.

An estimated 367 steelhead were harvested from the Klawock River sport fishery from Dececember 21, 1987 to June 19, 1988, with 95% C.I. from 110 to 623. Of that total, an estimated 177 fish (48%) were hatchery produced and 190 fish (52%) were wild.

The total estimate for steelhead released during the study period was 384 fish (273 hatchery, 111 wild), with 95% C.I. from 34 to 803. A summary of the total estimated angler effort and catch estimates is shown in Table 1.

Biweekly steelhead harvest rates ranged from 0 to 0.24 fish per hour, with an overall harvest rate of 0.10 steelhead per hour fished (95% C.I. from .05 to .12) (Figure 3). Peak harvest rates occurred from late December to mid-January and from late March to mid-April. Biweekly total steelhead catch estimates ranged from 0 to 0.71 fish per hour fished, with 0.20 steelhead caught per hour fished overall (95% C.I. from .06 to .28). Biweekly steelhead catch and release estimates are displayed in Figure 4.

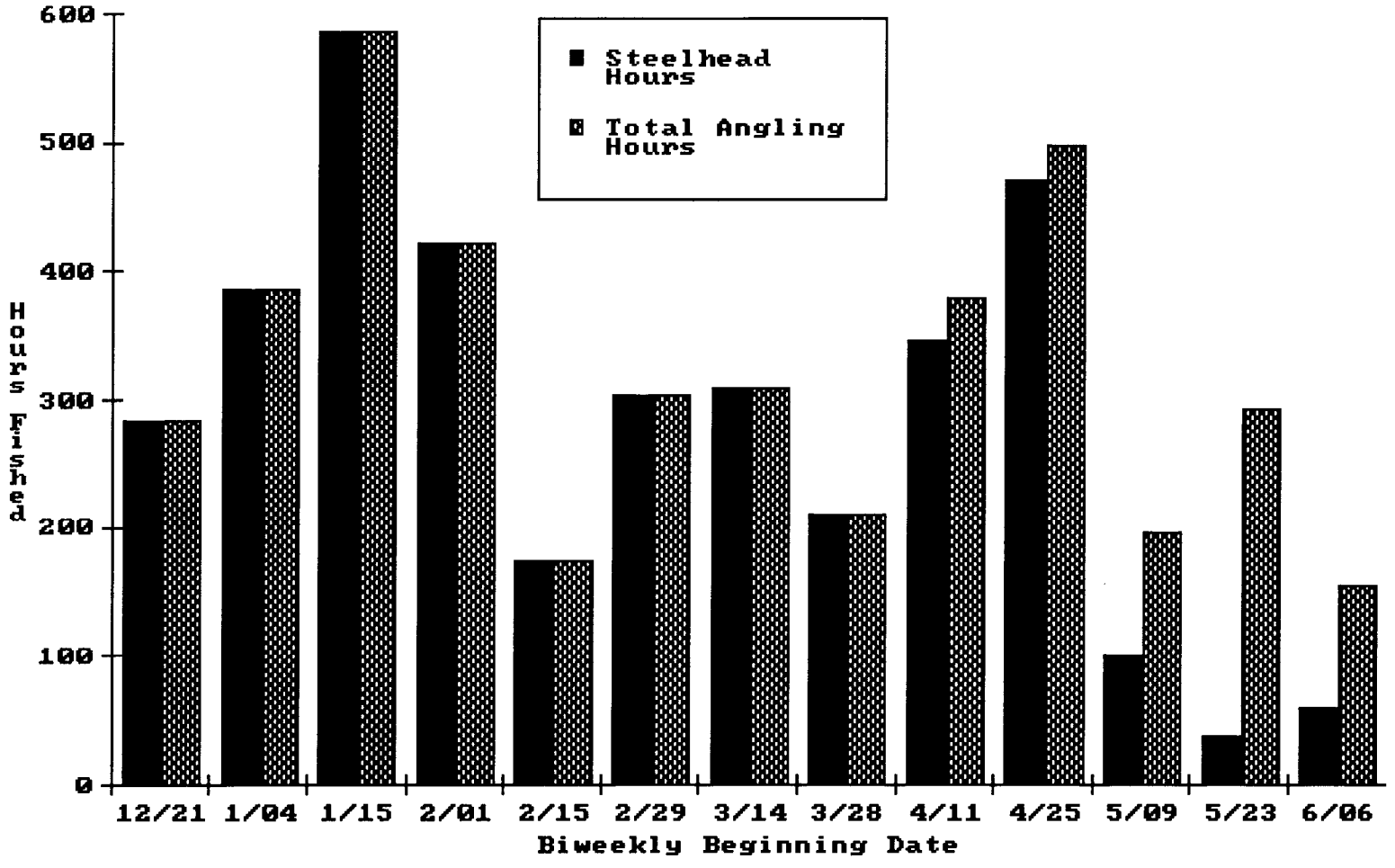


Figure 2. Estimated total biweekly sport fishing effort on the Klawock River from December 21, 1987 to June 19, 1988.

Table 1. Sport fishing effort and catch estimates on the Klawock River from December 21, 1987 through June 19, 1988.

| | 95% C.I. Lower Limit (Approx.) | Estimate | 95% C.I. Upper Limit (Approx.) |
|---|---|---|---|
| Angler Hours | 2,787 | 4,217 | 5,645 |
| Steelhead Hours | 2,229 | 3,711 | 5,121 |
| Salmon Hours | 0 | 0 | 0 |
| Cutthroat/Rainbow Trout Hours | 238 | 506 | 774 |
| All Steelhead Kept | 110 | 367 | 623 |
| Hatchery (clipped) | 9 | 177 | 373 |
| Wild (not clipped) | 63 | 190 | 317 |
| All Steelhead Released | 34 | 384 | 803 |
| Hatchery (clipped) | 29 | 273 | 622 |
| Wild (not clipped) | 6 | 111 | 215 |
| Coho Salmon Kept | 1 | 10 | 30 |
| Coho Salmon Released | 2 | 20 | 57 |
| Cutthroat Trout Kept | 4 | 48 | 140 |
| Cutthroat Trout Released | 14 | 204 | 431 |
| Rainbow Trout Kept | 5 | 128 | 269 |
| Rainbow Trout Released | 1,391 | 3,087 | 4,784 |
| Dolly Varden Char Kept | 7 | 159 | 357 |
| Dolly Varden Char Released | 20 | 444 | 991 |

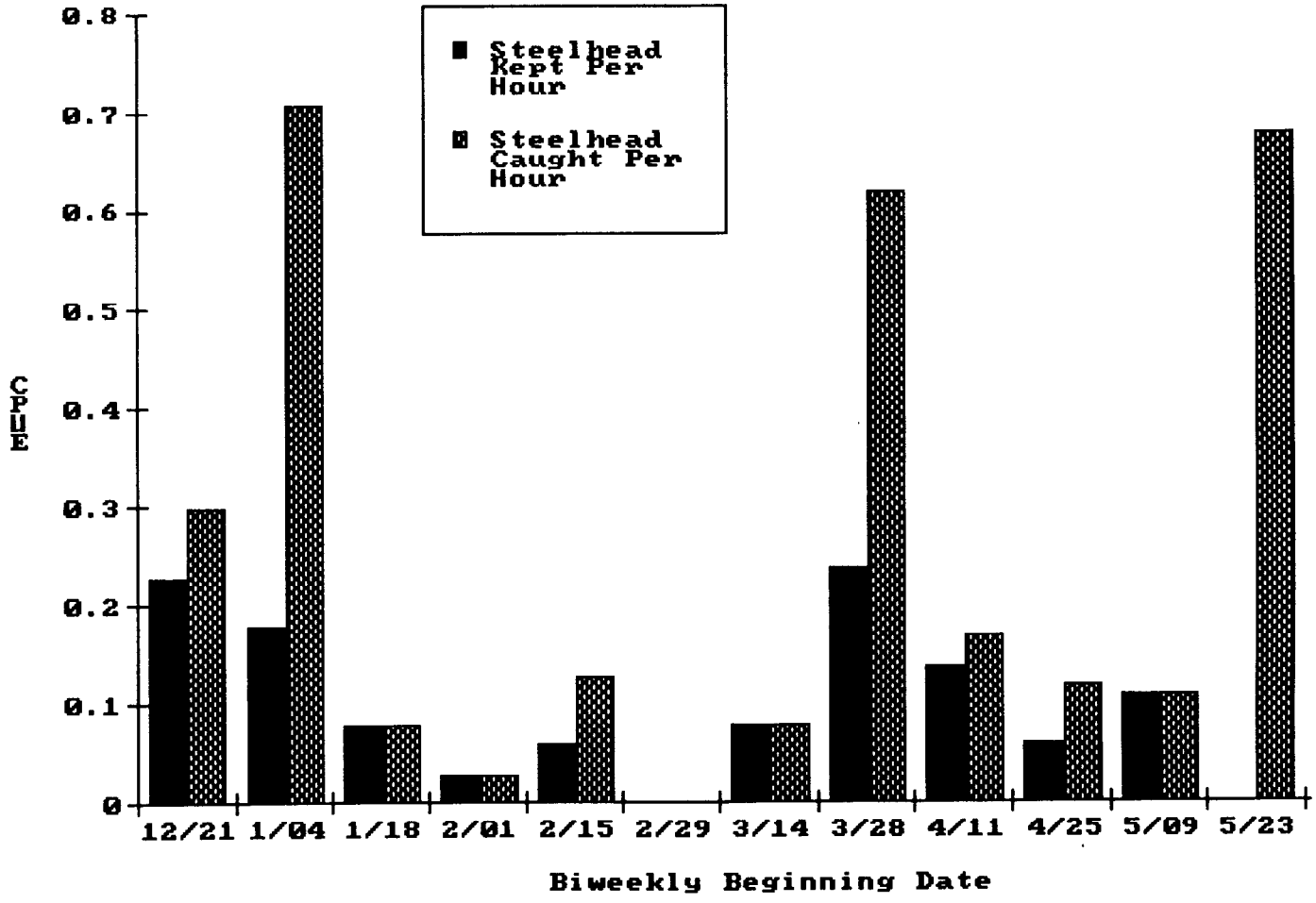


Figure 3. Biweekly estimates for rates of steelhead harvest and total catch per unit effort (CPUE) for steelhead anglers along the Klawock River from December 21, 1987 to June 19, 1988.

Seventy percent of the steelhead anglers used bait (i.e., salmon eggs). Other types of gear used, in descending order of use, included: spinners/spoons (18%); artificials (7%); and flies (5%) (Figure 5).

The total sport catch estimates for other species during the study period were: 30 coho salmon (10 kept); 252 cutthroat trout (48 kept); 3,215 rainbow trout (128 kept); and 603 Dolly Varden char (159 kept) (Table 1).

Scale analysis was successful for 33 steelhead (18 hatchery, 15 wild) which were sampled from the Klawock River sport fishery. Nine age classes, ranging from age 1.2 to 5.3 (i.e., 3 to 8 years old), were found among sampled fish (Table 1). Five of those steelhead (i.e., 15%) were repeat spawners. Wild steelhead resided in freshwater for two to five years (average 3.4 years) and in saltwater for two or three years (average 2.7 years). Hatchery steelhead resided in freshwater for one year and in saltwater for two or three years (average 2.6 years). Sampled steelhead averaged just under 8 lb. in weight; wild fish outweighed hatchery fish by less than 1 lb. on the average (Table 2).

## DISCUSSION

Winter sport fishing effort on the Klawock River appeared to correspond in part to seasonal employment patterns. Logging shutdowns and reduced commercial fishing opportunities from late December through mid-February correlated with peak steelhead fishing effort. Relatively low steelhead CPUE from mid-January through mid-February did not seem to discourage anglers during that time period. The second peak in steelhead angling effort, from mid-April through early May, corresponded more closely with the presence of steelhead.

Distinct fall and spring steelhead runs in the Klawock River were identified and supported by catch and harvest numbers as well as steelhead CPUE. February through mid-March marked a transition or "lull" between fall and spring runs (Figures 3 and 5). Fresh steelhead were last observed in the Klawock River in early May. Steelhead fishing dropped off thereafter and was effectively over by late May.

The estimated number of steelhead caught then released during biweekly periods beginning January 4 and May 23 appeared to be high (Figures 3 and 4). One angler's catch of eight steelhead (two kept, six released) in 3 hours of fishing accounted for the high estimate for the January 4-14 period. One steelhead was caught and released during the period May 23-June 4, when very low angling effort targeted on steelhead. Thus, total seasonal estimates for number of steelhead caught, steelhead caught per hour, and the number released (hatchery and wild) were presumed high (Figures 4 and 5). Estimates for steelhead kept and CPUE as displayed in Figures 3 and 5 appear consistent with observed sport catches.

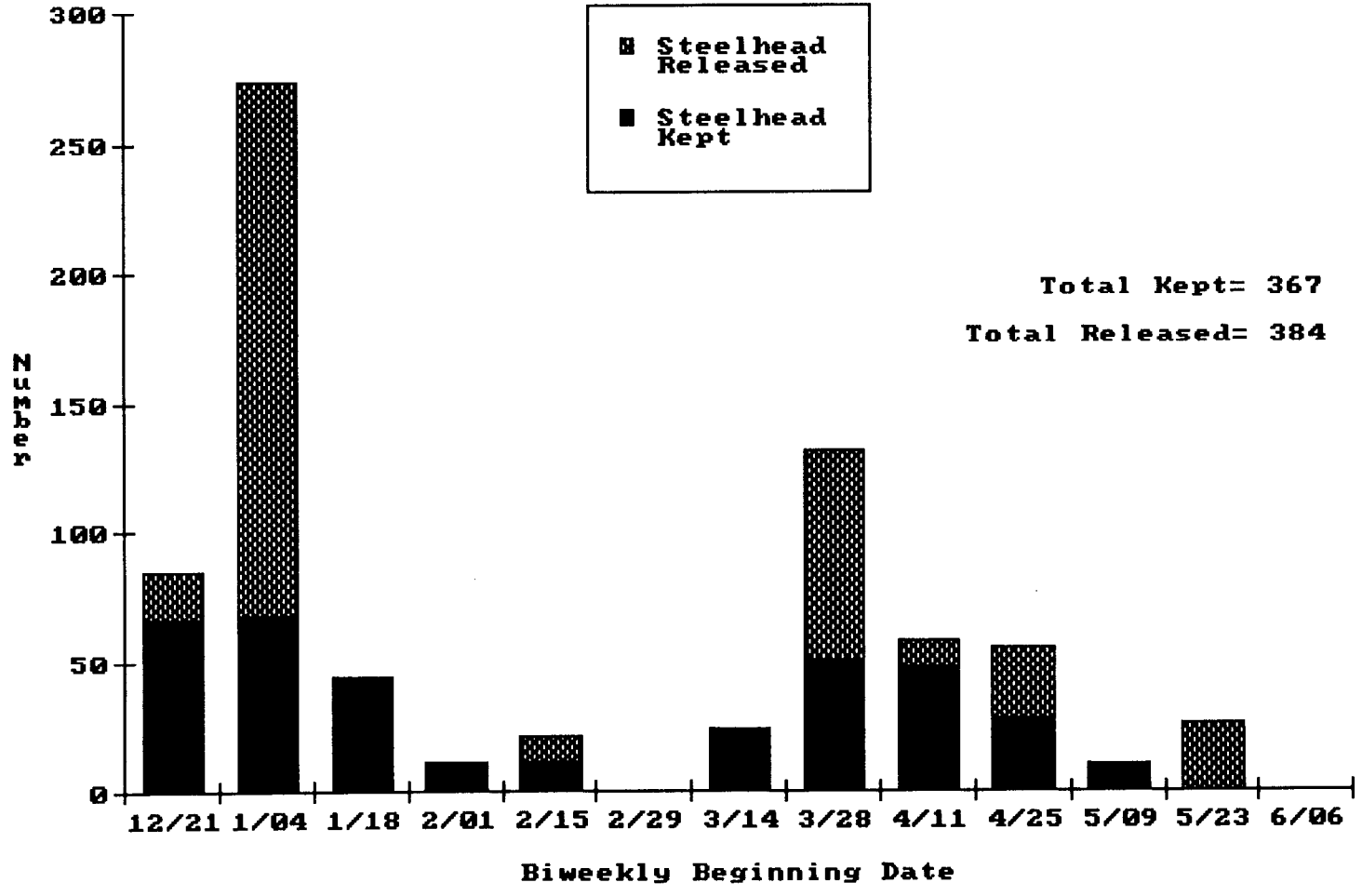


Figure 4. Steelhead biweekly catch and release estimates for the Klawock River sport fishery, between December 21, 1987 and June 19, 1988.

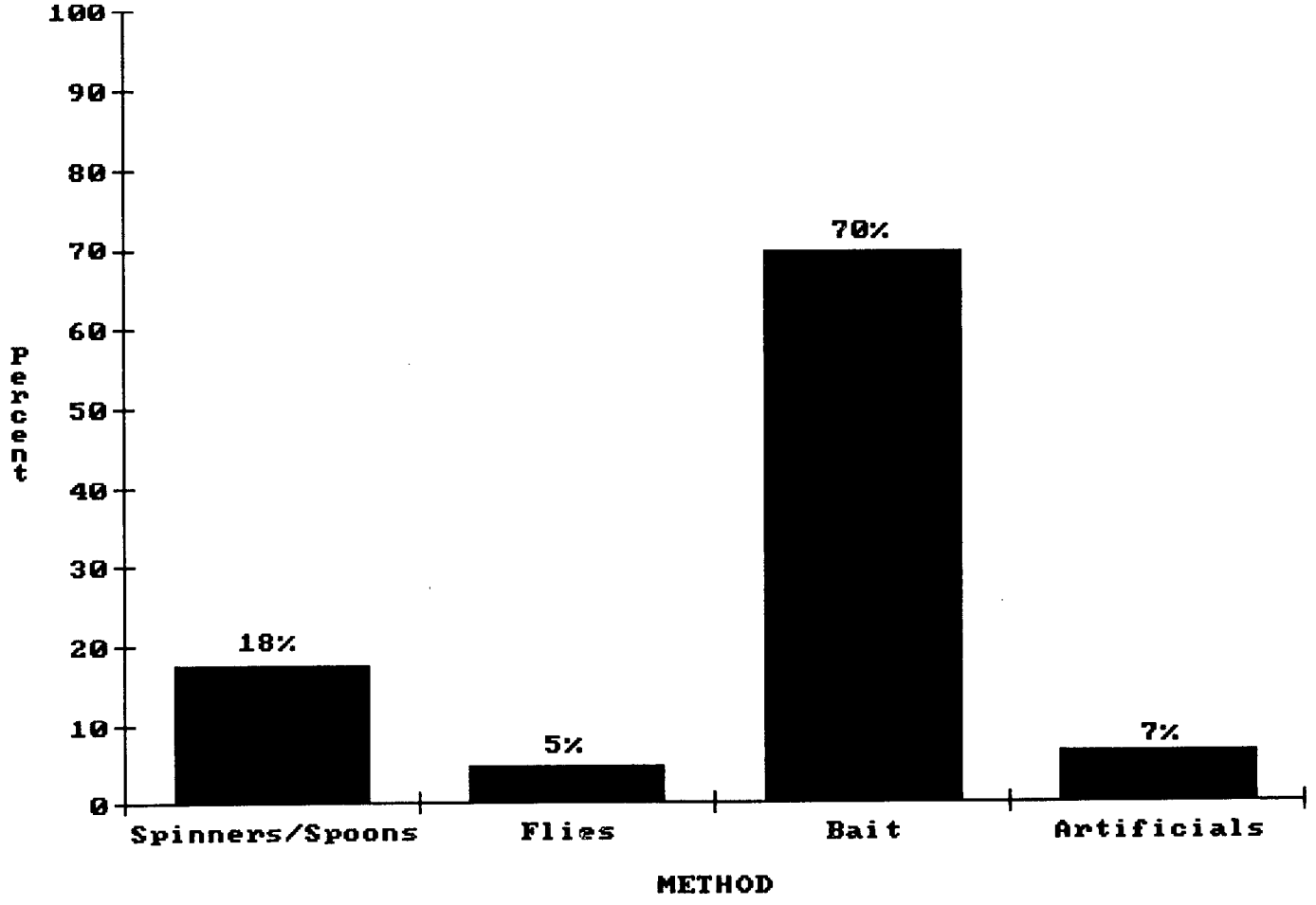


Figure 5. Terminal gear types used by Klawock River steelhead anglers interviewed in winter/spring 1987-1988.

Table 2. Age and length of steelhead sampled during the Klawock River creel census, 1987-88.

| Age | Number of fish | Number of Hatchery Fish | Length (mm) (Range) |
|---|---|---|---|
| 1.2 | 7 | 7 | 512-598 |
| 1.3 | 11 | 11 | 641-778 |
| 2.2 | 1 | 0 | 622 (only) |
| 2.3 | 2 | 0 | 682-732 |
| 3.2 | 1 | 0 | 561 (only) |
| 3.3 | 3 | 0 | 660-718 |
| 4.2 | 2 | 0 | 613-646 |
| 4.3 | 5 | 0 | 667-775 |
| 5.3 | 1 | 0 | 631 (only) |
| TOTAL | 33 | 18 | |

Table 3. Summary of average weights of steelhead harvested by anglers from the Klawock River between December 1987 and June 1988.

| | Average Weight (lb.) | | | |
|---|---|---|---|---|
| | Uncleaned | n | Cleaned | n |
| Total average weight | 8.1 (2.4)[1] | 22 | 5.5 (1.6) | 11 |
| Hatchery | 7.8 (2.8) | 12 | 5.0 (1.8) | 6 |
| Wild | 8.5 (1.9) | 10 | 6.2 (1.1) | 5 |

[1] Standard deviation in parentheses

Estimates for steelhead harvested from the Klawock River based on results of the Alaska Statewide Sport Fisheries Harvest Report were; 565 in 1987, 404 in 1986, and an average of 254 from 1982 to 1987 (Mills 1987). The estimated steelhead harvest of 367 (95% C.I. from 110 to 623) during this study period appears consistent with the published results of that statewide report.

Hatchery produced steelhead were released as smolts at the end of their first year. Though wild adult steelhead sampled were over two years older on average (i.e., primarily freshwater residence), adult hatchery fish sampled were not substantially smaller. This would indicate successful ocean rearing for two to three years for hatchery fish, which was the same ocean residence observed for wild steelhead. Fish length appeared to be related to years of saltwater residence: 2-ocean steelhead were longer than 3-ocean fish (Table 1). All age 4.3 and age 5.3 wild steelhead sampled were caught from April 12 to 29. These fish, which averaged over 9 lb. in weight, represented six of seven steelhead sampled during the same period of time. This may indicate presence of a later run of older, larger wild steelhead which return to freshwater in April.

Estimates for rainbow trout caught and released were excessively high (Table 1). The highest catches of rainbow trout occurred from late May to early June. This corresponded to peak coho salmon and steelhead smolt out-migrations as concluded following a F.R.E.D. Division smolt out-migrant study on the Klawock River in 1988. Since released rainbows were not identified by creel census personnel, it was assumed most all rainbows released were actually coho salmon and steelhead smolt. Catch estimates for rainbow trout kept and for other species appeared consistent with creel census observations.

## ACKNOWLEDGEMENTS

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## LITERATURE CITED

Clark, J.E., and D.R. Bernard. 1987. A compound multivariate binomial-hypergeometric distribution describing coded microwire tag recovery from commercial salmon catches in southeastern Alaska. Alaska Department of Fish and Game, Informational Leaflet, Number 261, Juneau.

Jessen, R.J. 1978. Statistical Survey Techniques. John Wiley and Sons, New York.

Lehmann, E.L. 1975. Non parametrics. Statistical methods based on ranks. Holden-Day, Inc., San Francisco.

Mills, M.M. 1987. Alaska Statewide Sport Fisheries Harvest Report. Alaska Department of Fish and Game, Fishery Data Series Number 2, Juneau.