Results of the Chinook Assessment Study Conducted on the Klinaklini River During 1999

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by

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ABSTRACT

Diewert, R.E., J.C. Sturhahn, and D.A. Nagtegaal. 2001. Results of the chinook assessment study conducted on the Klinaklini River during 1999. Can. Manuscr. Rep. Fish. Aquat. Sci. 2580: 45 p.

In 1999, the Biological Sciences Branch, Pacific Biological Station, continued a study of chinook salmon (*Oncorhynchus tshawytscha*) productivity in the Klinaklini River. Major components of this study included: i) enumeration of spawners, ii) collection of biological and environmental information, and iii) evaluation of a fishwheel as a stock assessment tool. Population estimates for chinook and all other salmon species encountered at the fishwheel were derived from fishwheel catch efficiencies determined by a tagging study. The total return of adult chinook to the Klinaklini River system was estimated to be 11,068 fish (95% CL: 5,031 – 17,105), the largest escapement since the study began in 1997. The majority of the spawners were aged as four and five year olds and approximately 87% showed a stream type life history. The total return of coho (*O. kitsutch*) was estimated to be 10,380 fish the majority of which (92.9%) were 2 year olds. Other species estimates included 1,802 sockeye (*O. nerka*) and 306 pink (*O. gorbuscha*) salmon. No estimate was possible for chum (*O. keta*) as there were no tags recaptured at the fishwheel. A total of 43 tagged chinook and 5 tagged coho were observed at the Mussel Creek fence representing 6.8% and 2.0% of the chinook and coho tagged at the fishwheel, respectively. Based on these ratios, a minimum of 879 adult chinook and 546 adult coho spawned in Mussel Creek in 1999.

RÉSUMÉ

Diewert, R.E., J.C. Sturhahn, and D.A. Nagtegaal. 2001. Results of the chinook assessment study conducted on the Klinaklini River during 1999. Can. Manuscr. Rep. Fish. Aquat. Sci. 2580: 45 p.

En 1999, la Direction des sciences biologiques de la Station biologique du Pacifique a poursuivi son étude de la productivité des stocks de saumons quinnats (*Oncorhynchus tshawytscha*) de la rivière Klinaklini. Cette étude comprenait trois grands volets : i) dénombrement des reproducteurs; ii) collecte de données biologiques et hydrographiques; iii) évaluation de l'efficacité du tourniquet installé à cet endroit comme moyen de recensement des stocks. Les chiffres de population concernant les quinnats et les autres espèces de saumons rencontrées au site du tourniquet ont été établis en fonction des résultats du programme de marquage-recapture. L'effectif de remonte des saumons quinnats dans le bassin de la rivière Klinaklini a été établi à 11,068 (TC 95% : 5,031 – 17,105), le plus haut taux d'échappement depuis le début de l'étude ayant été enregistré en 1997. La plupart des géniteurs étaient âgés de quatre à cinq ans, et environ 87%

étaient de type « dulcitrophiques ». L'effectif de remonte total des stocks de cohos (*O. kitsutch*) a été établi à 10,380, la majorité (92.9%) étant des sujets de deux ans. Parmi les autres espèces observées, ont a compté 1,802 saumons rouges (*O. nerka*) et 306 saumons roses (*O. gorbuscha*). Aucun chiffre n'a pu être établi pour le saumon kéta (*O. keta*) du fait qu'aucune étiquette n'a été récupérée au site du tourniquet. Un total de 43 saumons quinnats étiquetés et de 5 saumons cohos étiquetés a été observé à la barrière de comptage de Mussel Creek, soit 6.8% et 2.0% respectivement des sujets étiquetés au site du tourniquet, indiquant qu'au moins 879 quinnats et 546 cohos ont atteint les frayères de Mussel Creek en 1999.

INTRODUCTION

The Strait of Johnstone gives passage to several Canadian stock groupings of chinook salmon (*Oncorhynchus tshawytscha*). Various factors allow differentiation between stocks including run timing of spawning migration, ocean distribution of catch, and age at maturity. Chinook from the Fraser River above Hope, B.C. have a spring or summer spawning migration and range to the far north where they are caught primarily in Alaskan and northern B.C fisheries. Lower Fraser River chinook exhibit a fall spawning migration and are mainly white-fleshed fish from the Harrison River system. These fish are caught in the Strait of Georgia and off the west coast of Vancouver Island. The upper Strait of Georgia stock also has a fall spawning migration but ranges to the far north and has older ages at maturity than the Harrison or lower Strait stocks. Lower Strait of Georgia chinook have a late summer/fall spawning migration, a more restricted northward distribution, and mature at a younger age.

Chinook stocks are invaluable to both commercial and recreational fisheries of the Pacific northwest (Collicut and Shardlow, 1995). In spite of protective measures, the numbers of chinook salmon have continued to decline. This continued trend has resulted in the recent addition of chinook to the list of threatened and endangered species in the United States (Waples 1991). The problem of declining stocks is similarly serious on the West Coast of Canada, and has potential ramifications regarding the sustainability of British Columbia's fishing industry (Argue et al. 1983). In an effort to raise overall chinook populations to historical levels, a chinook rebuilding plan was initiated in 1985 through the Pacific Salmon Treaty between the United States and Canada (TCCHINOOK 87-4). This plan established a mandate requiring both parties to stop the decline in escapements to naturally-spawning chinook stocks and attain escapement goals in selected lower Strait of Georgia (Cowichan, Nanaimo, Squamish) and upper Strait of Georgia (Klinaklini, Kakweiken, Nimpkish, Wakeman, and Kingcome) indicator stocks. In addition, various "key streams" were selected to represent the overall status of chinook bearing streams along the B.C. coast. These keystreams (Robertson, Quinsam/Campbell, Kitsumkalem, Harrison, Big Qualicum) provide ongoing information to fisheries managers including accurate estimates of escapement and estimates of the relative contribution of hatchery and naturally reared production to these stocks. The lack of representation of central coast chinook stocks stimulated interest in conducting an ongoing assessment program in the Klinaklini River system at the head on Knight Inlet.

Salmonid enumeration studies have been conducted on the lower Klinaklini watershed since 1949. These evaluations consisted initially of stream walks and overflight counts of the few clear streams in a largely clouded glacial system. Clear tributaries include Mussel Creek (gazetted as Devereux Creek), Icy, Dice, and Jump creeks. All five salmonid species are supported by the Klinaklini system as well as steelhead (*O. mykiss*), cutthroat trout (*O. clarki*), Dolly Varden char (*Salvelinus malma*), bull trout (*S. confluentus*), mountain whitefish (*Prosopium williamsoni*), prickly sculpin (*Cottus asper*), redside shiner (*Richardsonius balteatus*), longnose sucker (*Catostomus catostomus*), and lamprey ammocetes (Rimmer and Axford 1990). It is believed that there are three chinook runs to the Klinaklini system based on migration timing (Berry 1991). As part of environmental impact assessments conducted by Interfor, Mike Berry[1] has collected and documented a considerable amount of anecdotal information concerning salmonid populations within the Klinaklini watershed.

In 1981, the Department of Fisheries and Oceans began a study to determine the viability of building salmonid enhancement facilities on Mussel Creek, which joins the Klinaklini River 8 km from the mouth. Aquatic Resources Ltd. conducted spawning studies and collected baseline information for pink (*O. gorbuscha*), chum (*O. keta*), sockeye (*O. nerka*), coho (*O. kisutch*) and chinook from Glendale Creek, the Ahnuhati River, the Klinaklini River, and Tom Browne Creek (Fielden and Slaney 1982). E.V.S. Consultants (Whelen and Morgan 1984) continued this work in 1983. Throughout this period, physical data, including water temperature, relative level and quality, population biological characteristics, and spawning habitat biophysical characteristics were collected.

Preliminary surveys of juvenile salmonid habitat utilization and evaluations of potential rearing area were completed on all study watercourses (Fielden et al. 1985). Other enhancement plans were considered for Knight Inlet with the goal of increasing salmonid production in the area. These included a pink spawning channel at Glendale Creek, a chum/pink spawning channel on the Ahnuhati River, juvenile chinook and coho outplanting to the Ahnuhati and Klinaklini rivers, and coho outplanting to Tom Browne and Glendale creeks.

As a result of this work, a pilot enhancement facility was built on Mussel Creek in 1985 and chinook and coho broodstock were collected. Approximately 265,000 chinook eggs were incubated of which 63% were released as coded-wire tagged fry and 24% as 4 to 5 g tagged smolts. For various reasons the facility was dismantled the following year. A total of five coded-wire tagged chinook were recovered from 1987-1989, three from Alaskan fisheries and two from northern BC sport and troll fisheries.

Renewed interest by FOC in 1997 resulted in a further and ongoing stock assessment study on the Klinaklini system. A fishwheel was constructed for use in the Klinaklini River to capture, tag, and sample chinook salmon and to evaluate overall escapement. Fishwheels have been used as an effective means for capturing live salmon in BC rivers since the late 1870's. Fishwheels were used up until the mid 1930's when excessive catch threatened the livelihood of those involved in traditional net fisheries. As a result of successful lobbying by the net fishers in 1934, fishwheels were banned from operating in BC; however, fishwheels have recently been developed as an assessment tool for fisheries managers and biologists (Link and English 1994). This report presents the results of the third year of this study with objectives including:

1. continued evaluation of the suitability of using a fishwheel to index the abundance and timing of chinook, coho, chum, pink, and sockeye returns to the Klinaklini system,
2. estimation of the total escapement of chinook and coho to the Klinaklini system,
3. collection of biological data for all salmonids, and

[1] Alby Systems Ltd., P.O. Box 71, Alert Bay, B.C. V0N-1A0

4. recording environmental information.

METHODOLOGY

STUDY AREA

Knight Inlet is a mainland fjord located approximately 220 km north of Vancouver on the British Columbia coast. The inlet extends inland from the Strait of Johnstone for approximately 120 km (Figure 1). The fjord itself is steep sided and averages 3 km in width with depths to 530 m. The Knight Inlet watershed is bounded by mountains on either side and receives runoff from a 7,800 km^2 area.

The Klinaklini River is the largest river system in the Mainland Coast Planning unit and is composed of the east and west arms which meet at a confluence 25 km upstream from the estuary. The west Klinaklini is a fairly short river section, which is fed directly by the Klinaklini glacier. The east Klinaklini passes through a canyon area and then extends into the B.C. interior. An extremely braided channel containing a multitude of sand and gravel bars, meanders, oxbows and side channels characterizes the lower 30 km section of the system. The Klinaklini River is a cold, glacial system and is the main contributor of glacial flour to Knight Inlet.

Mussel Creek (gazetted as Devereux Creek) is a clearwater stream, which joins the Klinaklini River approximately 8 km from the mouth (Figure 2). Draining a watershed of 74 km^2, the creek is 19 km long and is stabilized by a series of lakes. A section of rapids below Devereux Lake drops 120 m over a distance of 1.75 km and constitutes a potential migration barrier some species of salmon (Rimmer and Axford 1990). The lower reaches of the creek yield a gentle gradient with shallow runs connecting deeper pools where salmon typically hold before moving upstream to the spawning grounds. Mussel Creek is quite overgrown except for the lower section, which offers good overhead visibility and has been used for aerial enumeration purposes.

Mussel Creek and the lower Klinaklini River are accessed by logging roads, which are maintained in excellent condition, as they are the main lines for an active logging operation. International Forest Products operates a logging camp (Wahkash Contracting) along a side-channel of the Klinaklini River that is situated 4 km upstream from the estuary. The camp has a bunkhouse, several panabode homes, cookhouse, communication facilities (satellite phone), and a large workshop. Access to the camp is primarily by floatplane from Campbell River.

FISHWHEEL

Design

The fishwheel designed for use on the Klinaklini system is similar to the fishwheels that have been used on the Yukon, Taku and Nass rivers in recent years (Milligan et al. 1985; Link et al. 1993). There were several modifications made to adapt the standard three basket fishwheel design to meet the specific requirements for the Klinaklini glacial system. Table 1 contains a list of materials used while schematic diagrams of the unit are presented in Figures 3 and 4.

A rotating three basket welded aluminum fishwheel design was used for the 1997, 1998, and 1999 Klinaklini River chinook assessment programs. The fishwheel consisted of three basic components; platform, axle/basket assembly and the holding tanks. All welding was performed with a MIG[2] process, utilizing a root pass and a cover pass procedure. During the survey period there were no failures of welds made using this procedure.

Platform

Resembling a catamaran, (Figure 3) the two 9.4 m long pontoons each have a 75 cm wide tread plate surface, supported by a polystyrene foam floatation structure encased in 4.9 mm aluminum sheeting. The bow (upstream) of each pontoon is tapered 45 degrees to provide stabile floatation under high flow conditions (Figure 4). Past experience with rotary screw trap pontoons utilizing a simple 45-degree slope proved effective with minimal water resistance while ensuring low construction costs. During operation the fishwheel pontoons were attached to a solid upstream object with 12.7 mm galvanized steel cables. Structural members used to hold the pontoons apart at the bow and stern double as crosswalks joining the port and starboard pontoons. Each crosswalk is constructed of two 7.6 cm x 7.6 cm aluminum tubes covered with a 55.9 cm wide tread plate surface. The crosswalks are attached to the pontoons with four bolts at each corner creating a rigid fishwheel platform.

Axle/Basket assembly

A 2.8 m tall mast constructed of two 10.2 cm x 7.6 cm "I" beams is located on the inside centre section of each pontoon (Figure 4). A 636 kg hand winch is mounted on each mast requiring two people cranking simultaneously to raise or lower the axle/basket assembly. The axle spans from mast to mast, and is made from a 6.4 cm schedule 40 steel pipe, 3.5 m long. The fishwheel baskets connect to the axle by fitting into sockets made from 5.1 cm tubes that are 15.2 cm long and welded in a row 53.3 cm on centre, along the length of the axle. As there are three baskets there are also three rows of sockets placed 120 degrees apart. Nylon (UHMW)[3] blocks mounted within each mast act as the bearing surface on which the axle rotates. Each block is 30.5 cm square with a 7.6 cm hole in its centre to receive the axle. Each fishwheel basket is 3.5 m wide and 3.5 m long. They are built with seven evenly spaced 3.2 cm schedule

[2] Mixed Inert gas
[3] Ultra High Molecular Weight Polyethylene

40 aluminum pipes running the length of the basket. Each basket attaches to seven axle sockets at one end and is curved at the other end to form a scoop. The baskets are framed by a leading edge, intermediate cross member and axle cross member and covered with a 5.1 cm knotless fishing net soaked in water before installation to alleviate stretching and sagging during operation. Taught guy lines (6.4 mm galvanized cable) connected the leading edges of the baskets to each other to achieve rigidity.

Holding tanks

Live tanks are attached to the outside of the port and starboard pontoons at their middle by means of a continuous hinge. Each live tank was originally built 0.6 m wide, 1.2 m deep, and 2.9 m long from 4.9 mm aluminum sheet with an expanded metal type grate that slid vertically at each end. This design was modified in the first year by folding the walls together forming a doubly thick 45-degree surface that deflected debris. In addition, triangular gussets were installed on the top of the tank to bolster lateral strength. A second tank modification involved drilling a series of 5 cm holes through the floor sheets to minimize the build up of sediment. While minor amounts of silt did continue to build up by settling on the remaining flat surface between the holes it was not a major concern.

An additional design change was undertaken to modify the expanded metal gates, which had a sharp edge that captured fish would cut their snouts on as they looked for an escape. New gates that were 0.6 m by 1.2 m, were made from 2.5 cm pipe. One served as a rear gate, sliding vertically, the other was welded horizontally to the outside of the tank with the top of the gate at water level to allow fresh aerated water into the live tank. After the installation of the pipe gates, no further snout injuries were observed.

Recovery tanks were specifically designed and built to hold stressed fish until they recovered sufficiently from handling. The recovery tanks were 0.6 m wide, 0.9 m deep and 2.3 m long and were constructed from 3.2 mm aluminum sheets. Each tank was attached aft of the live tanks by means of a continuous hinge that allowed all tanks to be swung from their vertical position to facilitate transport of the fishwheel without disassembly. The bottoms of the recovery tanks were also perforated with 5 cm holes to prevent sediment build up.

Safety features

As a safety precaution, aluminum pipe handrails encircle both the inside and outside of the fishwheel platform. Handrails ensured that personnel could not "cut the corner" when walking around the fishwheel. This prevented possible injury from the rotating baskets which was especially dangerous when the baskets passed the mast in a scissor-like action. In addition, guards in the form of 2.5 cm netting were sewn into the spaces between the mast and the handrails.

Installation

The fishwheel was transported to Knight Inlet via barge and then moved 8 km by logging road to the assembly beach. Once assembled it was easily pulled .5 km upstream using a boat equipped with two 65-hp jet-drive outboard motors. Using two 17.7 m x 1.3 cm galvanized cable bridles, the fishwheel was attached to a double wrap basket hitch around the bridge pier on the deep side of the river. As the attachment point was near the edge of the river it was necessary to use a "stiff-leg" (a 6.4 cm schedule 40 x 5.9 m aluminum pipe) to position the fishwheel in the flow of the river. The stiff-leg was attached to the bow of the starboard pontoon with a type of ball and socket joint to allow movement. The shore end was jammed into large riprap and tied off for security. When finally positioned, the fishwheel operated approximately 5.6 m off the shore in about 4.4 m of water.

Operation

The fishwheel was operated 24 hours per day. Catch by species, biological data, water depth, flow rate, water clarity (secchi depth), temperature, and fishwheel RPM were recorded twice daily at 8 AM and 7 PM. Captured fish were removed from the holding tank by dipnet and transferred to a large cooler partially filled with water where processing for biological information and tagging occurred prior to release. Water depth was measured from a staff gauge mounted on a concrete bridge support structure. Water Survey Canada has a remote discharge recorder at the fishwheel site that electronically monitored the water depth and discharge.

Tagging and Sampling

All chinook and a subsample of all other species were tagged at the fishwheel with a Ketchum curl-lock sheep ear tag[4] for external identification. In addition, a secondary mark consisting of a hole punched through the operculum was applied. Most of the tagged fish were released approximately 0.5 km below the fishwheel. Recoveries at the fishwheel were recorded and tag recovery proportions used to estimate fishwheel catch efficiency.

All chinook salmon and a subsample of all other species captured at the fishwheel were sampled for post-orbital hypural (POH) length, sex, fish condition, age, and DNA analysis. Fish condition was recorded as good, fair or poor depending on external damage and overall health. Five scales per fish were collected for ageing purposes. DNA samples were collected by taking a hole punch from the operculum and storing it in 70% ethanol. Samples were combined and stored by week of capture.

MUSSEL CREEK FENCE

A resistance board weir similar in design to that described in Nagtegaal et al. (1994) was

[4] Ketchum Manufacturing Ltd., Ottawa, Ontario, Canada

installed in Mussel Creek just above the Klinaklini East main logging road (Figure 2). Several fence panels near the middle of the creek were removed daily allowing fish to pass upstream. Wherever possible, fish moving upstream of the fence were visually identified, counted and inspected for ketchum tags. No fish were sampled at the fence site in 1999.

POPULATION ESTIMATES

Population estimates for the overall system were determined for all species using fishwheel catch efficiencies. To incorporate potential variability in temporal efficiency patterns, chinook tag and recapture data were stratified into early, peak and late periods and separate efficiency values were calculated for each strata. The period specific efficiencies were then applied to the total catch to produce a range of values for the chinook population. The mean of these three values was determined to be the total chinook population estimate. The 95% confidence interval for this point estimate was determined by applying the critical value of Student's t-distribution at the 0.05 level of significance to the standard error of the mean of the three period specific estimates. For all other species, total population estimates were calculated by dividing fishwheel catch by efficiency for the entire study period.

Estimates of chinook and coho spawning in Mussel Creek were determined by using the number of tagged chinook and coho observed at the fence. These values provided the proportion of the total chinook and coho returning to the Klinaklini which moved into Mussel Creek.

RESULTS

FISHWHEEL

The fishwheel was in operation from July 13 to August 20, August 30 to September 4, September 14 to September 17 and from September 27 to October 4. The intermittent sampling schedule resulted from budget restrictions that limited the scope of the 1999 study. Since there was little movement of chinook at the beginning of the program and many days of zero catch at the termination of sampling, it is assumed that the entire chinook run was monitored. Coho continued to be caught in the fishwheel until the end of the project although in low numbers. A total of 656 chinook adults, 35 chinook jacks, 410 coho adults, 45 coho jacks, 35 chum, 47 pink, and 80 sockeye were captured by the fishwheel (Table 2). Diel catch patterns similar to those observed in past years continued in 1999 with the majority of fish captured during the daylight sampling period (Table 3).

Fishwheel operation was very successful in transferring fish from the baskets to holding tanks on either side of the pontoons. Modifications implemented over the past 2 years ensured that this occurred in all flow conditions. The improvised "ski-jump" type slide situated on the pontoon once again aided the transition of fish from the basket into the holding tank by raising the landing spot for the fish on the pontoon. Captured fish would exit the slide approximately 20 cm below the top of the pontoon. This modification has proved to be an excellent feature.

Fish captured in the fishwheel were generally in excellent condition. However, a small number (< 5%) of the fish handled exhibited scars likely caused by seals. Several seals frequented the area and were often observed catching salmon across the river from the fishwheel. In addition, several seals were sighted further up the river past the Mussel Creek confluence.

A total of 329 male, 28 jack and 332 female chinook salmon were measured for post-orbital hypural length. Male chinook length ranged from 46.0 cm to 98.0 cm while jacks ranged from 28.0 cm to 43.0 cm and females from 26.0 cm to 91.0 cm. Average lengths were 64.2, 34.9 and 67.6 cm for male, jack and female chinook, respectively (Table 4). A total of 230 chinook were aged by scale analysis. Ages ranged from 1 to 5 years and were dominated by 3 year old (40.0%) and 4 year old (37.8%) fish. Stream type age groups comprised 86.9% of the sample while ocean types accounted for only 13.1% (Table 5). Chinook were not sampled for flesh colour, although in a previous study (Whelen and Morgan 1984) red chinook comprised 52% of the population.

A total of 176 male and 215 female coho salmon were measured for post-orbital hypural length. Male coho length ranged from 45.0 cm to 68.0 cm while females ranged from 34.0 cm to 70.0 cm. Average lengths were 54.6 and 51.1 cm for male and female coho, respectively (Table 4). A total of 281 coho were aged by scale analysis. Two age classes were present in the sample which was comprised of 92.9% 2 year old (age 1.1) and 7.1% 3 year old (age 2.1) fish (Table 5).

Environmental data collected at the fishwheel included temperature, secchi depth, flow rate, fishwheel RPM, and river depth (Table 6). The Klinaklini River is largely a glacial fed system and is influenced by summer temperatures and the resulting glacial melt. This factor results in consistently low river temperatures (study period range= 4.0 to 8.0 ^{o}C; study period average = 6.9 ^{o}C) and increased river flow in the spring and summer months. Peak 1999 Klinaklini river flows were recorded in July, which is consistent with the 30 year mean (Figure 5). Flow rate over the duration of the study ranged from 0.069 m/s to 1.186 m/s and averaged 0.742 m/s. Water clarity was recorded in the form of secchi depth, which ranged from 10 cm to 35 cm and averaged 20.3 cm (Table 6).

Fishwheel rotational speed was directly related to the flow rate of the river (Figure 6). This relationship was linear and statistically significant (ANOVA: $F=422.2$; $p<0.05$). The rotational speed of the fishwheel had a notable effect on both chinook catch (Figure 7a) and total catch (Figure 7b). The relationship between both catch variables and fishwheel RPM was best described by a third order polynomial equation. Peak catch efficiency was at approximately 1.5 RPM for chinook and between 1.0 and 1.5 RPM for all species combined. The third order polynomial equation provided a better fit for total catch ($R^2=0.4197$) than for chinook catch only ($R^2=0.2713$).

Fishwheel efficiency was estimated for chinook, coho, pink, and sockeye (Table 7). Efficiency was not estimated for chum as no tagged fish were recaptured at the fishwheel. Fishwheel efficiency was greatest for pink salmon at 15.38% and lowest for coho at 3.95%. The catch efficiencies for chinook and sockeye were 6.17% and 4.44%, respectively. To investigate temporal efficiency patterns, chinook tag and recapture data were stratified into early, peak and late periods and separate catch efficiencies were calculated for each period. Results indicated that efficiency for the capture of chinook was highest in the early period and slightly lower in the peak and late periods (Table 7). No temporal stratification was possible for other species due to the low number of tags recaptured. Run timing, based on fishwheel catch, is presented in Figures 10 and 11 for chinook and coho, respectively.

No tag loss was recorded for sockeye or pink salmon recaptured at the fishwheel. For chinook, one out of the 39 tagged fish (2.6%) recaptured at the fishwheel had lost the Ketchum curl-lock tag. Coho exhibited a higher tag loss rate as one out of 10 tagged fish (10.0%) recovered at the fishwheel had lost the Ketchum curl-lock tag.

MUSSEL CREEK FENCE

The initial program design included monitoring all fish movement through the Mussel Creek fence in order to compile detailed enumeration data, monitor individuals tagged at the fishwheel for mark-recapture analysis, and to conduct biosampling for comparison with fishwheel results. These activities were not possible in 1999 due to budget constraints that limited program duration, staffing levels and equipment availability.

Fish movement through the fence was sporadic and salmon tended to hold in pools below the fence prior to upstream migration. This behaviour has been observed in the past prior to the establishment of a fence above the Mussel Creek bridge. As a result, it is assumed that the fence had minimal impact on fish movement upstream. The trap at the fence was not monitored on a 24 hour basis but instead, fence panels were removed daily allowing fish to migrate upstream and as much information as possible was collected through visual observation from the bridge.

A total of 606 chinook (43 tagged), 77 coho (5 tagged), 53 pink, 15 chum, and 35 sockeye were enumerated at the fence site. However, it should be noted that data collected at the fence in 1999 is of limited value as monitoring did not occur throughout the duration of the study, data recording was intermittent due to staff limitations, and counts were not always broken out by species due to poor visibility. In order to deal with the last problem, fish counts from August 12 to 20 were allocated to species based on 1997 and 1998 data for the same period (Table 8).

Water depth and temperature measurements were taken at the Mussel Creek fence site throughout the study period (Figure 8). Water temperature between July 12 and September 3 ranged from 12.0 to 16.0 and averaged 14.2 degrees Celsius. Water depth at the fence site for the same period ranged from 0.20 m. to 1.10 m and averaged 0.72 m.

POPULATION ESTIMATES

The population estimate for chinook and coho are for adult fish only as no jacks were tagged to determine jack catch efficiencies. The chinook estimate incorporated potential variability in temporal efficiency patterns by stratifying chinook tag and recapture data into early, peak and late periods. Using this method the total population estimate of chinook for the Klinaklini system was 11,068 adult fish (95% CL: 5,031 – 17,105). All other species specific population estimates were determined by dividing total fishwheel catch by the efficiency values determined from tag recaptures. Resulting population estimates were 10,380 adult coho, 1,802 sockeye and 306 pink salmon (Table 9). No estimate was possible for chum as no tagged chum were recovered at the fishwheel.

A total of 43 tagged chinook and 5 tagged coho were observed at the Mussel Creek fence. These values represent 6.8% and 2.0% of the chinook and coho tagged at the fishwheel, respectively. Based on these ratios, a minimum of 879 adult chinook and 546 adult coho spawned in Mussel Creek in 1999.

DISCUSSION

FISHWHEEL

The fishwheel was successful in capturing sufficient numbers of chinook to be used for tagging studies and biological sampling. Virtually all fish captured were in excellent condition and incurred minimal stress due to the simplicity of the handling process and low water temperatures.

The success or failure of a fishwheel depends on several key factors. A project, jointly funded by the Ministry of Environment, Lands and Parks and the Fraser River Action Committee of the Department of Fisheries and Oceans, studied various fishwheel designs and attempted to collate available information on optimal working design and environment for fishwheel operation (Mikkelsen 1995). Selection of an appropriate site was determined to be integral to successful fishwheel operation. For the current study, the position of the fishwheel had to meet several criteria. These included: a position close to the mouth of the Klinaklini River below which no chinook spawning occurred, shoreline topography that was amenable to proper positioning while offering easy accessibility, water depth that was slightly deeper than the sampling depth of the fishwheel, water velocity that remained within the range of operational capability of the fishwheel, and a position in the river that would provide some protection from downstream movement of large debris. Water depth, velocity, and shoreline features were recorded for several sites along the lower reaches of the Klinaklini River and a suitable site just below the million dollar bridge (Figure 2) was found that met all of the above criteria.

Water clarity plays a major role in the catching power of a fishwheel. It is understood that avoidance and reaction time to escape the fishwheel decreases as visibility decreases. Secchi depth measurements made in the Klinaklini River in 1999 ranged from 10 to 35 cm indicating low visibility, which reduced the likelihood of fish avoidance.

Mikkelsen (1995) plotted fishwheel efficiency against the number of baskets and determined that a four-basket fishwheel was twice as efficient as a two-basket design. It was pointed out, however, that the relative gain in overall efficiency decreases with the addition of more baskets, especially at higher flows, as the disturbance resulting from the baskets churning through the water causes a noise factor that may increase fish avoidance. In our situation, a three-basket wheel provided a balance between optimal efficiency and minimal disturbance.

Fishwheel rotational speed was also compared with efficiency (Mikkelsen 1995). Results showed that doubling the speed from 2 to 4 rpm does not double the efficiency but, depending on the water depth, may actually decrease efficiency. Indications were that rotational speed in the range of 2 - 3 rpm provided the best efficiency, and it was noted that visibility remained a key factor. The results from this study confirmed that rotational speed is linked to fishwheel efficiency. In our situation, we observed that optimal catches occurred at speeds between 1.0 and 1.5 rpm for all species combined and near 1.5 rpm for chinook only (Figure 7). The rotational speed of the fishwheel could be partially controlled by raising or lowering the baskets within the limits of the upright framework. During peak flows the fishwheel had a tendency to exceed the ideal range and in these situations it was difficult to maintain optimal rotational speed. It was discovered that increasing the lower limits of the framework and lowering the axle below the water line could partially control rotational speed. This allowed the baskets to act as a self-braking mechanism, slowing rotation closer to the optimum.

The correlation between differing size fish within species and catch efficiency rates has been demonstrated in the past as fishwheels have proven to be more efficient in capturing smaller chinook salmon (Meehan 1961). As a result, our population estimates were for chinook and coho adults only as no jacks were tagged to determine size specific catch efficiencies. Inter specific catch efficiencies ranged from 3.95 for coho to 15.38 for pink. It is unlikely that these ranges are strictly due to fish size as migration behaviour and timing must also play a role in capture efficiency.

Many of the aspects of fishwheel design and operation suggest that it has the potential to be a good in-river assessment tool. Limitations, both known and yet to be determined, may impact on the effectiveness and efficiency of this tool. While it appears that the advantages outweigh any limitations, it is important to continue the evaluation of fishwheel characteristics during all field studies employing this recently rediscovered sampling tool.

The 1999 fishwheel catch of chinook in the Klinaklini River was less than 1998 but higher than 1997 (Nagtegaal et al. 1998; Sturhahn et al. 1999). Catch efficiencies did not show the same trend as the 1999 chinook catch efficiency was the lowest of the three years of the study. It is likely that inter annual variation in environmental parameters such as flow (and fishwheel rpm), water clarity and fishwheel set up influence catch efficiency by effecting fishwheel operation and chinook migration patterns.

The age structure of the chinook population in 1999 was unusual as almost 87% of the samples showed a stream type life history. This differs from previous years when 60% and 41% of the samples were stream type for the years 1997 and 1998, respectively (Nagtegaal et al. 1998; Sturhahn et al. 1999). It has been suggested that the early growth rate of juveniles dictates which life history strategy is employed. If food sources do not limit growth then smoltification begins early with juveniles entering the ocean in their first year of life as ocean types (DFO, FRAP, 1995). Inter annual variability in freshwater habitat quality likely influences the life history strategy of juvenile chinook in the Klinaklini system.

No tag loss was recorded for sockeye or pink salmon recaptured at the fishwheel. For chinook, one out of the 39 tagged fish (2.6%) recaptured at the fishwheel had lost the Ketchum curl-lock tag. This low rate of tag loss was similar to the values observed in the 1997 (1.1%) and 1998 (4.4%) and indicates that the Ketchum tag was appropriate for chinook in this type of study.

MUSSEL CREEK FENCE

The Mussel Creek fence was not monitored on a 24 hour basis but instead, fence panels were removed daily allowing fish to migrate upstream and as much information as possible was collected through visual observation from the bridge. Data collected at the fence in 1999 was considered to be of limited value as monitoring did not occur throughout the duration of the study, data recording was intermittent due to staff limitations, and counts were not always broken out by species due to poor visibility. As a result of these limitation, Mussel Creek fence data was not used to generate population estimates. However, the visual tag enumeration data were used to determine a minimum proportion of the Klinaklini chinook population that spawned in the Mussel Creek system. Using this method the 1999 spawner distribution (6.8% Mussel Creek) was similar to the 1998 (4.6%) and 1997 (19.3%) values based on tag distribution (Nagtegaal et al. 1998; Sturhahn et al. 1999). However, radio telemetry data reveal a different picture as 44.6% and 79.0% of all radio tagged chinook were detected in Mussel Creek for the years 1998 and 1997, respectively. It is likely that the telemetry data more closely reflect the true proportion of chinook in Mussel Creek as fence enumeration is only a partial sample of the spawning migration.

POPULATION ESTIMATES

Population estimates for chinook, coho, pink and sockeye were determined using fishwheel catch efficiencies. The chinook population estimate (11,068 adults) was the highest since the program began in 1997 although study design and fishwheel orientation were nearly identical (Figure 9). The 1999 coho estimate was less than half of the 1998 value (Nagtegaal et al. 1998; Sturhahn et al. 1999). While this may reflect a reduced abundance of coho, the 1999 coho population estimate must be viewed with some caution as much of the run was not sampled by the fishwheel due to project limitations (Figure 11).

Sockeye and pink salmon population estimates were also substantially lower in 1999 than 1998 (Sturhahn et al. 1999). These inter annual differences in abundance likely reflect variability in fresh water and ocean survival rates, fishery catch patterns and possibly the cyclic nature of spawning returns for certain species.

Past studies have indicated that a size bias may be present in fishwheel samples. Meehan (1961) found that chinook captured by fishwheel were significantly smaller than those sampled on the spawning ground. Nagtegaal et al. (1998) compared the length frequency distributions of tagged (captured by the fishwheel) and untagged (not captured by the fishwheel) chinook sampled at the Mussel Creek fence and found no significant difference. While the size of the tagged recovery sample was small in that study, it does suggest that the fishwheel captures all size classes of chinook. However, our population estimates for chinook and coho were for adults only as jacks were not tagged to determine size specific fishwheel catch efficiencies. To address this concern, jacks should be tagged and separate efficiencies calculated for this size class in future fishwheel studies.

Aerial surveys are particularly useful for obtaining counts of spawners quickly and efficiently in areas where access to the spawning grounds is difficult or impossible by other means, and when the streams to be surveyed are too numerous or widespread to obtain sufficient counts by conventional ground-based methods. Although flights are normally conducted at peak spawning periods, a peak count does not represent the total escapement, due to variability in spawning time and duration. As a result, aerial overflights provide an index at best and should be treated as such (Cousens et al. 1982). Aerial overflight information was collected for the Klinaklini River in 1999 and offers an escapement estimate based on species counts and distribution for specific times and locations. It should be noted that only one flight was completed in 1999 due to budget restraints. The aerial count yielded an estimate of 400 chinook compared to the fishwheel efficiency estimate of 11,068 (Figure 9). Aerial overflight counts have been shown to underestimate overall escapement by as much as 60% as compared to methods such as Petersen mark-recapture (Tschaplinski and Hyatt 1991). For the Klinaklini system in 1999, the overflight estimate was approximately 96% less than the fishwheel efficiency estimate. It is likely that the limited aerial visibility due to turbidity and vegetation overgrowth, as well as the restriction to a single overflight accounted for a significant portion of the discrepancy between estimates.

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LITERATURE CITED

Argue, A.L., R. Hilborn, R.M. Peterman, M. J. Staley, and C.J. Walters. 1983. Strait of Georgia chinook and coho fishery. Can. Bull. Fish. Aquat. Sci. 211:91 p.

Berry, M. 1991. Stream narrative of the Klinaklini River. Unpubl. Manuscript.

Collicut, L.D. and T.F. Shardlow. 1995. Strait of Georgia Sport Fishery Creel Survey Statistics for Salmon and Groundfish, 1991. Can. Tech. Rep. Fish. Aquat. Sci., 2137: 75 p.

Cousens, N.B.F., G.A. Thomas, C.G. Swann, and M.C. Healey. 1982. A review of salmon escapement estimation techniques. Can. Tech. Rep. Fish.Aquat. Sci. 1108: 122 p.

Department of Fisheries and Oceans. 1995. Fraser River Chinook Salmon. Prepared by Fraser River Action Plan, Fishery Management Group. Vancouver, B.C. 24 p.

Fielden, R. and T. Slaney. 1982. 1981 survey of salmonids spawning in selected streams of Knight Inlet, British, Columbia. Prepared for Dept. Fish. and Oceans by Aquatic Resources Ltd. 89 p.

Fielden, R., T. Slaney, and G.J. Birch. 1985. Knight Inlet juvenile salmonid reconnaissance. Prepared for Dept. Fish. and Oceans by Aquatic Resources Ltd. 210 p.

Link, M.R. and K.K. English. 1994. The 1993 fishwheel project on the Nass River and an evaluation of fishwheels as an inseason management and stock assessment tool for the Nass River. Nishga'a Fisheries Report NF92-09, New Aiyansh, B.C.

Link, M.R., K.K. English, and R.C. Bocking. 1993. The 1992 fishwheel project on the Nass River and an evaluation of fishwheels as an inseason management and stock assessment tool for the Nass River. Nishga'a Fisheries Report NF92-09, New Aiyansh, B.C.

Meehan, W.R. 1961. Use of a fishwheel in salmon research and management. Trans. Am. Fish. Soc. 90: 490-494.

Mikkelsen, J. 1995. Development of fishwheels for use in British Columbia. Dept. of Mech. Eng., UBC, prepared for Ministry of Environment, Land and Parks and Dept. Fisheries and Oceans. 50 p.

Milligan, P.A., W.O. Rublee, D.D. Cornett, and R.A.C. Johnston. 1985. The distribution and abundance of chum salmon (*Oncorhynchus keta*) in the upper Yukon River basin as determined by radio tagging and spaghetti tagging program: 1982-1983. Can. Tech. Rep. Fish. Aquat. Sci. 1351: 89 p.

Nagtegaal, D.A., J. Candy, and B. Riddell. 1994. A preliminary report on the chinook productivity study conducted on the Cowichan River during 1990 and 1991. Can. Manuscr. Rep. Fish. Aquat. Sci. 2315: 84 p.

Nagtegaal, D.A., E.W. Carter, and D.C. Key. 1998. Results of the chinook assessment study conducted on the Klinaklini River during 1997. Can. Manuscr. Rep. Fish. Aquat. Sci. 2452: 59 p.

PSC (Pacific Salmon Commission). 1987. Joint chinook technical committee 1986 annual report. TCHINOOK (87)-4.

Rimmer, D.W. and F.N. Axford. 1990. A preliminary evaluation of fish habitat and recreational fisheries values in the mainland coast planning unit. Environment and Lands.

Sturhahn, J.C.and D.A.Nagtegaal. 1999. Results of the chinook assessment study conducted on the Klinaklini River during 1998. Can. Manuscr. Rep. Fish. Aquat. Sci. 2497: 65 p.

Tschaplinski, P.J. and K.D.Hyatt. 1991. A comparison of population assessment methods employed to estimate the abundance of Sockeye salmon (*Oncorhynchus nerka*) returning to Henderson Lake, Vancouver Island during 1989. Can. Tech. Rep. Fish. Aquat. Sci. 1798: 101 p.

Waples, R.S. 1991. Genetic Interactions between hatchery and wild salmonids: lessons from the Pacific Northwest. Can. J. Fish. Aquat. Sci. 48 (Suppl. 1): 124-133.

Whelen, M.A. and J.D. Morgen. 1984. 1983 spawning salmonid studies in selected watercourses of Knight Inlet, British, Columbia. Prepared for Dept. Fish. and Oceans by EVS Consultants Ltd. 172 p.

Table 1. Materials list for construction of the fishwheel.

Pontoons:
5 – 1/8" x 5' x 12' 5052 aluminum sheet
4 – 1/8" x 5' x 16' 3002 aluminum tread sheet
1 – 3/8" x 3" x 20' aluminum flat bar

Mast:
2 – 3" x 20' I Beam aluminum
¼ sheet - 1/8"x 4' x 8' 5052 aluminum sheet
¼ length – 3/8" x 3' x 20' aluminum flat bar
2 – 1400 lb. boat trailer winches
50' ¼" galvanized cable
2 – 2" double pulleys
1 – 2" single pulleys
4 – ¼" cable clamps
8 – 1 ½" x 6" x 12" Nylon Blocks (UHMW)

Crosswalks:
4 – 1/8" x 3" x 3" x 20' aluminum tubing
1 – 1/8" x 4' x 12' 5052 aluminum sheet

Handrails:
500' – 1 ¼" schedule 40 6063 aluminum pipe
100' – 1 ¼" schedule 40 6061 aluminum pipe

Axle:
1 - 2" x 20' schedule 40 steel pipe
¼ - 2" x 20' schedule 40 steel pipe
¼ - 2 ½" x 20' schedule 40 steel pipe
4 - 2 15/16" locking collars
1 - 3/8" x 3' x 20' aluminum flat bar
4 - 3/8" x 6" NC plated bolts c/w locking nuts

Baskets:
27 - 1 ¼" schedule 40 6061 aluminum pipe
100' - 3/8" galvanized cable
25 - 3/8" cable clamps
6 - 3/8" x 6" turnbuckles
6 - 5/16" shackles
15 – 3/8" x 4" NC plated bolts c/w locking nuts

Table 1 (cont'd.)

Slides:
3 sheets - 1/8"x 4' x 8' 5052 aluminum sheet
30 – ¼" NC plated bolts c/w locking nuts and flat washers

Stiff-leg:
1 - 2 ½" x 20' schedule 40 6061 aluminum pipe

Live tanks:
4 - 1/8" x 5' x 10' 5052 aluminum sheet
3 - 1/4" x 2' x 20' aluminum flat bar
5 - ¾" x 20' schedule 40 6061 aluminum pipe
1 - 5/8" x 20' steel rod

Recovery tanks:
4 - 1/8" x 4' x 8' 5052 aluminum sheet
3 - 1/4" x 2' x 20' aluminum flat bar
5 - ¾" x 20' schedule 40 6061 aluminum pipe
1 - 5/8" x 20' steel rod

Table 2. Daily fishwheel counts, Klinaklini River, 1999.

Date	Chinook		Coho		Chum	Pink	Sockeye	Total
	Adult	Jack	Adult	Jack				
13-Jul	1	0	0	0	0	0	0	1
14-Jul	4	0	0	0	0	0	2	6
15-Jul	0	0	0	0	2	0	1	3
16-Jul	4	0	0	0	0	0	0	4
17-Jul	2	0	0	0	1	0	2	5
18-Jul	0	0	0	0	0	0	0	0
19-Jul	1	0	1	0	1	0	2	5
20-Jul	3	0	0	0	0	0	0	3
21-Jul	4	0	0	0	0	0	0	4
22-Jul	1	0	0	0	0	2	0	3
23-Jul	3	0	1	0	1	0	0	5
24-Jul	5	0	0	0	0	0	1	6
25-Jul	14	0	0	0	1	2	3	20
26-Jul	25	1	0	0	1	0	3	30
27-Jul	18	0	0	0	0	0	6	24
28-Jul	14	1	1	0	2	0	0	18
29-Jul	3	1	0	0	1	0	1	6
30-Jul	14	0	1	0	2	0	1	18
31-Jul	19	5	1	0	0	0	0	25
01-Aug	15	1	2	0	3	0	3	24
02-Aug	30	2	4	1	1	0	1	39
03-Aug	22	3	1	0	1	0	4	31
04-Aug	12	0	1	0	1	0	0	14
05-Aug	10	0	2	0	0	0	4	16
06-Aug	11	0	1	0	1	0	2	15
07-Aug	15	1	3	0	0	0	0	19
08-Aug	18	0	3	1	0	0	0	22
09-Aug	38	1	6	1	2	0	1	49
10-Aug	48	2	7	0	0	0	1	58
11-Aug	32	4	9	0	1	0	2	48
12-Aug	65	2	3	0	0	2	4	76
13-Aug	49	3	9	1	1	4	3	70
14-Aug	29	0	12	0	1	3	8	53
15-Aug	39	0	15	1	1	1	3	60
16-Aug	9	0	10	0	2	1	1	23
17-Aug	18	0	23	2	0	6	7	56
18-Aug	14	0	18	0	1	3	4	40
19-Aug	6	0	5	0	0	3	3	17
20-Aug	12	0	9	0	0	2	2	25
21-Aug								
22-Aug								
23-Aug				Fishwheel not operating				
24-Aug								
25-Aug								

Table 2 (cont'd). Daily fishwheel counts, Klinaklini River, 1999.

Date	Chinook		Coho		Chum	Pink	Sockeye	Total
	Adult	Jack	Adult	Jack				
26-Aug								
27-Aug								
28-Aug			Fishwheel not operating					
29-Aug								
30-Aug	1	0	3	1	0	0	0	5
31-Aug	10	3	24	6	0	3	1	47
01-Sep	8	3	28	11	0	2	0	52
02-Sep	3	1	30	5	0	1	0	40
03-Sep	5	1	32	11	0	0	0	49
04-Sep	2	0	27	1	0	2	0	32
05-Sep								
06-Sep								
07-Sep								
08-Sep								
09-Sep			Fishwheel not operating					
10-Sep								
11-Sep								
12-Sep								
13-Sep								
14-Sep	0	0	5	0	0	2	1	8
15-Sep	0	0	21	0	1	2	1	25
16-Sep	0	0	24	0	0	3	1	28
17-Sep	0	0	11	1	0	2	0	14
18-Sep								
19-Sep								
20-Sep								
21-Sep								
22-Sep			Fishwheel not operating					
23-Sep								
24-Sep								
25-Sep								
26-Sep								
27-Sep	0	0	5	0	0	0	0	5
28-Sep	0	0	7	0	0	0	0	7
29-Sep	0	0	10	1	0	0	0	11
30-Sep	0	0	6	0	2	1	0	9
01-Oct	0	0	8	0	2	0	0	10
02-Oct	0	0	9	0	2	0	0	11
03-Oct	0	0	3	0	0	0	0	3
04-Oct	0	0	9	1	0	0	1	11
Total:	656	35	410	45	35	47	80	1308

Table 3. Diel fishwheel catches in the Klinaklini, by species, 1999.

			Day Catches							
			Chinook		Coho					DV/Bull
Date	Start	Finish	Adult	Jack	Adult	Jack	Chum	Pink	Sockeye	Trout
13-Jul	800	1900	1	0	0	0	0	0	0	0
14-Jul	800	1900	3	0	0	0	0	0	1	0
15-Jul										
16-Jul	800	1900	3	0	0	0	0	0	0	0
17-Jul	800	1900	1	0	0	0	1	0	2	0
18-Jul										
19-Jul	800	1900	1	0	1	0	0	0	1	0
20-Jul	800	1900	1	0	0	0	0	0	0	0
21-Jul	800	1900	4	0	0	0	0	0	0	0
22-Jul										
23-Jul	800	1900	1	0	1	0	1	0	0	0
24-Jul	800	1900	3	0	0	0	0	0	1	0
25-Jul	800	1900	6	0	0	0	1	2	2	0
26-Jul	800	1900	18	1	0	0	0	0	2	2
27-Jul	800	1900	11	0	0	0	0	0	3	0
28-Jul	800	1900	7	0	1	0	1	0	0	1
29-Jul	800	1900	2	1	0	0	1	0	1	0
30-Jul	800	1900	13	0	1	0	2	0	1	0
31-Jul	800	1900	14	5	1	0	0	0	0	0
1-Aug	800	1900	12	1	2	0	1	0	3	0
2-Aug	800	1900	21	1	3	1	0	0	1	0
3-Aug	800	1900	17	1	1	0	0	0	1	0
4-Aug	800	1900	10	0	1	0	1	0	0	0
5-Aug	800	1900	6	0	2	0	0	0	4	0
6-Aug	800	1900	9	0	1	0	0	0	1	0
7-Aug	800	1900	14	0	3	0	0	0	0	0
8-Aug	800	1900	17	0	3	1	0	0	0	0
9-Aug	800	1900	26	0	5	1	0	0	0	0
10-Aug	800	1900	29	0	5	0	0	0	1	0
11-Aug	800	1900	21	4	8	0	1	0	1	0
12-Aug	800	1900	27	0	1	0	0	0	2	0
13-Aug	800	1900	27	0	8	1	0	2	2	0
14-Aug	800	1900	17	0	12	0	0	3	6	0
15-Aug	800	1900	18	0	8	1	1	1	3	0
16-Aug	800	1900	6	0	6	0	0	0	1	0
17-Aug	800	1900	9	0	19	2	0	6	2	0
18-Aug	800	1900	11	0	17	0	0	3	3	0
19-Aug	800	1900	5	0	4	0	0	1	3	0
20-Aug	800	1900	7	0	8	0	0	1	2	0
21-Aug										
22-Aug					Fishwheel Not Operating					
23-Aug										
24-Aug										
25-Aug										

Table 3 (cont'd).

			Day Catches							
			Chinook		Coho					DV/Bull
Date	Start	Finish	Adult	Jack	Adult	Jack	Chum	Pink	Sockeye	Trout
26-Aug										
27-Aug					Fishwheel Not Operating					
28-Aug										
29-Aug										
30-Aug	800	1900	1	0	3	1	0	0	0	0
31-Aug	800	1900	3	1	12	4	0	2	1	0
1-Sep	800	1900	7	2	21	8	0	2	0	0
2-Sep	800	1900	1	1	22	4	0	1	0	0
3-Sep	800	1900	1	1	15	9	0	0	0	0
4-Sep	800	1900	0	0	11	0	0	0	0	0
5-Sep										
6-Sep										
7-Sep										
8-Sep					Fishwheel Not Operating					
9-Sep										
10-Sep										
11-Sep										
12-Sep										
13-Sep										
14-Sep	800	1900	0	0	5	0	0	2	1	0
15-Sep	800	1900	0	0	8	0	0	0	1	0
16-Sep	800	1900	0	0	14	0	0	1	0	0
17-Sep										
18-Sep										
19-Sep										
20-Sep										
21-Sep										
22-Sep					Fishwheel Not Operating					
23-Sep										
24-Sep										
25-Sep										
26-Sep										
27-Sep	800	1900	0	0	5	0	0	0	0	0
28-Sep	800	1900	0	0	4	0	0	0	0	0
29-Sep	800	1900	0	0	4	1	0	0	0	0
30-Sep	800	1900	0	0	2	0	2	1	0	0
1-Oct	800	1900	0	0	3	0	1	0	0	0
2-Oct	800	1900	0	0	2	0	0	0	0	0
3-Oct	800	1900	0	0	0	0	0	0	0	0
Total			411	19	253	34	14	28	53	3

Table 3 (cont'd)

			Night Catches							
			Chinook		Coho					DV/Bull
Date	Start	Finish	Adult	Jack	Adult	Jack	Chum	Pink	Sockeye	Trout
13-Jul										
14-Jul	1900	800	1	0	0	0	0	0	1	0
15-Jul	1900	800	0	0	0	0	2	0	1	0
16-Jul	1900	800	1	0	0	0	0	0	0	0
17-Jul	1900	800	1	0	0	0	0	0	0	0
18-Jul										
19-Jul	1900	800	0	0	0	0	1	0	1	0
20-Jul	1900	800	2	0	0	0	0	0	0	0
21-Jul										
22-Jul	1900	800	1	0	0	0	0	2	0	0
23-Jul	1900	800	2	0	0	0	0	0	0	0
24-Jul	1900	800	2	0	0	0	0	0	0	0
25-Jul	1900	800	8	0	0	0	0	0	1	0
26-Jul	1900	800	7	0	0	0	1	0	1	0
27-Jul	1900	800	7	0	0	0	0	0	3	0
28-Jul	1900	800	7	1	0	0	1	0	0	0
29-Jul	1900	800	1	0	0	0	0	0	0	0
30-Jul	1900	800	1	0	0	0	0	0	0	0
31-Jul	1900	800	5	0	0	0	0	0	0	0
01-Aug	1900	800	3	0	0	0	2	0	0	1
02-Aug	1900	800	9	1	1	0	1	0	0	0
03-Aug	1900	800	5	2	0	0	1	0	3	0
04-Aug	1900	800	2	0	0	0	0	0	0	0
05-Aug	1900	800	4	0	0	0	0	0	0	0
06-Aug	1900	800	2	0	0	0	1	0	1	0
07-Aug	1900	800	1	1	0	0	0	0	0	0
08-Aug	1900	800	1	0	0	0	0	0	0	0
09-Aug	1900	800	12	1	1	0	2	0	1	0
10-Aug	1900	800	19	2	2	0	0	0	0	0
11-Aug	1900	800	11	0	1	0	0	0	1	0
12-Aug	1900	800	38	2	2	0	0	2	2	0
13-Aug	1900	800	22	3	1	0	1	2	1	0
14-Aug	1900	800	12	0	0	0	1	0	2	0
15-Aug	1900	800	21	0	7	0	0	0	0	0
16-Aug	1900	800	3	0	4	0	2	1	0	0
17-Aug	1900	800	9	0	4	0	0	0	5	0
18-Aug	1900	800	3	0	1	0	1	0	1	0
19-Aug	1900	800	1	0	1	0	0	2	0	0
20-Aug	1900	800	5	0	1	0	0	1	0	0
21-Aug										
22-Aug										
23-Aug					Fishwheel Not Operating					
24-Aug										
25-Aug										

Table 3 (cont'd)

			Night Catches							
			Chinook		Coho					DV/Bull
Date	Start	Finish	Adult	Jack	Adult	Jack	Chum	Pink	Sockeye	Trout
26-Aug										
27-Aug			Fishwheel Not Operating							
28-Aug										
29-Aug										
30-Aug										
31-Aug	1900	800	7	2	12	2	0	1	0	0
01-Sep	1900	800	1	1	7	3	0	0	0	0
02-Sep	1900	800	2	0	8	1	0	0	0	0
03-Sep	1900	800	4	0	17	2	0	0	0	0
04-Sep	1900	800	2	0	16	1	0	2	0	0
05-Sep										
06-Sep										
07-Sep										
08-Sep										
09-Sep										
10-Sep			Fishwheel Not Operating							
11-Sep										
12-Sep										
13-Sep										
14-Sep										
15-Sep	1900	800	0	0	13	0	1	2	0	0
16-Sep	1900	800	0	0	10	0	0	2	1	0
17-Sep	1900	800	0	0	11	1	0	2	0	0
18-Sep										
19-Sep										
20-Sep										
21-Sep										
22-Sep										
23-Sep			Fishwheel Not Operating							
24-Sep										
25-Sep										
26-Sep										
27-Sep										
28-Sep	1900	800	0	0	3	0	0	0	0	0
29-Sep	1900	800	0	0	6	0	0	0	0	0
30-Sep	1900	800	0	0	4	0	0	0	0	0
01-Oct	1900	800	0	0	5	0	1	0	0	0
02-Oct	1900	800	0	0	7	0	2	0	0	0
03-Oct	1900	800	0	0	3	0	0	0	0	0
04-Oct	1900	800	0	0	9	1	0	0	1	0
Total			245	16	157	11	21	19	27	1

DV = Dolly Varden

Table 4. Length-frequency of salmon sampled at the fishwheel, Klinaklini R., 1999

Length	Chinook			Coho			Pink		Chum		Sockeye	
(cm)	M	J	F	M	J	F	M	F	M	F	M	F
22	0	0	0	0	0	0	1	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	1	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0
28	0	2	1	0	0	0	0	0	0	0	0	0
29	0	2	0	0	0	0	0	1	0	0	0	0
30	0	0	0	0	0	0	2	2	0	0	1	3
31	0	3	1	0	0	0	1	5	0	0	0	2
32	0	3	2	0	0	0	1	2	0	0	0	2
33	0	3	0	0	0	0	0	2	0	0	0	1
34	0	3	0	0	0	1	0	2	0	0	0	0
35	0	1	0	0	0	2	0	0	0	0	0	0
36	0	2	0	0	0	1	0	3	0	0	1	0
37	0	1	1	0	0	2	0	2	0	0	0	0
38	0	2	0	0	0	0	2	1	0	0	0	2
39	0	0	0	0	0	2	2	0	0	0	0	1
40	0	0	0	0	0	5	2	1	0	0	0	1
41	0	2	0	0	0	8	2	2	0	0	2	2
42	0	1	1	0	0	4	1	1	0	0	4	4
43	0	3	0	0	0	4	4	1	0	0	1	4
44	0	0	0	0	0	7	0	1	0	1	2	4
45	0	0	1	1	0	5	2	0	0	0	1	5
46	2	0	1	6	0	11	0	0	0	0	2	2
47	2	0	0	7	0	6	0	0	0	0	0	3
48	4	0	0	7	0	10	0	0	0	0	1	4
49	2	0	0	8	0	6	0	0	0	0	4	4
50	2	0	0	6	0	10	0	0	0	0	1	5
51	8	0	0	10	0	19	0	0	0	0	0	2
52	5	0	1	9	0	11	0	0	0	0	0	0
53	8	0	2	17	0	14	0	0	0	0	5	0
54	8	0	3	18	0	25	0	0	0	1	0	1
55	10	0	5	21	0	15	0	0	0	0	0	0
56	10	0	6	15	0	13	0	0	2	0	0	1
57	15	0	7	8	0	7	0	0	0	0	1	0
58	24	0	5	7	0	8	0	0	1	0	0	1
59	17	0	9	7	0	2	0	0	0	1	0	0
60	14	0	9	6	0	7	0	0	0	2	0	0
61	22	0	15	5	0	3	0	0	2	2	0	0
62	15	0	8	6	0	1	0	0	2	1	0	0
63	14	0	14	5	0	1	0	0	1	0	0	0
64	14	0	10	3	0	3	0	0	0	0	0	0
65	10	0	11	0	0	0	0	0	1	2	0	0

Table 4 (cont'd).

Length (cm)	Chinook M	Chinook J	Chinook F	Coho M	Coho J	Coho F	Pink M	Pink F	Chum M	Chum F	Sockeye M	Sockeye F
66	7	0	15	2	0	0	0	0	1	1	0	0
67	3	0	12	1	0	0	0	0	2	1	0	0
68	8	0	18	1	0	0	0	0	1	0	0	0
69	9	0	17	0	0	0	0	0	1	2	0	0
70	15	0	26	0	0	2	0	0	2	0	0	0
71	9	0	14	0	0	0	0	0	0	0	0	0
72	9	0	21	0	0	0	0	0	0	0	0	0
73	3	0	14	0	0	0	0	0	2	0	0	0
74	10	0	12	0	0	0	0	0	1	0	0	0
75	5	0	12	0	0	0	0	0	0	0	0	0
76	8	0	15	0	0	0	0	0	1	0	0	0
77	7	0	13	0	0	0	0	0	0	0	0	0
78	4	0	9	0	0	0	0	0	0	0	0	0
79	8	0	7	0	0	0	0	0	0	0	0	0
80	2	0	6	0	0	0	0	0	0	0	0	0
81	3	0	2	0	0	0	0	0	0	0	0	0
82	2	0	2	0	0	0	0	0	0	0	0	0
83	2	0	1	0	0	0	0	0	0	0	0	0
84	1	0	0	0	0	0	0	0	0	0	0	0
85	1	0	0	0	0	0	0	0	0	0	0	0
86	3	0	0	0	0	0	0	0	0	0	0	0
87	1	0	0	0	0	0	0	0	0	0	0	0
88	0	0	1	0	0	0	0	0	0	0	0	0
89	0	0	0	0	0	0	0	0	0	0	0	0
90	0	0	0	0	0	0	0	0	0	0	0	0
91	1	0	1	0	0	0	0	0	0	0	0	0
92	1	0	0	0	0	0	0	0	0	0	0	0
93	0	0	0	0	0	0	0	0	0	0	0	0
94	0	0	0	0	0	0	0	0	0	0	0	0
95	0	0	0	0	0	0	0	0	0	0	0	0
96	0	0	0	0	0	0	0	0	0	0	0	0
97	0	0	0	0	0	0	0	0	0	0	0	0
98	1	0	0	0	0	0	0	0	0	0	0	0
Total	329	28	332	176	0	215	20	26	20	14	26	54
Mean	64.2	34.9	67.6	54.6		51.1	38.3	35.9	66	61.6	46.2	43.9

Table 5. Age-frequency of chinook and coho sampled at the fishwheel, Klinaklini R., 1999.

	Chinook				Coho			
	Frequency				Frequency			
Age[1]	M	F	J	%	M	F	J	%
0.1	0	0	1	0.5	0	0	0	0.0
0.2	3	8	0	4.8	0	0	0	0.0
0.3	4	6	0	4.3	0	0	0	0.0
0.4	1	7	0	3.5	0	0	0	0.0
1.1	0	0	0	0.0	134	127	0	92.9
1.2	61	31	0	40.0	0	0	0	0.0
1.3	29	58	0	37.8	0	0	0	0.0
1.4	10	11	0	9.1	0	0	0	0.0
2.1	0	0	0	0.0	9	11	0	7.1
Total	108	121	1	100	143	138	0	100

[1] Age notation consists of fresh water years followed by salt water years, the sum of which gives total age.

Table 6. Environmental data collected at the fishwheel site, Klinaklini R., 1999.

DATE	TIME	TEMP. (Deg.C)	SECCHI DEPTH (cm)	FLOW START	FLOW END	FLOW DIFF	FLOW RATE (mps)	REV'S FOR 5 MIN.	RPM	DEPTH GUAGE (cm)
12-Jul-99	800	7	25	663254	675285	12031	1.078	13.6	2.72	584
12-Jul-99	1900	8	22					11	2.2	580
13-Jul-99	700	7	23.5	686480	696204	9724	0.871	11	2.2	571
13-Jul-99	1900	8	23	700162	709931	9769	0.875	10.5	2.1	568
14-Jul-99	700	7		710000	719339	9339	0.837	10.7	2.14	560
14-Jul-99	1900	8	16.8	719340	728718	9378	0.840	10.3	2.06	620
15-Jul-99	830	7	17	728723	738043	9320	0.835	10.7	2.14	580
15-Jul-99	1900	6	16	738050	747695	9645	0.864	10.7	2.14	580
16-Jul-99	800	6	17	747705	757635	9930	0.889	10.3	2.06	570
16-Jul-99	1900	8	17	757636	766532	8896	0.797	10.6	2.12	568
17-Jul-99	800	6	17	766521	775241	8720	0.781	9.7	1.94	562
17-Jul-99	1900	8	16	775243	784020	8777	0.786	9.4	1.88	564
18-Jul-99	800	7	16	784030	792359	8329	0.746	9.6	1.92	560
18-Jul-99	1900	8	16	792361	801202	8841	0.792	9.7	1.94	566
19-Jul-99	800	7	17	801204	810304	9100	0.815	10.3	2.06	576
19-Jul-99	1900	8	16	810298	818461	8163	0.731	9	1.8	576
20-Jul-99	800	7	17	818466	827808	9342	0.837	9.8	1.96	576
20-Jul-99	1900	8	20	827807	837436	9629	0.863	9.6	1.92	578
21-Jul-99	700	7	20	837446	845953	8507	0.762	9.8	1.96	578
21-Jul-99	1900	8	20							578
22-Jul-99	700	7	21	845958	855050	9092	0.814	9.8	1.96	580
22-Jul-99	1900	8	22	855036	864494	9458	0.847	10.2	2.04	578
23-Jul-99	700	8	22	864491	874321	9830	0.881	10.2	2.04	580
23-Jul-99	1900	8	21	874372	884259	9887	0.886	10.2	2.04	585
24-Jul-99	700	7	21	884261	894003	9742	0.873	10.2	2.04	580
24-Jul-99	1900	8	20	894022	902543	8521	0.763	10	2	570
25-Jul-99	700	7	23	902532	911322	8790	0.787	9.2	1.84	558
25-Jul-99	1800	8	23	911333	919259	7926	0.710	9	1.8	549
26-Jul-99	700	7	23	919250	926490	7240	0.649	8	1.6	537
26-Jul-99	1900	8	22	926500	933690	7190	0.644	8	1.6	539
27-Jul-99	700	6	23	933700	942400	8700	0.779	6	1.2	550
27-Jul-99	1900	7	23	942400	951400	9000	0.806	10	2	558
28-Jul-99	700	6	22	951420	961032	9612	0.861	10	2	565
28-Jul-99	1900	7	23	961000	970953	9953	0.892	10	2	580
29-Jul-99	700	6	22	971000	983390	12390	1.110	11.3	2.26	600
29-Jul-99	1900	8	18	983400	996228	12828	1.149	12.5	2.5	605
30-Jul-99	700	6	20	996000	1005342	9342	0.837	10.3	2.06	595
30-Jul-99	1900	8	19	5000	13690	8690	0.778	10	2	580
31-Jul-99	700	6	22	14000	22570	8570	0.768	9.2	1.84	567
31-Jul-99	1800	8	17	22570	31873	9303	0.833	9	1.8	562
01-Aug-99	800	7	16	31880	40909	9029	0.809	8.5	1.7	558
01-Aug-99	1830	8	17	40910	49379	8469	0.759	8.5	1.7	552
02-Aug-99	800	6	17	49386	58445	9059	0.811	8	1.6	548

Table 6 (cont'd)

DATE	TIME	TEMP. (Deg.C)	SECCHI DEPTH (cm)	FLOW START	FLOW END	FLOW DIFF	FLOW RATE (mps)	REV'S FOR 5 MIN.	RPM	DEPTH GUAGE (cm)
02-Aug-99	1830	8	17	58442	67922	9480	0.849	7.5	1.5	552
03-Aug-99	800	7	17	67930	77439	9509	0.852	9	1.8	560
03-Aug-99	1830	8	17	77440	86535	9095	0.815	9	1.8	568
04-Aug-99	800	7	16	86540	96210	9670	0.866	9	1.8	576
04-Aug-99	1830	8	16	96200	108243	12043	1.079	10	2	584
05-Aug-99	800	7	16	108240	121365	13125	1.176	11	2.2	590
05-Aug-99	800	8	16	121360	133970	12610	1.130	10	2	598
06-Aug-99	800	7	16	133974	146991	13017	1.166	11	2.2	604
06-Aug-99	1830	8	16	240260	253380	13120	1.175	11	2.2	608
07-Aug-99	800	7	15	253380	266341	12961	1.161	11	2.2	612
07-Aug-99	1830	8	15	266332	279576	13244	1.186	11	2.2	605
08-Aug-99	800	7	15	279580	291510	11930	1.069	9.5	1.9	600
08-Aug-99	1800	8	16	291520	302208	10688	0.957	9	1.8	596
09-Aug-99	800	8	16	302200	313183	10983	0.984	9	1.8	586
09-Aug-99	1800	8	16	313180	323499	10319	0.924	9	1.8	582
10-Aug-99	930	7	22	323500	333983	10483	0.939	8	1.6	576
10-Aug-99	1800	8	19	339790	349981	10191	0.913	9.5	1.9	574
11-Aug-99	730	7	21	349990	359391	9401	0.842	8.7	1.74	564
11-Aug-99	1830	7	22	359380	368340	8960	0.803	8.5	1.7	556
12-Aug-99	700	7	22	368338	376898	8560	0.767	8.5	1.7	549
12-Aug-99	1830	8	23	376900	385741	8841	0.792	8.7	1.74	550
13-Aug-99	700	6	23	385730	395243	9513	0.852	9	1.8	550
13-Aug-99	1830	8	22	395250	404543	9293	0.832	9	1.8	548
14-Aug-99	700	7	21	404550	413343	8793	0.788	8.5	1.7	545
14-Aug-99	1900	7	22	421910	430302	8392	0.752	8.5	1.7	536
15-Aug-99	700	7	22	430310	438910	8600	0.770	8	1.6	534
15-Aug-99	1900	7	21	447760	456671	8911	0.798	8.5	1.7	548
16-Aug-99	700	6	22	456660	466193	9533	0.854	8.7	1.74	549
16-Aug-99	1900	6	23	466190	475009	8819	0.790	8.5	1.7	541
17-Aug-99	700	6	23	475010	484282	9272	0.831	7.7	1.54	532
17-Aug-99	1900	7	22	491950	500698	8748	0.784	8	1.6	536
18-Aug-99	700	6	22	500700	509540	8840	0.792	8	1.6	542
18-Aug-99	1900	7	21	517990	527401	9411	0.843	8.7	1.74	548
19-Aug-99	700	6	21	527400	536611	9211	0.825	8.7	1.74	553
19-Aug-99	1900	7	21	536610	545208	8598	0.770	9	1.8	554
20-Aug-99	700	6	20	545210	554552	9342	0.837	9	1.8	550
20-Aug-99	1400	7	21	554550	562955	8405	0.753	8.5	1.7	539
30-Aug-99	1900	8	10	562950	570055	7105	0.636	5	1	530
31-Aug-99	800	6	10	570055	575862	5807	0.520	4	0.8	515
31-Aug-99	1900	4	10	575870	581910	6040	0.541	5	1	498
01-Sep-99	800	6	10	581910	588875	6965	0.624	4.8	0.96	488
01-Sep-99	1900	7	12	588871	595429	6558	0.587	4.7	0.94	480
02-Sep-99	800	6	12	595422	601542	6120	0.548	4.6	0.92	474
02-Sep-99	1900	7	12	601540	608383	6843	0.613	5.2	1.04	470

Table 6 (cont'd)

DATE	TIME	TEMP. (Deg.C)	SECCHI DEPTH (cm)	FLOW START	FLOW END	FLOW DIFF	FLOW RATE (mps)	REV'S FOR 5 MIN.	RPM	DEPTH GUAGE (cm)
03-Sep-99	800	6	12	608392	614892	6500	0.582	5.5	1.1	468
03-Sep-99	1900	8	12	614900	622567	7667	0.687	6.5	1.3	468
04-Sep-99	800	6	12	622567	629300	6733	0.603	6	1.2	475
14-Sep-99	1600	7	20	629360	632264	2904	0.260	4.8	0.96	465
15-Sep-99	800	6	21	632270	637905	5635	0.505	3.2	0.64	465
15-Sep-99	1600	6	21	637905	641864	3959	0.355	4.3	0.86	460
16-Sep-99	800	6	22	641850	648563	6713	0.601	5.4	1.08	462
16-Sep-99	1900	8	21	648565	651692	3127	0.280	5	1	455
17-Sep-99	800	5	21	651692	660035	8343	0.747	7.5	1.5	458
27-Sep-99	1500	8	24	661510	665484	3974	0.356	2.3	0.46	400
28-Sep-99	800	6	32	665484	668831	3347	0.300	1	0.2	390
28-Sep-99	1630	5	32	668844	671793	2949	0.264	1.3	0.26	390
29-Sep-99	800	6	27	671786	678543	6757	0.605	4.3	0.86	410
29-Sep-99	1700	6	26	678540	680554	2014	0.180	2.3	0.46	400
30-Sep-99	800	5	29	680555	682036	1481	0.133	4.3	0.86	390
30-Sep-98	1630	7	31	687031	689304	2273	0.204	2	0.4	390
01-Oct-99	800	5	32	689348	691791	2443	0.219	2	0.4	380
01-Oct-99	1600	6	30	691798	692650	852	0.076	0.3	0.06	380
02-Oct-99	800	5	31	692652	699347	6695	0.600	4	0.8	385
02-Oct-99	1600	6	31	699341	701991	2650	0.237			380
03-Oct-99	800	6	35	701999	707970	5971	0.535	4.3	0.86	380
03-Oct-99	1600	7	29	708000	708773	773	0.069			386
04-Oct-99	800	5	35	708000	711750	3750	0.336	1	0.2	370

Table 7. Summary of fishwheel mark-recapture efficiency test by species, 1999.

Species	Period	Number Tagged	Number Recaptured[1]	Recapture Rate (%)	Mean Days at Large
Chinook	Jul 13 - Aug 4	214	17	7.94	11.1
	Aug 5 - Aug 19	380	20	5.26	8.2
	Aug 20 - Sep 14	38	2	5.26	7.5
	Total	632	39	6.17	9.5
Coho		253	10	3.95	10.9
Sockeye		45	2	4.44	2.5
Pink		13	2	15.38	2.0
Chum		29	0	0.00	na
Total:		972	53	5.46	
Mean:				5.99	6.2

[1] Fish captured and tagged at the fishwheel, released 0.5 km downstream, and recovered at the fishwheel.

Table 8. Mussel Creek fence counts, 1999.

Date	Chinook		Coho		Chum	Pink	Sockeye
	Total	Tagged	Total	Tagged			
23-Jul	16	0	0	0	1	0	0
24-Jul							
25-Jul	10	0	0	0	0	0	0
26-Jul	16	0	0	0	1	0	1
27-Jul	18	0	0	0	1	0	1
28-Jul	10	0	0	0	0	0	0
29-Jul							
30-Jul							
31-Jul	18	0	0	0	0	0	0
1-Aug							
2-Aug	22	1	1	0	2	0	0
3-Aug	24	1	1	0	1	0	0
4-Aug	42	1	1	0	1	0	0
5-Aug							
6-Aug	33	2	1	0	1	0	1
7-Aug	22	2	1	0	1	0	0
8-Aug							
9-Aug	15	1	1	0	0	0	0
10-Aug	39	2	3	0	0	0	0
11-Aug	41	2	2	0	0	0	0
12-Aug [1]	29	3	10	0	1	7	0
13-Aug [1]	38	5	12	0	2	9	5
14-Aug [1]	33	2	11	0	1	8	6
15-Aug [1]	24	3	8	0	1	6	5
16-Aug [1]	33	4	10	0	1	8	4
17-Aug [1]	28	5	3	2	0	4	5
18-Aug [1]	47	7	5	3	0	6	2
19-Aug [1]							3
20-Aug [1]	27	2	3	0	0	4	2
2-Sep	21	0	4	0	0	1	0
Total	606	43	77	5	15	53	35

[1] Counts on these dates were not broken out by species. Total counts were allocated to species based on past year's species composition at the fence for the same period.

Table 9. Population estimates, by species, based of fishwheel mark-recapture efficiencies, Klinaklini River, 1999.

Species	Period	Total Fishwheel Catch	Efficiency (%)	Period Population Estimate	Total Population Estimate[1]
Chinook	Jul 13 - Aug 4	214	7.94	2,695	8,262
	Aug 5 - Aug 19	401	5.26	7,624	12,471
	Aug 20 - Sep 14	41	5.26	779	12,471
	Total	656		11,068	
				Upper 95% CL	17,105
				Lower 95% CL	5,031
Coho		410	3.95		10,380
Sockeye		80	4.44		1,802
Pink		47	15.38		306
Chum		35	0.0		n/a

[1] Chinook estimates are based on period specific catch efficiencies and total fishwheel catch.

Table 10. Visual survey data collected for the Klinaklini system by Fishery Officers stationed in the Campbell River subdistrict.

			Chinook				
			Jacks		Adults		
	Method[1]	Date	Count	Estimate	Count	Estimate	River Segment[2]
1979	H	Sept. 15					Mussel
Estimate for Season[3]						3000	
1980	F	Aug. 29					Mussel
Estimate for Season						500	
1981	F	July 26					Mussel
	F	Aug. 29					Mussel
	F	Sept. 22					Mussel
	F	Oct. 5					Mussel
Estimate for Season						1000	
1982	No observation						
Estimate for Season						No Est	
1983	H	July 23					Mussel
	H	Oct. 28					Mussel
Estimate for Season						1220	
1984	H					1000	Mussel[4]
Estimate for Season[3]						1000	
1985	H	June 25					Mussel
	H	Aug. 7					Mussel
	H	15					Mussel
	H	Sept. 15				650	Mussel
Estimate for Season						650	
1986	H	Oct. 15				500	Mussel
Estimate for Season						500	

Table 10. (cont'd)

	Method[1]	Date	Chinook Jacks Count	Jacks Estimate	Adults Count	Adults Estimate	River Segment[2]
1987	H	June 25				1	Mussel
	H	Aug. 7				5	Mussel
	H	15				50	Mussel
	H	Sept. 15				600	Mussel
Estimate for Season						706	
1988	H	Sept. 12				1000	Mussel
Estimate for Season						1000	
1989	H	Oct. 2				250	Mussel
Estimate for Season						250	
1990	No observations						
Estimate for Season						No Est	
1991	H	July 12				45	Mussel
	H	22				110	Mussel
	H	Aug. 16				57	Mussel
	H	Sept. 21				114	Mussel
	H	Oct. 9				8	Mussel
Estimate for Season						500	
1992	H	Aug. 13				650	Mussel
	H	Sept. 18				700	Mussel
Estimate for Season						700	
1993	H	Aug. 29				585	Mussel
	H	Sept. 29				99	Mussel
	H	29				60	Icey
	H	Oct. 26				65	Mussel
Estimate for Season						809	

Table 10. (cont'd)

	Method[1]	Date	Chinook Jacks Count	Chinook Jacks Estimate	Chinook Adults Count	Chinook Adults Estimate	River Segment[2]
1994	H	Sept. 17			719		Mussel
	H	Nov. 11					Icy/Dice
	H	Nov. 11			1		Mussel
Estimate for Season[3]						720	
1995	H	Aug. 4			69	250	Mussel
	H	Aug. 4			6	10	Icy/Dice
	H	Aug. 25			800	800	Mussel
	H	Sept. 22			1400	1400	Mussel
	H	Sept. 22			450	450	Icy/Dice
	H	Oct. 30			11	11	Icy/Dice
	H	Oct. 30			20	20	Jumper
Estimate for Season						3290	
1996	H	Aug. 22			257	800	Mussel
	H	22			0	0	Icy/Dice
	H	Oct. 18			776		Mussel
Estimate for Season[3]						2600	Icy/Dice/ Mussel
1997	H						
Estimate for Season[3]						2100	Icy/Dice/ Mussel
1998	H	Aug 20			740	1036	
Sep 18			7	10			
Oct 22			0	0			
Estimate for Season[3]						1046	Icy/Dice/ Mussel
1999	H						
Estimate for Season[3]						400	Icy/Dice/ Mussel

[1] S - Swim survey, H - Helicopter survey, F - boat survey
[2] Refer to Fig. 2
[3] Total escapement estimate for adult chinook
[4] In November a 200 m slide into Mussel Cr. Likely destroyed most of the chinook spawn.

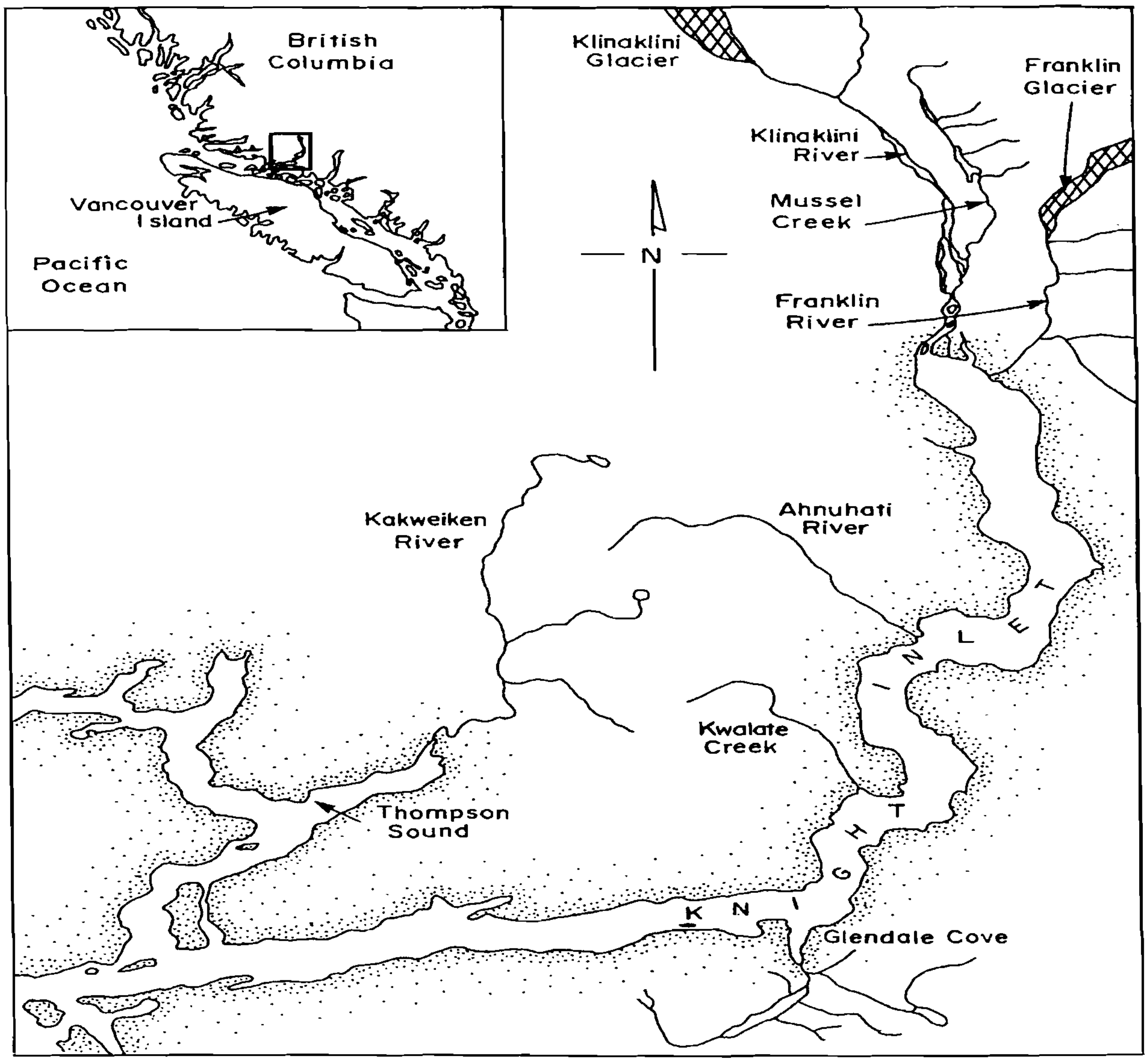

Figure 1. Knight Inlet study area.

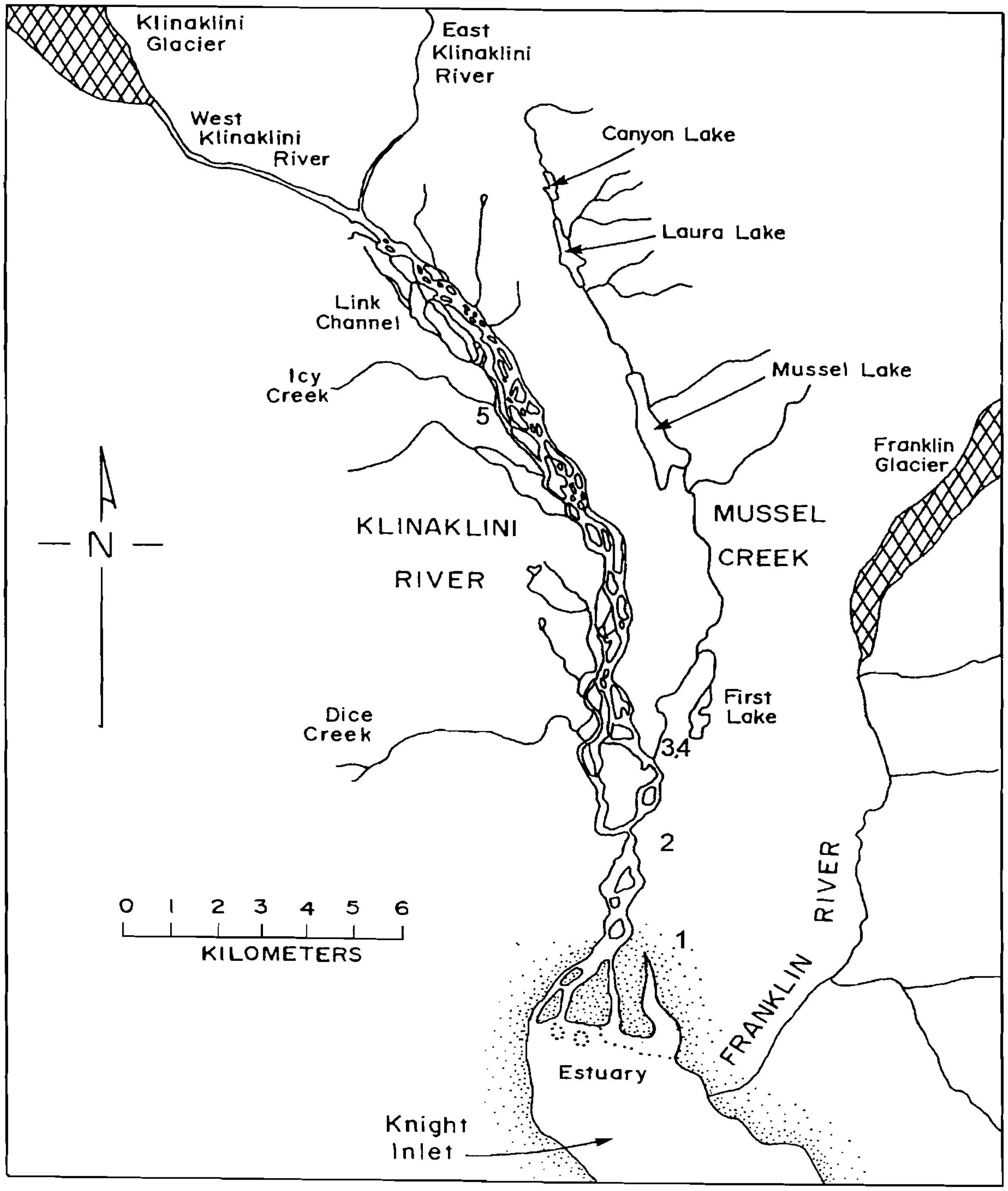

Figure 2. Location of 1)Interfor camp, 2)fishwheel, 3)Mussel Creek counting fence.

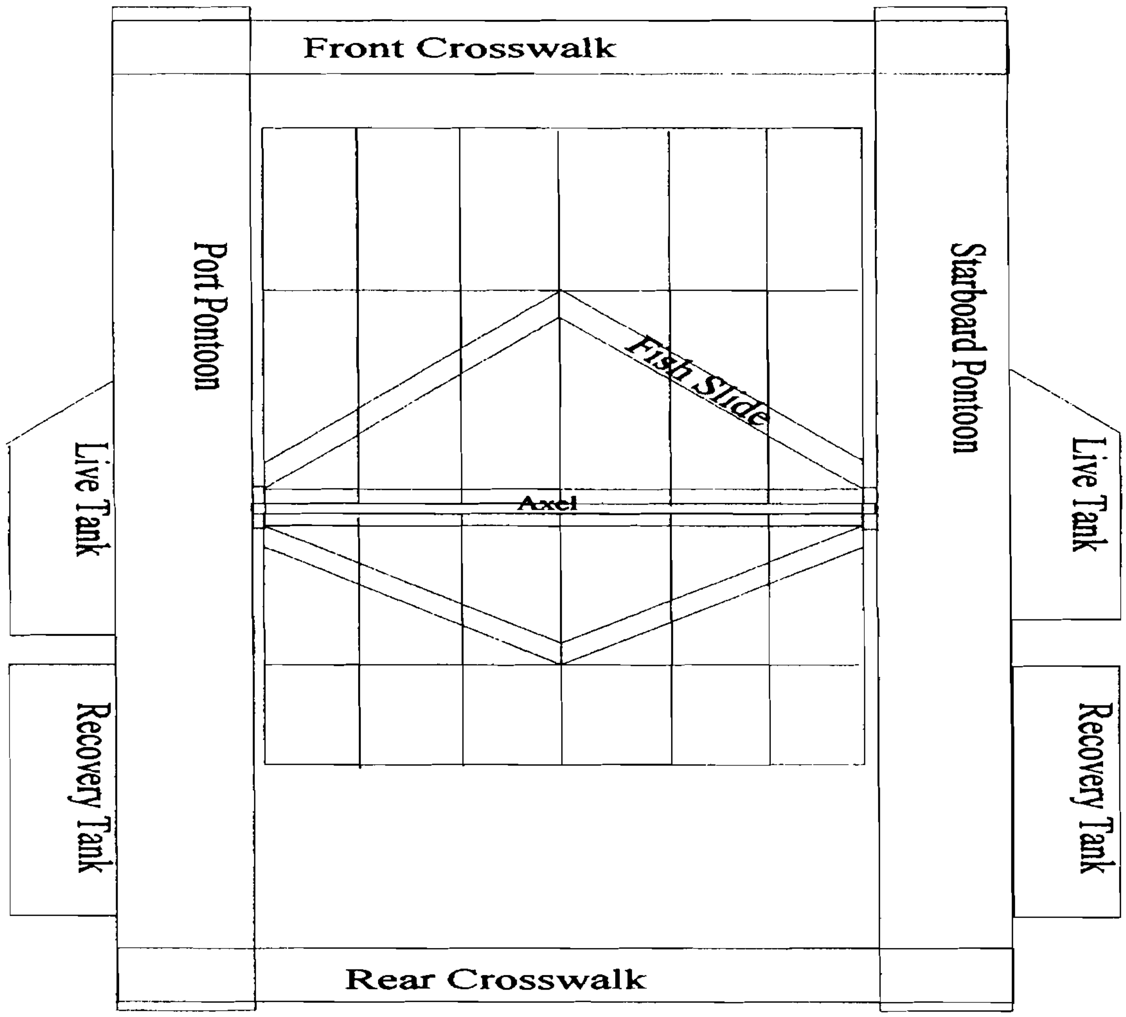

Figure 3. Schematic diagram of fishwheel (aerial view).

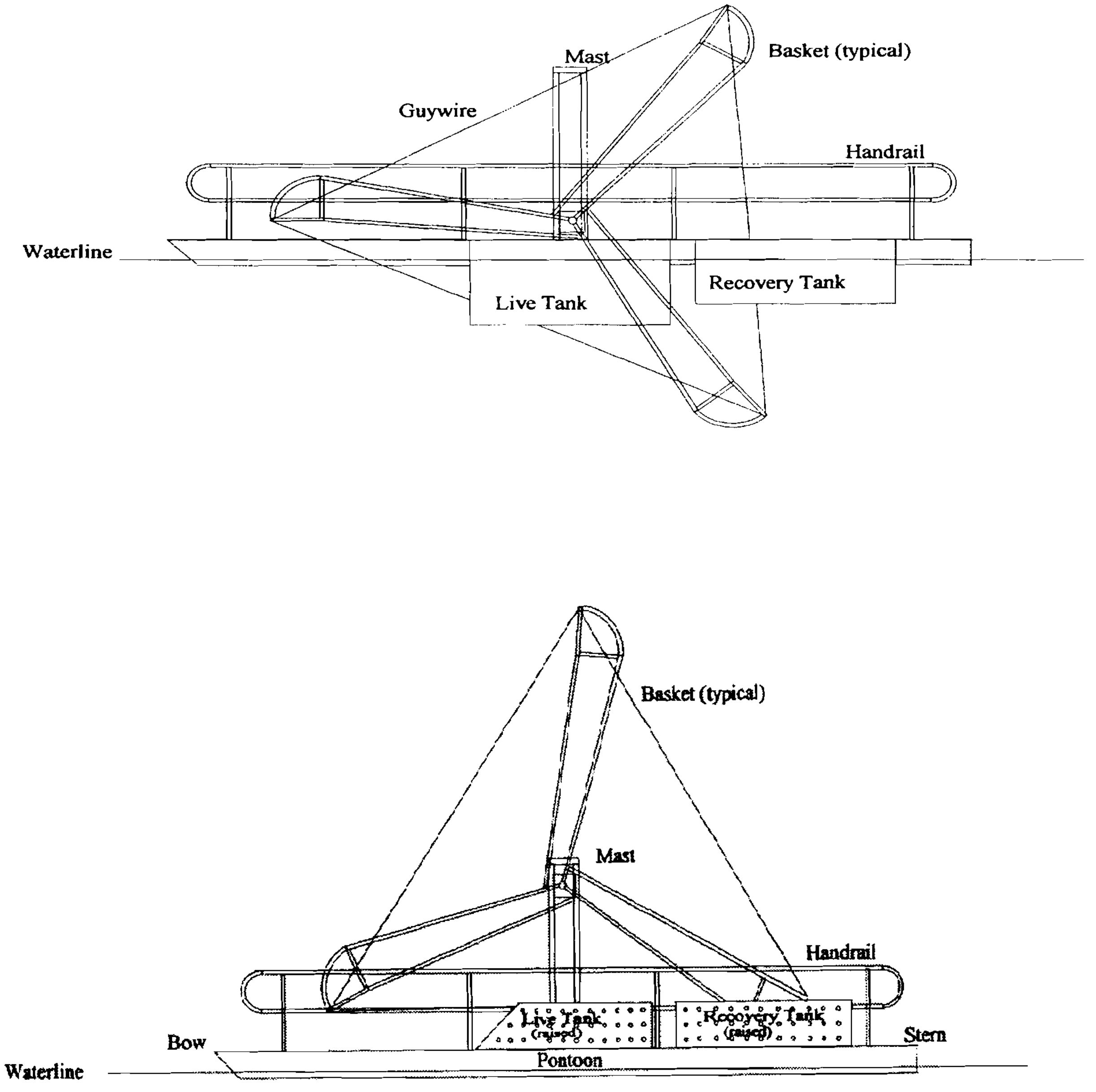

Figure 4. Schematic diagram of fishwheel in the lowered (top) and raised (bottom) position.

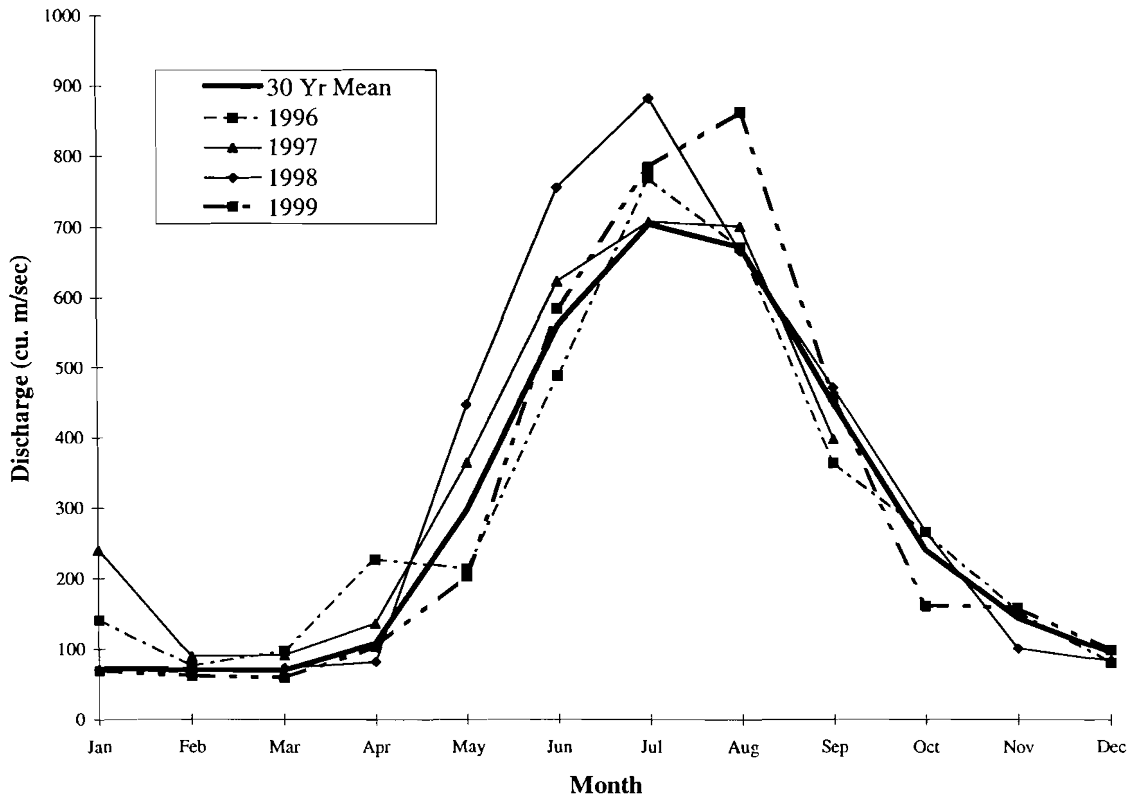

Figure 5. Klinaklini River discharge.

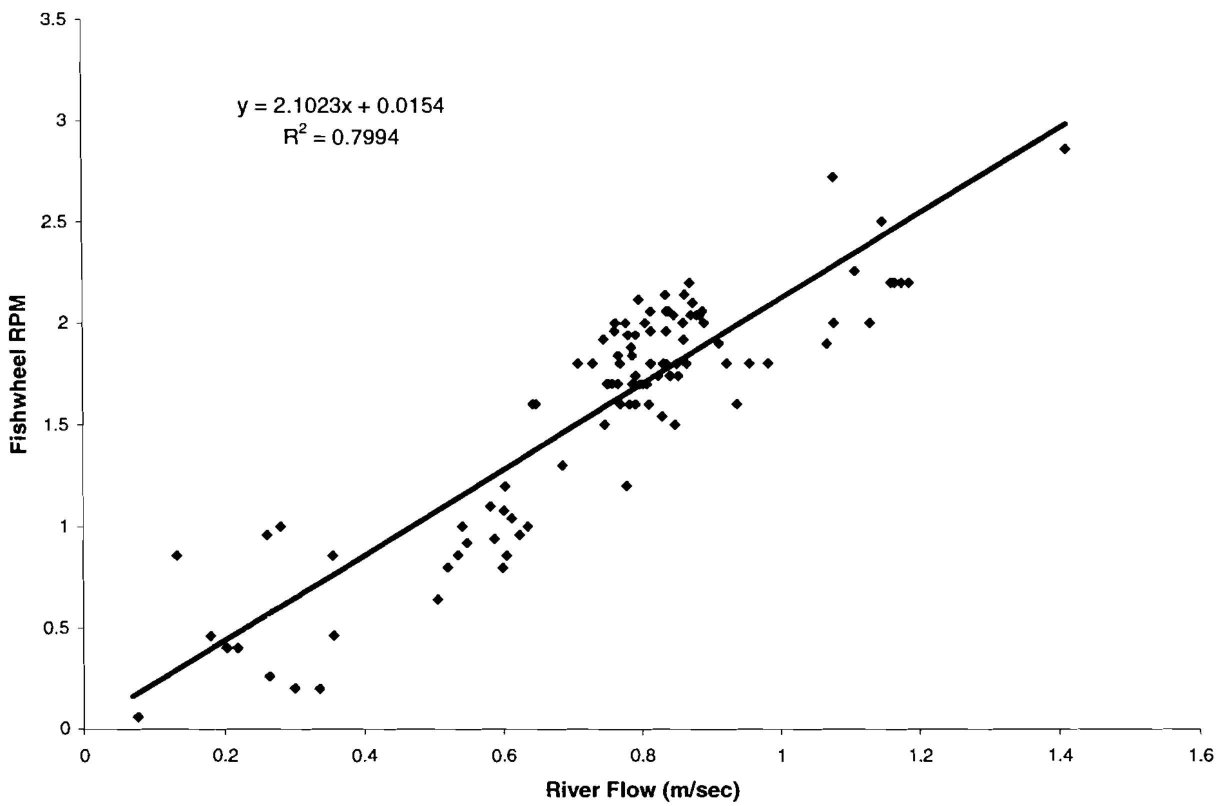

Figure 6. Fishwheel rotational speed related to water flow, Klinaklini R., 1999.

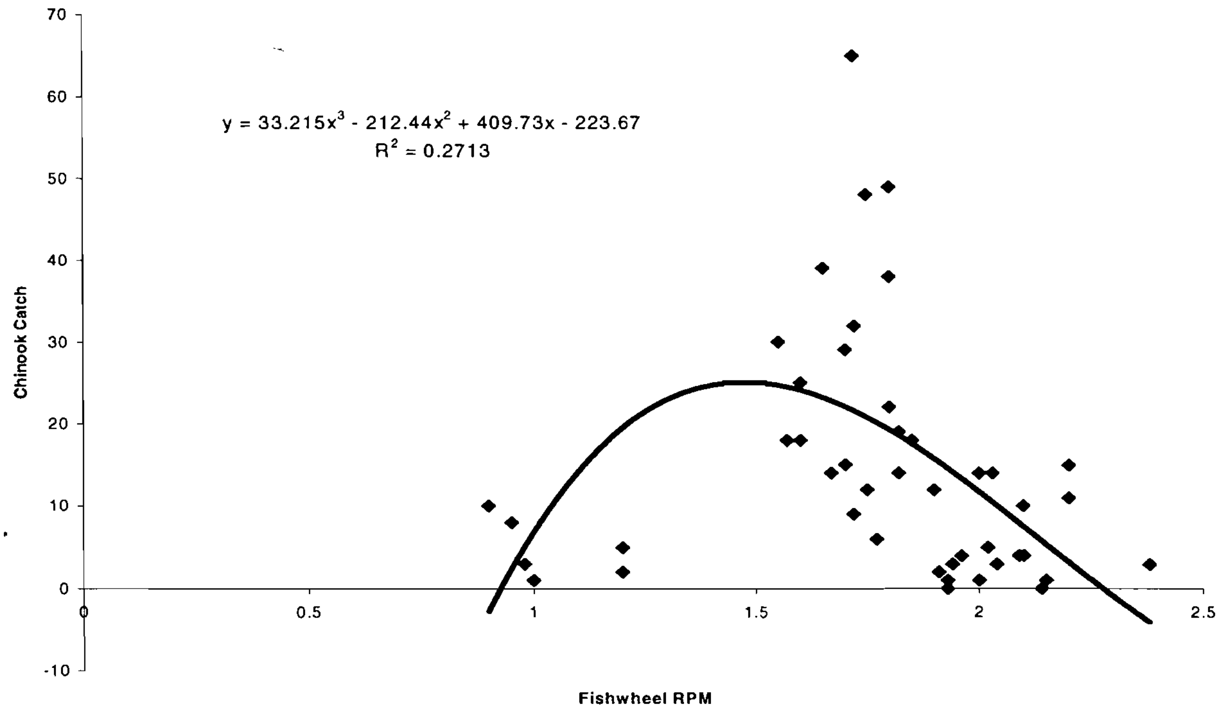

Figure 7a. Fishwheel rotational speed related to chinook catch, Klinaklini R., 1999.

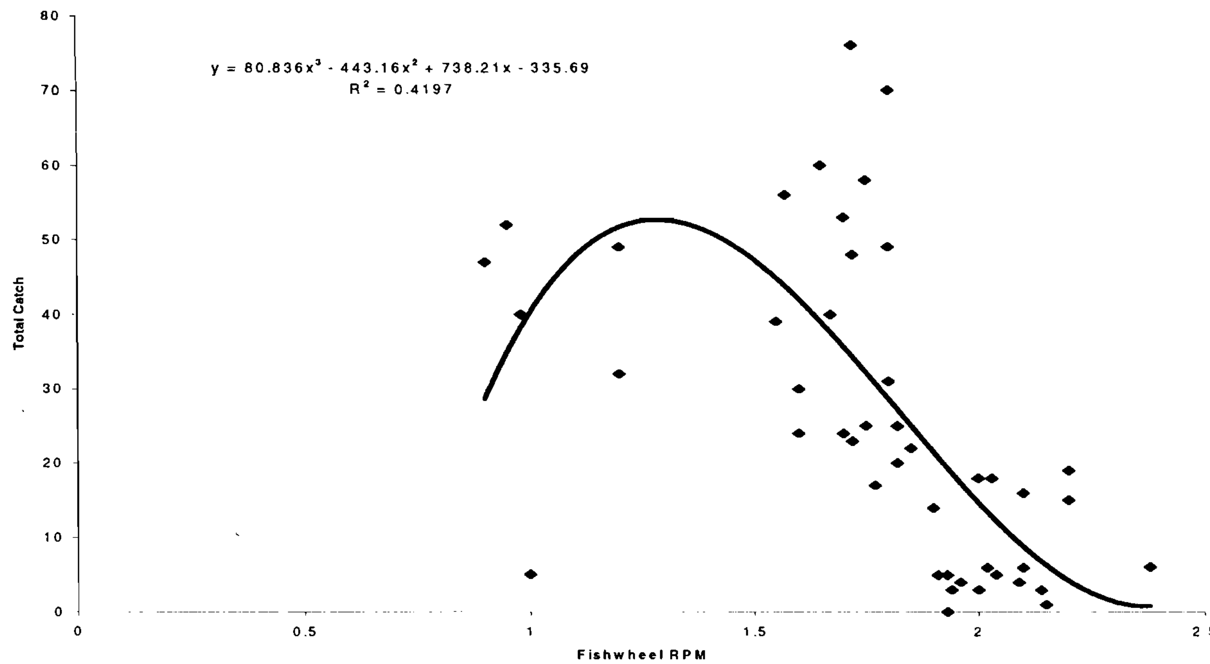

Figure 7b. Fishwheel rotational speed related to total catch, Klinaklini River, 1999.

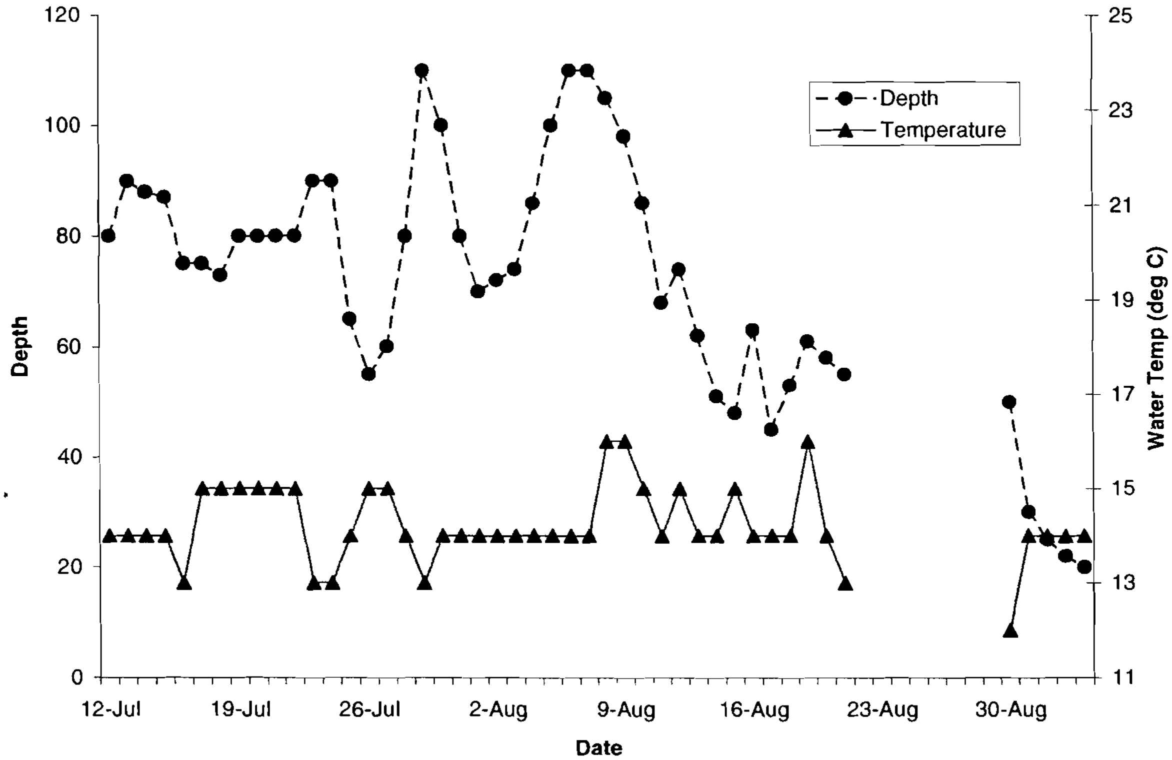

Figure 8. Mussel Creek environmental data, 1999.

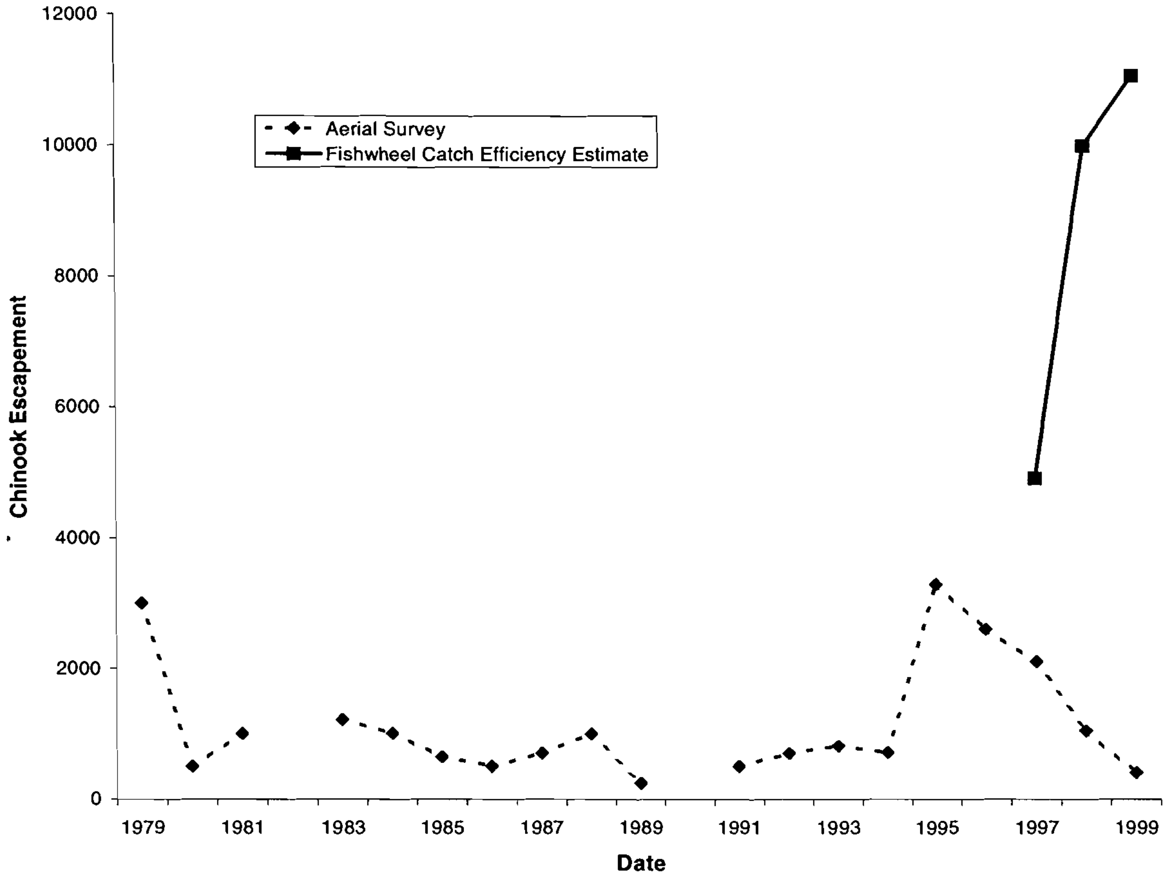

Figure 9. Chinook escapement estimates, Klinaklini system, 1979-99.

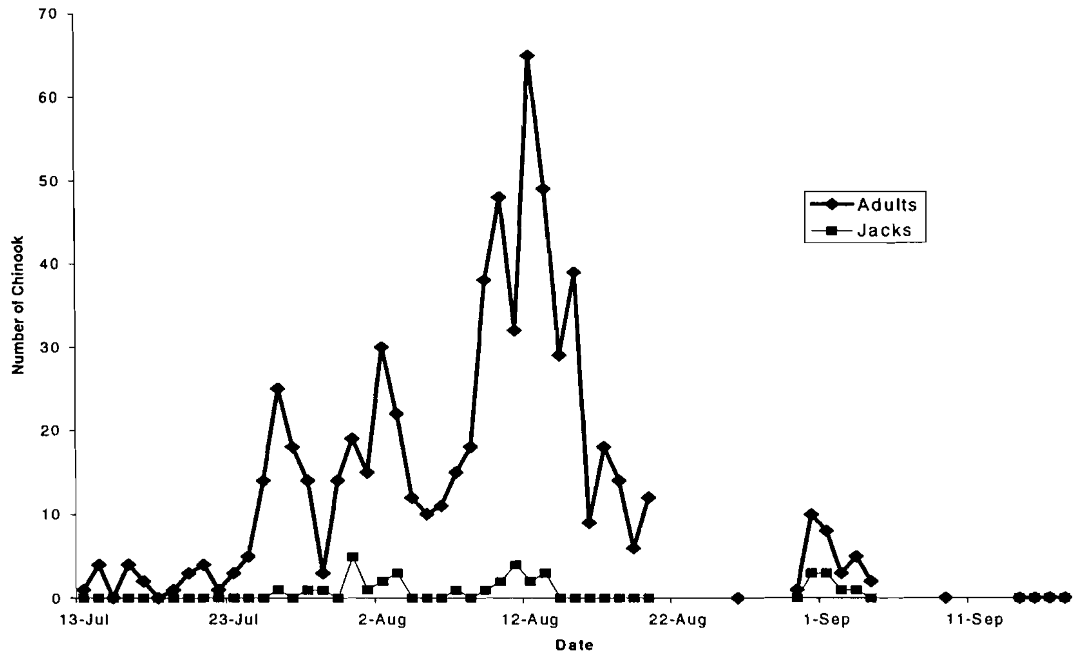

Figure 10. Chinook run timing, Klinaklini River, 1999.

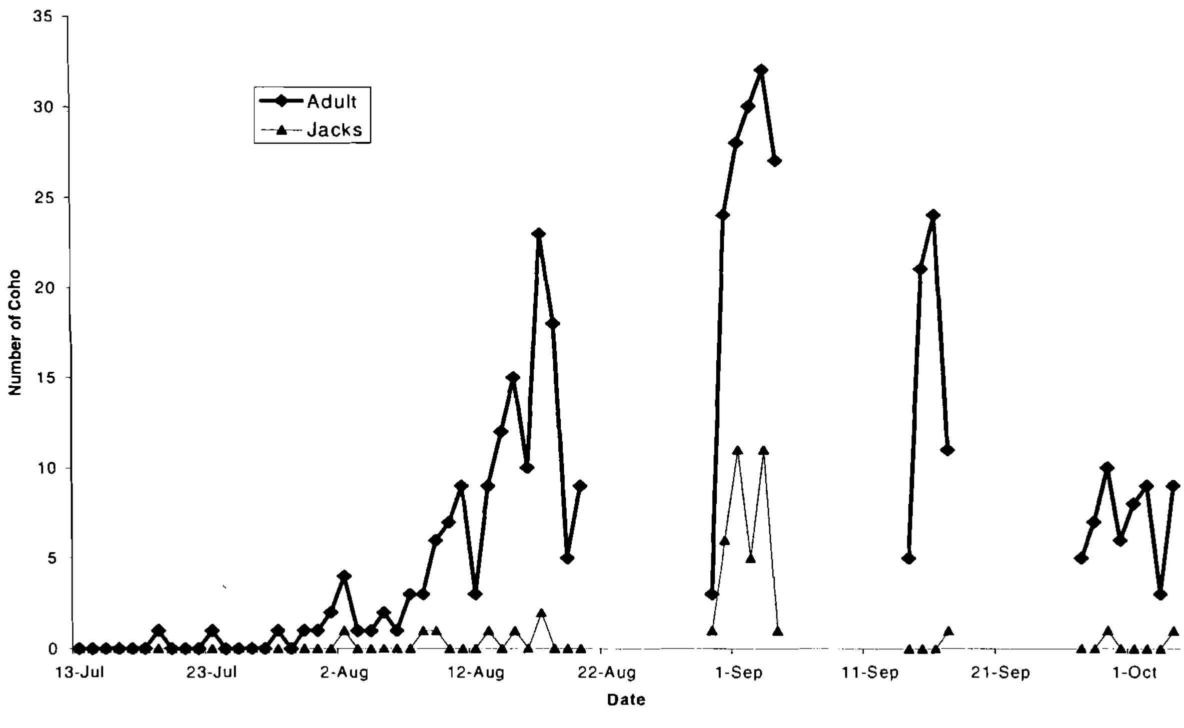

Figure 11. Coho run timing, Klinaklini River, 1999.