

Kwethluk River Counting Tower Salmon Assessment Project, 1998

by

**Jennifer L. Chris
and
Thomas Cappiello**

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AUTHORS

Jennifer Chris, fishery biologist for the Association of Village Council Presidents, Inc., Natural Resources Department, P.O. Box 219, Bethel, Alaska 99559.

Thomas Cappiello, former Kuskokwim Area Assistant Management Biologist for the Alaska Department of Fish and Game, Commercial Fisheries Division, P.O. Box 1467, Bethel, Alaska 99559.

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ABSTRACT

In 1996 the Association of Village Council Presidents (AVCP) in cooperation with the Alaska Department of Fish and Game (ADF&G) and the U.S. Fish and Wildlife Service (USFWS) initiated and operated a salmon counting tower on the Kwethluk River, a tributary of the lower Kuskokwim River. Funding was renewed in 1997 and 1998 to continue the project. This report presents the results of the counting tower operations in 1998.

The 1998 counting operation began on 24 July and ended on 18 August. Passing salmon were counted the first 20 min of each hour, 24 h a day. Daily salmon passage by species was estimated by multiplying the daily sum of the 20 min counts by three. The total estimated passage during the operational period was 120 chinook, 120 sockeye, 720 chum, 4,398 pink, and 2,367 coho.

High water levels in the Kwethluk River delayed counting by 32 days and forced a premature end to the project by 16 days. As a consequence, the 1998 tower operations comprised only a fraction of the total passage of each salmon species. The limited passage estimates were useful mostly in the context of comparing 1998 numbers to the estimates of 1992, 1996 and 1997, within the same time period.

Overall, the chinook, chum, pink and coho passages all appeared to be relatively low in 1998. Sockeye salmon have a naturally low incidence in the Kwethluk River and the numbers observed in 1998 appeared comparable to past years. To adequately assess coho and pink salmon escapements, the tower must operate until at least mid-September, which is not a realistic expectation for the tower due to chronic poor counting conditions in August and September. Although species identification by the tower crew did not appear to be a significant problem, tower operation in following years should include an evaluation of the crew's variability in salmon identification.

INTRODUCTION

Draining an area of about 3,400 km², the Kwethluk River originates in the Kilbuck Mountains and flows for approximately 220 km to the Kuskokuak Slough of the Kuskokwim River (Brown 1983). Most of the Kwethluk River drainage is within the Yukon Delta National Wildlife Refuge, which is managed by the U.S. Fish and Wildlife Service (USFWS). The mouth of the Kwethluk River, where the village of Kwethluk (population ~650) is located, is about 170 km from the mouth of the Kuskokwim River. The lower 5 km of the Kwethluk River is tidally influenced.

Chinook (*Oncorhynchus tshawytscha*), chum (*O. keta*), sockeye (*O. nerka*), coho (*O. kisutch*), and pink salmon (*O. gorbuscha*) spawn in the Kwethluk River. Common resident species include rainbow trout (*O. mykiss*), Dolly Varden (*Salvelinus malma*), Arctic grayling (*Thymallus arcticus*), burbot, or "lush" (*Lota lota*), northern pike (*Esox lucius*), and whitefish (*Coregonus spp*).

Subsistence and commercial fishers who live along the Kuskokwim River place major cultural and economic importance on harvests of salmon. Commercial fisheries occur in two non-contiguous districts (Districts 1 and 2) in the Kuskokwim River stretching from the river mouth to Chuathbaluk (Figure 1). The 10-year average (1988-1997) commercial harvest for both districts combined is approximately 31,000 chinook, 64,000 sockeye, 451,000 chum, and 545,000 coho salmon (Burkey et al. 1997). The 1988-1997 average subsistence harvest of chinook, sockeye, chum and coho salmon in the Kuskokwim River is approximately 83,000, 35,000, 100,000, and 37,000 respectively (Burkey et al. 1997). The Kwethluk River is one of many salmon producing tributaries of the Kuskokwim River that support these fisheries.

Kwethluk River salmon stocks are harvested by commercial and subsistence fishers in District 1 and by subsistence and sport fishers in the Kwethluk River. The overall exploitation rate of Kwethluk River stocks is unknown due to the lack of stock identification tools. Previous genetic studies have not been able to distinguish among stocks of early run chum salmon in the Kuskokwim River, which includes the Kwethluk River chum salmon population (Seeb et al. 1997). Genetics stock identification of other species has not been investigated.

In 1992, the USFWS operated a resistance board weir on the Kwethluk River. This project was successful in enumerating salmon escapement from 21 June through 12 September. In 1996 the Association of Village Council Presidents (AVCP), in cooperation with the Alaska Department of Fish and Game (ADF&G) and USFWS, initiated and operated a salmon counting tower (Cappiello and Sundown 1998). Funding was renewed to continue the project in 1997 and 1998. This report presents the results of the 1998 counting tower operation.

METHODS

Study Site

The counting tower and field camp were located approximately 130 river kilometers (rkm) from Bethel (60.29.049 N lat.; 161.05.296 W long.; Figure 1). The camp and one tower were located on the west bank (Figure 2), at approximately rkm 83 of the Kwethluk River. The tower was approximately 3 km upstream from the 1992 weir site. The channel width at the tower site was approximately 53 m, with a maximum depth of 1 m at normal flow. Immediately upstream from the tower site, a narrow, shallow channel branches off the mainstem and joins an old oxbow which rejoins the mainstem several hundred meters upstream from the tower site. No fish were observed attempting to migrate through this small channel.

Tower Operation

A fish lead (approximately 22 m wide), measuring 28" wide by 80" high, assembled from wooden tripods and tubular aluminum panels, directed fish over an open stretch of channel with flash panels attached to the substrate for contrast. Three 500W halogen lights used for lighting were attached to the 20 ft tower fashioned from scaffolding and constructed and situated similar to that in 1996 and 1997 (Cappiello and Sundown 1998), (Figure 1). In 1998 white-painted expanded steel with dimensions of 48" x 96" and 3/4" mesh was used for flash panels, instead of sandbags, and an additional spotlight was added. This paneling was approximately 29.3 m wide.

The project operated from 24 July to 18 August and 20 min counts were made every hour, 24 h per day, 7 days per week. Age, sex and length (ASL) sampling by beach seine was unsuccessful due to the swiftness of the Kwethluk River and the difficulty of using beach seines in such debris-filled waters and was discontinued in 1997 (Cappiello and Sundown 1998).

Data Analysis

For each 24 h period (0000 to 2300 h) fish passage was counted the first 20 minutes of each hour. This actual count was multiplied by three to obtain the expanded full-hour passage. Then, at the end of the last count each day, the full-hour counts were summed to generate the daily passage estimates. Whenever hourly counts were missed, they were accounted for with an interpolated "estimate." During the 1998 season no counts were estimated as most every day, the full 24 hours were counted. The first and last days weren't given daily total estimates because of the lack of adjacent days to extrapolate from.

RESULTS

Counting first began at 1600 hours on 24 July and ended for the season at 0620 hours on 18 August. Water conditions during the operating period were adequate for counting fish (Appendix A.1). The counting schedule was uninterrupted except on 26 July when counts were suspended from 2000 to 2100 h due to lightning storms. Tables 1 through 5 present the actual (20 min counts) and expanded full-hour counts, total hours counted, and the estimated daily counts for each salmon species. Figure 3 illustrates the daily passage estimates for 1998 for each species.

The total expanded count of chinook salmon was 120 (Table 1). Chinook salmon were first counted on 24 July and continued to pass through the end of the operational period. Neither the beginning nor the midpoint of the chinook run were identified due to insufficient data collected because of the late start in counting.

The total expanded count of sockeye salmon was 120 (Table 2). Sockeye were first counted on 24 July and continued to pass through the end of operational period. As with chinook, neither the beginning nor the midpoint of the sockeye run were identified.

The total expanded count of chum salmon was 720 (Table 3). Chum were first counted on 24 July and continued to pass through the end of the operational period. Once again, neither the beginning nor the midpoint of the chum run were identified.

The total expanded count of pink salmon was 4,398 (Table 4). Pinks were first counted on 24 July and continued to pass through the end of the operational period. The pink run was expected to peak about mid-August and continue to mid-September. No conclusions on run timing or strength were made for 1998 due to the late start and early finish in counting.

The total expanded count of coho salmon was 2,367 (Table 5). Coho were first counted on 27 July and continued to pass through the end of the operational period. Once again, the coho run was expected to peak around late August and continue well into September. As with pinks, no conclusions on run timing or strength were made for 1998.

Tables 6 through 10 show the historic daily passage estimates, the cumulative counts and the percent passage by species, for applicable years for the 1992 and 1996 through 1998 operational periods. The cumulative counts of the truncated 1998 counting schedule, along with the same time period from the previous three years of operation, is outlined to compare those estimated passages.

DISCUSSION

An important analytical aspect of the escapement from this tower project, and most tower projects in general, is ensuring that estimated portions of the total are not biased. Since there were no estimated hourly counts in 1998, this was not of concern. In order for the estimate of the total run size to be unbiased, the 20 min counts must be representative of the entire hour's passage. Possible factors that could affect the extrapolated counts include driving a boat across the river or other activity such as making repairs to the flash panels, or noise made by the counter climbing the tower before counting.

In 1998, there were no known factors that could have systematically biased the estimates of fish passage. The tower and camp were located on the same riverbank so there was no need to frequently cross the river. Weir and flash panel cleaning and/or repairs were generally done during the morning hours from 0600 to 1200, either before or after a counting shift by one of the technicians. Counting was not interrupted.

The estimated number of chinook salmon counted in 1998 (120) was lower, during the same operating period, than in previous years. The total count of chinook between 24 July and 18 August from the Kwethluk weir project in 1992 was 9,675 (Harper 1998) and the tower estimates in 1996 and 1997 were approximately 7,400 and 10,400, respectively (Cappiello and Sundown 1998); with only about 3% to 5% of the run yet to pass based on run timing in 1992. The George River weir (Figure 1), also indicated below average chinook salmon escapement in 1998 (ADF&G 1998). This project also suffered a high water, truncated season. Chinook salmon are harvested by subsistence fishers and taken incidentally in the commercial chum fishery in the Kuskokwim River. Low chum salmon returns in 1998 limited Kuskokwim River fishing to five short commercial fishing periods during the directed chum fishery. Consequently, the incidental commercial harvest of chinook salmon was reduced.

The estimated number of sockeye salmon counted in 1998 (120) was much lower than that in 1997 (1,374), 1996 (1,804) (Cappiello and Sundown 1998), and 1992 (1,316) (Harper 1998). When comparing the time period counted in 1998 to the previous years of operation there did not appear to be that great of a contrast. Typical sockeye rearing habitat, such as large volume lakes, is absent in the Kwethluk River drainage. There are some smaller lakes in the headwaters but their potential for sockeye production is unknown. Similar to the Holitna River (Figure 1), the sockeye salmon in the Kwethluk are most likely a "river-type"; that is they spawn and rear exclusively in flowing waters.

The estimated number of chum salmon passed in 1998 was 720 and much lower, during the same period in 1992, when 30,596 chum passed the weir (Harper 1998). Low chum escapement was observed at other assessment projects throughout the Kuskokwim River drainage in 1998 (ADF&G 1998). As mentioned above, only five commercial fishing periods were allowed in District 1 during the chum directed fishery.

With the shortened counting schedule in 1998, the only objective comparisons to make are of

that same time period counted in 1998, to those in previous years (24 July to 18 August). The only year which counted the same period of time was 1992. Along these lines, chinook salmon returns in 1998 were 11% (N=120) of what returned in 1992 (1,090). Sockeye salmon were 65.2% (N=120) of 1992 counts (184). Chum salmon returns were 6.5% (N=720) of 1992 counts (11,149). Pink salmon were 10.4% (N=4,398) of what returned in 1992 (42,090). Coho salmon returned at 31.7% (N=2,367) of that of 1992 (7,462), counts in the same time period. These numbers support the fact that some of the systems monitored on the Kuskokwim River saw disastrous returns in 1998, although the escapement data in 1998 was not adequate enough to declare all species' escapements to be disastrous. Also, the subsistence needs appeared to have been met, while there was very limited commercial fishing.

The Kwethluk River tower operation ended before escapements of pink and coho salmon could be assessed. In 1992, the floating weir operated until 12 September, well after peak migration of both species. The coho and pink salmon escapements in 1992 were 45,952 and 45,605 respectively (Harper 1998). Little is actually known about the run dynamics and escapement of pink salmon throughout the Kuskokwim River. Pink salmon exhibit even year dominance, and therefore, are expected to arrive in higher numbers in 1998, compared to odd years. Pink salmon generally occur in relatively low numbers in the Kuskokwim River. They are not a very important commercial or subsistence resource although they may be an important source of nutrient enrichment for some systems. The count of pinks at the Kwethluk River weir in 1992 was the highest documented escapement of this species in any stream in the Kuskokwim Area.

Because the Kwethluk River tower is relatively far upstream and close to the spawning grounds, most salmon observed passing are water marked (in spawning coloration) and fairly easy to identify. However, species identification problems are inherent in any fish counting tower project where more than one species occurs. Although species identification problems were not fully assessed, misidentification was presumed low

The Kwethluk River characteristically, is susceptible to high water from seasonal freshets, and murky water caused by clay or loess riverbanks. The tower is on the west side of the river and glare from the morning sun has a negative impact on an observer's ability to see fish. To help alleviate this problem, polarized sunglasses were worn by the counters to help in seeing the fish. Fortunately, fish passage is generally low during the morning hours. During 1998, there was one period (26 July, from 2000 to 2100 h) where weather conditions severely impaired counting fish, aside from the high waters that kept the project from starting as desired and then ending earlier than expected. Water conditions were high throughout the Kuskokwim River drainage, and in some areas, local elders had not seen such high water in many years.

RECOMMENDATIONS

The Kwethluk River tower project was operated very well during the truncated 1998 season. The

field technicians were very experienced and adept at species identification. The remote nature of the tower and field camp has both negative and positive aspects. There are few suitable sites for a tower downstream so the general vicinity of the present location is appropriate. The biggest difficulties with the tower operations were the high water conditions and maintaining the morale of the crew.

Subsistence activities are a necessary part of life in the Kuskokwim area, and are not always compatible with a wage-earning work schedule. One way to address this problem with those working as technicians on this project, is to rotate personnel on a one-week-on and one-week-off schedule or something of that nature. This year an alternate technician was hired to be "on call" to accommodate a "time off" schedule. Having additional people trained and familiar with such a project is beneficial. There are many variations of scheduling employees for tower projects but the main intent is to get 24-h counts *and* maintain crew morale. It is recommended however that prior to hiring or rehiring personnel, their needs are identified and all attempts should be made to accommodate them with a flexible schedule.

Sampling by beach seine for ASL information was unsuccessful in 1996 and 1997 (Cappiello and Sundown 1998), again due to the swiftness and the amount of debris found in the Kwethluk River. Therefore, such attempts were not made in 1998. Instead, this project concentrated on counting for 24 h per day, 7 days per week. Each person should count 8 hours, therefore a minimum of three people are needed at all times. If 24-h counts are not possible everyday, an 18-h per day count schedule is acceptable, only if 24-h counts can be made regularly; a minimum of 2 or 3 times a week. It is also important to sample most intensively during the peak of the species run of interest. There are many ways to schedule employees for tower projects, but again, the main objective should be to maximize the number of counts while maintaining crew morale, and staying within the budget.

Although species identification was not known to be a significant problem at the Kwethluk River tower, differences in identification among the crew should be assessed, especially if new crew members are hired. Accurately validating the species of passing salmon would be difficult, but knowing relative observer error would be important for assessing overall success of the project. It would be beneficial to have "test" counts at the beginning of the operation period, and also during peak times, where two people count simultaneously, after the 20 min count is achieved by the assigned counter. Then, compare their numbers and identify any differences in counts and address what might be the causes. These calibration counts would be helpful in estimating the percentage of "error" between observers.

One difficulty that was apparent during 1997 was the inadequacy of the lighting system for counting at night. The lights used were too diffuse, and more concentrated spot-type lighting was needed. In 1998, an additional spotlight was attached to the tower and used at night. Also needed was a better flash-panel system. The previous method of using white sand bags is acceptable only as a last resort. Expanded steel, which is a mesh-like fencing, was purchased, painted white, and placed on the river bottom and secured with sand bags for the 1998 season. Two small problems observed were an occasional pile-up of gravel on a panel, or rust forming on lightly-coated areas. These were the only identified problems by the experienced technicians with this new paneling.

It is now the preferred system to use, when compared to using sandbags.

The difficult accessibility of the Kwethluk River tower site complicates logistics. In 1998, as well as in the previous years, many costly trips by jet boat were made to resupply the camp with food, gas and supplies. With some careful planning, supply trips should not be necessary more than once a week. At the beginning of the season enough trips should be made to haul in gas and food to last several weeks. A regular supply trip schedule should be established so that the crew knows when to expect supplies, and people who are involved with the project can plan ahead for visiting and helping out. Communications with a VHF radio to Bethel were often unreliable. Use of single-side-band radio with the ADF&G office seemed to be the best way to communicate and will be used in following years.

The late start-up and premature end in 1998 was unavoidable due to the high water conditions. We can expect this to continue to periodically inhibit the completion of our goal on the Kwethluk River. Still, for two of the three years of operation, water conditions did allow for adequate enumerating in June and most of July, when most of the chinook passage occurs. Full assessment of the chum salmon escapement, however, has not been achieved in any of the three years of tower operation. In 1998, we likely missed the first half of the chum salmon run due to the late start-up date. In 1996 and 1997 much of the second half of the chum run was missed, due to the premature end of operation.

Realistically, there is little hope for the tower to be operated for the entire pink and coho runs, because of the chronically poor counting conditions that occur during these runs. The limited operating time elemental to the counting tower design will continue to significantly hinder fulfillment of project objectives on the Kwethluk River.

The most cost effective solution to these problems is to install a weir or, more favorably, a floating weir, on the Kwethluk River. A floating weir would solve most, if not all of the problems that are associated with the high water conditions that occur each season on this river, and in trying to get full, actual escapement counts for each species desired. Also, the weir would allow for easier sex composition of the run to be determined. The effectiveness of a weir was proven in 1992.

The tower operation should continue as long as the budget will allow, but there is little reason to continue past mid-August if the objectives do not include enumerating coho and pink salmon. The use of a weir, however, would allow counts to continue into September.

The goal of the Kwethluk River counting tower is to estimate the total spawning populations of each salmon species in the river. As such, it is critically important that the project be in operation during the entire duration of each salmon run being monitored.

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Table 1. Net upstream passage (actual and expanded) of chinook salmon during hourly 20-min counts at the Kwethluk River Tower, 1998. Negative numbers represent fish going downstream.

Date	Total Hours																				Total Count	Expanded Count				
	Counted	0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800			1900	2000	2100	2200
7/24	8																1	0	1	0	1	0	0	0	3	9
7/25	24	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	1	1	1	0	0	1	0	0	7	21
7/26	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0
7/27	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	0	2	0	0	0	0	0	7	21
7/28	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	3	9
7/29	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/30	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/31	24	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	4	12
8/1	24	1	0	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	5	15
8/2	24	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	3
8/3	24	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2	6
8/4	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	3
8/5	24	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	-1	0	0	0	0
8/6	24	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	-1	0	0	0	0	1	3
8/7	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	-1	0	0	0	0	0	0	0
8/8	24	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0	0	1	0	0	4	12
8/9	24	0	0	0	0	0	0	0	0	0	0	1	0	-1	0	0	0	0	0	0	0	0	0	0	0	0
8/10	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/11	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/12	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/13	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	3
8/14	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/15	24	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	3
8/16	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/17	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/18	6	0	0	0	0	0	0																		0	0

Table 2. Net upstream passage (actual and expanded) of sockeye salmon during hourly 20-min counts at the Kwethluk River Tower, 1998. Negative numbers represent fish going downstream

Date	Total Hours																							Total Count	Expanded Count		
	Counted	0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100			2200	2300
7/24	8								1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1	3	
7/25	24	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	12
7/26	23	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	6
7/27	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/28	24	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	0	0	0	0	0	4	12
7/29	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	5	0	0	7	21	
7/30	24	0	0	0	3	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	6	18
7/31	24	0	1	1	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	7	21	
8/1	24	2	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	8	24	
8/2	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/3	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/4	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/5	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/6	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/7	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/8	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/9	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/10	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/11	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	3
8/12	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/13	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/14	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/15	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/16	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/17	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/18	6	0	0	0	0	0	0																			0	0

Table 3. Net upstream passage (actual and expanded) of chum salmon during hourly 20-min counts at the Kwethluk River Tower, 1998. Negative numbers represent fish going downstream.

Date	Total Hours																							Total Count	Expanded Count		
	Counted	0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100			2200	2300
7/24	8																	2	0	0	0	-1	8	4	7	20	60
7/25	24	4	7	6	4	5	2	3	4	1	0	2	3	1	2	2	0	0	0	2	3	1	0	0	2	54	162
7/26	23	0	4	1	0	0	0	2	0	0	1	-1	1	0	0	0	0	2	0	0	2		3	0	3	18	54
7/27	24	0	0	0	0	0	0	3	0	1	0	0	1	0	2	2	2	4	1	0	1	0	0	1	0	18	54
7/28	24	0	1	2	0	0	0	0	0	0	0	0	0	0	1	0	3	0	1	11	0	0	1	0	1	21	63
7/29	24	0	0	0	0	0	0	1	1	0	1	0	2	0	0	1	0	2	5	1	2	2	1	3	1	23	69
7/30	24	0	2	7	0	1	0	0	0	0	0	0	1	0	0	0	2	1	0	1	2	0	2	2	2	21	63
7/31	24	1	2	2	3	-1	1	0	0	0	1	1	0	0	0	0	0	0	0	1	-1	0	0	1	4	15	45
8/1	24	4	0	3	3	-1	1	1	3	0	0	0	0	0	0	0	0	0	2	0	0	1	0	-1	2	18	54
8/2	24	0	2	1	0	0	0	0	0	0	0	1	0	1	0	-1	1	0	-1	0	0	0	1	0	-1	4	12
8/3	24	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2	6
8/4	24	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	-1	0	0	1	0	0	2	6
8/5	24	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	2	1	7	21
8/6	24	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	3
8/7	24	1	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0	1	0	0	5	15
8/8	24	0	0	0	0	0	0	0	0	0	-1	0	0	0	0	0	0	0	0	1	1	0	0	0	1	2	6
8/9	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	6
8/10	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/11	24	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	4	12
8/12	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/13	24	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6
8/14	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/15	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/16	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/17	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3
8/18	6	0	0	0	0	0	0																			0	0

720

Table 4. Net upstream passage (actual and expanded) of pink salmon during hourly 20-min counts at the Kwethluk River Tower, 1998. Negative numbers represent fish going downstream.

Date	Total Hours																							Total Count	Expanded Count		
	Counted	0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100			2200	2300
7/24	8																1	1	2	2	0	1	1	4	12	36	
7/25	24	1	2	1	0	1	1	0	0	0	1	0	1	0	0	0	1	1	2	0	0	0	0	1	2	15	45
7/26	23	5	12	2	3	1	0	5	0	-1	0	0	2	0	0	1	1	0	0	1		1	-1	0	32	96	
7/27	24	4	0	6	5	1	2	0	0	0	0	0	0	0	1	0	0	-1	2	0	2	2	1	2	1	28	84
7/28	24	5	5	4	4	2	3	1	2	1	1	1	0	0	1	3	0	2	0	2	1	0	2	1	2	43	129
7/29	24	2	2	1	1	3	1	2	0	2	1	1	0	1	1	2	0	5	0	2	4	4	3	0	1	39	117
7/30	24	4	4	8	1	4	0	0	0	0	0	0	2	1	2	1	0	2	0	2	0	1	0	4	0	36	108
7/31	24	1	0	0	0	2	1	1	0	0	0	1	1	0	3	2	-1	3	0	0	2	1	3	3	3	26	78
8/1	24	5	7	4	3	2	3	1	1	2	3	2	1	-1	0	4	3	2	2	0	2	1	3	1	5	56	168
8/2	24	3	2	5	1	5	1	2	3	3	2	0	0	1	1	0	0	1	1	7	4	5	5	3	2	57	171
8/3	24	3	5	4	3	2	0	2	4	1	1	1	1	0	1	1	1	1	0	1	1	0	2	4	1	40	120
8/4	24	1	2	2	2	1	0	0	1	2	0	3	3	1	1	0	1	4	-1	2	1	3	3	1	1	34	102
8/5	24	1	2	7	0	1	2	2	0	-1	1	6	1	3	3	4	-1	3	2	1	6	0	1	6	-1	49	147
8/6	24	4	1	3	2	0	1	1	3	2	-1	1	0	1	2	3	1	2	2	2	0	3	0	1	4	38	114
8/7	24	4	0	2	3	1	-1	0	1	0	0	0	1	1	2	1	2	0	1	2	3	14	2	1	7	47	141
8/8	24	7	5	8	9	5	2	2	3	-2	4	2	0	2	2	0	2	2	12	4	3	3	6	4	7	92	276
8/9	24	2	7	3	7	1	0	3	3	3	1	2	1	5	3	2	2	5	3	3	1	2	3	5	6	73	219
8/10	24	4	6	4	4	-1	0	1	1	0	6	2	1	6	-1	11	3	0	1	12	7	5	16	2	3	93	279
8/11	24	17	7	3	4	0	5	4	1	2	1	4	3	4	3	2	6	5	1	6	2	17	6	4	7	114	342
8/12	24	5	6	7	10	3	6	5	2	1	2	0	2	1	3	7	12	10	5	1	3	6	3	1	2	103	309
8/13	24	4	6	1	4	2	3	1	1	2	1	4	5	1	3	6	3	0	9	6	4	1	11	10	4	92	276
8/14	24	3	5	1	4	1	4	3	1	2	0	3	2	2	4	2	3	4	4	9	8	15	3	10	8	101	303
8/15	24	2	7	4	4	2	3	1	0	3	1	1	3	7	5	3	7	4	3	3	1	-2	2	1	8	73	219
8/16	24	3	2	2	2	1	1	0	2	2	2	1	0	2	0	6	1	3	11	5	1	2	0	0	6	55	165
8/17	24	4	0	4	0	1	3	1	2	2	1	5	5	3	2	7	7	7	7	5	5	8	7	5	4	95	285
8/18	6	9	5	4	4	1	0																			23	69

4,398

Table 5. Net upstream passage (actual and expanded) of coho salmon during hourly 20-min counts at the Kwethluk River Tower, 1998. Negative numbers represent fish going downstream.

Date	Total Hours																							Total Count	Expanded Count							
	Counted	0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100			2200	2300					
7/24	8																	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/25	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/26	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/27	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0
7/28	24	0	0	0	3	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0
7/29	24	0	1	1	2	0	1	1	2	0	0	1	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
7/30	24	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/31	24	0	2	3	2	0	0	0	0	0	0	1	0	0	0	1	0	0	0	2	1	1	3	0	4	20	4	20	60	60	60	
8/1	24	0	0	7	1	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	1	2	18	54	54	54		
8/2	24	0	2	0	2	1	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/3	24	0	2	0	0	3	0	0	0	1	0	0	2	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8/4	24	1	2	1	1	0	0	0	0	1	1	0	1	0	1	0	0	0	0	0	0	0	0	2	0	2	13	39	39	39		
8/5	24	1	3	1	0	2	4	2	0	1	0	1	1	0	1	2	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0
8/6	24	7	3	1	3	2	-1	0	1	2	1	3	0	0	2	0	1	2	0	1	1	0	0	1	0	0	0	0	0	0	0	0
8/7	24	0	1	1	0	0	1	1	2	0	1	1	0	0	0	0	1	0	0	1	2	5	2	3	11	33	99	99	99	99		
8/8	24	3	5	1	0	1	1	0	1	0	1	0	0	3	0	0	0	2	3	1	7	11	6	0	1	47	141	141	141	141		
8/9	24	2	6	2	2	0	2	0	1	2	0	0	0	3	1	0	4	0	6	3	1	0	0	10	4	49	147	147	147	147		
8/10	24	2	6	2	2	0	0	0	0	0	1	2	0	0	0	1	0	0	0	5	1	10	4	7	3	46	138	138	138	138		
8/11	24	1	1	4	2	0	1	0	2	0	0	1	2	0	0	0	3	1	4	3	2	7	4	2	5	45	135	135	135	135		
8/12	24	3	4	2	3	0	3	0	2	2	0	0	0	0	0	0	1	2	2	2	1	0	0	2	3	32	96	96	96	96		
8/13	24	3	3	2	3	0	0	1	0	1	1	1	0	0	1	0	0	3	1	0	1	0	7	6	6	40	120	120	120	120		
8/14	24	10	4	4	3	0	0	2	1	1	0	2	0	1	1	2	4	1	3	8	4	2	1	6	2	62	186	186	186	186		
8/15	24	5	18	13	14	8	1	2	3	0	1	1	4	0	0	1	1	0	2	0	1	0	3	1	0	79	237	237	237	237		
8/16	24	17	12	7	11	3	3	0	0	3	0	1	0	2	0	5	0	3	8	15	3	4	8	2	12	119	357	357	357	357		
8/17	24	3	2	3	0	4	0	3	0	1	2	1	1	3	0	5	1	3	2	14	12	10	6	4	4	84	252	252	252	252		
8/18	6	2	4	2	0	1	0																			9	27	27	27	27	27	
2,367																																

Table 6. Historic chinook salmon passage at the Kwethluk River weir (1992) and tower (1996 - 1998).

Date	Daily				Cumulative				Percent Passage		
	1992	1996	1997	1998	1992	1996	1997	1998	1992	1996	1997
6/20											
6/21	0				0				0		
6/22	2	15	0		2	15	0		0	0	0
6/23	3	96	51		5	111	51		0	1	1
6/24	2	51	288		7	162	339		0	2	4
6/25	36	42	138		43	204	477		0	3	5
6/26	42	3	153		85	207	630		1	3	7
6/27	64	75	216		149	282	846		2	4	9
6/28	55	214	324		204	496	1,170		2	6	13
6/29	89	253	315		293	749	1,485		3	10	16
6/30	108	211	261		401	960	1,746		4	12	19
7/01	202	49	63		603	1,009	1,809		6	13	20
7/02	358	107	444		961	1,116	2,253		10	14	24
7/03	497	111	775		1,458	1,227	3,028		15	16	33
7/04	1,248	1,098	822		2,706	2,325	3,850		28	30	42
7/05	400	746	1,144		3,106	3,071	4,994		32	39	54
7/06	642	563	1,050		3,748	3,634	6,044		39	46	66
7/07	364	336	145		4,112	3,970	6,189		43	51	67
7/08	442	393	94		4,554	4,363	6,283		47	56	68
7/09	361	519	16		4,915	4,882	6,299		51	62	68
7/10	661	339	3		5,576	5,221	6,302		58	66	68
7/11	381	210	91		5,957	5,431	6,393		62	69	69
7/12	304	155	124		6,261	5,586	6,517		65	71	71
7/13	36	186	216		6,297	5,772	6,733		65	73	73
7/14	137	210	192		6,434	5,982	6,925		67	76	75
7/15	548	115	174		6,982	6,097	7,099		72	78	77
7/16	366	387	330		7,348	6,484	7,429		76	83	81
7/17	317	252	337		7,665	6,736	7,766		79	86	84
7/18	273	155	372		7,938	6,891	8,138		82	88	88
7/19	69	242	630		8,007	7,133	8,768		83	91	95
7/20	46	135	111		8,053	7,268	8,879		83	92	96
7/21	205	217	117		8,258	7,485	8,996		85	95	97
7/22	144	179	231		8,402	7,664	9,227		87	98	100
7/23	195	83			8,597	7,747			89	99	
7/24	149	55		9	149	55		9	90	99	
7/25	122	45		21	271	100		30	92	100	
7/26	143	3		0	414	103		30	93	100	
7/27	35	9		21	449	112		51	94	100	
7/28	39			9	488			60	94		
7/29	49			0	537			60	94		
7/30	49			0	586			60	95		
7/31	89			12	675			72	96		

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Table 6. (page 2 of 2)

Date	Daily				Cumulative				Percent Passage		
	1992	1996	1997	1998	1992	1996	1997	1998	1992	1996	1997
8/01	44			15	719			87	96		
8/02	33			3	752			90	97		
8/03	11			6	763			96	97		
8/04	18			3	781			99	97		
8/05	23			0	804			99	97		
8/06	65			3	869			102	98		
8/07	19			0	888			102	98		
8/08	26			12	914			114	98		
8/09	16			0	930			114	98		
8/10	7			0	937			114	99		
8/11	11			0	948			114	99		
8/12	27			0	975			114	99		
8/13	72			3	1,047			117	99		
8/14	18			0	1,065			117	100		
8/15	8			3	1,073			120	100		
8/16	4			0	1,077			120	100		
8/17	6			0	1,083			120	100		
8/18	7			0	1,090			120	100		
8/19	3				1,093				100		
8/20	3				1,096				100		
8/21	3				1,099				100		
8/22	0				1,099				100		
8/23	0				1,099				100		
8/24	3				1,102				100		
8/25	0				1,102				100		
8/26	0				1,102				100		
8/27	0				1,102				100		
8/28	0				1,102				100		
8/29	1				1,103				100		
8/30	0				1,103				100		
8/31	0				1,103						
9/01	0				1,103						
9/02	0				1,103						
9/03	0				1,103						
9/04	1				1,104						
9/05	0				1,104						
9/06	0				1,104						
9/07	0				1,104						
9/08	0				1,104						
9/09	0				1,104						
9/10	1				1,105						
9/11	0				1,105						
9/12	0				1,105						

Table 7. Historic sockeye salmon passage at the Kwethluk River weir (1992) and tower (1996 - 1998).

Date	Daily				Cumulative				Percent Passage		
	1992	1996	1997	1998	1992	1996	1997	1998	1992	1996	1997
6/20											
6/21	0				0				0	0	
6/22	6	0	0		6	0	0		0	0	
6/23	34	0	0		40	0	0		3	0	
6/24	53	0	0		93	0	0		7	0	
6/25	70	0	21		163	0	21		12	0	
6/26	41	6	39		204	6	60		15	0	
6/27	69	69	21		273	75	81		21	4	
6/28	51	105	102		324	180	183		25	9	
6/29	34	63	93		358	243	276		27	12	
6/30	14	75	90		372	318	366		28	15	
7/01	30	54	24		402	372	390		30	18	
7/02	63	111	42		465	483	432		35	23	
7/03	75	135	69		540	618	501		41	30	
7/04	86	89	228		626	707	729		47	34	
7/05	38	67	135		664	774	864		50	38	
7/06	58	86	87		722	860	951		55	42	
7/07	50	168	32		772	1,028	983		59	50	
7/08	45	186	55		817	1,214	1,038		62	59	
7/09	36	110	10		853	1,324	1,048		65	64	
7/10	36	34	6		889	1,358	1,054		67	66	
7/11	13	92	0		902	1,450	1,054		68	70	
7/12	16	73	60		918	1,523	1,114		70	74	
7/13	5	115	24		923	1,638	1,138		70	80	
7/14	23	48	27		946	1,686	1,165		72	82	
7/15	33	53	24		979	1,739	1,189		74	85	
7/16	18	42	24		997	1,781	1,213		76	87	
7/17	19	66	17		1,016	1,847	1,230		77	90	
7/18	20	24	23		1,036	1,871	1,253		79	91	
7/19	19	30	45		1,055	1,901	1,298		80	92	
7/20	21	57	0		1,076	1,958	1,298		82	95	
7/21	19	42	12		1,095	2,000	1,310		83	97	
7/22	8	9	27		1,103	2,009	1,337		84	98	
7/23	17	6			1,120	2,015			85	98	
7/24	4	0		3	4	0		3	85	98	
7/25	5	39		12	9	39		15	86	100	
7/26	14	0		6	23	39		21	87	100	
7/27	8	3		0	31	42		21	87	100	
7/28	10			12	41			33	88		
7/29	8			21	49			54	89		
7/30	9			18	58			72	89		
7/31	15			21	73			93	90		

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Table 7. (page 2 of 2)

Date	Daily				Cumulative				Percent Passage		
	1992	1996	1997	1998	1992	1996	1997	1998	1992	1996	1997
8/01	12			24	85			117	91		
8/02	9			0	94			117	92		
8/03	8			0	102			117	93		
8/04	4			0	106			117	93		
8/05	6			0	112			117	93		
8/06	18			0	130			117	95		
8/07	8			0	138			117	95		
8/08	8			0	146			117	96		
8/09	7			0	153			117	97		
8/10	6			0	159			117	97		
8/11	5			3	164			120	97		
8/12	5			0	169			120	98		
8/13	5			0	174			120	98		
8/14	3			0	177			120	98		
8/15	2			0	179			120	98		
8/16	3			0	182			120	99		
8/17	2			0	184			120	99		
8/18	0			0	184			120	99		
8/19	4				188				99		
8/20	1				189				99		
8/21	1				190				99		
8/22	1				191				99		
8/23	3				194				100		
8/24	2				196				100		
8/25	1				197				100		
8/26	0				197				100		
8/27	0				197				100		
8/28	1				198				100		
8/29	0				198				100		
8/30	1				199				100		
8/31	0				199				100		
9/01	0				199				100		
9/02	0				199				100		
9/03	1				200				100		
9/04	0				200				100		
9/05	0				200				100		
9/06	0				200				100		
9/07	0				200				100		
9/08	0				200				100		
9/09	0				200				100		
9/10	0				200				100		
9/11	1				201				100		
9/12	0				201				100		

Table 8. Historic chum salmon passage at the Kwethluk River weir (1992) and tower (1996 - 1998).

Date	Daily				Cumulative				Percent Passage		
	1992	1996	1997	1998	1992	1996	1997	1998	1992	1996	1997
6/20											
6/21	28				28						0
6/22	82	3	0		110	3	0				0
6/23	78	132	41		188	135	41				1
6/24	83	144	30		271	279	71				1
6/25	281	102	18		552	381	89				2
6/26	449	27	54		1,001	408	143				3
6/27	346	516	27		1,347	924	170				4
6/28	314	305	84		1,661	1,229	254				5
6/29	287	811	87		1,948	2,040	341				6
6/30	30	1,307	135		1,978	3,347	476				6
7/01	147	378	72		2,125	3,725	548				7
7/02	490	706	207		2,615	4,431	755				9
7/03	908	1,179	468		3,523	5,610	1,223				12
7/04	855	2,834	579		4,378	8,444	1,802				14
7/05	469	1,357	492		4,847	9,801	2,294				16
7/06	754	1,724	372		5,601	11,525	2,666				18
7/07	533	1,916	217		6,134	13,441	2,883				20
7/08	847	1,421	124		6,981	14,862	3,007				23
7/09	522	998	32		7,503	15,860	3,039				25
7/10	1,361	803	63		8,864	16,663	3,102				29
7/11	1,169	565	99		10,033	17,228	3,201				33
7/12	831	608	266		10,864	17,836	3,467				36
7/13	716	537	96		11,580	18,373	3,563				38
7/14	589	812	60		12,169	19,185	3,623				40
7/15	1,031	448	225		13,200	19,633	3,848				43
7/16	1,145	1,503	402		14,345	21,136	4,250				47
7/17	751	509	296		15,096	21,645	4,546				49
7/18	758	346	525		15,854	21,991	5,071				52
7/19	687	495	915		16,541	22,486	5,986				54
7/20	470	861	279		17,011	23,347	6,265				56
7/21	584	1,271	348		17,595	24,618	6,613				58
7/22	731	1,071	402		18,326	25,689	7,015				60
7/23	1,102	414			19,428	26,103					64
7/24	1,196	539		60	1,196	539		60			67
7/25	894	281		162	2,090	820		222			70
7/26	849	273		54	2,939	1,093		276			73
7/27	583	266		54	3,522	1,359		330			75
7/28	559			63	4,081			393			77
7/29	841			69	4,922			462			80
7/30	733			63	5,655			525			82
7/31	693			45	6,348			570			84

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Table 8. (page 2 of 2)

Date	Daily				Cumulative				Percent Passage		
	1992	1996	1997	1998	1992	1996	1997	1998	1992	1996	1997
8/01	611			54	6,959			624	86		
8/02	484			12	7,443			636	88		
8/03	363			6	7,806			642	89		
8/04	349			6	8,155			648	90		
8/05	452			21	8,607			669	92		
8/06	614			3	9,221			672	94		
8/07	301			15	9,522			687	95		
8/08	190			6	9,712			693	95		
8/09	368			6	10,080			699	96		
8/10	231			0	10,311			699	97		
8/11	123			12	10,434			711	98		
8/12	171			0	10,605			711	98		
8/13	238			6	10,843			717	98		
8/14	90			0	10,933			717	99		
8/15	80			0	11,013			717	99		
8/16	59			0	11,072			717	99		
8/17	37			3	11,109			720	99		
8/18	40			0	11,149			720	99		
8/19	41				11,190				100		
8/20	30				11,220				100		
8/21	26				11,246				100		
8/22	21				11,267				100		
8/23	9				11,276				100		
8/24	17				11,293				100		
8/25	8				11,301				100		
8/26	6				11,307				100		
8/27	5				11,312				100		
8/28	7				11,319				100		
8/29	4				11,323				100		
8/30	4				11,327				100		
8/31	2				11,329						
9/01	2				11,331						
9/02	0				11,331						
9/03	2				11,333						
9/04	2				11,335						
9/05	0				11,335						
9/06	0				11,335						
9/07	2				11,337						
9/08	0				11,337						
9/09	1				11,338						
9/10	0				11,338						
9/11	0				11,338						
9/12	1				11,339						

Table 9. Historic pink salmon passage at the Kwethluk River weir (1992) and tower (1996 - 1998).

Date	Daily				Cumulative				Percent Passage		
	1992	1996	1997	1998	1992	1996	1997	1998	1992	1996	1997
6/20											
6/21	0				0						0
6/22	0	0	0		0	0	0				0
6/23	0	0	0		0	0	0				0
6/24	0	0	0		0	0	0				0
6/25	1	0	0		1	0	0				0
6/26	0	0	0		1	0	0				0
6/27	1	0	0		2	0	0				0
6/28	1	0	0		3	0	0				0
6/29	1	0	0		4	0	0				0
6/30	4	0	0		8	0	0				0
7/01	7	0	0		15	0	0				0
7/02	10	0	0		25	0	0				0
7/03	33	3	0		58	3	0				0
7/04	72	42	0		130	45	0				0
7/05	7	24	0		137	69	0				0
7/06	20	42	0		157	111	0				0
7/07	21	72	0		178	183	0				0
7/08	31	81	0		209	264	0				0
7/09	25	63	9		234	327	9				1
7/10	37	33	75		271	360	84				1
7/11	35	18	0		306	378	84				1
7/12	50	21	19		356	399	103				1
7/13	20	23	0		376	422	103				1
7/14	41	168	18		417	590	121				1
7/15	88	150	24		505	740	145				1
7/16	143	204	21		648	944	166				1
7/17	109	99	6		757	1,043	172				2
7/18	114	73	42		871	1,116	214				2
7/19	130	165	90		1,001	1,281	304				2
7/20	123	165	21		1,124	1,446	325				2
7/21	187	382	33		1,311	1,828	358				3
7/22	207	270	27		1,518	2,098	385				3
7/23	295	175			1,813	2,273					4
7/24	269	169		36	269	169		36			4
7/25	360	219		45	629	388		81			5
7/26	423	174		96	1,052	562		177			6
7/27	282	64		84	1,334	626		261			6
7/28	230			129	1,564			390			7
7/29	366			117	1,930			507			8
7/30	331			108	2,261			615			8
7/31	534			78	2,795			693			9

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Table 9. (page 2 of 2)

Date	Daily				Cumulative				Percent Passage		
	1992	1996	1997	1998	1992	1996	1997	1998	1992	1996	1997
8/01	558			168	3,353			861	10		
8/02	657			171	4,010			1,032	12		
8/03	399			120	4,409			1,152	13		
8/04	721			102	5,130			1,254	14		
8/05	1,261			147	6,391			1,401	17		
8/06	2,597			114	8,988			1,515	22		
8/07	1,372			141	10,360			1,656	25		
8/08	1,817			276	12,177			1,932	28		
8/09	4,271			219	16,448			2,151	37		
8/10	2,437			279	18,885			2,430	42		
8/11	2,020			342	20,905			2,772	46		
8/12	3,507			309	24,412			3,081	53		
8/13	6,601			276	31,013			3,357	66		
8/14	2,970			303	33,983			3,660	72		
8/15	2,356			219	36,339			3,879	77		
8/16	2,496			165	38,835			4,044	82		
8/17	1,422			285	40,257			4,329	85		
8/18	1,833			69	42,090			4,398	89		
8/19	1,257				43,347				91		
8/20	1,156				44,503				94		
8/21	838				45,341				95		
8/22	633				45,974				97		
8/23	417				46,391				97		
8/24	309				46,700				98		
8/25	394				47,094				99		
8/26	175				47,269				99		
8/27	111				47,380				99		
8/28	40				47,420				100		
8/29	41				47,461				100		
8/30	33				47,494				100		
8/31	31				47,525				100		
9/01	19				47,544				100		
9/02	17				47,561				100		
9/03	17				47,578				100		
9/04	12				47,590				100		
9/05	14				47,604				100		
9/06	12				47,616				100		
9/07	17				47,633				100		
9/08	7				47,640				100		
9/09	3				47,643				100		
9/10	1				47,644				100		
9/11	1				47,645				100		
9/12	1				47,646				100		

Table 10. Historic coho salmon passage at the Kwethluk River weir (1992) and tower (1996 - 1998).

Date	Daily				Cumulative				Percent Passage		
	1992	1996	1997	1998	1992	1996	1997	1998	1992	1996	1997
6/20											
6/21	0				0						0
6/22	0	0	0		0	0	0				0
6/23	0	0	0		0	0	0				0
6/24	0	0	0		0	0	0				0
6/25	0	0	0		0	0	0				0
6/26	0	0	0		0	0	0				0
6/27	0	0	0		0	0	0				0
6/28	0	0	0		0	0	0				0
6/29	0	0	0		0	0	0				0
6/30	0	0	0		0	0	0				0
7/01	0	0	0		0	0	0				0
7/02	0	0	0		0	0	0				0
7/03	0	0	0		0	0	0				0
7/04	0	0	0		0	0	0				0
7/05	0	0	0		0	0	0				0
7/06	0	0	0		0	0	0				0
7/07	0	0	0		0	0	0				0
7/08	0	0	0		0	0	0				0
7/09	0	0	0		0	0	0				0
7/10	0	0	0		0	0	0				0
7/11	0	0	0		0	0	0				0
7/12	0	0	0		0	0	0				0
7/13	0	0	0		0	0	0				0
7/14	0	0	0		0	0	0				0
7/15	0	0	0		0	0	0				0
7/16	0	0	0		0	0	0				0
7/17	0	0	0		0	0	0				0
7/18	0	0	0		0	0	0				0
7/19	1	0	0		1	0	0				0
7/20	1	0	0		2	0	0				0
7/21	7	15	0		9	15	0				0
7/22	1	9	0		10	24	0				0
7/23	5	6			15	30					0
7/24	5	27		0	5	27		0			0
7/25	8	24		0	13	51		0			0
7/26	12	69		0	25	120		0			0
7/27	6	30		9	31	150		9			0
7/28	8			21	39			30			0
7/29	13			36	52			66			0
7/30	38			3	90			69			0
7/31	67			60	157			129			0

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Table 10. (page 2 of 2)

Date	Daily				Cumulative				Percent Passage		
	1992	1996	1997	1998	1992	1996	1997	1998	1992	1996	1997
8/01	57			54	214			183	0		
8/02	62			24	276			207	1		
8/03	27			33	303			240	1		
8/04	40			39	343			279	1		
8/05	116			63	459			342	1		
8/06	489			90	948			432	2		
8/07	159			99	1,107			531	2		
8/08	106			141	1,213			672	3		
8/09	355			147	1,568			819	3		
8/10	133			138	1,701			957	4		
8/11	237			135	1,938			1,092	4		
8/12	605			96	2,543			1,188	6		
8/13	1,255			120	3,798			1,308	8		
8/14	793			186	4,591			1,494	10		
8/15	609			237	5,200			1,731	11		
8/16	894			357	6,094			2,088	13		
8/17	616			252	6,710			2,340	15		
8/18	752			27	7,462			2,367	16		
8/19	612				8,074				18		
8/20	701				8,775				19		
8/21	822				9,597				21		
8/22	1,651				11,248				24		
8/23	1,748				12,996				28		
8/24	2,125				15,121				33		
8/25	6,099				21,220				46		
8/26	3,677				24,897				54		
8/27	1,984				26,881				58		
8/28	1,181				28,062				61		
8/29	1,820				29,882				65		
8/30	2,003				31,885				69		
8/31	2,353				34,238				74		
9/01	3,425				37,663				82		
9/02	1,443				39,106				85		
9/03	881				39,987				87		
9/04	1,102				41,089				89		
9/05	2,654				43,743				95		
9/06	781				44,524				96		
9/07	331				44,855				97		
9/08	357				45,212				98		
9/09	282				45,494				98		
9/10	128				45,622				99		
9/11	160				45,782				99		
9/12	413				46,195				100		



Figure 1. Map of the Kuskokwim Area showing locations of commercial fishing districts and salmon escapement assessment projects, including the Kwethluk River counting tower.

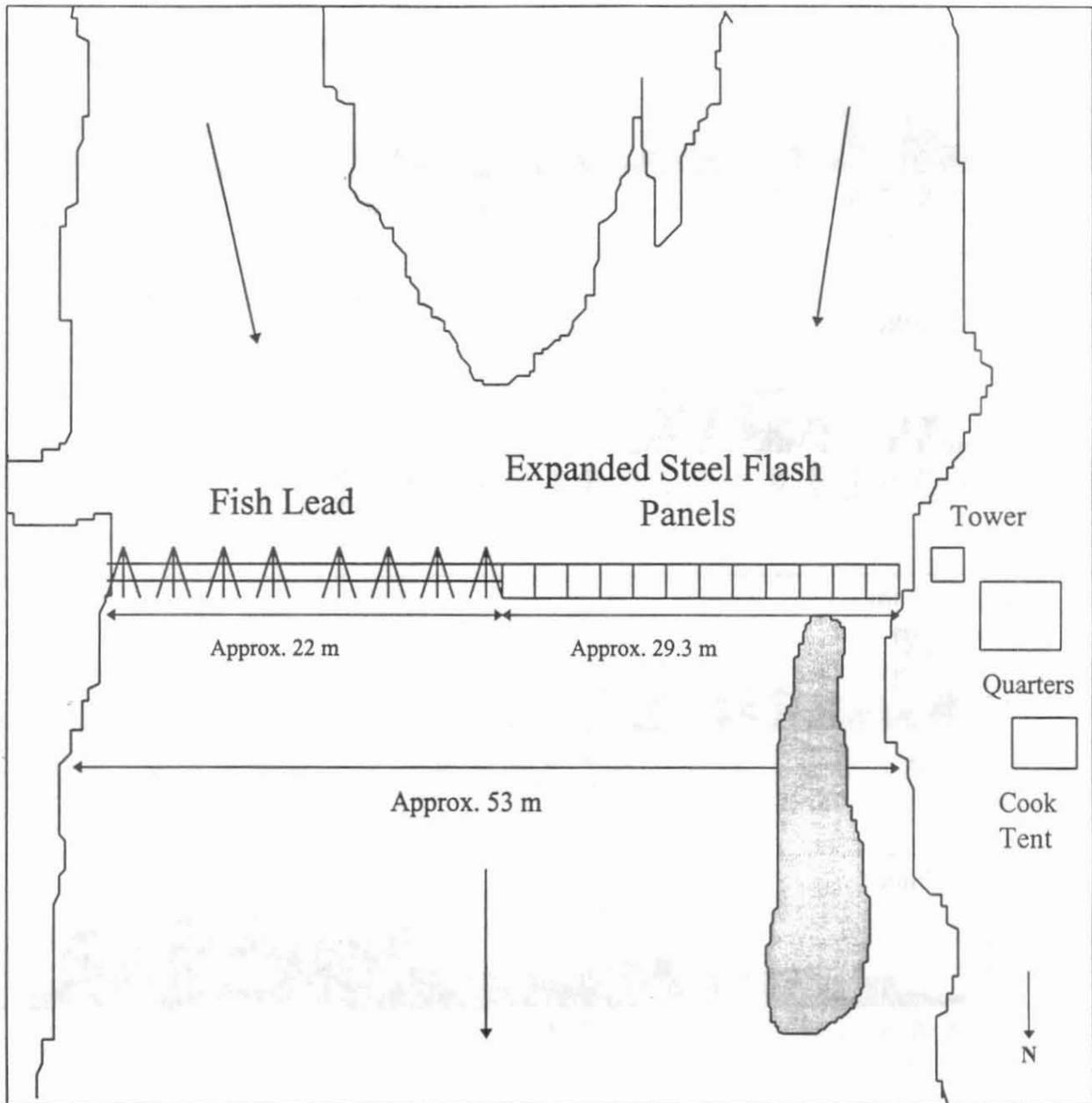


Figure 2. Schematic of the Kwethluk River counting tower and field camp (not drawn to scale; shaded area indicates a gravel bar; arrows flowing North indicate direction of water flow).

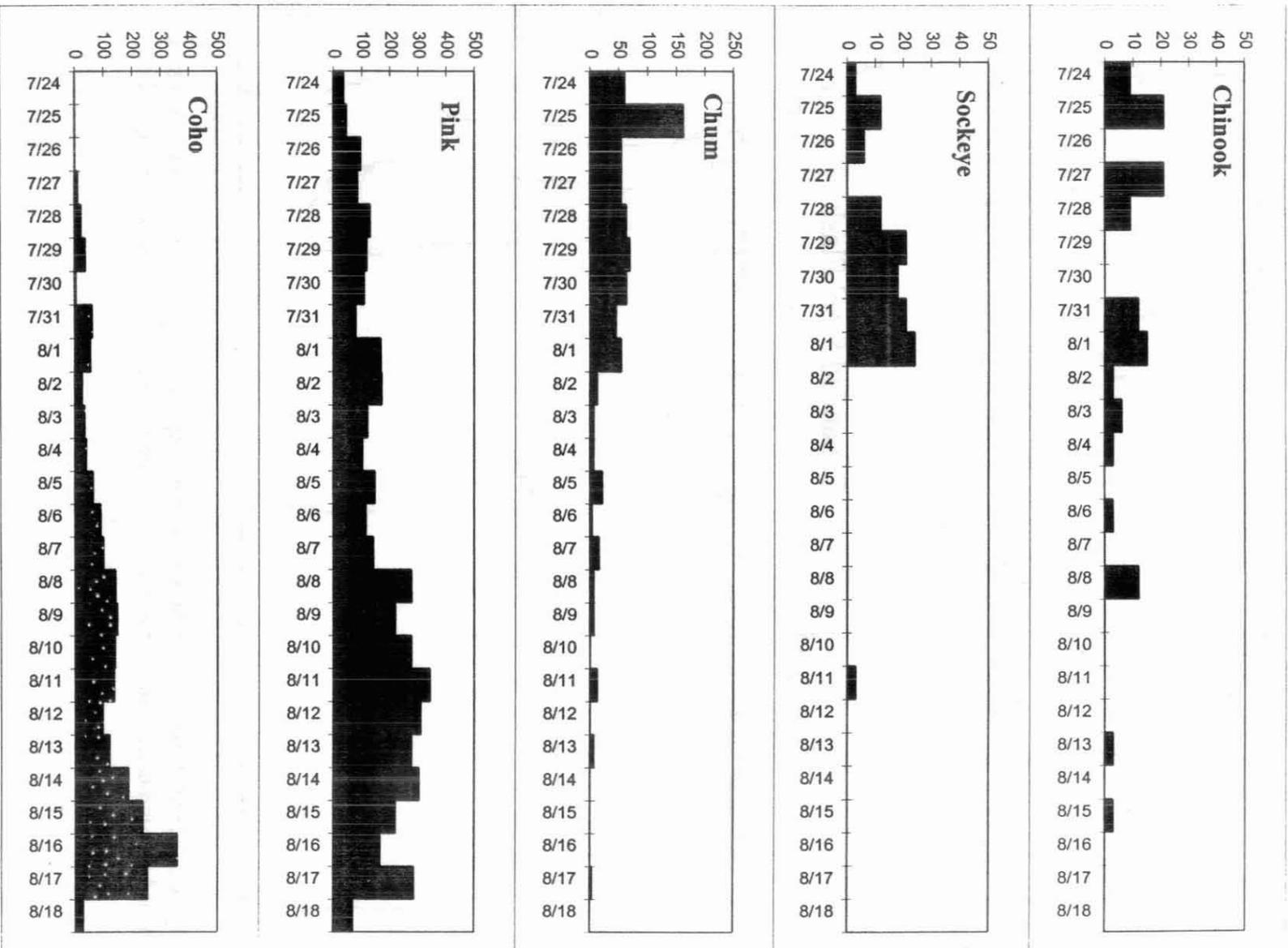


Figure 3. Daily passage estimates of salmon at the Kwethluk River counting tower, 1998.

Appendix A.1. Daily meteorological and hydrological conditions at the Kwethluk River counting tower, 1998.

Date	Time	Precipitation	Wind		Cloud Cover	Temperature (C)		Water Level (cm)	Water Clarity
			Direction	Speed (mph)		Air	Water		
21-Jun	0700	1	S	10-15	3			13	dirty
22-Jun	0700	0		calm	1			12	dirty
23-Jun	0700	0		calm	3	9	10	11	dirty
24-Jun	0700	0	S	3-5	4	8	8	10/25	dirty
25-Jun	0700	0		calm	3	4	8	25	silty
26-Jun	0700	0	S	7-10	3	9	10	24	silty
27-Jun	0900	0		calm	3	9	10	25	silty
28-Jun	0700	0		calm	3	9	10	25	silty
29-Jun	0700	0		calm	4	8	11	26	silty
30-Jun	0700	0	S	3-5	2	11	11	27	silty
01-Jul	0700	0		calm	3	11	12	29	silty
02-Jul	0700	0		calm	1	10	10	34	silty
03-Jul	0800	0		calm	2	11	11	36	silty
04-Jul	0900	2		calm	2	13	11	33	silty
05-Jul	1000	1	SW	3-5	2	14	11	33.5	dirty
06-Jul	0700	0	SW	5-7	2	10	10	40.5	dirty
07-Jul	1000	0		calm	3	13	11	44	murky
08-Jul	0700	1	S	10-12	3	10	11	42	dirty
09-Jul	0700	1	S	10-12	3	8	9	39	dirty
10-Jul	0700	0		calm	2	9	10	40	dirty
11-Jul	0800	0		calm	4	7	10	37	silty
12-Jul	0800	0	W	1-3	1	11	10	32	silty
13-Jul	0700	0		calm	3	12	11	29	silty
14-Jul	0700	0		calm	4	8	11	28	silty
15-Jul	0700	0		calm	2	10	12	26	silty
16-Jul	0700	0		calm	3	9	11	25	silty
17-Jul	0700	0		calm	3	9	11	23.5	silty
18-Jul	0800	0	E	10-15	2	14	11	22	clear
19-Jul	1000	0	E	5-7	2	15	12	20	clear
20-Jul	1700	0	E	10-25	3	23	14	18.5	clear
21-Jul	0800	1		calm	3	16	13	17.5	clear
22-Jul	1000	0	E	3-5	3	17	13	16.5	clear
23-Jul	0730	0		calm	3	13	13	16.5	clear
24-Jul	0730	0		calm	3	10	14	17	clear
25-Jul	0945	0	SE	1-5	3	14	15	16.5	clear
26-Jul	0800	0		calm	3	10	12	15	clear
27-Jul	0700	1	S	3-5	3	10	12	15	clear
28-Jul	0700	1	S	1-5	3	10	12	13.5	clear
29-Jul	0700	0		calm	4	8	11	16	silty
30-Jul	0700	1	S	1-3	3	11	12	14.5	clear
31-Jul	0700	0		calm	3	12	12	13.5	clear
01-Aug	0800	0	S	5-7	3	12	13.5	12	clear
02-Aug	1030	1	S	10-15	3	13.5	13	11	clear
03-Aug	0700	0	S	3-5	3	10	11	16.5	clear
04-Aug	0700	0	S	3-5	3	9.5	10	18	clear
05-Aug	0700	0	S	5-10	3		12	16.5	silty
06-Aug	0700	0		calm	3	6	10	15.5	silty
07-Aug	0700	0	SW	1-5	3	7	10	15	clear
08-Aug	0700	0		calm	4	6	10	15	clear
09-Aug	1000	0	S	1-5	3	10.5	10	14.5	clear
10-Aug	0700	0		calm	3	8	10	11	clear

--Continued--

Appendix A.1. (page 2 of 2)

Date	Time	Precipitation	Wind		Cloud Cover	Temperature (C)		Water Level (cm)	Water Clarity
			Direction	Speed (mph)		Air	Water		
11-Aug	0700	0		calm	1	6	10	10	clear
12-Aug	0700	0	S	5-10	3	10	10	8	clear
13-Aug	0700	1	S	15-20	3	9	10	8	clear
14-Aug	0700	1	S	5-10	3	7	10	8	clear
15-Aug	0700	1	S	10-15	3	10	11	8.5	clear
16-Aug	0800	1	S	35-40	3	10	10	9	clear
17-Aug	0700	0	W	5-10	3	5	9	13	silty
18-Aug	0700	1	S	1-3	3	7	8	17	muddy
19-Aug	0700	1	S	25-30	3	9	10	17	muddy
20-Aug	0700	1	S	10-12	3	9	10	15.5	clearing
21-Aug	0700	1	S	10-12	3	8	10	13	clear
22-Aug	1000	0		calm	3	6	8	15	silty
23-Aug	0800	2	SE	5-7	3	10	9	15.5	silty
24-Aug	0700	1	S	10-15	3	6	8	18.5	silty

Codes:

Precipitation:

- 0 - none
- 1 - light or intermittent rain
- 2 - continuous rain
- 3 - thundershowers

Cloud Cover:

- 1 - clear sky
- 2 - less than 50% cover
- 3 - more than 50% cover
- 4 - solid overcast (high or low)
- 5 - fog and/or smoke