Salmon Escapement to Englishman River, 2005

Ian Matthews and Alan Eden[1]

South Coast Area
Fisheries and Oceans Canada
3225 Stephenson Point Road
Nanaimo, BC
V9T 1K3

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[1] – 365 Dunsmuir Rd, Qualicum Bay, V9K 2A1

Abstract

From 1999 to 2003 extensive spawning salmon assessments were conducted on the Englishman River. Funding for this escapement work was provided through the Pacific Salmon Endowment Fund (PSEF). Budgetary constrains precluded any escapement work being conducted in 2004. However, funding and in-kind donations from The Nature Trust and Fisheries and Oceans Canada provided resources for the 2005 escapement work. Spawning surveys are an important part of any salmon stock assessment and rebuilding program.

Bi-weekly snorkel surveys of the Englishman River mainstem were conducted through the Fall of 2005 and escapement for four species of salmon were estimated using Area-Under-the-Curve analysis. These estimates were; 4,900 pink, 950 chinook, 3,700 coho and 7,300 chum salmon.

There were sources of uncertainty in data collection due to incomplete coverage and periods of poor visibility in the lower reaches of the river. Bank erosion during high run-off was the primary source of this increased turbidity and during these high flow events it was not feasible to swim some sections of the river.

These escapements are at or above the long term average but must be considered with several factors. The methodology of escapement enumeration was changed in 1999 which would have affected the reported numbers. The marine conditions have decreased the ocean survival of smolt to returning adults, which limited the ability of the stocks to withstand high levels of exploitation by the various fisheries. As a result DFO fishery managers drastically reduced the opportunities for the commercial and sport fishing sectors for coho and chinook. This reduction in exploitation rate increased the escapement of salmon to southern BC creeks in general, not just the Englishman River.

Introduction

Extensive salmon escapement programs were conducted from 1999 through 2003 on the Englishman River (DFO NuSEDs database, Baillie and Young 2002, Baillie and Young 2003). This work was funded through The Pacific Salmon Endowment Fund Society and the Englishman River Watershed Recovery Plan (ERWRP) steering committee. The goal of this fund is to achieve healthy, sustainable and naturally diverse salmon stocks by conserving and rebuilding salmon populations through strategic and focused efforts. The Georgia Basin coho (*Oncorhynchus kisutch*) and steelhead (*O. mykiss*) stocks are one of three concerns that the Society has identified as a priority for developing a recovery plan.

Due to funding constraints no escapement surveys were conducted in 2004. Funding and in-kind donations for the 2005 escapement work were received from the Nature Trust, Pacific Salmon Endowment Fund, Fisheries and Oceans Canada, the Mid Vancouver Island Habitat Enhancement Society and the Englishman River Enhancement Society.

One of the primary components of a recovery strategy is a comprehensive monitoring program. This program is used to track the salmon populations to measure whether objectives are being met and to detect stock declines and increases in each area of concern. Part of this monitoring program is to enumerate the salmon escapement using scientifically accepted practices approved by DFO.

The Englishman River watershed has all species of salmon including steelhead and is designated a sensitive stream by the BC government under the Fish Protection Act (Bocking and Gaboury 2001). Annual escapement estimates of salmon from 1953 to 2003 are presented in Table 1.

The Englishman River flows into the Strait of Georgia at Parksville on Vancouver Island and drains roughly 324 km^2 (Figure 1). The river originates on the eastern slopes of Mt. Arrowsmith (1820 m) and Mt. Moriarty Ridge and flows in an easterly direction for 40 km. The mainstem has an accessible reach of 15.85 km. There are four main tributaries: South Englishman River (4.5 km accessible reach), Morison Creek (2.1 km), Centre Creek (5.2 km), and Shelly Creek (1.0 km). Centre Creek is a tributary of the South Englishman, located approximately 200 m upstream from the confluence of the South Englishman with the mainstem (Bocking and Gaboury 2001).

All five species of Pacific salmon, coho, pink (*O. gorbuscha*), chum (*O. keta*), chinook (*O. tshawytscha*) and sockeye (*O. nerka*) occur in the Englishman River. As well as steelhead trout, there are rainbow trout in the system (the non-anadromous form of steelhead trout) and coastal cutthroat trout (*O. clarki clarki*). Coastrange sculpin (*Cottus aleuticus*) and prickly sculpin (*C. asper*) are also resident fish species. Other species that may be present are threespine stickleback (*Gasterosteus aculeatus*) and lamprey (*Lampetra* sp.).

This report presents the results of salmon escapement enumeration work that was done in the Englishman system in the fall of 2005.

Methods

Surveys

Snorkel surveys were conducted by two swimmers at approximately bi-weekly intervals beginning in early September and ending in mid December (Table 2). Surveys were confined to the Englishman River mainstem, which for the previous escapement projects had been divided into 26 sections of approximately 600 meters each. To facilitate data collection in 2005 these were combined into three survey reaches (Figure 2). The lower reach (sections 0 to 8) started at the estuary and covered the first 3.9 km to the top of Allsbrook Canyon. The middle reach (sections 9 to 15) was 5.8 km long ending approximately 2 km upstream of the South Englishman confluence. The upper reach (sections15 to 26) comprised the remaining 6.2 km to the Englishman River Falls. It generally took two to three days for the survey crew to cover the full length of the river accessible to migrating salmon. These surveys were then combined to provide a single estimate of salmon in the river for that time period. The number of live fish observed were recorded by species.

Population Estimate calculations

Each survey count must be expanded to account for missed salmon within the survey reach (Observer Efficiency, or OE) and for missed salmon outside of the survey reach (Coverage).

OE is an estimate of how many fish were missed by the swimmers and is expressed as a proportion of the total that was enumerated. This is estimated by taking into account reduced visibility from turbid water conditions, deeper pools, overcast days and amount of cover such as log jams and cut banks in which fish could hide.

Coverage refers to the proportion of the total fish population that was present in the reach surveyed by the swimmers. As the 2005 surveys were only performed on the Englishman River mainstem and were not always complete an expansion factor was applied to many of the counts to derive an estimate for the total salmon in the accessible watershed. This expansion varies by species over time and was based on survey data from the more extensive 2001 Englishman River project (Baillie and Young 2002). These data are presented in Table 3. Applying these two expansions to the observed counts from each set of surveys produced an estimate for the total number of salmon in the system at that time.

Final escapement estimates were calculated from the expanded survey data using Area-Under-the-Curve analysis (AUC) (English et al. 1992). The estimated number of fish from each survey is plotted against time and the integral of this curve is divided by the survey life (SL) of the fish. This is described by the following formulae;

1. $$P = {}^{Count}\Big/_{{}^{Obs.Eff.}/_{Coverage}}$$

2. $$AUC = \sum_{i=2}^{n}((t_i - t_{i-1})(P_i + P_{i-1}) * 0.5)$$

3. $$Esc.Est. = \frac{AUC}{SurveyLife}$$

were P_i is the estimate of fish in the stream on the i^{th} day, t_i the number of days measured from the first day fish entered the survey area and n is the number of surveys conducted. Survey life is defined as the average length of time a salmon is available to be surveyed. When a creek is surveyed from the anadromous barrier down to the estuary, the SL used would be equal to the stream life, or the average length of time a salmon is in fresh water. If a tributary or a segment of the river were surveyed, then the SL life used would only be the average length of time a salmon is within the surveyed reach.

The SL statistic is essential for calculating AUC escapement estimates and can be derived in several ways. Ideally there would be an SL tagging program for salmon as they enter the river, however, time and budgetary constraints did not allow for an independent SL study in 2005. Therefore the survey life values derived in the more extensive 2002 Englishman River Salmon Escapement project were used for analysis of this year's data. The population estimate that resulted from the AUC calculation was rounded to two significant digits.

The low levels of sockeye escapement are not appropriate for an AUC estimate. The final escapement estimate would be the maximum count recorded which is a minimum estimate of the escapement.

Results

Pink

The estimated total escapement for pinks was 4,900. This number is based on the expanded peak live count that was observed on 6th September (Table 3).

The number that was derived from AUC calculations was 3900, which is less than the expanded peak count. Observed and expanded numbers are presented in Table 3.

Pinks were only observed on the first three surveys, declining to 126 by 8th October. They occurred throughout the surveyed reaches of the Englishman River system, however the majority were holding and spawning in the middle and lower survey reaches.

Chinook

The estimated total escapement for chinook was 950. This number was derived from AUC calculations using the expanded estimates and a survey life of 18 days (Baillie and Young 2003). The peak count of 285, expanded to 375, occurred on 8th October. Observed and expanded numbers are presented in Table 3.

Three chinook were counted during the first survey on 6th September and were last observed on 12th November when two were counted. They occurred throughout the survey area although primarily within the middle and lower reaches.

Chum

The estimated total escapement for chum was 7,300. This was derived from AUC calculations using the expanded estimates and a survey life of 10 days (Baillie and Young 2003). The peak count was 862 on 24th October. This was expanded to an estimated peak of 2,694 due to poor coverage of the lower reach were approximately 50% of chum were generally seen. Observed and expanded numbers are presented in Table 3.

Chum were first observed in the river on 8th October when 105 were counted. A single chum was counted on the final survey on 15th December.

Sockeye

Two sockeye were counted in the middle survey reach on 21st September.

Coho

The estimated total escapement for coho was 3,700. This was derived from AUC calculations using the expanded estimates and a survey life of 20 days (Baillie and Young 2003). The peak count of 561 occurred on the final survey on 15th December. This was expanded to 1,558 as only the middle reach was covered during this survey. Observed and expanded numbers are presented in Table 3.

Five coho were counted during the first survey on 6th September and as mentioned above coho were still present in the river on the final survey. They were observed throughout the survey area.

Discussion

Escapement enumeration for four of the five species of Pacific salmon (pink, chum, coho and chinook) was successful. The escapement estimate for sockeye is a minimum estimate, but any inference on the actual escapement is not supported by any field data. The escapement levels for pink, chum, coho and chinook have shown an increase in recent years over long-term averages but there are several points that must be considered in the current situation.

First, the methodology of estimating escapement on the Englishman changed in 1999. Prior to this year the escapements were estimated by DFO charter patrol and Fisheries Officers and, considering the other demands on the time of these workers, we may assume estimates were based on fewer and less extensive counts. Assessment effort significantly increased in 1999. When the historic data is examined this change in survey effort must be kept in mind. Any inferences about population trends may be the result of changes in methodology and not necessarily real.

Second, there have been major shifts and increases in commercial and sport fishing restrictions that have a direct influence in the number of salmon returning to fresh water to spawn. In 1998 the troll fishery along the west coast of Vancouver Island was halted, resulting in a dramatic increase in coho escapement along both sides of Vancouver Island in 1998. The progeny of this brood returned in 2001 and continued the large escapement record for this brood line. Additionally, the sport fishing sector has had severe restrictions in both coho and chinook retention, resulting in additional escapement (Baillie et al. 1999, Simpson et al.1999).

Finally, ocean survivals of smolts, particularly coho and steelhead, have been low in recent years (DFO 2002). Any change in this factor will affect the number of salmon that return to freshwater. This may mask any changes in the population levels of the Englishman stocks that are due to changes in the fresh water habitat. Escapement enumerations are a necessary but not sufficient evaluation of the status of Englishman River stocks and the effectiveness of the recovery plan.

Percent Coverage

Distribution of salmon varies by species throughout the watershed as the spawning season progresses based on differing run timing and preferred habitat. For example, the majority of any coho that have started to entered freshwater in September would likely still be holding in the lower river at that time, therefore minimal expansion should be applied to coho counted in the first two surveys. However, by late November most coho will have moved to the upper watershed and tributaries to spawn leaving only an estimated 20% remaining in the lower mainstem. This was complicated somewhat in 2005 by the unusually late arrival of more coho resulting in the peak count of 561, many of which were new arrivals, on 15th December. Unfortunately this survey only covered the middle reach therefore percent coverage for coho was estimated to be 45%.

Conversely pink and chum rarely migrate much beyond preferred spawning locations in the lower mainstem, therefore an expansion factor would only need to be applied if this reach was not fully surveyed. This is reflected in the estimated 40% coverage for chum counts on 24th October and 12th November when the lower reach was not surveyed. This was due to elevated turbidity levels primarily from bank erosion at kilometre 8.4 which precluded any chance of observing fish below this point. This reduced visibility was usually only a serious issue during periods of higher flow and increased run-off.

Area Under the Curve

Analysis of escapement data for AUC requires a zero count for the first and last survey. As time and budget constraints often limit the number of surveys performed it is not unusual to find some salmon already in freshwater at the start of escapement projects or a few late spawners still present on the last swim. This was the situation with the 2005 Englishman River project where pinks, chinook and coho where observed on the first swim. As pinks were present in such high numbers it was decided that an appropriate zero count should be two weeks prior to this initial survey (Table 2). For the same reason an end zero count two weeks after the final survey was used for coho and chum. Also an estimate of 1,000 pinks was added one week prior to this initial survey to better represent their likely migration timing/pattern and therefore provide a more representative plot for the AUC analysis.

Pink

The Englishman pink salmon stock has been supplemented since 1993 by the Quinsam River Hatchery (Bocking and Gaboury, 2001). In subsequent years fry releases have been 1.5 million, 0.9 million, 1.5 million and 1.3 million for 2001, 2002, 2003 and 2004, respectively. Although between 0.5 million and 1.5 million pink fry have been released each year, it was only the last few years that resulted in any substantial return. The resulting progeny from these recent stronger returns should assist in establishing a pink run.

The AUC estimate of 3900 was judged to be an underestimate of the true escapement based on the expanded peak live estimate of 4900. Two explanations for this difference are:

1. The SL used for this estimate was 26 days (Baillie and Young 2003) is an overestimate of the true SL. Dividing the AUC summation by the estimated escapement would give an approximation of the SL, which works out to be 20.5 days, or
2. The assumption that 1000 pink salmon were in the Englishman River on 31 August is incorrect and that the true number is similar to the peak count.

Neither hypothesis can be disproved although the second explanation may be the most likely.

Chinook

Chinook salmon production has been supplemented by the Englishman River Enhancement Society for nine years. Chinook fry transferred from the Little Qualicum hatchery are reared to the three month stage and released into a pond that drains into the Timberwest side channel. The chinook fry migrate downstream immediately although some individuals reside for one year before smolting. Usually 150,000 to 300,000 fry are released although in 2000 680,000 fry were released.

None of the releases prior to 2003 were marked so the escapement cannot be divided into wild and enhanced origin. Starting in 2003 a thermal mark has been applied so that enhanced chinook will be distinguishable from the wild production when this brood starts to return in 2006.

Chum

There has been no enhancement of chum in the Englishman River therefore the escapement estimate for chum is indicative of natural production for this system.

Calculating total chum escapement from the 2005 survey data was complex as only two of the four survey periods in which chum were counted covered the lower reach. This was one of the primary areas in which chum were observed in 2001 and 2002 (pers. comm., S. Baillie, Fisheries and Oceans Canada, Nanaimo). As mentioned above, surveys of the lower reach were not always possible due to reduced visibility at times of higher run-off.

Coho

Coho production has been supplemented in 1998 and 2001 when 6,000 fed fry and 50,400 fed fry were released into Morison Creek. There has been no enhancement since 2001.

The coho return was unusual this year in that the peak count occurred on the final survey on 15th December. This pattern was not seen in the 2001 and 2002 Englishman River escapement projects and is not the migration pattern observed in other Georgia Strait streams where coho escapement surveys are performed (pers. comm., S. Baillie, Fisheries and Oceans Canada, Nanaimo). However, 2005 was unusual in that there had been an extended dry period from early November to early December and many streams levels were down to summer flow rates (Figure 3). This may well have had a delaying effect on the coho run resulting in this late push of salmon into the Englishman River. This is supported by the observation that many of the coho counted in this final survey were bright, indicating they had likely only recently entered fresh water. Similarly, late components of coho returns were observed in other Georgia Straight systems in 2005 (anecdotal reports).

This late push of salmon in conjunction with incomplete coverage with this final survey makes it difficult to expand the count to a full system estimate of coho. Based on coho distribution data for this time of the year collected in the more extensive 2001 Englishman River escapement project it was assumed that similarly high numbers would be present in the remainder of the river system (Baillie and Young 2002). Consequently a percent coverage of 45% combined with a reasonably good OE of 80% produced the relatively high total estimate of 1,558 coho on the final survey.

Recommendations

1. An assessment of the success of habitat improvements funded by the PSEF should be conducted. This will require smolt and adult enumeration estimates of coho and steelhead production in the Englishman River.
2. The escapement surveys for 2005 were successful, but they would benefit by having additional swims conducted towards the end of the salmon migration period, and with stream walks added for the tributaries.
3. A survey life study should be conducted as this would improve accuracy of the AUC estimates.
4. Thermally marked chinook will be returning in 2006, therefore it would be worthwhile conducting a carcass-pitch program to recover samples. This would provide an estimate of enhancement contribution to the Englishman River chinook production.

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Figures

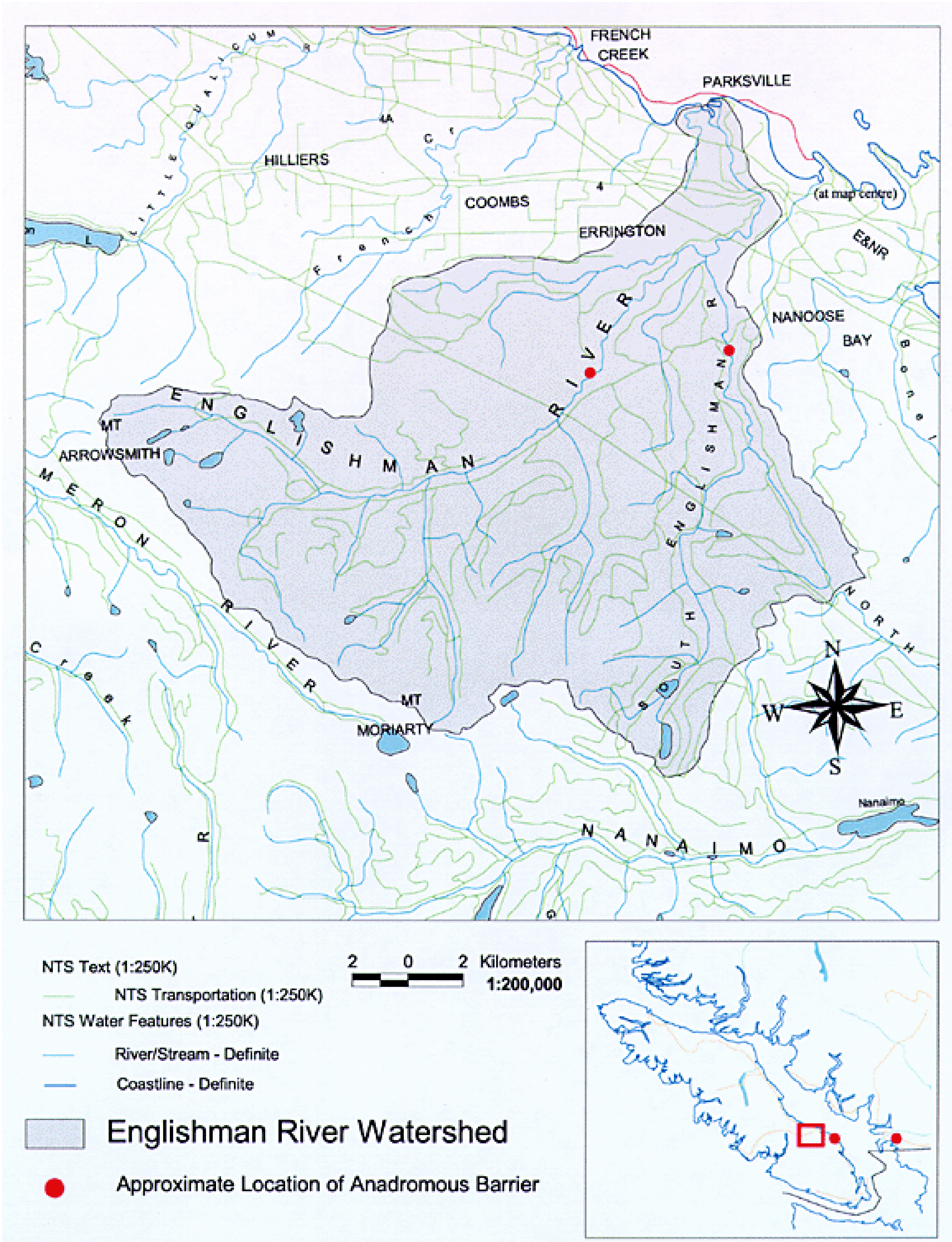

Figure 1. The Englishman River watershed and its relative location on Vancouver Island. Map obtained from the British Columbia Conservation Foundation web site (http://www.bccf.com/steelhead/focus7.htm#eng).

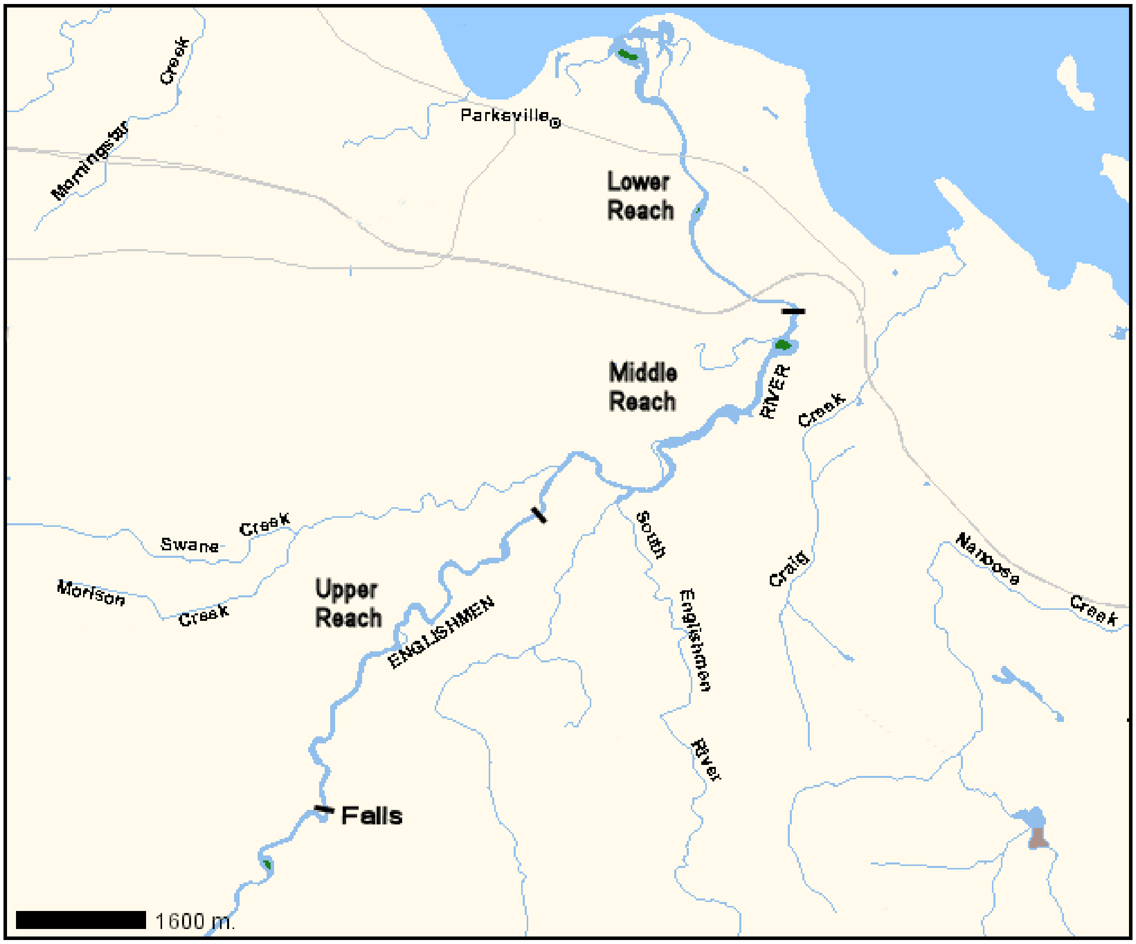

Figure 2. Map of lower Englishman River showing the three survey reaches used in 2005 escapement surveys.

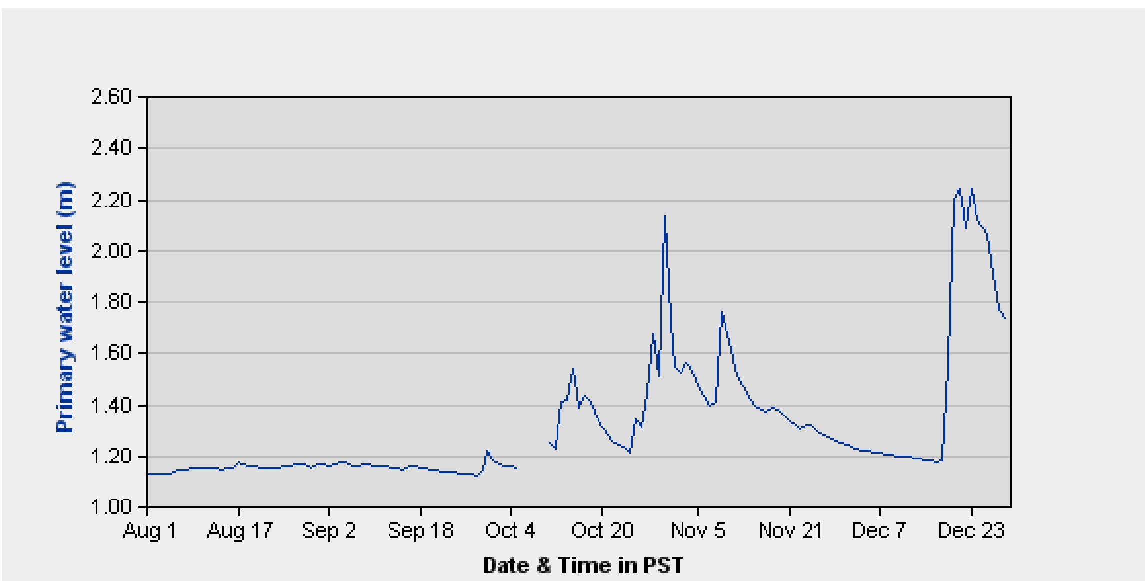

Figure 3. Water levels for Englishman River from August 1st to December 31st, 2005

Tables

Table 1. Salmon escapement estimates to the Englishman River, 1953-2004, from DFO NuSEDS database. UNK = unknown, NO = none observed, NI = not inspected, AP = adults present.

	Sockeye	Coho	Pink	Chum	Chinook
2004	NI	NI	NI	NI	NI
2003	NO	3200	AP	34800	260
2002	4	3100	12100	9500	600
2001	11	8000	13500	10400	2900
2000	25	5280	1600	3500	1200
1999	20	2978	2500	25000	750
1998	UNK	1500	350	8000	UNK
1997	UNK	200	100	8000	20
1996	UNK	250	800	900	50
1995	UNK	UNK	UNK	2000	UNK
1994	NO	1150	NO	5500	NO
1993	30	246	UNK	1100	24
1992	UNK	440	2000	3500	40
1991	15	800	50	250	50
1990	10	1050	UNK	800	100
1989	30	200	UNK	1500	UNK
1988	30	250	UNK	3000	NO
1987	50	200	UNK	600	NO
1986	10	65	NO	2000	NO
1985	UNK	UNK	UNK	2500	UNK
1984	UNK	2000	UNK	2500	UNK
1983	UNK	UNK	UNK	200	UNK
1982	18	1000	3	2500	14
1981	UNK	300	UNK	400	NO
1980	UNK	300	100	1000	UNK
1979	UNK	1200	UNK	4000	UNK
1978	300	1500	10	6000	75
1977	25	1500	25	1500	25
1976	25	750	25	1500	25
1975	25	400	75	750	75
1974	25	1500	25	5000	25
1973	75	750	25	7500	75
1972	25	400	25	15000	75
1971	25	1500	25	3500	75
1970	25	1500	75	3500	75
1969	25	400	25	7500	75
1968	75	1000	100	6000	115
1967	20	285	NO	500	75
1966	25	1500	200	7500	25
1965	UNK	1500	NO	1500	75
1964	25	1500	NO	1500	25
1963	UNK	750	2	750	25
1962	NO	750	NO	3500	UNK
1961	25	750	25	3500	25
1960	25	400	200	3500	25
1959	1	750	1	3500	UNK
1958	25	750	400	15000	UNK
1957	25	3500	3500	7500	UNK
1956	25	1500	400	750	UNK
1955	25	750	750	1500	UNK
1954	UNK	1500	750	15000	UNK
1953	UNK	750	200	15000	UNK

Table 2. Salmon counts for 2005. NS = Not Surveyed.

Pink

Date	Upper	Middle	Lower	Total
6 Sept.	NS	NS	3506	3506
21-23 Sept.	NS	931	528	1459
7-9 Oct.	18	53	55	126
22-25 Oct.	0	0	NS	0
12-13 Nov.	0	0	NS	0
26-27 Nov.	NS	0	0	0
15 Dec	NS	0	NS	0

Chinook

Date	Upper	Middle	Lower	Total
6 Sept.	NS	NS	3	3
21-23 Sept.	NS	3	227	230
7-9 Oct.	3	93	189	285
22-25 Oct.	62	119	NS	181
12-13 Nov.	2	0	NS	2
26-27 Nov.	NS	0	0	0
15 Dec	NS	0	NS	0

Chum

Date	Upper	Middle	Lower	Total
6 Sept.	NS	NS	0	0
21-23 Sept.	NS	0	0	0
7-9 Oct.	0	5	100	105
22-25 Oct.	48	814	NS	862
12-13 Nov.	17	181	NS	198
26-27 Nov.	NS	139	124	263
15 Dec	NS	1	NS	1

Coho

Date	Upper	Middle	Lower	Total
6 Sept.	NS	NS	5	5
21-23 Sept.	NS	2	31	33
7-9 Oct.	3	24	264	291
22-25 Oct.	34	297	NS	331
12-13 Nov.	42	2	NS	44
26-27 Nov.	NS	68	325	393
15 Dec	NS	561	NS	561

Table 3. Salmon counts with Observer Efficiency and Percent Coverage expansions for 2005 swim surveys. Red text indicates estimated values added for AUC calculation.

Pink

Date	Counts	Observer Efficiency	Coverage	System Estimate
24-Aug-05	0	100%	100%	0
31-Aug-05	1000	100%	100%	1000
6-Sep-05	3506	90%	80%	4869
22-Sep-05	1459	90%	70%	2316
8-Oct-05	126	90%	70%	200
24-Oct-05	0	100%	100%	0
12-Nov-05	0	100%	100%	0
26-Nov-05	0	100%	100%	0
15-Dec-05	0	100%	100%	0
31-Dec-05	0	100%	100%	0

Chinook

Date	Counts	Observer Efficiency	Coverage	System Estimate
24-Aug-05	0	100%	100%	0
31-Aug-05	0	100%	100%	0
6-Sep-05	3	80%	100%	4
22-Sep-05	230	80%	95%	303
8-Oct-05	285	80%	95%	375
24-Oct-05	181	70%	75%	345
12-Nov-05	2	50%	75%	5
26-Nov-05	0	100%	100%	0
15-Dec-05	0	100%	100%	0
31-Dec-05	0	100%	100%	0

Coho

Date	Counts	Observer Efficiency	Coverage	System Estimate
24-Aug-05	0	100%	100%	0
31-Aug-05	0	100%	100%	0
6-Sep-05	5	70%	100%	7
22-Sep-05	33	70%	95%	50
8-Oct-05	291	70%	100%	416
24-Oct-05	331	60%	40%	1379
12-Nov-05	44	40%	45%	244
26-Nov-05	393	80%	69%	712
15-Dec-05	561	80%	45%	1558
31-Dec-05	0	100%	100%	0

Table 3, continued

Chum

Date	Counts	Observer Efficiency	Coverage	System Estimate
24-Aug-05	0	100%	100%	0
31-Aug-05	0	100%	100%	0
6-Sep-05	0	90%	100%	0
22-Sep-05	0	90%	100%	0
8-Oct-05	105	90%	100%	117
24-Oct-05	862	80%	40%	2694
12-Nov-05	198	50%	40%	990
26-Nov-05	263	80%	90%	365
15-Dec-05	1	80%	50%	3
31-Dec-05	0	100%	100%	0