Trout Utilization of Side-Channels
on the East Coast of Vancouver Island

Photo: Wightman et al, 1998

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Summary

The objective of this report is to present the results of research on fish utilization, and habitat preference in six existing East Coast Vancouver Island side-channels, and to recommend design standards for future side-channel construction projects. Species studied included juvenile steelhead and cutt-throat trout (*Oncorhynchus mykiss, O. clarkii clarkii)* and coho salmon (*O. kisutch*), with an emphasis on trout. The method used to gather fish data was minnow trapping.

Data collection was conducted October 6-10, 1999, December 14-18, 1999 and March 11-14, 2000. Juvenile trout utilization of side-channels varied spatially and temporally. Moreover, trout displayed preferences for habitat features such as LWD (large woody debris), crown closure, instream boulder cover and water velocity. Side-channels on the Puntledge River provided an abundance of all habitat features examined. Trout utilization numbers here were correspondingly high, with 204 trout trapped over the whole study. In each of the other sampled side-channels there was a deficiency of at least one habitat feature and far fewer trout, 37 trout were trapped over the whole study in all five other channels combined.

Recommendations that may be used as an enhancement tool for recovery of East Coast Vancouver Island steelhead are presented for new or existing side-channels designed for salmon as well as for new side-channels designed specifically for trout. Particulars include the addition of LWD at 15m intervals, addition of boulders and cobble to the substrate (10-15% of total), the retention of existing native bank and adjacent forest vegetation wherever possible, replanting of native vegetation where needed, and assurance of constant year round water levels. Further intensive and year round studies are also recommended to follow up on this preliminary research.

Acknowledgements

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- Clay Young from the Englishman River Hatchery and Salmon Enhancement Group;
- John Hargrove from the Little Qualicum Hatchery; and
- my fiancée Lisa Brinkman.

Thank you all for helping me to reach the goal of completing this project.Suitability of Habitat, and Juvenile Salmonid use of Side-Channels on Four East Coast Vancouver Island Rivers

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1.0 Introduction

Beginning in the 1980's Vancouver Island steelhead populations started to decline (Wightman, *et al* 1998). To mitigate this problem, the Ministry of Environment Lands and Parks (MOELP) have implemented various initiatives on Vancouver Island rivers such as catch and release sport fishing regulations, river closures as well as augmenting wild steelhead populations with hatchery fish to increase stocks and provide anglers with a harvestable catch (Wightman, *et al* 1998). MOELP is conducting research on side-channels to determine utilization by juvenile steelhead. "Artificial spawning channels (side-channels) are an established means of increasing production of salmon and trout by providing habitat that is, ideally, optimal for spawning and incubation in that the gravel is of a selected size range and extremes of discharge are eliminated"(Mundie and Crabtree,1997).

Side-channels included in this study were constructed for rearing and spawning of coho, (*O. kisutch*), pink (*O. gorbuscha*), and chum salmon (*O. keta*) (DFO,1999). However, when exclusion is not practiced other species of fish, including trout may enter and utilize the side-channels. If trout are utilizing the side-channels, Department of Fisheries and Oceans (DFO) and MOELP are interested in trout utilization numbers and habitat preferences. These data could then be used by the MOELPs' "Recovery Plan for East Coast Vancouver Island Steelhead Trout" as a tool to strengthen stocks. "The Ministry of Environment Lands and Parks-Fisheries Branch, although often involved in the planning process, have limited information regarding trout utilization of side-channels"(Axford,1999).

This report describes the overall suitability of constructed habitats for juvenile salmonids, as well as structural design, fish and species utilization of the side-channel projects examined.

1.1 Background

This project was a cooperative effort with Rick Axford and Craig Wightman of the MOELP (Nanaimo), and commenced in August, 1999 and finished in April, 2000. MOELP has initiated the development of “A Recovery Plan for East Coast Vancouver Island Steelhead Trout”, and requested this study be undertaken to help the Ministry understand if side-channels are being utilized by trout. Data were collected in October 1999, December 1999, and March 2000 to investigate trout utilization during different seasonal periods. Questions that needed to be answered were, do juvenile trout rear, and over winter in side-channels? Are the channels utilized as spawning habitat, or do trout follow spawning salmon up the channels to feed on eggs, and return to the river when the food supply is gone?

1.2 Objectives

The purposes of this study were to:

1. Determine if trout utilize side–channel habitat in the Puntledge, Oyster, Englishman, and Little Qualicum Rivers;
2. Identify habitat preferences of trout in side–channels and;
3. Recommend design standards for future side–channel construction projects.

2.0 Study Area

This study was conducted on the East Coast of Vancouver Island between Campbell River and Nanaimo (Figure 2). Mixed coniferous and deciduous forests surround all four rivers examined in the study and their adjacent side-channels on the following rivers were sampled:

- Englishman River – Timber West Spawning Channel,
- Little Qualicum River – Spawning Channel No.1,
- Oyster River – Channel No.2,
- Oyster River - Natural Channel,
- Puntledge River – Upper Site Spawning Channel,
- Puntledge River – Lower Site Spawning Channel.

2.1. Englishman River, Timber West Side-Channel

The Englishman River is 28km long and drains a watershed of 324km^2. The Timber West side-channel on the Englishman River was constructed in 1989 with funding from the DFO and Timber West (Figure 1). Historically, the Englishman River supported peak runs of 3 500 coho and 15 000 chum. It also has small runs of chinook, pink and sockeye. The Timber West side-channel was initially colonized with pinks, chum, and chinook (Miller,1997). Presently, the side-channel supports all five species of Pacific salmon as well as a population of trout (Young,1999).

Figure 1. Englishman River Timber West Spawning Channel

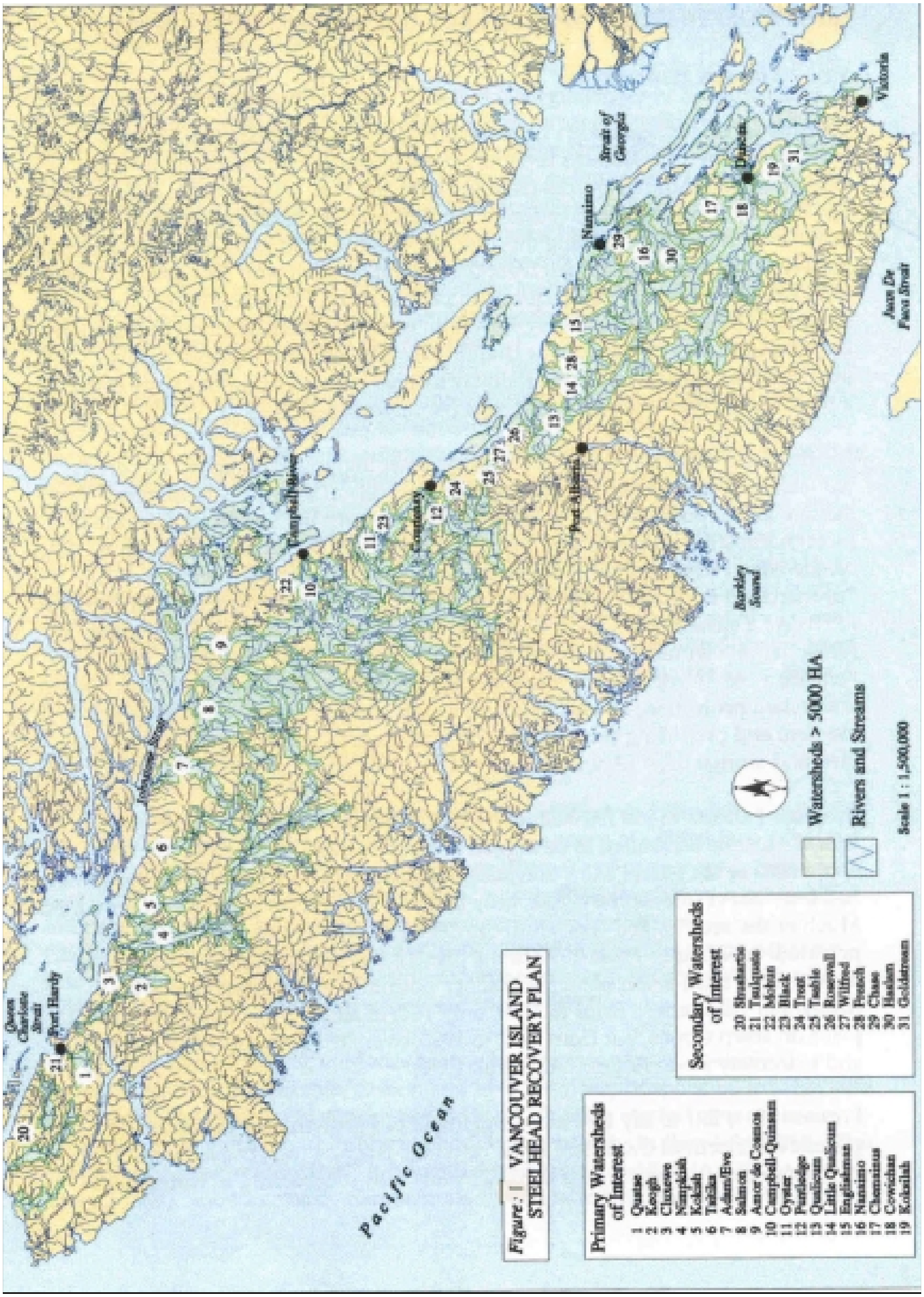

Figure 2. Map of Study Area (Wightman *et al*, 1998)

2.2 Little Qualicum River Spawning Channel #1

The Little Qualicum River is 18km in length and the watershed drains an area of 249km^2. The Little Qualicum River side-channel was completed in 1975 at a cost of 3.5 million (figure 3). The side-channel is 4.17km long and is 7.62m wide. Intended for use by chum salmon, the channel also produces coho, chinook, and steelhead (Mundie and Crabtree, 1997). The side-channel is also known to support a population of trout (Hargrove, 1999).

Figure 3. Little Qualicum River Chum Spawning Channel #1

2.3 Oyster River, Channel #2, and Natural Channel

The Oyster River is 55km in length and the watershed encompasses 376km^2. The Oyster River #2 North and side-channel was completed in September, 1998 (figure 4). The natural channel at the downstream end of the #2 channel was also sampled. BC Hydro, Fisheries Renewal BC, The Oyster River Enhancement Society, the Pacific Salmon Foundation, and the DFO provided funding for the side-channels. The side-channels are 3km in length and are fed by a combination of surface and ground water. Rearing and over-wintering for chum, pink and coho salmon was intended to be the main function of the side-channels. However, the channels now support runs of all five Pacific salmon species. Trout are abundant in the side-channels and are now considered pests (Petruzelka,1999).

Figure 4. Oyster River Spawning Channel #2

2.4 Puntledge River, Upper and Lower Sites

The Puntledge River is 20.5km in length and the watershed drains an area of 841km^2. The upper channel is 495m in length and the lower channel is 311m long. Its side-channels were intended for use by chum and pink salmon spawning.(figure 5,6) However, all five species of Pacific salmon inhabit the side-channels. Populations of trout are also known to utilize the habitat. (Fetzner, D. 1999)

Figure. 5 Puntledge River Upper Site

Figure. 6 Puntledge River Lower Site

3.0 Methods and Materials

Minnow trapping was used to gather presence / absence data on juvenile trout in the side-channels. Habitat parameters were also recorded at trap sites to supply information relative to juvenile trout utilization numbers and habitat preferences.

3.1 Minnow Trapping

Gee minnow traps were baited with salmon roe and placed in the streams for a minimum 20-hour soak (figure 7). Ten minnow traps were placed in areas with habitat components required by trout in an attempt to gather presence / absence data representative of the overall channel. Traps were set at various depths according to stream features in locations that provided varying degrees of cover, pool habitat and flow. Sampling was conducted on October 6-10, 1999, December 14-18, 1999 and March 11-14, 2000.

Figure 7. Gee Type Minnow Trap in Side-Channel

3.2 Fish Sampling

Fish were measured from the nose to the fork in the tail, weighed with a Sarritarius digital scale and counted. Minnow trapping data were entered into an Excel spreadsheet. The report deals only with trout and coho parr and fry.

Figure 8. Fish Sampling Equipment

3.3 Habitat Parameters

Habitat data were recorded using a simplified version of the Urban Stream Habitat Assessment Procedures for Vancouver Island (USHP reference) as a standard. Ten minnow traps were set in each sample location to gather qualitative and quantitative habitat data representative of the individual side-channels. Parameters assessed in this study were:

- land use,
- water velocity,
- wetted width,
- water depth,
- bank vegetation,
- substrate composition in %,
- in stream cover,
- stream gradient,

- crown closure,
- water temperature.

Habitat data were entered into a spreadsheet. Parameters included in USHP but not covered in this study are pool area (%), number of obstructions, pH, dissolved oxygen, gradient, and off-channel habitat.

4.0 Results

Results are outlined in the following tables.

4.1 Minnow Trapping Data

Results of minnow trapping data collection are presented in the tables below.

Table I. Minnow Trapping Data Collected October 6-10, 1999.
Table II. Minnow Trapping Data Collected December 14-18, 1999.
Table III. Minnow Trapping Data Collected March 11-14, 2000.

- fish lengths are in mm
- fish weights are in grams.

Table I. Minnow Trapping Data Collected October 6-10, 1999.

Side-channel	Englishman	LittleQ.	Oyster #2 North	Oyster Natural	Puntledge Upper	Puntledge Lower
Fish Parameter						
Total trout	4	8	0	0	11	47
Total coho	88	9	175	189	13	57
Average weight coho	3.5	7.4	3.7	4.9	4.8	4.9
Average weight trout	1.3	8.1	0	0	3.5	6.3
Average length coho	64	87	76	69	75	68
Average length trout	49	93	0	0	76	67

Table II. Minnow Trapping Data Collected December 14-18, 1999.

Side-channel	Englishman	LittleQ.	Oyster u/s	Oyster d/s.	Puntledge Upper	Puntledge Lower
Fish Parameter						
Total trout	5	6	2	2	42	57
Total coho	11	32	48	31	19	41
Average weight coho	3.1	5.8	7.7	3.2	7.8	5.6
Average weight trout	2.6	7.8	3.6	3.6	10.5	6.0
Average length coho	64	88	70	85	81	79
Average length trout	64	108	72	74	93	95

Table III. Minnow Trapping Data Collected March 11-14, 2000.

Side-channel	Englishman	LittleQ.	Oyster #2 North	Oyster Natural	Puntledge Upper	Puntledge Lower
Fish Parameter						
Total trout	5	5	0	0	12	35
Total coho	1	1	38	26	4	2
Average weight coho	4.5	5.9	4.6	4.0	7.3	5.0
Average weight trout	3.4	19.3	0	0	11.0	5.7
Average length coho	74	82	77	73	89	81
Average length trout	68	118	0	0	104	82
Total Trout	**14**	**19**	**2**	**2**	**65**	**139**

4.2 Habitat Parameter Data

Habitat parameter data results are listed in the tables below.

Table IV. Habitat Parameter Data. Collected October 6-10, 1999.

Table V. Habitat Parameter Data. Collected December 14-18, 1999.

Table VI. Habitat Parameter Data. Collected March 11-14, 2000.

- All measurements are in meters.
- Substrate data- b=boulder >10cm, c=cobble 5cm-10, g= gravel 2-50mm, f=fine 2mm or less.
- Bank vegetation- d= deciduous, c= coniferous, m= mixed.
- Min = Minimal, Good, Exc = Excellent
- For = Forested

Table IV. Habitat Parameter Data. Collected October 6-10, 1999.

Side-Channel	Englishman	Little Q.	Oyster #2	Oyster Nat.	Pun. Up.	Pun. Low
Habitat Parameter						
Wetted width avg.	1.9	7.6	3.2	3.2	3.2	3.3
Water depth avg.	0.39	0.50	0.53	0.51	0.40	0.44
Substrate	g,c,f,b	g,c	g,b,c,f	f,g,c,b	g,c,b,f	g,c,b,f
In stream cover: boulder	min	min	exc	min	good	exc
In stream cover: LWD	min	none	exc	good	good	exc
Crown closure avg.%	45	0	0	20	40	70
Velocity m/sec	>1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Bank vegetation	m	riprap	replanted	m	m	m
Land use	for	grass	for	for	for	for

Table V. Habitat Parameter Data. Collected December 14-18, 1999.

Side-Channel	Englishman	Little Q.	Oyster #2	Oyster Nat.	Pun. Up.	Pun. Low
Habitat Parameter						
Wetted width avg.	1.85	13	3.1	2.9	2.6	3.1
Water depth avg.	0.32	0.85	0.51	0.36	0.66	0.47
Substrate	g,c	b,f	g,b	g,c,b	g,c,b	g,c,f
In stream cover: boulder	min	good	good	min	good	min
In stream cover: LWD	min	min	exc	good	good	exc
Crown closure avg.%	60	45	80	50	45	55
Velocity m/sec	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Bank vegetation	m	riprap	replanted	m	m	m
Land use	for	grass	for	for	for	for

Table VI. Habitat Parameter Data. Collected March 11-14, 2000.

Side-Channel	Englishman	Little Q.	Oyster #2	Oyster Nat.	Pun. Up.	Pun. Low
Habitat Parameter						
Wetted width avg.	1.8	7.6	3.6	2.9	4.0	3.5
Water depth avg.	.34	.32	.50	.36	.34	.28
Substrate	g,f.c	g,c,b	g,c,b	g,f,c	g,c,f	g,c,f
In stream cover: boulder	min	good	good	good	good	good
In stream cover: LWD	min	min	good	min	exc	exc
Crown closure avg.%	62	0	15	58	31	55
Velocity m/sec	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Bank vegetation	m	riprap	replanted	m	m	m
Land use	For	grass	for	for	for	for

5.0 Discussion

Juvenile trout utilization of side-channels varied temporally. Furthermore, trout displayed a preference for certain habitat features such as LWD, crown closure, instream boulder cover and water velocity. Side-channels on the Puntledge River provided an abundance of all examined habitat features and trout. While in each of the other side-channels there was a deficiency of at least one habitat feature and far fewer trout. Therefore, habitat parameter and juvenile trout utilization data collected in the Puntledge River side-channels can be contrasted to the data collected in the other side-channels to determine juvenile trout habitat preference.

LWD stabilizes waterways and provides a nutrient source for side-channels. By impeding water LWD also creates pockets of low velocity with cover for juvenile fish. Trout hold in these pockets because they afford safety from predation and the trout expend a minimum energy waiting for food. The correlation between side-channels containing large amounts of LWD and juvenile trout populations was inconsistent (figure.9).

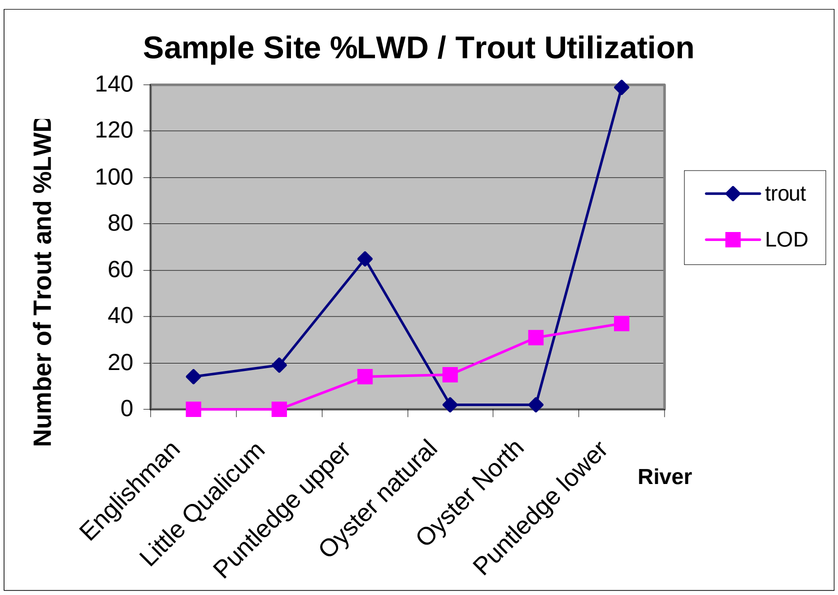

Figure 9. Sample Site Average % LWD / Trout Utilization

The relationship is confused by the fact that the Oyster River side-channels have an abundance of LWD and produced only 4 trout throughout the whole study. In the Puntledge channels, minnow traps placed in sites under or near LWD and adjacent to faster riffled water produced the most trout. The Englishman and Little Qualicum Rivers provide no LWD and trout utilization was correspondingly low. Juvenile trout can have winter survival rates as high as 17% in stable streams with large amounts of LWD, compared to 2% in streams without sufficient LWD.(Poulin, *et al*, 1991) These data suggest that LWD is likely a significant and preferred factor in juvenile trout utilization.

Crown closure and bank vegetation provide cover for fish and side-channels. This cover helps protect fish from predation, provides food in the form of terrestrial fauna and stabilizes side-channel water temperatures. The relationship between crown closure and juvenile trout utilization was also inconsistent (figure.10).

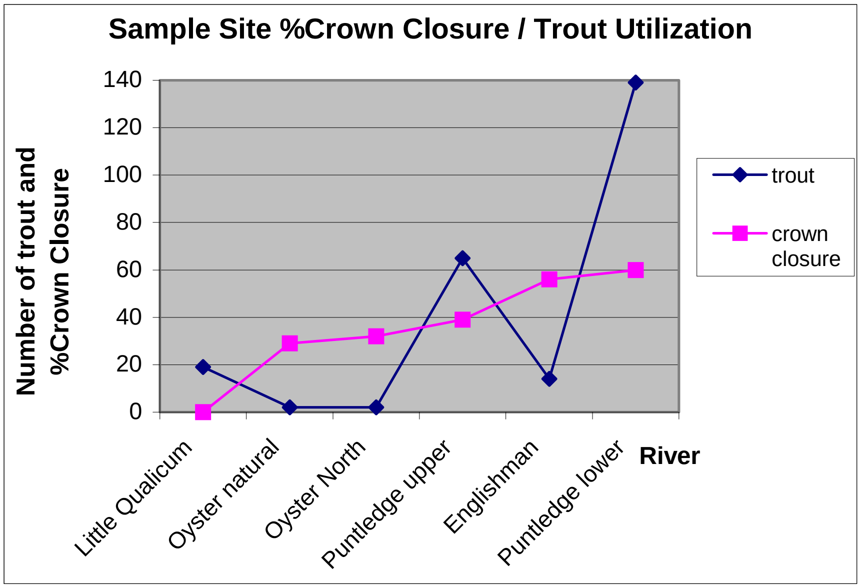

Figure 10. Sample Site Average % Crown Closure / Trout Utilization

The Englishman River side-channel provides sufficient bank vegetation and crown closure, but lacks LWD and other features essential to juvenile trout survival and therefore produced few trout. Side-channels on the Puntledge River have a high percentage of crown closure, plentiful bank vegetation and high incidences of trout utilization. The Little Qualicum River has no crown closure or bank vegetation and produced 19 trout. The Oyster River North channel has an abundance of LWD, but no surrounding vegetation, while the natural channel has vegetation but minimal LWD; both produced few trout. Puntledge River side-channel data contrasted with the other rivers indicates that crown closure is an important and preferred habitat feature for juvenile trout.

Instream boulders provide cover for fish and add stability to streams. Holding areas chosen by steelhead often contain an abundance of cover including large boulders, ledges and overhanging vegetation (Burgner,1992). The percent instream boulder cover and juvenile trout utilization correlation in this study was inconsistent.(figure.11) Again, the Puntledge River side-channels provided adequate amounts of boulder cover and the trout utilization numbers are relatively high. While other side-channels with similar amounts of boulder cover had low utilization numbers. Since variations in boulder cover were minimal, it is possible that instream boulder cover is not as essential to trout survival as crown closure and LWD.

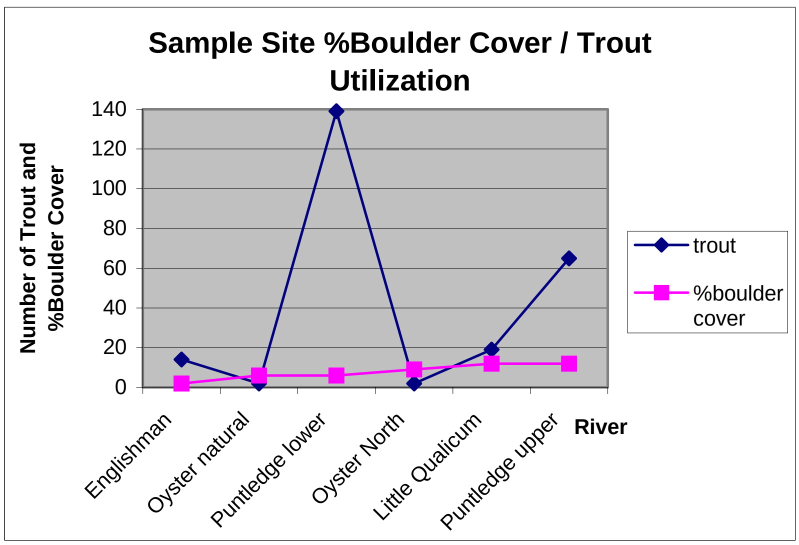

Figure 11. Sample Site Average % Boulder Cover / Trout Utilization

Juvenile trout displayed a preference for shallow water in this study. Water depth and juvenile trout utilization was positively correlated. Traps set in areas with shallow water produced the largest numbers of trout. While traps placed in pool habitat, at depths of 3.1m and 1m produced a total of 50 coho and 0 trout in one sample set.

Water velocity was also positively correlated with juvenile trout utilization. In December, traps placed in the lower Puntledge sites with velocities greater than 1.0m/s produced 17 trout and 1 coho. Two traps placed on the Putledge in pool habitat with stagnant water produced only coho. As stated earlier, trout were successfully trapped in sites with low velocity and cover, but adjacent to higher velocity areas. In the Puntledge River side-channels trout were trapped in open faster flowing habitat as well. Similarly, other studies have found that "fry were primarily located in pockets within glides and along the periphery or in tail-out areas of pools"(Griffith,1980). Likely, this is related to food supply access, as higher average water velocity and slightly larger substrate in shallow habitats may support a more abundant benthic fauna (Harvey,1995).

Data collected regarding wetted widths was inconclusive. Although, with increased wetted width crown closure will usually decrease, and within flowing water systems water depth will increase. Both of these factors have shown to deter trout utilization.

Data regarding land use indicated that forest habitat adjacent to a side-channel is a preferred feature in juvenile trout side-channel utilization. The Little Qualicum and Oyster River North side-channels have no immediate forest vegetation and their utilization numbers although not directly related, reflect these data. Puntledge River side-channels are surrounded by mature forest habitat.

Within the sampled side-channels, utilization numbers, average trout weights and lengths varied over time. In three of four rivers where trout were trapped in all rounds of sampling trout utilization was highest in October and December, with numbers trailing off in March(figure.12). Reasons for the lower numbers in March could be due to several factors. Fish that are ready to smolt could be out-migrating from the side-channels into the river's main stem or ocean. Fish may have also migrated down stream to feed on emerging salmon fry, or the fish could have simply migrated to another part of the side-channel.

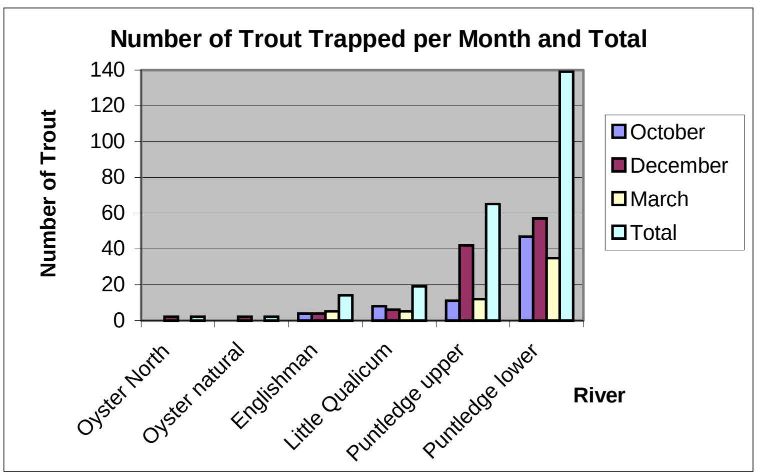

Figure 12. Number of Trout Trapped per Month Over Study Period

In three of the four sampled side-channels where trout were trapped in every round of sampling, average trout weights increased over time.(Figure 13) The lower Puntledge was the exception; it had a slight decline, which may have been caused by the out-migration of the larger fish. Another factor that may influence these data is the amount of roe bait that the fry consume while in the trap. Many of the trapped fry's stomachs were visibly packed full.

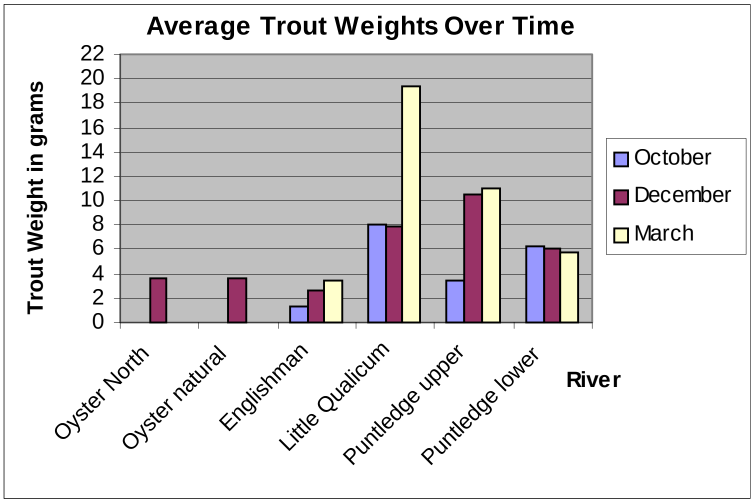

Figure 13. Average Trout Weights Over Study Period

Similar to the average weights, average lengths of trapped trout increased over time in three of the four sampled side-channels.(Figure.14) Again with the lower Puntledge being the exception. This inconsistency could also be caused by the out-migration of larger fish.

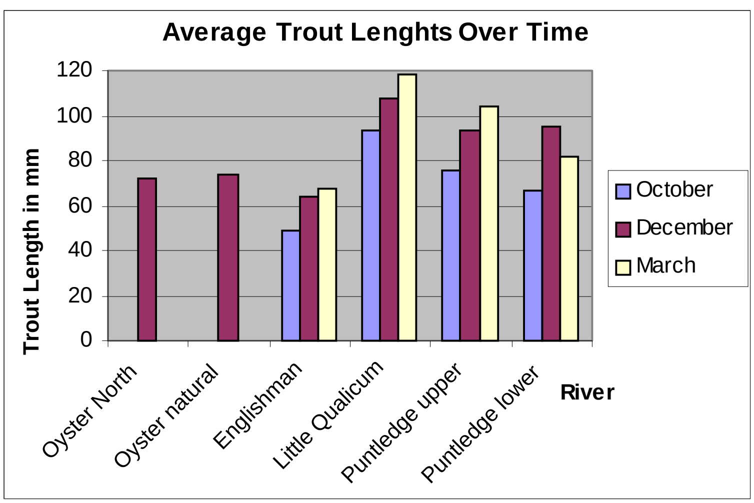

Figure 14. Average Trout Lengths Over Study Period

Both side-channels on the Puntledge River display strong evidence of juvenile trout utilization for rearing and over-wintering. However, no evidence of trout spawning was recorded. The channels do provide a safe, stable environment with an abundance of LWD, instream boulder cover, bank vegetation and crown closure. Moreover, fish have access to upstream and downstream ends of the side-channels on the Puntledge River. Research indicates that "steelhead typically spawn in moderate to high gradient sections of streams."(Burgner, R.L.1992) The channels on the Puntledge are located approximately 11km from the ocean, sufficiently far enough upstream for steelhead spawning to take place. Side-channels on the Puntledge were not built specifically for trout, but the hatchery encourages trout utilization in the channels.

Side-channels on the Oyster River produced few juvenile trout and displayed little evidence of trout rearing or over-wintering utilization. The channels do not provide the essential habitat parameters to attract trout. For example, the North channel has adequate instream cover and LWD, but because the channel was recently constructed there is no bank vegetation or crown closure. Another possible reason for the lack of trout could be that fish must enter the side-channels from the downstream end, as the upstream intake is screened. Also, the side-channels are situated in the flat, middle to lower reaches of the river which may be located downstream of steelhead spawning habitat, making it difficult for juvenile fish to migrate to side-channel habitat. These channels were not built for trout, and the hatchery considers trout detrimental to the production of salmon because they feed on eggs and emerging fry.

Trout show preference to dynamic habitat. The Little Qualicum side-channel is homogeneous in nature. Due to the likeness, and an inadequacy of habitat features within the side-channel, small numbers of fish were trapped. Crown closure, LWD and bank vegetation are non-existent. The side-channel has a diversion fence on the upstream end, which is passable, and there is a pipe that leads from the diversion to the channel. Fish display an aversion to entering long dark structures such as pipes and culverts (Axford, 2000).The down stream end has a few small weirs, but obstructions to the side-channel are considered passable by juvenile fish. Furthermore, this channel was not built to habituate juvenile trout.

The Englishman River spawning channel produced relatively few, and on average small trout. In the sampled area LWD was minimal. Fish must enter the side-channel from the downstream end, as there is a screened intake at the top of the channel; but downstream access to the channel is hampered by a series of beaver dams. Again, this channel was not constructed for trout utilization, and trout are considered a pest.

6.0 Conclusions and Recommendations

Although the habitat data collected may be considered inconstant within four of the six sampled side-channels, data from the Puntledge River side-channels produced sound evidence about juvenile trout habitat preference. Trout displayed preference for areas that provided several specific habitat features. Crown closure, LWD, bank vegetation as well as instream boulder cover were most preferred. If all these features were provided within the same area trout utilization numbers were highest. In side-channels where one of these parameters were absent trout utilization numbers dropped significantly. Trout were over-wintering and rearing in the Putledge and Little Qualicum River side-channels. Minimal evidence of trout over-wintering or rearing was recorded in the Oyster or Englishman River side-channels.

Based on the data collected in this study several recommendations can be made regarding design standards for side-channel projects. Recommendations will be presented for new or existing side-channels designed for salmon as well as new side-channels designed specifically for trout.

It is recommended that new or existing side-channels designed for the spawning and rearing of salmon, but also intended for trout utilization should have increased complexity and be returned to, or remain as close to "natural" as possible. This could be accomplished with the:

- addition of LWD to side-channels at 15m intervals,
- addition of boulders and cobble to the substrate(10-15% of total),
- retention of existing native bank and adjacent forest vegetation wherever possible,
- replanting of native vegetation wherever needed,
- assurance of constant year round water levels.

To increase steelhead stocks it is recommended that new side-channels be designed specifically for trout should follow the previous recommendations. However, to improve the chances of trout utilization and exclusion of other species trout side-channels should be constructed in areas farther upstream than most Pacific salmon migrate to spawn.

Upstream habitats are generally of higher gradient, which would attract trout and inhibit salmon. To further enhance populations, wild stocks could be augmented with the release of hatchery fry in hopes that fish will return to spawn and later rear in their stream of origin.

To help understand the role side-channels play in the success of trout, it is recommended that further research regarding juvenile trout utilization of side-channels be undertaken. Research gathered over a three to four year time span would give a more complete picture of the importance of side-channels.

Individual channels should be sampled more intensively. Habitat parameters measured in this study, as well as others not covered, such as stream gradient should be recorded year round over the complete length of each side-channel. Minnow traps should be placed at 10m intervals over the complete length of each side-channel. Due to time and resource restraints these recommendations could not be met by this preliminary study.

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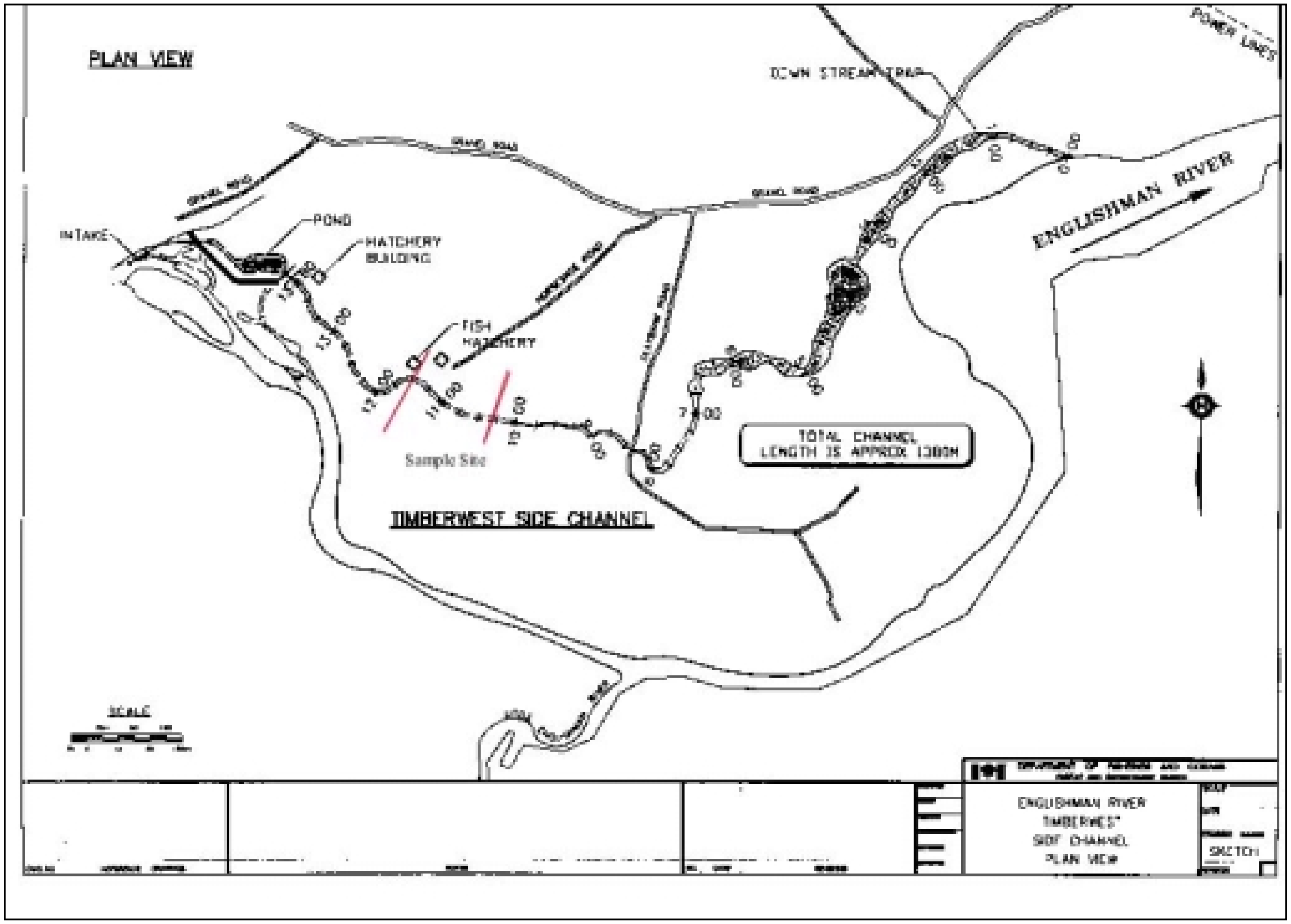
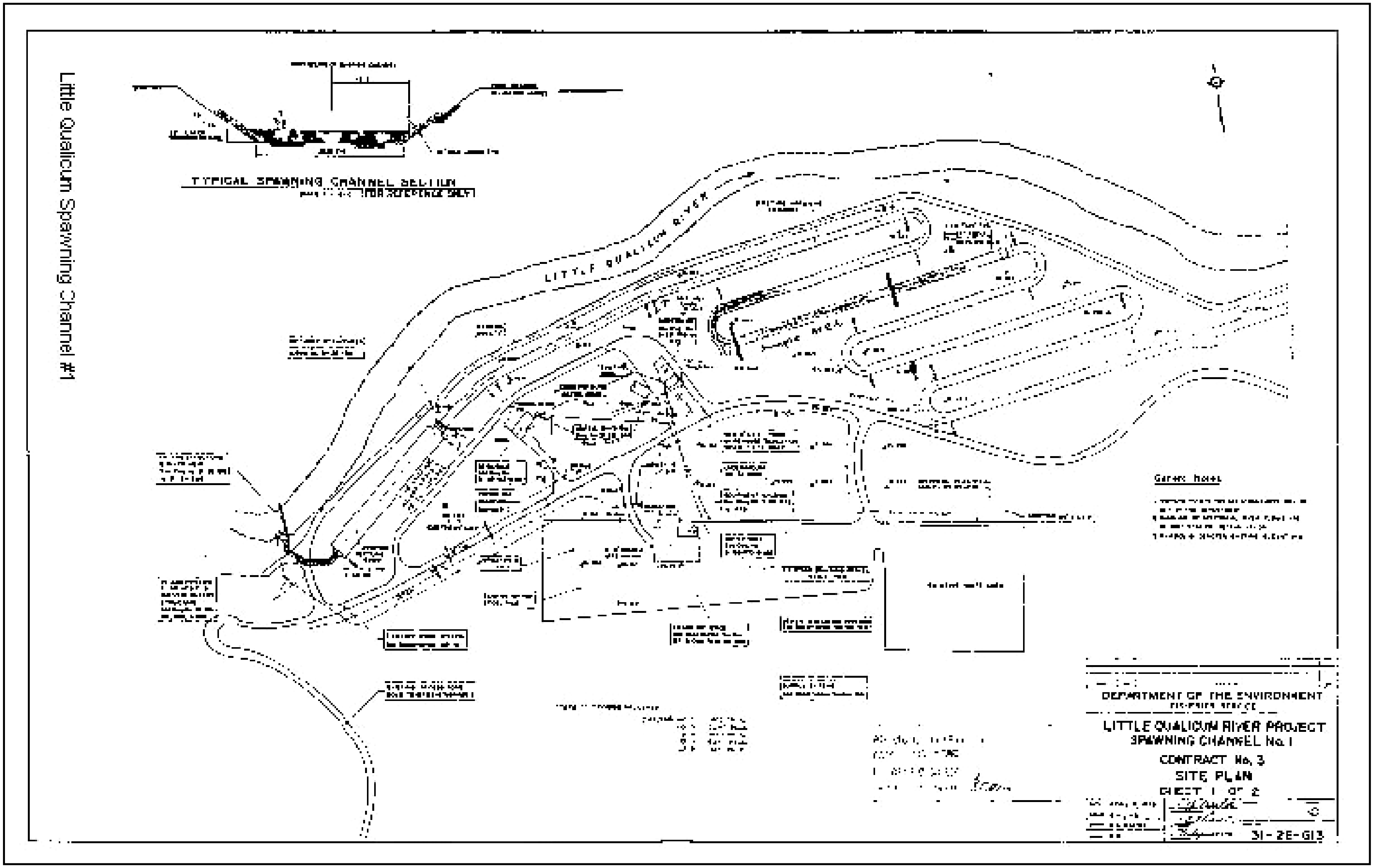
Appendix A

Sample Site Maps
Englishman, Little Qualicum, Oyster, and Puntledge Rivers.

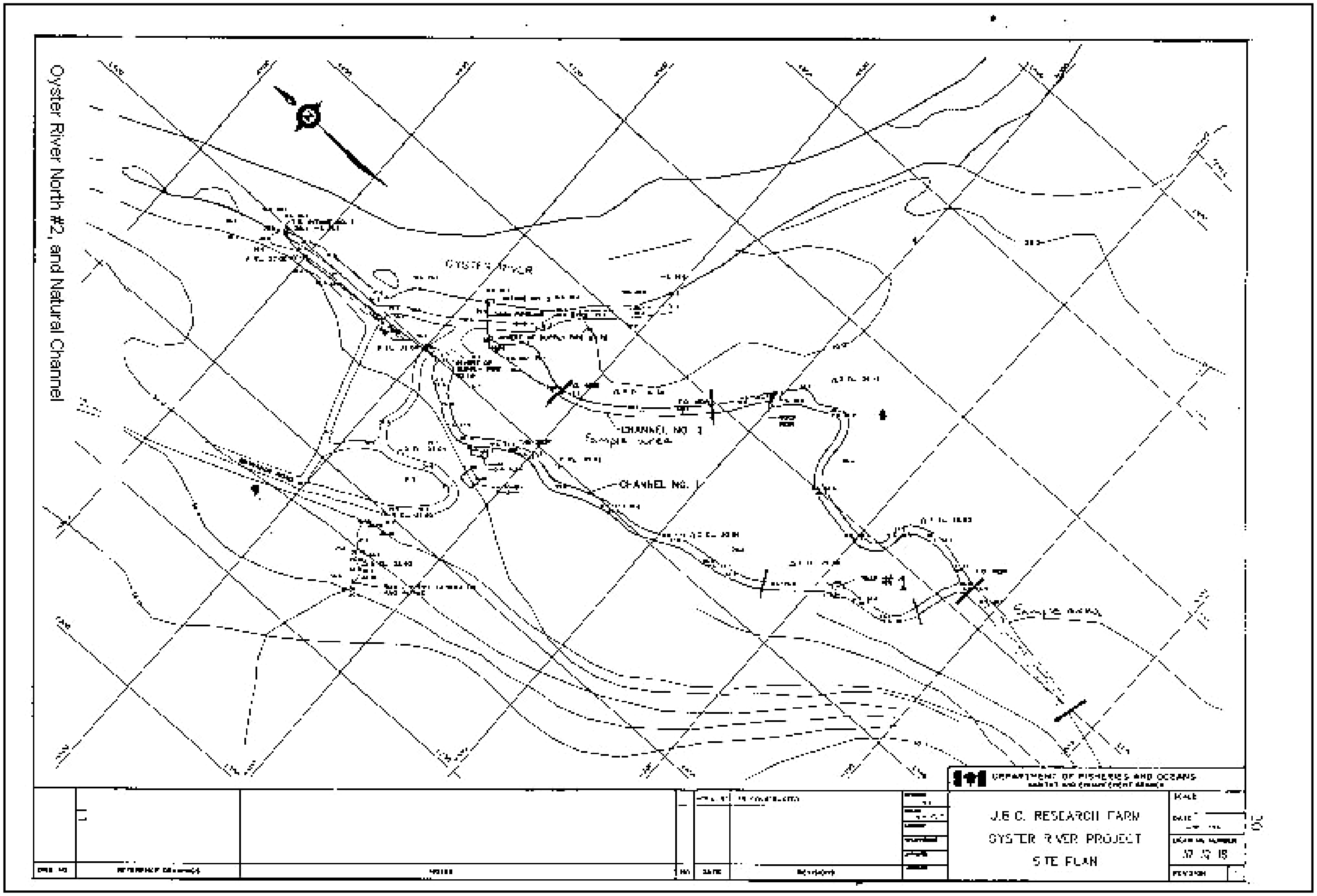
Appendix A



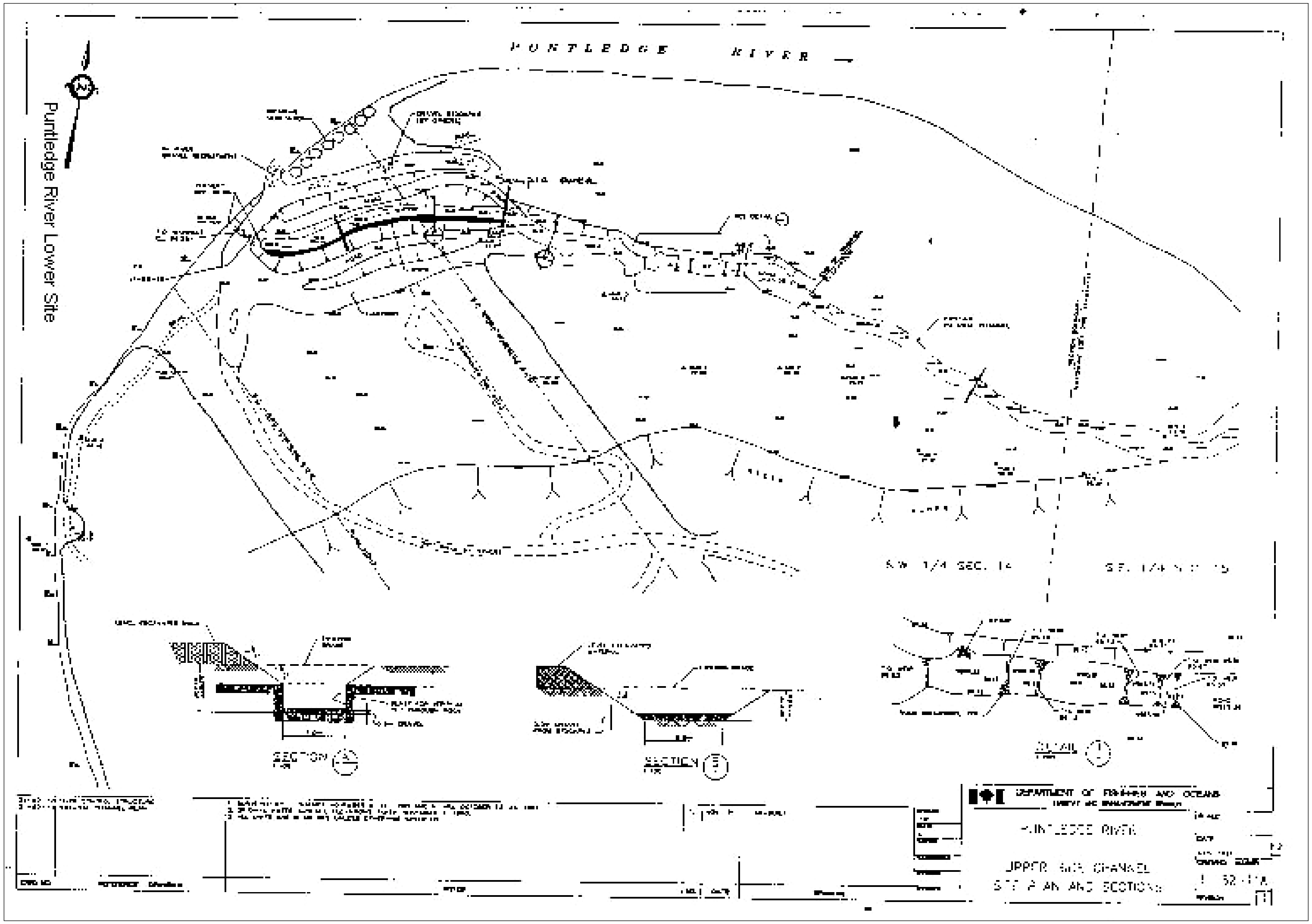
Englishman River Map



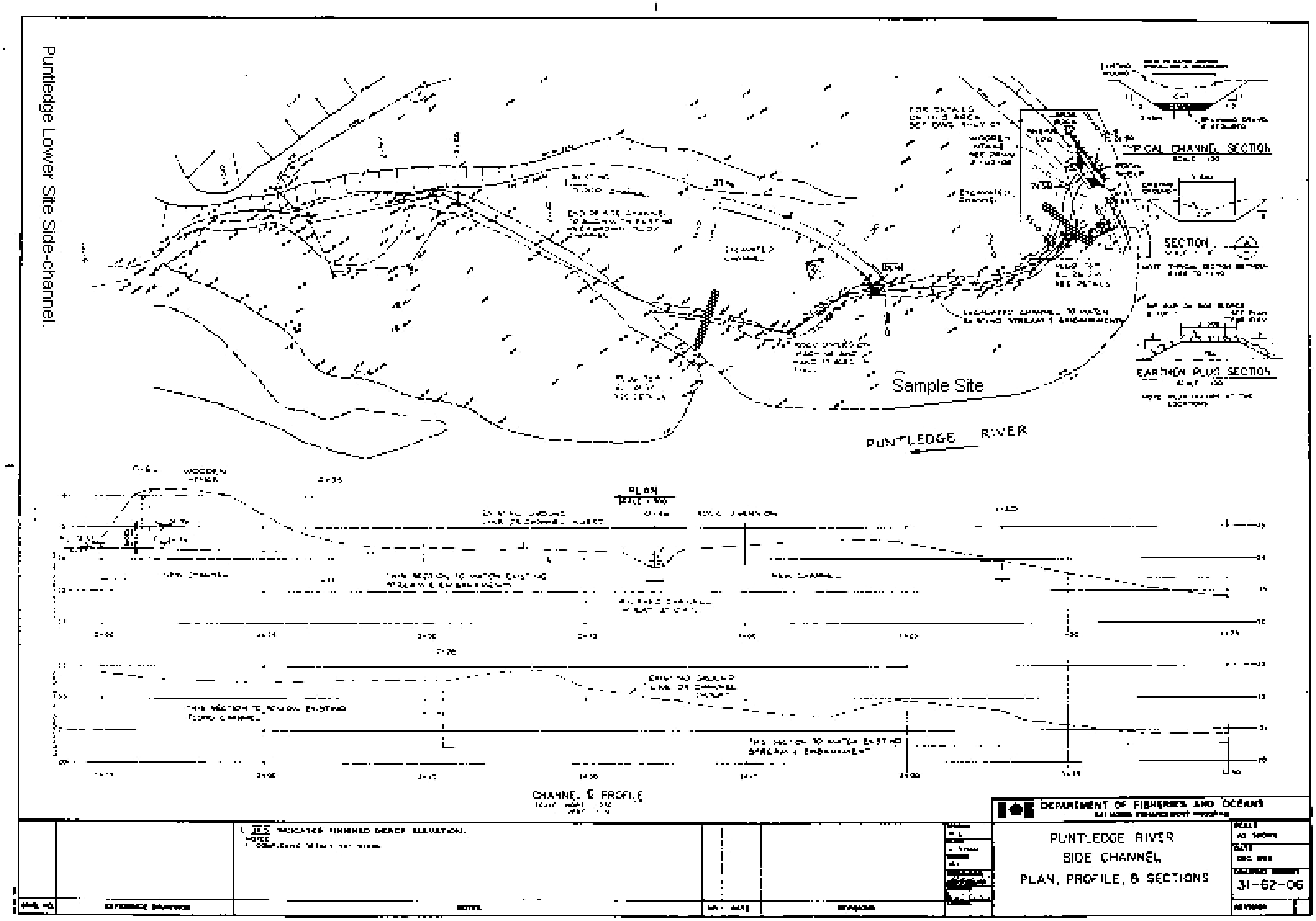
Little Qualicum map



Oyster River Map



Upper Puntledge River Map



Lower Puntledge River Map

Appendix 2

Fish and Habitat Parameter Data
Englishman, Little Qualicum, Oyster, and Puntledge Rivers.

Puntledge River

Upper Site

Date: October 8, 1999

Trap #					Site Description											
	weight in gr.			length in mm.												
	coho		trout		loc	loc	depth	wwidth	substrate	in st cover	bank cover	land use	veg type	Q	cr close	Comments
					m	m	m	m	b/c/g/f	%type	%type			m/s	%	
1			8	93												
			2.2	58												
			3.6	68												
2			3.1	68												
			5	72												
			2.4	63												
3																
4			2.3	61												
			2.3	59												
			2.2	58												
			4.1	72												
	2.6			61												
5	3			62												
	4.6			72												
6																
7																
8			3.9	69												
	5			76												
	5			77												
	8.6			97												
	10.2			100												
	4.9			78												
	5.4			77												
	3.9			70												
9	2.3			58												
	2.2			57												
10																
Total coho 13 Total trout 11																
Average weight coho			3.40 grams													

Location: Little Qualicum River

Side-channel: Chum salmon spawning channel

Date: October 6, 1999

Trap #					Site Description				Comments						
	weight in gr.			length in mm.	loc	depth	wwidth	substrate	in st cover	bank cover	land use	veg type	Q	cr close	Comments
	coho		trout		m	m	m	b/c/g/f	%type	%type			m/s	%	
1-10	4.1			74											
			7.8	94											
	9			94											
			8.2	96											
	9.8			108											
			9.6	100											
			6.9	87											
	6.8			85											
			6.3	84											
			11.8	108											
	5.3			81											
			9.8	98											
			4.6	78											
	6.8			81											
	10.1			97											
	6.2			81											
	8.6			85											
Total coho 9 Total trout 8															
Average weight coho			7.41	grams											
Average weight trout			8.13	grams											
Average fish length			90.06	mm											

Site : Oyster River

Side-channel: Natural

Date: October 8, 1999

Trap #					Site Description	h2o depth		h2o temp.	Comments					
	weight in gr.		length in mm.											
	coho	trout		loc	depth	wwidth	substrate	in st cover	bank cover	land use	veg type	Q	cr close	Comments
				m	m	m	b/c/g/f	%type	%type			m/s	%	
1	2.9		65											
	4.2		72											
	4.6		77											
	3.8		70											
2 -- 3	3.5		76											
	3.5		71											
	5.6		84											
	4.3		75											
	6.8		85											
	10.1		97											
	4.3		73											
	9.3		94											
	8.1		87											
	5.1		79											
	3.8		83											
	4.1		67											
	3.5		67											
	3.4		68											
	3.6		69											
	4		72											
	4.4		74											
	3.5		67											
	3.9		71											
	3.3		65											
	5.8		77											
	7.8		89											
	7.1		87											
	7.8		83											
	4.5		75											
	2.6	+40 coho	62											
4		23 coho			instream boulder cover 15%, crown closure 0%, substrate-…									
5		23 coho			instream boulder cover 15%, crown closure 25%									
6		7 coho			instream boulder cover 20%, crown closure 0%									
7		26 coho			instream boulder cover 20%, crown closure 15%									
8		19 coho			instream boulder cover 20%, crown closure 15%									
9		1 coho			instream boulder and LOD cover 25%, crown closure 0%									
10		20 coho			instream boulder 15%, crown closure 0%									
Total coho 189 Total trout 0														
Average weight coho		4.97 grams												
Average weight trout		0 grams												

River: Lower Puntledge

Side-channel:

Date:

Trap #							Site Description								
	weight in gr			length mm											
	coho		ct. trout		loc	depth	wwidth	substrate	in st cover	bank cover	land use	veg type	Q	cr close	Comments
					m	m	m	b/c/g/f	%type	%type			m/s	%	
1	2 coho		7 trout												
2	5 coho		5 trout												
3	5.3			64											
	5.7			75											
	3.1			63											
	3.5			72											
	6.8			82											
	4.4			71											
	4.3			69											
	4.4			64											
	4.4			75											
	2.6			62											
4															
5			14.1	118											
			14.9	117											
			5.4	78											
			3.5	69											
			5.1	79											
			3.3	70											
			5.3	82											
			5.1	80											
			2.8	65											
			1.8	58											
			3.6	73											
			3.6	75											
	7.9			92											
	2.9			66											
6			20.6	136											
			8.7	98											
			3.3	71											
	6.3			84											
	7.7			93											
	8.3			95											
	4			76											
	2.3		14 coho	62											
7			2	60											
			1.3	53											

Table continued

	1 coho		1.3	49											
8			18 coho												
9			34.8	151											
			4.6	78											
			2.5	63											
			2.8	67											
			1.8	58											
	9 trout		3.3	65											
10			21.1	129											
			3.3	68											
			2.4	62											
			2	58											
			4	74											
	5 trout		1.8	58											
Total coho 57 Total trout 47															
Average weight coho			4.91	grams											
Average weight trout			6.34	grams											
Average fish length			77.17	mm											

Puntledge River
Upper Site
Date: October 8, 1999

Trap #					Site Description											
	weight in gr.			length in mm.												
	coho		trout		loc	loc	depth	wwidth	substrate	in st cover	bank cover	land use	veg type	Q	cr close	Comments
					m	m	m	m	b/c/g/f	%type	%type			m/s	%	
1			8	93												
			2.2	58												
			3.6	68												
2			3.1	68												
			5	72												
			2.4	63												
3																
4			2.3	61												
			2.3	59												
			2.2	58												
			4.1	72												
	2.6			61												
5	3			62												
	4.6			72												
6																
7																
8			3.9	69												
	5			76												
	5			77												
	8.6			97												
	10.2			100												
	4.9			78												
	5.4			77												
	3.9			70												
9	2.3			58												
	2.2			57												
10																

Total coho 13 Total trout 11				
Average weight coho			3.40	grams
Average weight trout			3.55	grams
Average fish length			70.70	mm