Kalispel Resident Fish Project

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KALISPELL RESIDENT FISH PROJECT

ANNUAL REPORT 1996

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Executive Summary

In 1996 the Kalispel Natural Resource Department (KNRD) in conjunction with the Washington Department of Fish and Wildlife (WDFW) continued the implementation of a habitat and population enhancement project for bull trout (*Salvelinus confluentus*), westslope cutthroat *(Oncorhynchus clarki iewisi)* and largemouth bass *(Micropterus salmoides*). A habitat and population assessment was conducted on Browns Creek a tributary of Cee Cee Ah Creek. one of the priority tributaries outlined in the 1995 annual report. The assessment was used to determine the type and quality of habitat that was limiting to native bull trout and cutthroat trout populations. Analysis of the habitat data indicated high amounts of sediment in the stream. low bank cover, and a lack of winter habitat. Data collected from this assessment was used to prescribe habitat enhancement measures for Browns Creek. Habitat enhancement measures, as outlined in the recommendations from the 1995 annual report, were conducted during field season 1996. Fencing and planting of riparian areas and instream structures were implemented. As a precursor to these enhancement eforts, pre-assessments were conducted to determine the affects of the enhancement. Habitat quality, stream morphology and fish populations were pre-assessed. The construction of the largemouth bass hatchery was started in October of 1995. The KNRD, Contractors Northwest Inc. and associated subcontrators are in the process of constructing the hatchery. The projected date of hatchery completion is summer 1997.

Acknowledgments

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Introduction

Bull trout and cutthroat trout habitat assessment andpopulation abundance

In 1995 seven tributaries to the Pend Oreille River were identified as priority streams for enhancement of native bull trout and westslope cutthroat trout habitat. Field season 1996 saw the continued assessment of stream habitat, as well as, the begining of the implementation phase of The Kalispel Resident Fish Project. Browns Creek was assessed to continue our data base for the priority tributaries outlined in the 1995 annual report (KNRD and WDFW. 1995). In addition to the new assessments, all stream reaches designated as sites for enhancement were given an intense prestructure assessment. These microassessments of the actual structure sites combined with the standard overall stream assessments will aid in determining each structures effect in its specific location, individual reach and the stream as a whole. Upon completion of the preassessments. implementation of recomended enhancement measures was begun. This report will detail the measures completed and the preassessment data, however; the discusion of this data will be used as a comparative tool with the completion of post assessments.

Description of Study Area

The Pend Oreille River system begins as the Clark Fork River in west central Montana. The Clark Fork River empties into Pend Oreille Lake. The Pend Oreille River begins at the outflow of Pend Oreille Lake. The river flows westward into Washington then turns northward until it reaches Canada, eventually flowing into the Columbia river. The study area is in the northeast corner of Washington State. The approximate drainage area of the Pend Oreille River between the border of Idaho, Washington and the international border is 65.300 km'.

Browns Creek (Figure 1) is a major tributary of Cee Cee Ah Creek. Originating from springs fed by Browns Lake. the creek flows approximately 3.4 miles from the origin to the confluence with Cee Cee Ah Creek. Browns Creek begins in a series of beaver ponds in the headwaters and runs through relatively undisturbed forests to another series of beaver ponds in the middle reach. The lower portion runs through mature forests with a fairly substantial gradient. The drainage basin area for Browns Creek is approximately 21.5 km'.

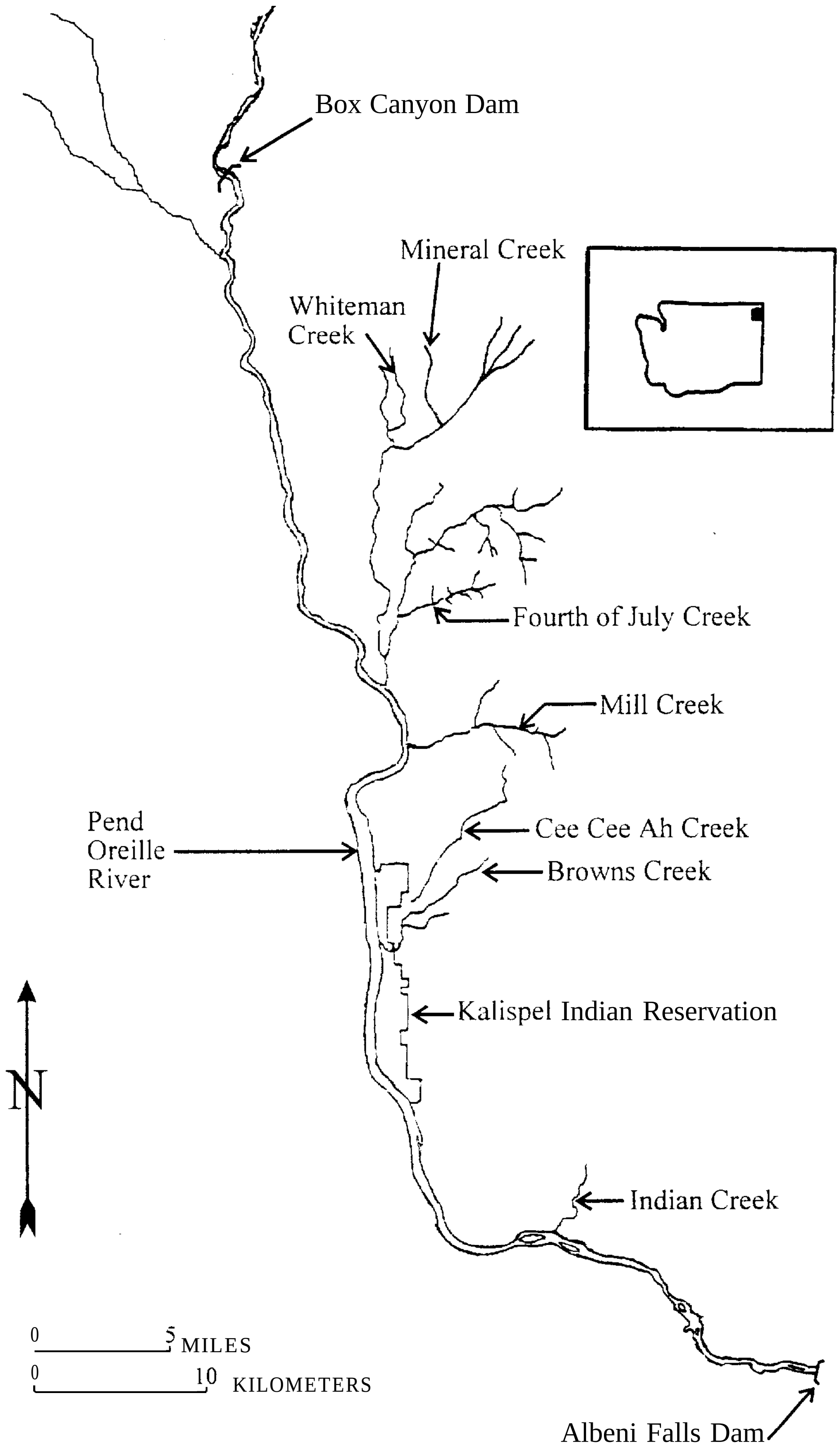

Figure 1. Box Canyon Reservoir and priority tributaries.

Methods

Bull trout and cutthroat trout habitat assessment andpopulation abundance

The stream habitat survey methodology contained four facets: transect surveys, reach overviews, inter-reach comparisons and fish surveys. The compilation of transect surveys and reach overviews were used to define the most degraded reaches through interreach comparisons. Snorkel surveys and electroshocking were used to determine fish population densities and age class distribution for all salmonid populations within each stream and were combined with the interreach comparisons to draw conclusions on the effects of degraded habitat quality and non-native salmonids on native salmonid species. Conclusions were used to aid in more informed restoration recommendations. Stream and fish population survey methodology used within the Box Canyon Reach is similar to that developed by Espinosa (1988) and further revised by Huntington and Murphy (1995) (KNRD internal doc. l-95).

Habitat surveys were broken into two components 1) transect surveys and 2) reach overview surveys. Transect surveys are the division of the stream into 30m segments. Primary pools, spawning habitat and acting woody debris counts were collected for the entire length of each 30m segment. The remainder of the habitat quality parameters in Table 1 were collected at the end of each 30m segment (the actual transect site). This method allows for a number value to be assigned to each habitat quality parameter. Reaches were defined by stretches of stream with common gradient, substrate and vegetation. Breaks between two homogeneous areas defined a new reach. Reach overview surveys are the visual observation and description of variables occurring within each reach (Table 2). Each reach was permanently marked and flagged using aluminum tags and flagging as a reference point for long-term monitoring.

Following the compilation of transect data, an interreach comparison was conducted using the mean values for each reach. This was the fundamental unit of comparison to determine specific reaches for enhancement projects. Threshold values were established for embeddedness, bank stability, bank cover, instream cover, pool-riffle ratio, spawning gravel and primary pools (Table 3). All threshold values were obtained from Hunter (199 1) and/or MacDonald *et ul.* (199 1). The mean data for each reach was analyzed by using these threshold criteria. Each habitat value that did not fall within the threshold was counted as habitat that was unsatisfactory for quality or quantity. The reaches with the most numerous unsatisfactory habitat values were identified as enhancement sites for that particular stream.

The data from the specific reaches identified in the inter-reach comparison were evaluated in a flowchart to provide a list of possible options for the types of structures or measures to be used in enhancement (Figure 2). Each structure is designed to perform specific functions and requires specific habitat placement (Table 4). Specific structure selection was made by reviewing the list of options for enhancement and choosing the structure that addresses the limiting factors for each particular reach of enhancement. Reach accessibility was also considered when choosing between structures with similar function but varying levels of effort in their construction. Specific placement was determined by the transects within each reach that were in the habitat type each structure was designed for.

Fish density estimates were collected using standard snorkel survey techniques (Espinosa 1988) for Browns Creek. Sampling was conducted during the period from July 15 through September 15. Population density was addressed by number, size (age class) and species of fish per $100m^2$ (Table 5). The standard size/age classes for salmonid species were determined according to Espinosa (1988). Lengths of stations were 30 meters and selected so that beginning and ending points for stations never bisected pool habitat. Fish stations were permanently marked and flagged using aluminum tags and flagging.

Table 1. Transect Variables and Method of Collection.

Variable	Method of collection
Habitat Type	Visually determine habitat types (i.e., pool, riffle, glide, pocketwater, run, alcove).
Dominant Substrate Size	Visually determine largest percentage of substrate for that habitat type (i.e., silt, sand, gravel, cobble, boulder, bedrock).
Habitat Function	Visually determine habitat functions (i.e., winter, summer, spawning or unusable).
Spawning Gravel Amount and Quality	Measure potential square meters of spawning gravels within each transect and quality (i.e. gravel size, location and current velocity Kalispel internal doc. l-95) Good = All criteria met. Fair = 2 criteria met. Poor = 1 criteria met.
Stream Depths	Measure depth at 1/4, 112, 314 across channel to the nearest cm.
Habitat Widths	Measure each specific habitat type in a transect to the nearest 0. l m.
Primary Pools	Number of pools with length or width greater than the avg. width of stream channel within each transect.
Pool Quality	Rating based upon collection of length, width, depth, and cover.
Pool Creator	Identify item creating the pool (e.g., large woody debris, boulders, beaver, enhancement, other).
Cobble Embeddedness	Visual estimate of the percentage fine or coarse sediment surrounding substrate / Actual measurement was recorded with an embed meter approximately every 20 transects, Regression of the estimated numbers with the actual measurements calculated a correction factor for all estimated values.
Bank Stability	Visual estimate of the percentage of unstable bank per transect for possible sediment source.
Instream Cover Rating	Percent of the stream surface covered by large woody debris, aquatic vegetation, bank vegetation in or near the surface of the water / Amount of cover provided by undercuts. root wads, boulders or turbulence.
Dominant/Subdominant Riparian Vegetation	Visual estimate of dominant vegetation and of subdominant vegetation species.
Stream Channel Gradient	Using a clinometer measure percent slope
Acting Woody Debris	Number of woody debris with a diameter >10cm and a length >1 m in the stream.
Potential Debris Recruitment	Number of trees within the transect that could potentially fall into the stream > 10 cm and a length > Im.
Residual Pool Depth	The average pool depth by averaging the deepest portion of the pool and the pool tailout. Measure to the nearest 0.01cm.

Table 2. Reach Variables and Method of Collection.

Variables	Method of Collection
Air and Water Temperature	Thermometer reading in centigrade.
Channel Type	A general classification of channel type based on channel morphology (see Rosgen 1994).
Average Embeddedness	Estimate of the average embeddedness for the entire reach Actual measurement was recorded with an embed meter approximately every 20 transects, Regression of the estimated numbers with the actual measurements calculated a correction factor for all estimated values.
Dominant Habitat Type	Dominant habitat type for the reach (i.e., pool, riffle, glide, pocketwater, run, alcove).
Disturbance	Estimation of the effects of land use practices (i.e. logging, roads, cattle, mining).
Aquatic Vegetation	Estimation of the occurrence of aquatic vegetation for the reach (i.e., abundant, fairly common, scarce, none).
Shading	Visual estimation of the amount of stream shaded by canopy along the stream reach
Habitat Quality	Estimation of the habitat quality for the entire reach (i.e., good, fair, poor).
Other	Any notable attribute not required for recording that can be recorded for reference to impact, or in interest to habitat quality.

Table 3. Interreach comparison threshold values (after Hunter 1991; MacDonald 1991).

Limiting Factors	Threshold Value
Embeddedness	Any value 2.30 or ≤ .70
Bank Stability	Any value ≤ 75%
Bank Cover	Any value ≤ 2.5
lnstream Cover	Any value ≤ 2.0
Pool - Riffle Ratio	Any value ≤ .5:1 or ≥ 1.5:1
Spawning Gravel	Three lowest cumulative values
Primary Pools	Three lowest values

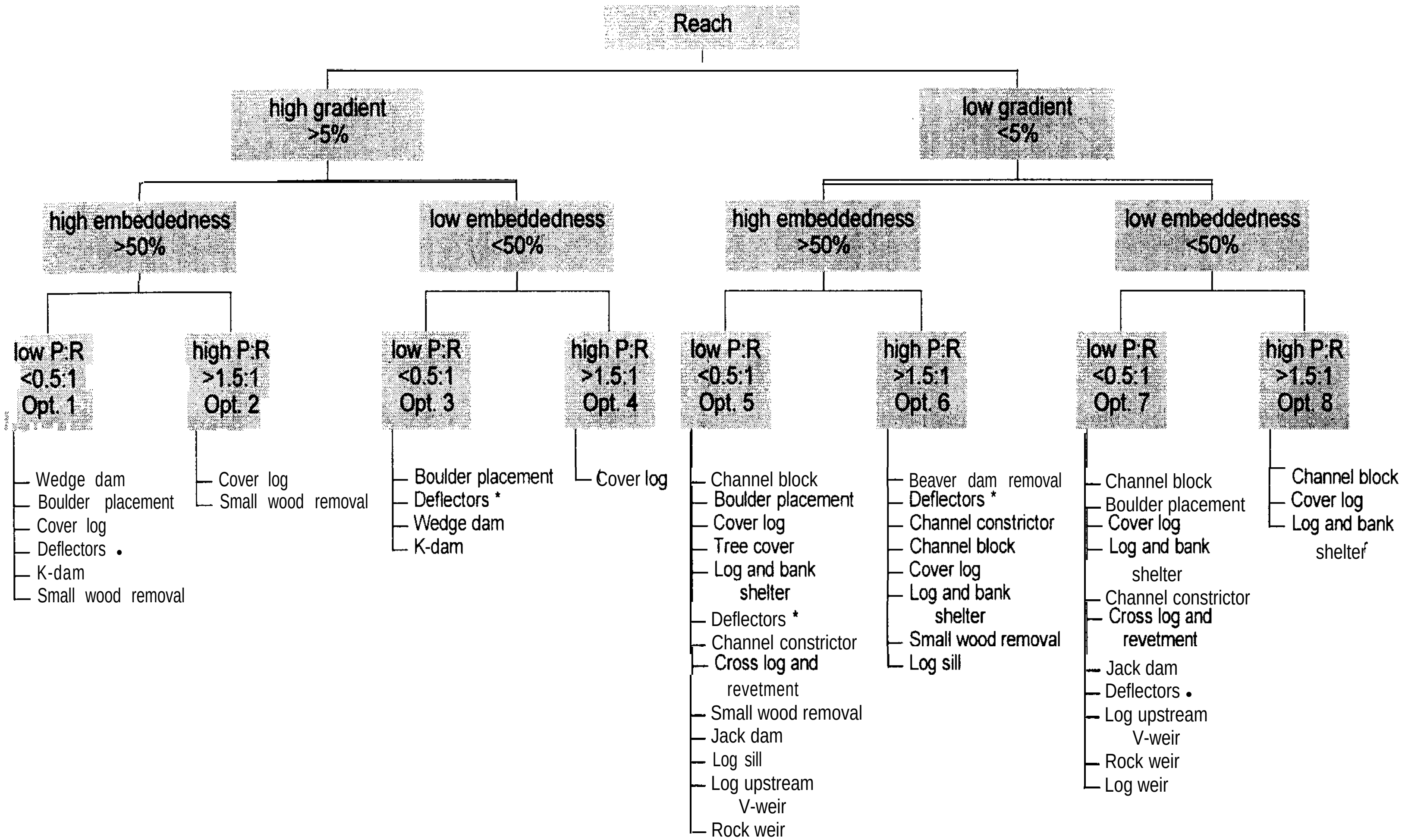

Figure 2. Flowchart for indentified reaches of enhancement and the possible structures available for enhancement. Values derived after Harrelson et al. 1994, Macdonald 1991 and Hunter 1991.

Table 4. Instream structures and the descriptions for placement requirements, function and impacts.

Structure	Habitat	Stream Requirements	Purpose	Impacts
Wedge dam	Riffles Runs	Well defined stream banks. Stream < 30 ft. wide. Gradient >5%. Substrate consisting of: rubble, cobble and gravel Ideal locations are at a break in gradient with a steeper section immediately upstream.	Creates a fair to excellent scour pool. Creates spawning gravel at tail-out of poo.l	+/- Creates calmer water above the structure. + Creates a scour pool below the structure. +/- May act as a trap for sediment.
Boulder placement	Riffles Runs Glides Open Pools	Greatest benefits in currents exceeding 2 feet pet second. Suitable for any size stream.	Provides overhead cover and resting areas. Creates natural appearance.	+ Creates pocketwater behind boulder. + Added depth is also created by the scouring resulting from reduced channel capacity and increased current velocity,
Cover log	Open Pools Runs	Works best in meanders or in conjunction with deflectors. Requires adequate water depth (at least 8” deep.) Suitable for any size stream.	Provides optimum cover.	+ Creates overhead cover. + Directs current away from meander. - May cause unwanted bank cutting.
Single-Wing Deflector	Riffles Glides Runs	When possible, divert water into a relatively stable section of stream bank. Suitable for a variety of sites. Most suitable in wide shallow riffles	Constricts and diverts water flow so that pools are formed by scouring. Creates spawning gravel.	+ Constricts and diverts water flow. +/- May cause deposition of sediment just below structure towards bank. + Directs meande.r - May cause unwanted bank cutting.

Table 4. continued

Structure	Habitat	Stream Requirements	Purpose	Imnacts
Double-Wing Deflector	Riffles Runs Glides	Especially suitable for shallow sections of stream where the gradient is too steep for effective deflector and cover log.	Creates mid-channel pools through scouring. Creates spawning gravel at tail-out of pool.	+ Narrows channel. + Scours a pool below structure. +/- May cause deposition of sediment just below structure towards bank. - May cause unwanted bank cutting.
Channel Constrictor	Riffles Runs Glides	Provides best results when placed in long, straight, low-gradient stretches of stream.	Provides overhead cover. Narrows channel. Scour and deepen streambed.	+ Scours the streambed. + Increases velocity. + Helps transport sediment. - May concentrate sediment below structure. +/- Incises the channel.
Log Deflector	Riffles Glides Runs	When possible, divert water into a relatively stable section of stream bank. Suitable for a variety of sites. Most suitable in wide shallow riffles.	Constricts and diverts water flow so that pools are formed by scouring. Creates spawning grave.1	+ Constricts and diverts water flow. +/- May cause deposition of sediment just below structure towards bank. + Directs meander.
Log Paired Deflector	Riffles Runs Glides	Especially suitable for shallow sections of stream where the gradient is too steep for effective deflector and cover log.	Creates mid-channel pools through scouring. Creates spawning gravel at tail-out of pool.	+ Narrows channel + Scours a pool below structure. +/- May cause deposition of sediment just below structure towards bank.

Table 4. continued

Structure	Habitat	Stream Requirements	Purpose	Impacts
Rock Deflector	Riffles Runs Glides	When possible, divert water into a relatively stable section of stream bank. Suitable for a variety of sites. Most suitable in wide shallow riffles.	Directs flow from cut bank. Directs meander. Scours pool.	+ Constricts and diverts water flow. +/- May cause deposition of sediment just below structure towards bank. + Directs meander.
Boulder Paired Deflector	Riffle Runs Glides	Especially suitable for shallow sections of stream where the gradient is too steep for effective deflector and cover log.	Creates mid-channel pools through scouring. Creates spawning gravel at tail-out of pool.	+ Narrows channel. + Scours a pool below structure. +/- May cause deposition of sediment just below structure towards bank.
K-Dam	Riffles Runs	Well defined stream banks. Stream <15 ft. wide. Gradient >5%. Substrate consisting of: rubble, cobble and gravel. Ideal locations are at a break in gradient with a steeper section immediately upstream.	Creates a fair to excellent scour pool. Creates spawning gravel at tail-out of pool.	+/- Creates calmer water above the structure. + Creates a scour pool below the structure. +/- May act as a trap for sediment. - Prone to undercutting of structure.
Small Wood Removal	Riffles Glides Runs	Small wood must be acting as a silt trap or inhibiting fish migration in order to be removed. Typically used to increase velocity and transport sediment.	Typically used to increase velocity and transport sediment. Helps expose substrate.	+ Increases velocity. + Transports sediment. + Exposes substrate. + Narrows channel.

Table 4. continued

Structure	Habitat	Stream Requirements	Purpose	Impacts
Channel Block	Braided Channel	Braided channel that is virtually unusable.	Consolidates flow into a single, deeper channel.	+ Concentrates flow into a single deeper channel. + May increase velocity. - May concentrate sediment deposition downstream.
Tree Cover	Riffles Runs Glides	Suitable for a variety of sites. Greatest benefits probably occur in wide shallow streams with sand or gravel substrate.	Provides excellent overhead cover. Increases stream velocity. Transports sediment.	+ Constricts wide shallow channels. + Increases stream velocity. + Transports sediment.
Log & Bank Shelter	Open Pools	Suitable for use in low gradient. Stream bends or meanders. Can be used with a deflector.	Provides overhead cover. Provides some streambank protection	+ Creates overhead cover. + Directs current away from meander
Cross Log & Revetment	Riffles Runs	Structure works best in low gradient sections of the stream. Works even better at the beginning of wide, shallow bends with marginal pools or cover.	Creates scour pool. Creates overhead cover. Protects the bank.	+ Creates a scour pool. + Protects bank.
Jack Dam	Riffles Runs	High banks. Moderate to steep gradient.	Produces deep scour pools.	+/- Creates calmer water above the structure. + Creates scour pool.
Log Sill	Riffles Runs	Well defined stream banks. Stream < 15 ft. wide. Gradient <5%.	Creates scour pool. May create spawning gravel.	+/- Creates calmer water above the structure. + Creates a scour pool below the structure. +/- May act as a trap for sediment.

Table 4. continued

Structure	Habitat	Stream Requirements	Purpose	Impacts
Log Upstream V-Weir	Riffles Runs	Well defined stream banks. Stream < 15 ft. wide. Gradient <5%. Works well in sand and gravel substrate.	Creates deep plunge pool. Creates spawning gravel at tail-out of pool.	+/- Creates calmer water above the structure. + Creates a scour pool below the structure. +/- May act as a trap for sediment.
Rock Weir	Riffles Runs	Well defined stream banks. Stream < 15 ft. wide. Gradient <5%.	Creates scour pool.	+/- Creates calmer water above the structure. + Creates a scour pool below the structure. +/- May act as a trap for sediment.
Log Weir	Riffles Runs	Well defined stream banks. Stream < 15 ft. wide. Gradient <5%.	Creates scour pool.	+/- Creates calmer water above the structure. + Creates a scour pool below the structure. +/- May act as a trap for sediment.
Beaver dam removal	Long Pools	A beaver dam in the in the lower 2/3 of the stream . A beaver dam that may inhibit fish passage.	Narrows channel. Exposes substrate.	- Releases a large volume of sediment downstream. +/- Incises the channel . + Decreases sediment upstream. + May expose substrate such as cobble, gravel and boulders.

Table 5. Fish species age/length class distributions (Espinosa 1988).

Species	Age	Length
Cutthroat Trout	0+	< 65 mm FL
Rainbow Trout	1+	6.5-110 mm FL
	2+	111-150 mm FL
	3+	151-200 mm FL
	4+	201-305 mm FL
	BIG	> 305 mm FL
Bull Trout	o+	< 65 mm FL
Brook Trout	1+	65-115 mm FL
Brown Trout	2+	116-165 mm FL
	3+	166-210 mm FL
	4+	211-305 mm FL
	BIG	>305 mm FL
Mountain Whitefish	N/A	< 100 mm
	N/A	100 - 305 mm
	N/A	> 305 mm
Sculpin	Total Number	Record Species If Possible
Sucker	Total Number	Record Species If Possible

All sites selected as areas for enhancement were pre-assessed using an intense version of the standard transect methodology, prior to implementation. The only modification to the transect methodology was shortening the length between transects. Riparian project areas were assessed with 10m transects for each kilometer where fencing and planting occurred. Instream structures were assessed using 5m transects from 30m above the structure site to 30m below. Cross sections of the stream were measured at a rate of one per every 30m (riparian restoration) and 10m (instream restoration), to be used as a comparative model with post assessment cross sections. Cross section sites were benchmarked using aluminum tags. labeled with cross section number, and attached to rebar stakes.

Fish sample stations for riparian restoration were calculated to be one 30 meter snorkel station per every 250 meters of stream (Figure 3.). A minimum sample size of three snorkel stations for each restoration area was conducted, unless the area was less than or equal to 90 meters long. in which case the entire area was snorkeled. Assuming the lowest known bull trout population density (0.075 bull trout/30 meters) in the state of Washington (Hillman and Platts 1993). we were 95% confident that if bull trout were in the stretch of the stream we would observe them at this rate of sampling. Bull trout were used to determine the sample size because they are the least abundant native salmonid species in the area.

Each station was benchmarked at the upper and lower boundary with labeled aluminum tags attached to rebar stakes. The same stations will be sampled in the spring, summer. and fall. Data from snorkel stations will be used to determine densities of all fish species present. Fish sampling for instream structures was conducted with a 60m station, 30m above and 30m below. to determine the fish numbers and species associated with the structure. To avoid confusion of benchmarks, fish stations are located at the actual structure.

$$n = \frac{-ln(1-a)}{b}$$

Where: n = the number of sample 30 meter snorkel stations
$-ln$ = negative natural log
a = level of confidence
b = lowest density (fish/30m of stream) of bull trout in the state of Washington

Figure 3. Calculation for number of sample stations

Results

Bull trout and cutthroat trout habitat assessment undpopulation abundance

As with streams surveyed last season, Browns Creek also exhibited moderate to high rates of embeddedness ($\bar{x}$ = 42.0% ± 19.1). Although the overall mean for the stream was relatively low, several individual reaches exhibited embed rates higher than 60% (Table 6). Browns Creek contained 106.8m^2/km of spawning gravel, the highest amount of quality spawning gravels of any stream surveyed to date. This is similar to results from previous assessments that streams with lower embed rates contained the higher amounts of quality spawning gravels. Browns Creek was also similar to previous assessments in that, there was very little habitat diversity with predominantly summer habitat. Reach 5 was an 854m reach of beaver ponds ranging up to 70m wide (wetted width), with no means of accurate measurements and no current plans for beaver removal from this reach, no assessments were conducted.

Only non-native species were recorded in snorkel stations at Browns Creek (Figure 3). Brook trout populations were almost twice as dense as brown trout (8.4 brook trout/l 00m^2 and 4.8 brown trout/l 00m^2).

The interreach comparison of Browns Creek's data filtered out the specific reaches with the most numerous limiting factors for fish habitat. The habitat quantity or quality values that did not fall within the threshold values were addressed with specific structure or enhancement measure selection (Table 7). Two reaches were selected as sites for enhancement projects.

Table 8 shows the mean values for the 5m pre-assessment transects. Twenty four 5m transect measurements were taken in each reach, where structures were to be constructed. Table 9 shows the mean values for the 10m pre-assessment transects. These transects measurements were taken for the entire reach, where riparian fencing and planting or small woody debris removal was to be conducted. These data will be used to compare to the the same measurements taken during the post assessment.

Table 6. Browns Creek reach data,

Habitat Variables	Reach 1 Mean	Reach 1 S.D	Reach 2 Mean	Reach 2 SD.	Reach 3 Mean	Reach 3 SD.	Reach 4 Mean	Reach 4 S D.	Reach 5	Reach 6 Mean	Reach 6 S D	Reach 7 Mean	Reach 7 S D	Reach 6 Mean	Reach 6 SD.	Reach 9 Mean	Reach 9 S.D
Embeddedness (%)	74.3	25.9	45 6	23 1	36	24 5	1 5 8	1 7 1		47 1	27 9	60.5	27.6	65.8	30 1	33 1	1 9 2
Bank Stability (%)	a5	10.3	87.7	5.3	91.1	4 3	86.9	3.2		71.9	9.5	78.5	8.9	68.6	18.6	80.5	19 1
Bank Cover	2.1	1.4	2.5	1.4	1 7	0.93	1 5	0.65		3.1	1.2	2.8	1.3	3 7	1.4.	1 9	0 92
Instream Cover	2.2	1.1	3.5	1.4	3.6	1 1	2.7	0 55		3.6	1.5	3.6	1.5	3.7	1 4	3.2	2 01
Pool-Riffle Ratio	1.3:1		.1:1		1:1		0.00			.1:1		.2:1		.2:1		0:00	
Acting Debris (#/1 00m)	27 6		19.2		17.5		197			33.9		29.6		29		23.9	
Primary Pools (#/Km)	20.4		1.4		0		0			3.7		1		4.8		1.5	
Gradient (%)	2.5	1.7	4.3	1	63	19	10.9	18		3.9	0.52	5.4	0.71	3 4	0.69	12	5.03
Avg Depth (cm)	38.8		184		19.4		18			16.1		17.8		28 5		27.4	
Avg Stream Width (m)	103		5.9		4.8		2.9			5 2		5 1		4.4		4 4	

Spawning Gravel (sq m)	Spnng	Fall	Spring	Fall	Spring	Fall	Spring	Fall		Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
Fair:	0	1.5	53.5	43 3	25.2	16	0	14		27.5	104	596.5	93	34	27.5	11.5	10
Good:	0	3.5	5.5	12.5	25	34 3	0	0		0	0	15	11	0	0	0	0
Poor:	0	0	0	0	0	0	0			0	0	0	0	0	0	0	0

Habitat Function	Occurrence	Occurrence	Occurrence	Occurrence		Occurrence	Occurrence	Occurrence	Occurrence
Unusable:	0.0%	0.0%	0 0 %	0.0%		0.0%	0.0%	0.0%	0.0%
Summer:	60%	98.7%	96.5%	100%		78.6%	98.7%	63.8%	93.4%
Winter:	40.8%	0.0%	1.4%	0.0%		0.0%	0.0%	36.2%	6.6%
Spawning:	0.0%	1.3%	2.1%	0.0%		21.4%	1.3%	0.0%	0.0%

Table 7. Reaches of enhancement and their data compared to threshold values.

	%Embeddedness ≥ 30 or ≤ .70	Hank Stability ≤75%	Hank Cover ≤ 2.5	Instrcam Cover ≤2.0	Pool - Riffle Ratio ≤ .5:1 or ≥ 1.5:1	Spanning Gravel 3 lowest values/stream	Primary Pools/Km 3 lowest values/stream
Browns							
Reach 4	15.8	86.9	1.5	2.7	0:00	14.0	0
Reach 9	33.1	80.5	1.9	3.2	0:00	21.5	1.5

Table 8. Compiled 5m transect p-e-assessment data.

	CEE CEE AH Reach 4		CEE CEE AH Reach 5		CEE CEE AH Reach 6		WHITEMAN Reach 5		WHITEMAN Reach 6		MINERAL Reach 1		4TH OF JULY Reach 6		MILL Reach 6	
Habitat Variables	Mean	S.D.	Mean	s. D.	Mean	S. D.	Mean	SD.	Mean	s. D.	Mean	S. D.	Mean	S.D.	Mean	S.D.
Embeddedness (%)	47.9	27 2	77	18	58.6	21.7	54.1	19.3	73.3	13.6	52.8	28.4	81.9	23.1	72.8	22.7
Bank Stability	861	77	77 9	6.5	72 2	11.5	80.5	6.9	85.7	12.2	75.5	16	88.1	8	45.8	11.7
Bank Cover	2 9	1.2	3.9	0 32	34	1	2.2	0.81	2	0.58	2.4	1.3	4	0	2.1	0.63
Instream Cover	4 3	0.76	4	0.2	3.5	0.8	2.5	1	2.2	0.68	3.9	0.93	4	0	2.4	0.72
Pool-Riffle Ratio	41		2:1		.2:1		.2:1		.3:1		.5:1		.1:1		.2:1	
Acting Debris (#II 00m)	37.9		73.1		156		70.9		36.4		19.4		34.3		43.3	
Primary Pools (#/Km)	13.8		15.4		37		0		0		24.2		0		0	
Gradient (%)	6.1	1	4	0.66	3.5	0.56	9.3	0.49	9.4	0.23	7.5	2.5	6.5	1.2	7.3	0.42
Avg. Depth (cm)	18.8		16.2		18.7		19.9		23.4		16.4		12.5		40.2	
Avg. Stream Width (m)	3.1		3.1		2.5		3.9		3.8		2.6		2.4		5.9	
Spawning Gravel (sq m)	Spring	Fall	Spring	Fall	Spring	Fail	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
Poor:	13.1	4	0	0	5.1	5.3	0	0	2	2	10.1	14.3	7	7	2	2
Fair:	12.7	4.1	0	0	2.6	1.1	0	0	0	0	15.5	1	2	2	0	0
Good:	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Habitat Function	Occurrence		Occurrence		Occurrence		Occurrence		Occurrence		Occurrence		Occurrence		Occurrence	
Unusable:	2.1%		0.0%		0.0%		0.0%		0.0%		0.0%		0.0%		0.0%	
Summer:	90%		97.3%		94.2%		93.1%		91.7%		93.9%		100%		94.1%	
Winter:	6.5%		2.7%		5.8%		6.9%		8.3%		3.3%		0.0%		5.9%	
Spawning:	1.4%		0.0%		0.0%		0.0%		0.0%		2.8%		0.0%		0.0%	

Table 8. continued

	INDIAN Reach 3		INDIAN Reach 4	
Habitat Variables	Mean	SD	Mean	S D.
Embeddedness (%)	79.9	27 7	525	6
Bank Stability	86	147	79 4	14 4
Bank Cover	3.1	0 7.5	4	1.3
Instream Cover	4.2	0.46	4 7	0.95
Pool-Riffle Ratio	2:1		0 00	
Acting Debris (#/100m)	14.4		29.2	
Primary Pools (#/Km)	0		8.3	
Gradient (%)	2.5	0.7	6.6	0.7
Avg. Depth (cm)	25.7		24.2	
Avg. Stream Width (m)	4.2		3 3	

Spawning Gravel (sq m)	Spring	Fall	Spring	Fall
Poor:	12	12	5	2
Fair:	8	8	3 5	3.5
Good:	3	3	0	1

Habitat Function	Occurrence	Occurrence
Unusable:	9 7%	0.0%
Summer.	90.3%	100.0%
Winter:	0.0%	0.0%
Spawning:	0 0%	0.0%

Table 9. Compiled 10m transect pre-assessment data.

	WHITEMAN Reach 4		4TH OF JULY Reach 4		MILL Reach 4	
Habitat Variables	*Mean*	*SD*	*Mean*	*S.D*	*Mean*	*S.D.*
Embeddedness (%)	*91.9*	164	93 2	16.8	58.1	17.5
Bank Stability (%)	67 5	146	70	11 a	a4 1	7.2
Bank Cover	1 8	0 a2	2 6	0 81	2 9	11
Instream Cover	1 5	0 53	2 7	0 a9	31	0.9
Pool-Riffle Ratio	4.1		2.1		21	
Acting Debris (#/100m)	24 1		31		61 a	
Primary Pools (#/Km)	7 9		3 2		20	
Gradient (%)	2.1	0.75	2 7	0 65	7	11
Avg. Depth (cm)	36.9		15.8		27.9	
Avg. Stream Width (m)	4.1		1.8		4	

Spawning Gravel (sq m)	Spring	Fall	Spring	Fall	Spring	Fall
Poor:	3.5	7	42	39.5	0	1
Fair:	0	3 5	20 5	18.5	0	0
Good:	0	0	2	1	0	0

Habitat Function	Occurrence	Occurrence	Occurrence
Unusable:	0.0%	0.0%	0.0%
Summer:	575%	97.2%	94 9%
Winter:	42.5%	2.8%	5.1%
Spawning:	0.0%	0.0%	0.0%

Discussion

Bull trout und cutthroat trout habitat assessment andpopulation abundance

Browns Creek exhibits reaches with highly degraded stream conditions. Sediment and lack of habitat diversity are the most prevalent problems. Sediment, in the amounts found in Browns Creek, has adverse impacts on salmonid reproduction, salmonid rearing, invertebrate production, species diversity, bedload transport, water quality, and stream depth (MacDonald *et* al. 199 1, Beschta and Platts 1986, Hynes 1970). The lowest embeddedness rate for a reach surveyed was 15.8 percent the highest was 74.3; however the mean embed rate for the entire stream was 42%.

Stream degradation, in terms of increased sediment, has direct impact on salmonid populations. It has been recorded that embeddedness of greater than 20 percent limits salmonid alevin emergence from interstitial spaces by 30 to 40 percent (Hynes 1970). Studies have described bull trout survival rates to emergence at nearly 50 percent in substrates containing 10 percent or less fine materials and zero percent survival in substrates containing 50 percent or greater fine materials (Weaver *et al.* 1985). Bull trout's long overwinter incubation and development make them additionally vulnerable to increases in fine sediments and degradation of water quality (Fraley and Shepard 1989).

The overall reduction of the median bed material particle size is one of the most common and probably the most damaging effects of land-use practices in forested streams. Reduction in particle size in bed material directly affects the flow resistance in the channel and the stability of the bed (Beschta and Platts 1986). If the bed is composed solely of fine materials, the spaces between particles are too small for many organisms. Coarser materials provide a variety of small niches important for all small fish (e.g. juvenile salmonids) and benthic invertebrates (MacDonald *et al.* 1991).

There is some evidence that increased deposition of fine materials may be partially self perpetuating. In some cases the occurrence of bedload transport is delayed when interstitial spaces are filled with sediment, resulting in a decreased frequency of bedload transport (MacDonald *et al.* 1991). This would provide more opportunity for sediment deposition and limit the frequency at which sediment is washed out during high flow events. This can explain the lack of pools and the poor pool-riffle ratios in some reaches of Browns Creek. The threshold of sediment which can be transported may have been exceeded, and therefore, sediment is not being transported through the system.

Although stream degradation is detrimental to native salmonids, it generally favors the introduced salmonid species. Behnke (1979) described how clearcutting along two streams in the Smith River drainage of Montana increased erosion, sediment loads and water temperatures. The westslope cutthroat population was eliminated in the disturbed area and brook trout became the principle species. However, a small area in the headwaters of one stream was not logged and an indigenous cutthroat population still dominated in that reach. Platts (1974) also reported that cutthroat were common only in undisturbed reaches of streams in the Salmo River drainage of Idaho. This supports the argument that protection of high quality habitat is essential for the continued existence of westslope cutthroat populations (Liknes and Graham 1988).

The removal of riparian vegetation alters bull trout and cutthroat trout habitat by reducing recruitment of woody debris and opening the canopy (Oliver 1979, Shepard *et al.* 1984. Elliot 1986, Goetz 1989, Buckman *et al.* 1992). Instream woody debris serves an important habitat function. Bull trout juveniles have been found to heavily utilize woody debris in low flow areas and side channels (Goetz 1991). Adult bull trout were found to use woody debris as cover and territory to occupy when in competition with other species (Shepard et *al.* 1984, Oliver 1979).

The removal of riparian vegetation also increases the mean stream temperature. Increased temperatures may increase competition with more temperature tolerant species, such as brook trout. brown trout (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*) (Ratliff *et* al. 1992). Higher stream temperatures are limiting to bull trout egg survival, embryo growth rates and juvenile growth rates (McPhail *et al.* 1979, Shepard *et al.* 1984). The highest embryo survival was documented to be in 2-4° C water (McPhail *et al.* 1979, Brown 1985, Carl 1985). Bull trout prefer to live in temperatures ranging from 5-12.5° C and fall spawning does not start until the water temperature is 9" C with optimum temperatures at around 5° C (McPhail *et* al. 1979, Wydoski *et al.* 1979, Weaver *et al.* 1985, Fraley *et* al. 1989). Cutthroat trout are spring spawners that also prefer colder stream temperatures near 10° C (Roscoe 1974). This is why many of the interior cutthroat trout are found in small. high-elevation streams above the upstream limit of brook trout (MacPhee 1966, Griffith 1988). Stream temperatures are generally cooler at upstream sites dominated by cutthroat trout than at downstream sites dominated by brook trout (De Staso and Rahel 1994). Cold water temperatures may provide a competitive advantage to cutthroat trout that allows them to resist brook trout invasions (Fausch 1989).

These types of stream and riparian degradation were relatively common in Browns Creek and can help to explain the general pattern exhibited in Browns Creek; that non-native salmonids were more abundant with generally more stable populations. Habitat degradation and non-native introduction in this region has led to the proliferation of those species, predominantly brook trout. It appears that brook trout and other non-native species have less restrictive habitat requirements and are more tolerant to habitat degradation, as they were found even in the poorest of habitats. This suggests that maintenance of high quality habitat and enhancement of degraded habitat is necessary in order to increase native populations and strengthen their community dynamics.

Recommendations

Riparian area und instream restoration

The list of recommendations for each stream represents the continued enhancement of reaches identified in last years annual report and the two additional reaches for Browns Creek. The recommendation for the removal of non-native brook trout from Cee Cee Ah Creek will be carried over to field season 1997. Two additional recommended enhancements will also be carried over from last field season. The fencing project in reach 3 of Mineral Creek and 3 structures in Fourth of July Creek were not completed and will be constructed this year. The remainder of the 27 structures, two kilometers of fence and 10,000 trees/shrubs recommended were completed in field season 1996.

Mill Creek

Reach 8

In order to increase the flow velocity in this reach, small woody debris will be removed. Increasing the velocity will decrease embeddedness for this reach and aid in scouring around structures implemented this season.

Cee Cee Ah Creek

Reach 4

One log sill will be constructed in four separate riffle transects (129, 130, 13 1 and 132) to increase pool-riffle ratio and primary pools by scouring action in shallow sections of the stream. Increasing pools in this stream will increase winter habitat and instream cover. These structures may also act as sediment traps.

Reach 5

One cross log and revetment structure will be constructed in four separate riffle transects (149, 150, 15 1 and 152) to create scour pools. The revetment logs will provide cover, protect banks, as well as, provide pockets of spawning gravel in the tailout area of the pools.

Reach 6

One log upstream v-weir will be constructed in four separate riffle transects (183, 184, 185 and 186). These structures will create deep plunge pools and spawning gravels in the pool tailout.

Browns Creek

Reach 4

One K-dam will be constructed in three separate riffle transects (93, 94 and 95). These structures will provide scour pools below the structure and calmer water above.

Reach 9

One single-wing deflector will be constructed in three separate riffle transects (176, 177 and 178). These structures will help to divert into relatively stable portions of the stream bank and direct meanders.

Fourth of July Creek

Reach 3

An additional 2,500 trees will be planted to vary the age class from last season's planting. 1000 black cottonwoods, 1000 western redcedar and 500 red osier dogwoods will be planted.

Reach 8

One log weir will be constructed in three separate riffle transects (124, 125 and 126). These structures will create scour pools and create calmer waters above the structure.

Whiteman Creek

Reach 4

One channel block will be constructed in three separate transects in a braided channel section (37, 38 and 39). These structures will help to consolidate flow into a single deeper channel in an area almost unusable due to previous cattle induced bank erosion. Having fenced this reach this season, we will also try to provide some of the missing cover in this portion of the stream. One log and bank structure will be constructed in three separate open pool transects (53, 54 and 55) to provide overhead cover and direct current away from meanders. Three cover log structures will be constructed in pool/run transects (57, 58 and 59), which also provide similar cover and current direction. An additional 2,500 trees will be planted to vary the age class from last season's planting. 1000 black cottonwoods, 1000 western redcedar and 500 red osier dogwoods will be planted.

Mineral Creek

Reach 1

One single-wing deflector will be constructed in three separate riffle transects (12, 13 and 14). These structures will help to divert flow into relatively stable portions of the stream bank and direct meanders.

Reach 3

Two sets of three boulder placements will be constructed in three separate riffle/run transects (59, 60, 61 and 76, 77, 78). These structures will provide overhead cover, resting areas in the pocket water behind the boulders and some additional scouring.

Indian Creek

Reach 3

Two sets of three channel constrictors will be constructed in three separate riffle/run transects. Transects 51, 52 and 53 will be constrictors with a diamond shaped structure built at the upstream end and transects 54, 55 and 56 will be standard channel constrictors. These structures will provide overhead cover, narrow the channel and scour the streambed.

Reach 4

One log weir will be constructed in three separate riffle transects (108, 109 and 110) to create scour pools. In addition, one single-wing deflector will be constructed in three separate riffle transects (113, 114 and 115) to direct meanders.

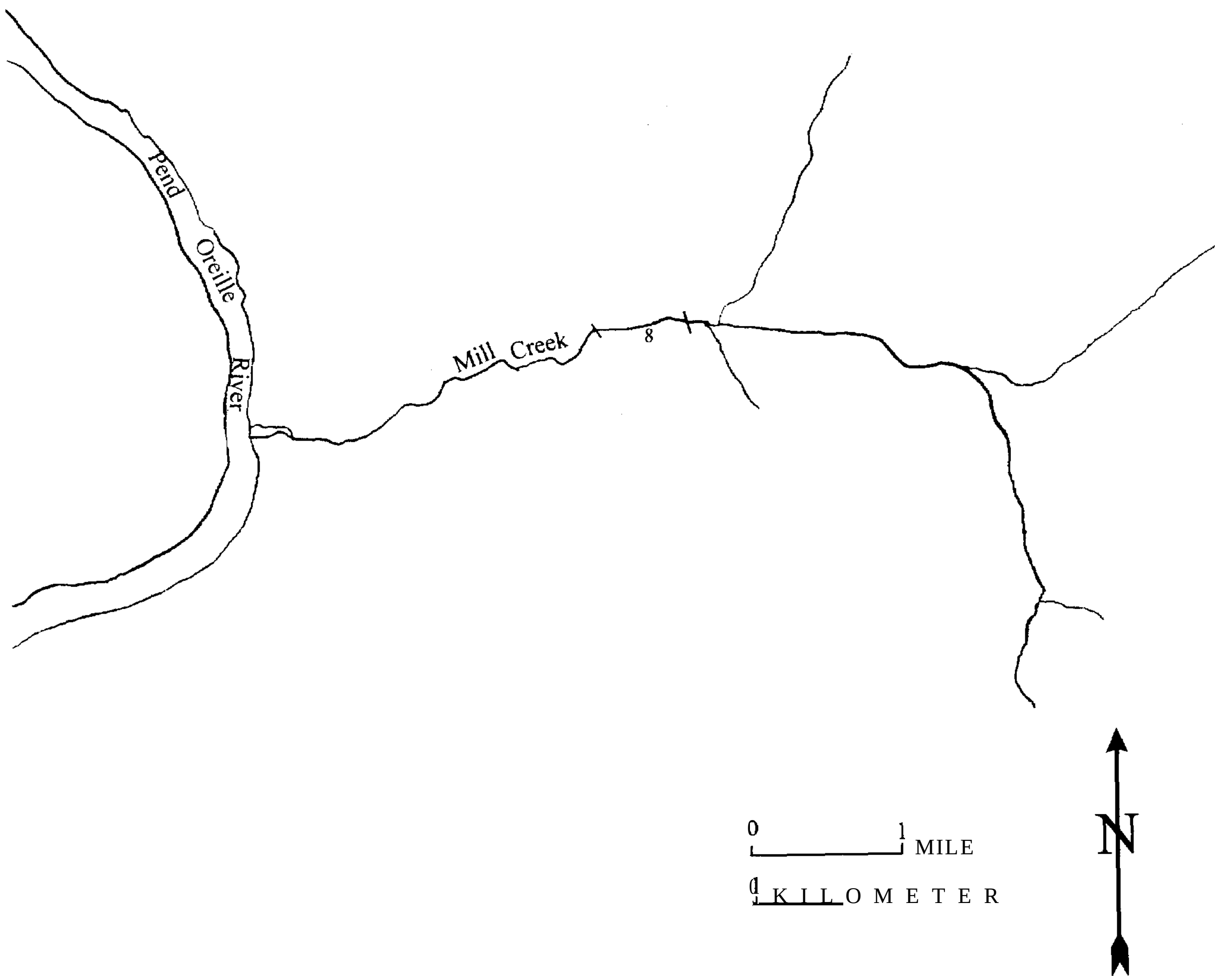

Figure 6. Mill Creek reach and transect locations for enhancement.

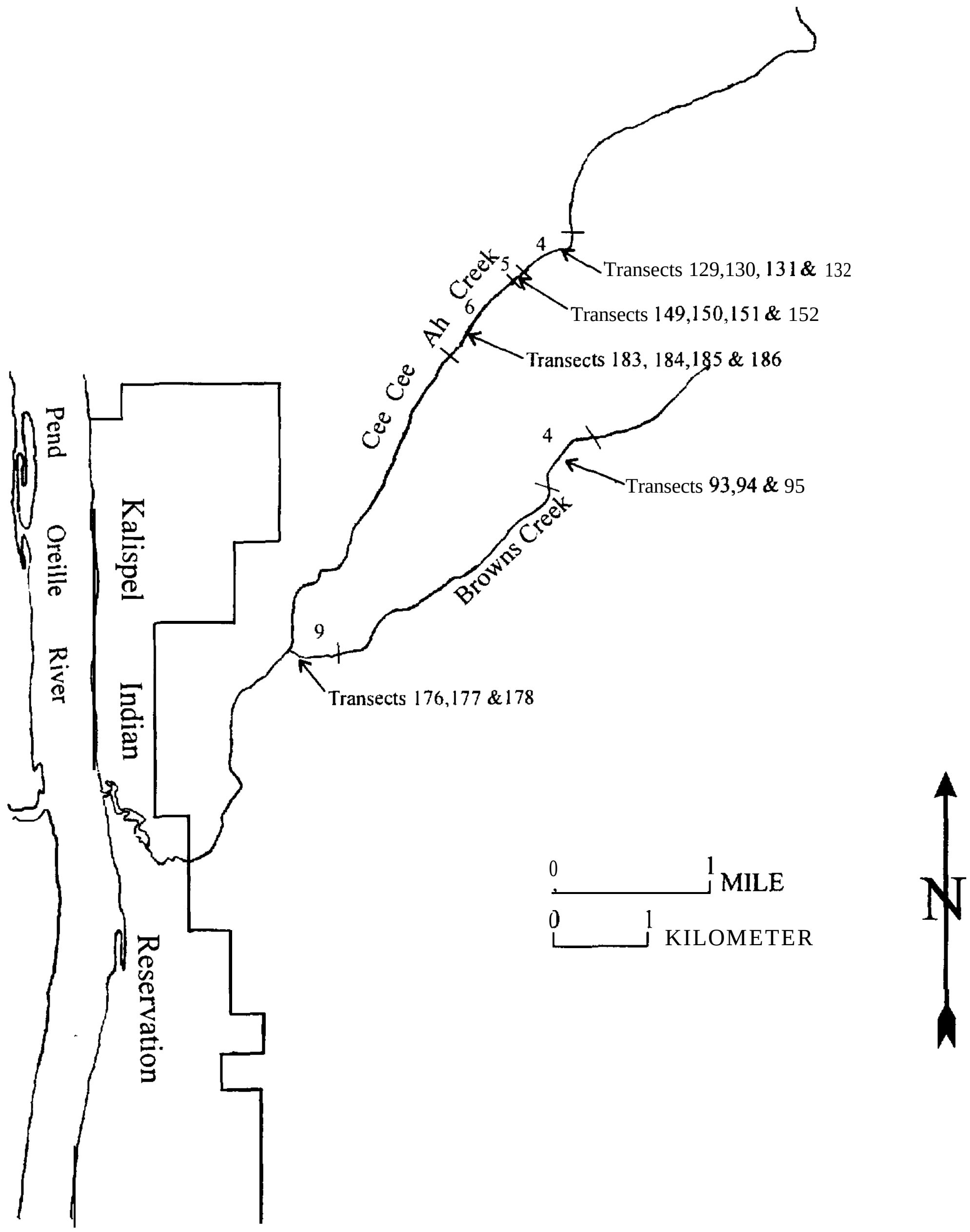

Figure 7. Cee Cee Ah Creek and Browns Creek reach and transect locations for enhancement.

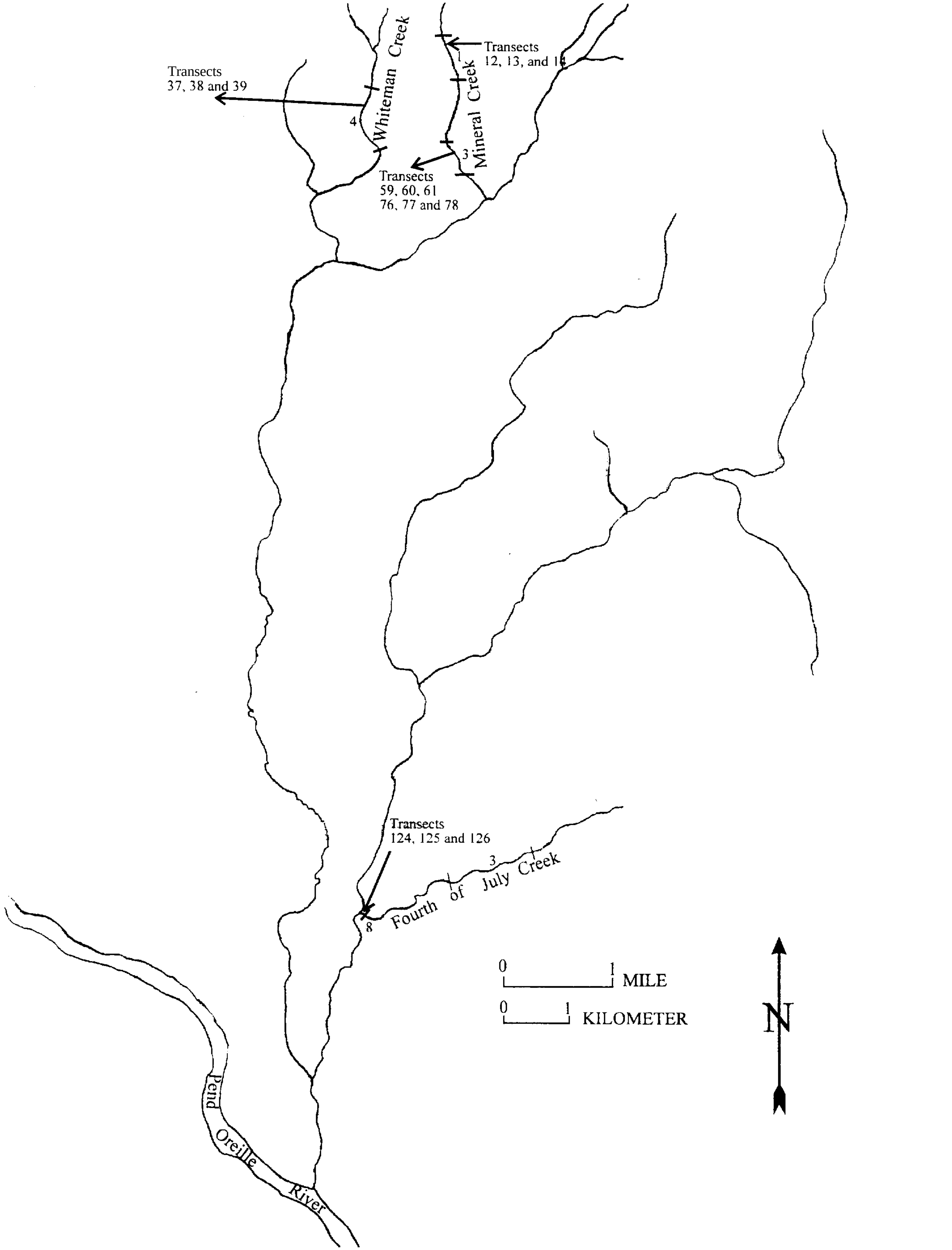

Figure 8. Fourth of July Creek, Whiteman Creek and Mineral Creek reach and transect location for enhancement.

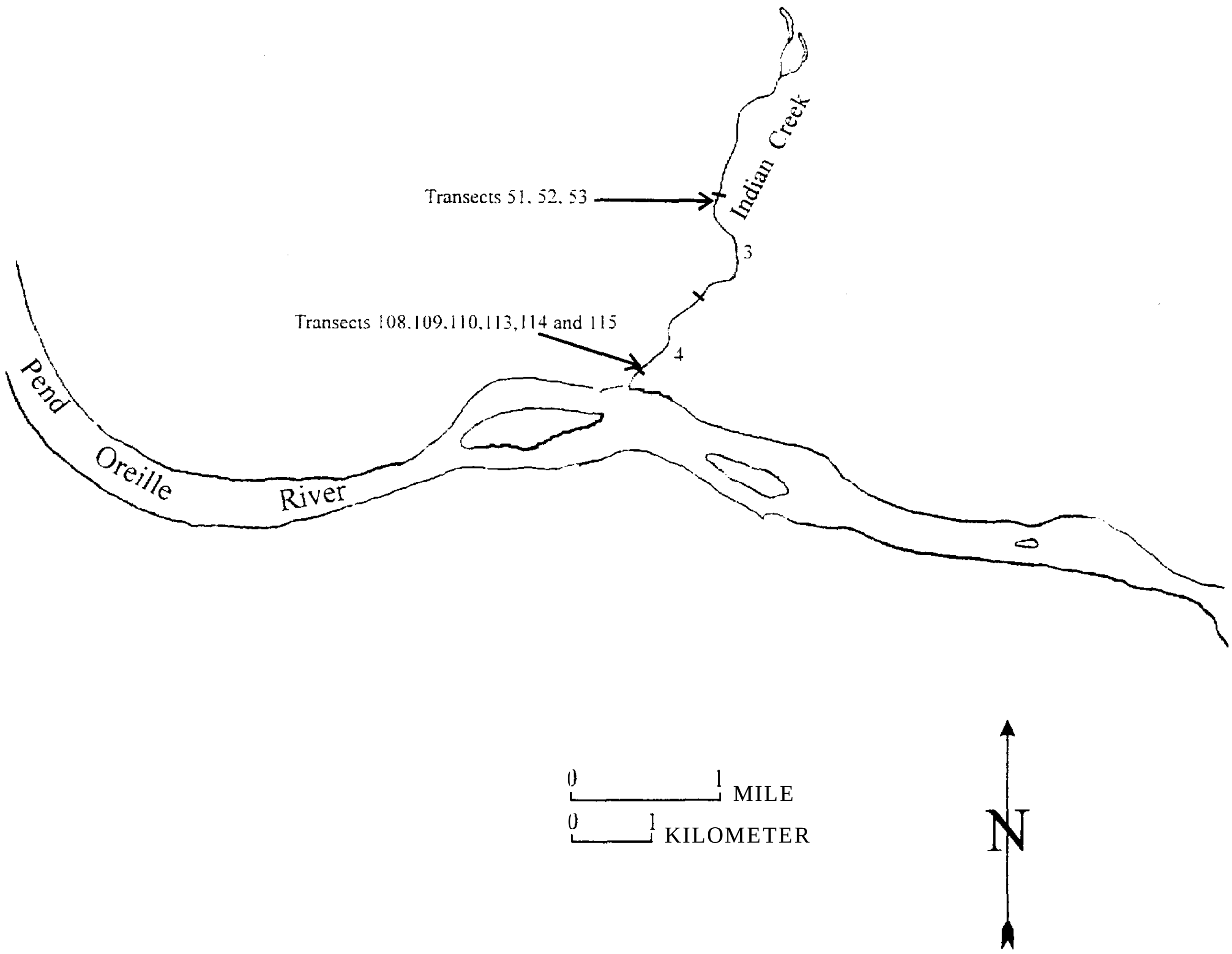

Figure 9. Indian Creek reach and transect locations for enhancement.

Biological objectives

The overall biological objectives were established to provide production goals for all of the Box Canyon Reach tributaries, as adopted by the NWPPC. Monitoring and evaluation of each individual project tributary will determine the need for modification of these objectives. Through these adaptive management strategies biological objectives that are more suitable for these tributaries may be established at a later date.

Biological objective 1

Attain densities (all age classes) of 9.8 bull trout/100m^2 (or 390 fish /linear mile) age class in the upper one third of each major tributary system. This equates to 97,410 bull trout (all age classes) in approximately 250 miles of suitable tributary habitat in the system. Total numbers of adult bull trout recruited to the fishery will be 4,410 fish, composed of an escapement of 2,205 and harvest of 2,205 fish, by the year 2016.

Biological objective 2

Interim bull trout targets are established at 48,855 total fish (all age classes), including a total of 2,205 fish recruited to the fishery, composed of an escapement of 1,102 fish and a harvest of 1,103 fish, by the year 2006.

Biological objective 3

Attain population of 242,212 adult cutthroat in 500 miles of suitable cutthroat habitat in the system, including an escapement of 156,800 fish and harvest of 85,412 fish by the year 20 16.

Biological objective 4

Interim cutthroat targets are established at 12 1,106 total adults recruited to the fishery, composed of an escapement of 78,400 fish and harvest of 42,706 fish by the year 2006.

Monitoring and evaluation of riparian area restoration, instream restoration and exotic brook trout removal will determine the effectiveness of these measures toward meeting the biological objectives established for each tributary. These objectives all contain interim and final targets that are subject to modification based on the data collected during the monitoring and evaluation process. The biological objectives for the individual tributaries will establish goals for production that will increase bull trout and cutthroat trout populations. Decisions pertaining to target numbers for biological objectives were extracted from 1995 fish abundance data. These increases will forward this project toward meeting the biological objectives established for the Box Canyon Reach.

Browns Creek

Biological Objective 1

To increase bull trout abundance from a remnant population to an interim target of 0.5 fish per kilometer in 1998, to 1 fish per kilometer by 2003, to 4 fish per kilometer by 2008.

Biological Objective 2

To increase cutthroat trout abundance from a remnant population to an interim target of 20 fish per kilometer by 1998, to 40 fish by 2003, to 60 fish per kilometer by 2008.

Largemouth Bass Supplementation and Habitat Implementation

Introduction

Bass rearing and population supplementation

In 1996 the construction of a largemouth bass hatchery on the Pend Oreille Wetlands Mitigation Project was started. The completion date for the hatchery building is July 1997. Completion of the entire facility is slated for spring of 1997. With the completion of the hatchery, bass will be spawned and reared in the facility, with initial plants of juvenile largemouth bass to be supplemented in the Box Canyon Reach of the Pend Oreille River in summer and fall 1997.

Bass habitat enhancement

The initial 1996 bass habitat study will not be completed due to time constraints associated with the hatchery construction process. A slightly modified study will be shifted to sloughs not associated with hatchery construction so as to eliminate the delays due to construction. Pre-structure placement sampling will take place in prospective slough study sites to substitute for a siough known to be void of fish prior to the study.

Description of Study Area

The Pend Oreille River begins at the outlet of Pend Oreille Lake, Idaho, and flows in a westerly direction to approximately Dalkena. Washington. From Dalkena the river turns and flows north into British Columbia, where it flows into the Columbia River. The approximate drainage area at the international border is 65,300 km^2 (Barber *et al.* 1990). The normal high flow month is June with a mean discharge of 61,858 cfs, the normal low flow month is August with a mean discharge of 11,897 cfs (Barber *et al.* 1990). The Box Canyon Reservoir has 47 tributaries and covers 90 river kilometers of the Pend Oreille River. from Albeni Falls Dam at the southern border to Box Canyon Dam at the northern border.

The warm water fish hatchery is located on the 436 acre Pend Oreille Wetlands Wildlife Mitigation Project site. The project is located on the east side of the Pend Oreille River. approximately nine miles north of the Usk bridge on LeClerc Road adjacent to the north boundary of the Kalispel Indian Reservation (Figure 10)

The bass habitat enhancement study will be located in zero flow areas of the reservoir. The favored sites would be off the mouths of, and inside sloughs. Sloughs such as. Calispell, Cee Cee Ah . Red Norse (Figure 11) and others will be sites for the study.

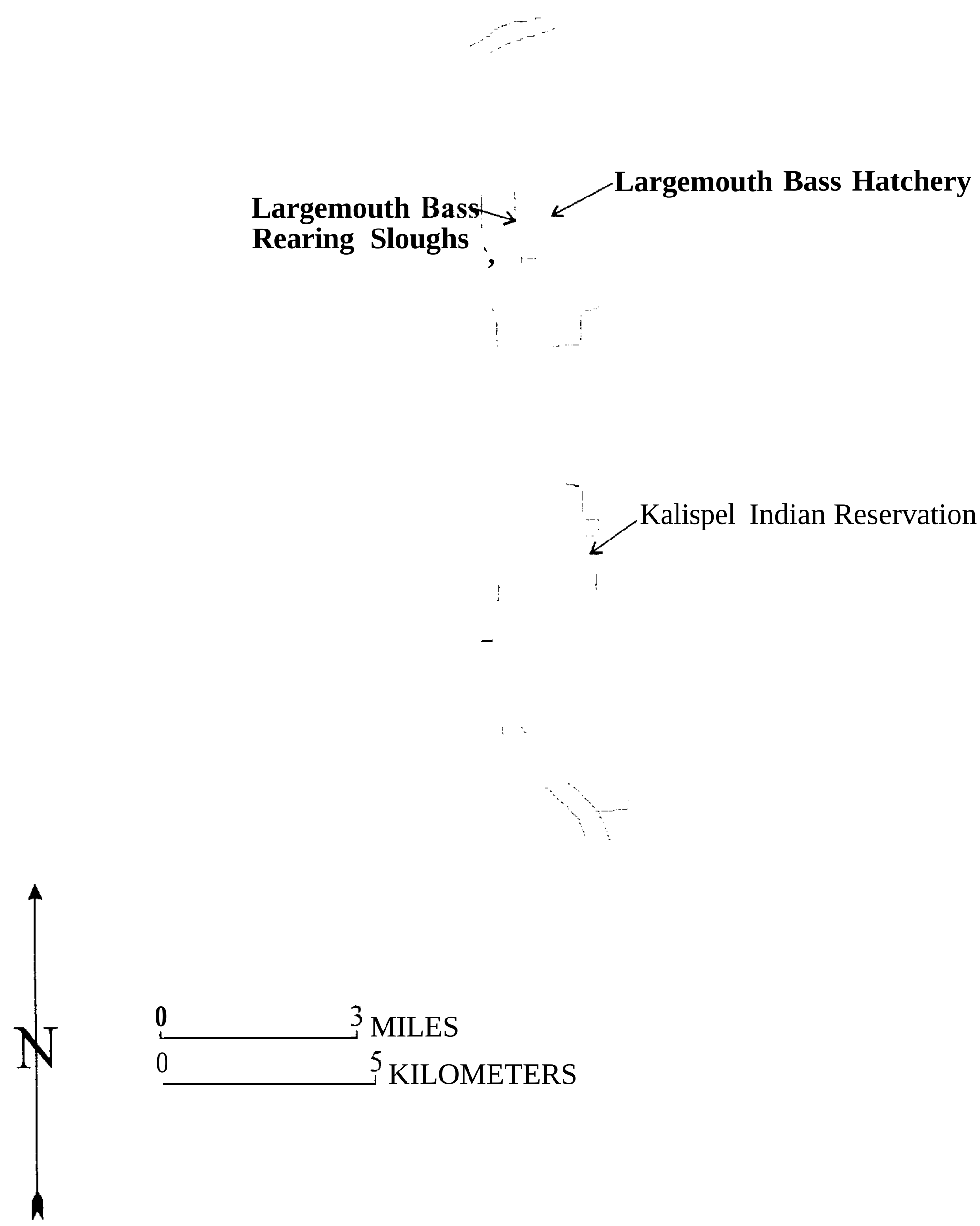

Figure 10. Largemouth bass hatchery and rearing sloughs.

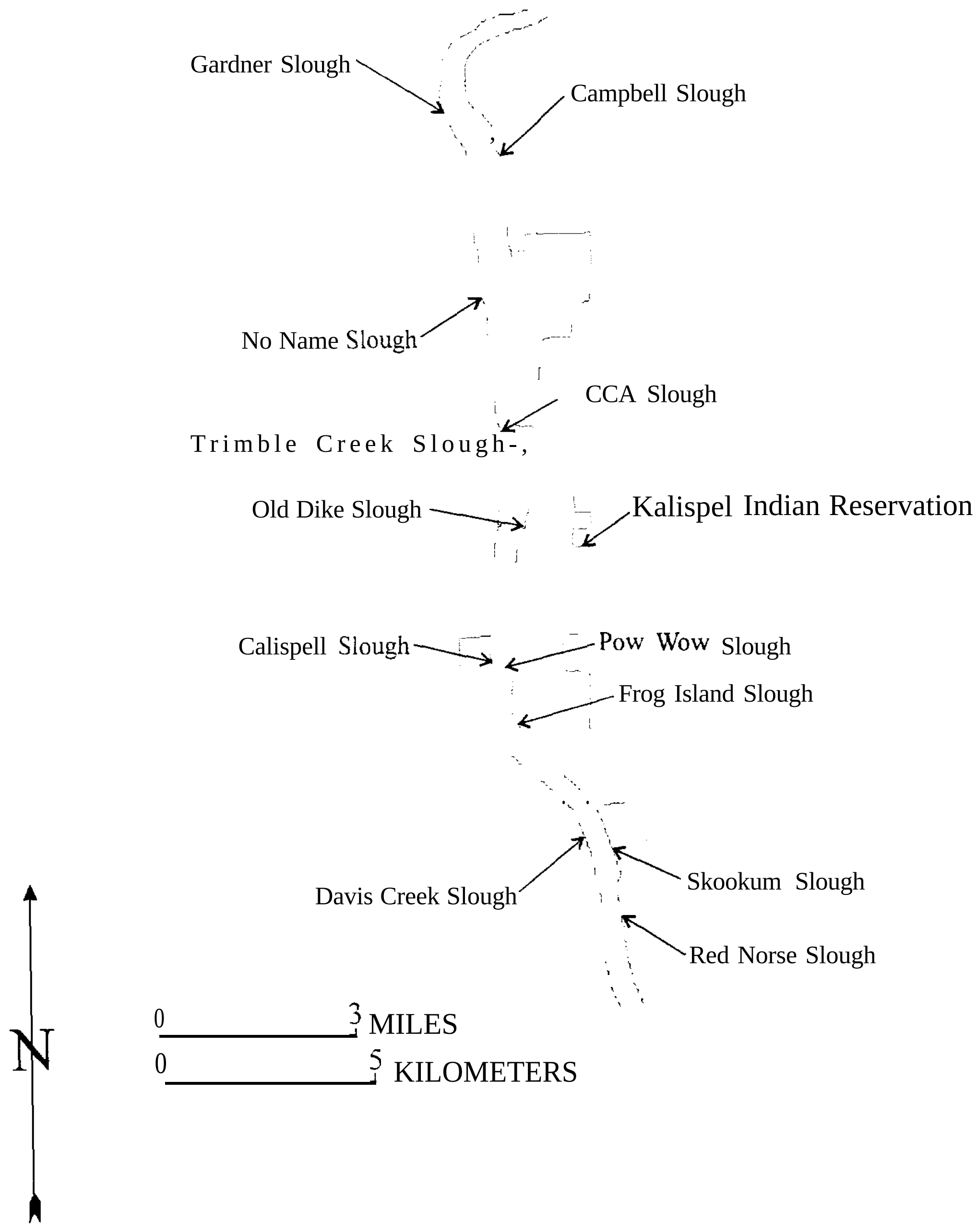

Figure 11. Potential sites for habitat study and habitat structure placement.

Monitoring and Evaluation

Bass habitat enhancement

Transects will be established for each experimental slough (Figure 11) and electroshocked with an electroshocking boat 3 times a year. The first year each transect will be void of habitat structures. The amount of largemouth bass, and their size will be recorded to determine bass usage of these transects. The second year the same transects will be electroshocked following the installation of habitat enhancement in the transects. Bass numbers and age will be recorded. The two sets of data will be compared to determine usage of habitat enhancement: difference in usage between different habitat structures and the age of fish utilizing the habitat structures.

Timeline for planning and construction of the largemouth bass hatchery

January

J-U-B engineers working on completion of Hatchery Final Design.

February

J-U-B engineers working on completion of Hatchery Final Design.
Permitting process to obtain U.S. Army Corp of Engineers 404 permit (Corp 404), Water Right. County Shoreline and Hydrolic Permit Application (HPA) permits.
February 7. meeting between Tribe, J-U-B, JC Aquaculture and Bonneville Power Administration (BPA) engineers to discuss hatchery design plans.
February 29, meeting with Pend Oreille County P.U.D. to determine the feasibility and cost of power service to the hatchery.

March

Permitting process to obtain Corp 404. Water Right, County Shoreline and HPA permits.
March 17. Hatchery Final Design completed.

April

Permitting process to obtain Corp 404, and Water Right, County Shoreline and HPA permits.
BPA engineers began review of hatchery design.

May

Permitting process to obtain Corp 404, Water Right, County Shoreline and HPA permits.
SEPA checklist sent off for permit process.
May 28, meeting between Tribe and BPA to discuss hatchery design. It was determined the hatchery project would operate on a performance based contract.

June

June 19, preliminary Environmental Assessment (EA) finished.
Permitting process to obtain Corp 404, Water Right. County Shoreline and HPA permits.
Contacted the Bureau of Indian Affairs (BIA) about the water right issue.
Preliminary draft EA and historic water right certificate sent to BIA for Water Right permit.

July

July 9, County Shoreline permit issued.
July 16, Request for proposal meeting with Contractors Northwest Inc., R. R. A. Co. and S. G. Mann and Sons. Contractors Northwest Inc. Submitted the lowest bid.
July 23, Washington Department of Fish and Wildlife HPA permit issued.
July 31, Corp 404 permit issued
Permitting process to obtain Water Right permit.

August

Cultural resource mitigation for construction of the hatchery was request by BPA. This mitigation was done on the site where the hatchery will be built. Resources to be dug are camas pits and artifacts that would be covered or disturbed by the hatchery construction
August 27, EA commenting published in the Federal Register.
Permitting process to obtain Water Right permit.

September

September 17, Construction begins on foundation work and pipeline from river.
September 26, Performance based contract signed between Kalispel Tribe and BPA (Project number 95-01-01).
NEPA process EA completed.
Permitting process to obtain Water Right permit.

October

Hatchery construction continues.
Permitting process to obtain Water Right permit, with an expected completion time of Spring 1997.

November

Hatchery construction continues.

December

Projected completion of hatchery building.

January, February, March

Internal components of hatchery to be installed by J.C. Aquaculture and hatchery personnel.

Spring 1997

Completion of pump house on river.
Construction of raceway cover.

May 1997

Expected completion date for entire Hatchery project

Predicted project outyear budget (x 1000).

OBJECTIVE	1996	1997	I "9X	1999	2000	200 1	2002	2003	2004	2005
Bass I latchery	473	I I 5	0	0	0	0	0	0	0	0
Bass hatchery O&M	0	100	104	146	150	154	159	164	168	172
Cutthroat and bull trout investigations	0	x i	85	0	0	0	0	0	0	0
Cutthroat and hull trout habitat projects	201	248	250	0	0	0	0	0	0	0
Brook trout removal Cee Cee Ah	2	2	0	0	0	0	0	0	0	0
Bass nursery sloughs	117	0	0	0	0	0	0	0	0-	0
Baas winter cover	2	2	0	0	0	0	0	0	0	0
M&E for objectives listed (LMB.)	0	100	52	3X	38	38	0	0	0	0
M&E for objectives listed (CTT, BT)	0	23	20	90	90	90	0	0	0	0
ANNUAL TOTAL	795	675	511	254	27x	282	159	164	168	172
IO YR TOTAL	3,458									

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