

# **Strategic Fisheries Overview for the Middle Fraser Habitat Management Area**

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**STRATEGIC FISHERIES OVERVIEW**

**FOR THE**

**MIDDLE FRASER HABITAT MANAGEMENT AREA**

***Final Report***

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Prepared for:

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## EXECUTIVE SUMMARY

This strategic fisheries report provides a summary of the fisheries resources, biophysical features and land use issues that have affected or have the potential to affect fish production in salmon bearing watersheds within the Middle Fraser Habitat Management Area (HMA). From this information, current impacts of resource development are identified and management priorities and recommendations are developed to minimize further impacts of resource development on the fisheries resource.

The Middle Fraser Habitat Management Area (HMA) consists of the Fraser River mainstem and 15 small to medium sized tributaries draining into the Fraser River between Hope and Quesnel. Salmon species produced in the study area include sockeye (*Oncorhynchus nerka*), pink (*Oncorhynchus gorbuscha*), chinook (*Oncorhynchus tshawytscha*), coho (*Oncorhynchus kisutch*), chum salmon (*Oncorhynchus keta*) and steelhead/rainbow trout (*Oncorhynchus mykiss*). The Fraser River between Hope and Quesnel provides a critical migration corridor for upper Fraser River salmon stocks and also provides important rearing habitat, primarily for chinook and coho salmon. The study area includes a wide range of physiographic, geologic and climatic conditions with lower gradient, drier, plateau like terrain in northern regions and steep, wet, mountainous terrain in southern sections.

Pink are the most abundant salmon species with an average annual escapement of 43,445 fish between 1981-1992 and a maximum historical escapement of 187,741 adults. Sockeye are the second most abundant species with an average escapement of 6,050 fish between 1981-1992 and a historical maximum of 19,381. Chum salmon are produced primarily in the southern portion of the Middle Fraser HMA with an average escapement of 1,571 fish and a historical maximum of 4503 fish. Coho salmon are the fourth most abundant species in the study area with an average escapement of 802 fish and a historical maximum of 17,881 adults. Chinook escapement averaged 502 fish between 1981-1992 with a historical maximum of 1400 fish.

Non salmon producing tributaries to the Fraser provide important habitat characteristics essential for salmonid production in the Fraser River watershed. Small, low gradient tributaries provide critical rearing habitat during the spring and summer when sediment loads are high in the mainstem Fraser. In addition, steep and flashy tributaries draining into the Fraser canyon provide limited spawning and rearing habitat but these glacial fed streams provide critical cold water holding pools at their confluence with the Fraser mainstem. An adequate number of cold water refuge areas are believed to be essential for successful migration of adults through the Fraser canyon.

Linear development has had the greatest impact on fisheries resources in the Fraser River mainstem and the Coquihalla River watershed. Within the Coquihalla River, linear development includes a major 4 lane highway (Highway 5), 2 industrial roads, Trans Mountain Pipeline, West Coast Energy gas pipeline and the B.C. Telephone fibre optic lightguide. Several major diversions, bank stabilization works and channel encroachments have occurred as a result of

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Highway 5 construction between Othello and Boston Bar Creek. Highway and pipeline construction and maintenance practices have resulted in the permanent loss of fish habitat and degraded the quality of spawning and rearing habitat. Linear development in combination with natural slides and sidecast failures from the old railway exacerbates the impacts of flood flows and results in a constant loss of riparian function, high rates of bedload movement and loss of fish habitat. Increased bedload movement from the upper river to the lower river has increased flooding and erosion problems adjacent to Hope.

In the Fraser River corridor, linear development includes the Trans Canada Highway, B.C. Railway, Canadian National Railway and hydroelectric power transmission lines. Site specific impacts in the upper river include side channel alienation, loss of riparian habitat and channelization in small tributaries. Through the Fraser Canyon, the primary impact of linear development results from railway maintenance practices where rock and debris are sidecasted into the Fraser River. Sidecasted materials are known to infill critical holding areas or create additional hydraulic barriers that increase the mortality of migrating salmon. Management priorities for linear development in the Fraser River corridor and the Coquihalla River are to facilitate passage of migrating salmonids and to minimize the impacts of encroachment, channelization, flooding and maintenance activities on migration, spawning and rearing habitat.

Urban development has impacted stream and riparian habitat in the Fraser River mainstem at Quesnel, Baker Creek, Williams Lake River, Knife Creek, Kawkawa Creek and the Coquihalla River. Major impacts from urban development include channelization, loss of stream complexity, encroachment, bank stabilization practices using rip rap, loss of riparian vegetation, alteration of the streambed for flood control works and culvert placement that create migration barriers. Management recommendations to minimize the impacts of urban development on water quality, water quantity and fish habitat include the utilization of the land development guidelines as a minimum. Additional management priorities include the evaluation of low flow conditions in Kawkawa Creek and restoration of riparian habitat in the lower reaches of Baker Creek.

The two watersheds with the greatest forest harvesting activity are the Anderson River and Gordon Creek where 23% of the total watershed area has been logged. The remaining drainages have less than 12% of the total watershed area logged. Although the percentage logged on a watershed level appears low throughout the study area, the rate of harvesting in the Middle Fraser HMA salmon streams has increased in recent years with the majority of cutblocks harvested in the last 10 years. Furthermore, in many watersheds, forest harvesting has been concentrated in a small number of sub-basins, creating drainage specific problems associated with hydrology, terrain stability or channel stability. Site specific problems associated with forest harvesting have been identified in the Nahatlatch River, Churn Creek, Anderson River, Gordon Creek and the Coquihalla River. Known impacts of forestry development on fisheries values include road and slope failures, degraded riparian habitat, channel bank erosion, road encroachments, increased suspended sediment loads and channel instability. A more detailed analysis of the equivalent clearcut area by sub-basin would provide more specific evaluation of the hydrologic effects of forest harvesting on fisheries values. Priority watersheds include the Nahatlatch River, Anderson

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River, Coquihalla River, Churn Creek and Narcosli Creek. Management recommendations include the development of watershed specific Riparian Management Plans to direct forest development activities on a *site specific basis* in addition to the provincial Forest Practices Code Riparian Management Guidelines.

Agriculture has the potential to alter the natural hydrologic regime by extracting surface and ground water for stock watering, domestic use and irrigation and thereby increase minimum flow problems. Extensive agricultural development can increase peak flows as a result of the conversion of forested land to pasture land. The impacts of water withdrawal for agricultural purposes can also reduce the dilution factor in the mainstem Fraser River thereby increasing the impacts of wastewater effluents on salmonids. The most extensive agricultural development within the Middle Fraser HMA has occurred in Baker Creek, Narcosli Creek, Williams Lake River, Knife Creek and Churn Creek. The majority of agriculture is forage based, supporting cattle and dairy operations with some better sites supporting field crops and cereal grain production. Major surface water extraction for irrigation occurs in Williams Lake River, Knife Creek, Baker Creek and Narcosli Creek. Water demands on Williams Lake River and Knife Creek amount to most of the natural late summer flows and both these systems are fully recorded. Low flow problems are being partially addressed in Williams Lake River, Knife Creek and Churn Creek, where water storage structures for irrigation are used to meet water demands in low flow periods. Other impacts of agriculture on fisheries values within the study area from overwintering of cattle and the operation of feedlots adjacent to streams and fording the streams result in the degradation of water quality and riparian vegetation.

Management priorities to address agricultural concerns include the assessment of ranching impacts on minimum flow requirements, riparian areas and water quality in Churn Creek, Williams Lake River, Knife Creek, San Jose River, Narcosli Creek and Baker Creek. The assessment can be used to identify those streams which require a more detailed water management plan that identifies water demand, maintenance flows for fisheries values, water storage opportunities and potential impacts of water extraction.

Relative to other resource development activities, there have been smaller impacts from hard rock mining, placer mining and pulpmill development on fisheries values in the Middle Fraser HMA. These impacts have occurred in the Fraser River mainstem, Churn Creek and the Coquihalla River.

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## 1.0 INTRODUCTION

This strategic fisheries report provides a summary of the fisheries resources, biophysical features and land use issues that have affected or have the potential to affect fish production in salmon bearing watersheds within the Middle Fraser Habitat Management Area (HMA). The objective of this report is to document existing salmon values and the current extent of resource development activities. This information is used to identify important management issues and subsequently develop effective management recommendations that will assist in minimizing further impacts of resource development on the fisheries resource. A companion document consisting of watershed summary profiles provides an overview of this report in an ACCESS database format.

The Middle Fraser Habitat Management Area (HMA) consists of the Fraser River mainstem and small to medium sized tributaries draining into the Fraser River between Hope and Quesnel. There are 15 salmon bearing watersheds within the Middle Fraser HMA. (Fig 1). Salmon species produced in the study area include sockeye (*Oncorhynchus nerka*), pink (*Oncorhynchus gorbuscha*), chinook (*Oncorhynchus tshawytscha*), coho (*Oncorhynchus kisutch*) salmon, chum (*Oncorhynchus keta*) and steelhead/rainbow trout (*Oncorhynchus mykiss*). The study area covers a wide range of physiographic, geologic and climatic conditions (Rood and Hamilton 1995a, 1995b). Lower gradient, drier, plateau like terrain occurs in northern regions whereas steep, wetter, mountainous terrain is more common in southern sections of the Middle Fraser HMA.

This review is based on existing information from fisheries and land use management agencies. Most of the information has been obtained from published literature in addition to direct input of habitat biologists and technicians from the Department of Fisheries and Oceans (DFO) and the Ministry of Environment, Lands and Parks (MELP). Most of the physiographic and hydrologic information is from Rood and Hamilton (1995a, 1995b) and information on Baker Creek, Narcosli Creek, Williams Lake River and Churn Creek was compiled by Rowland and MacDonald (1996).

## **2.0 FISHERIES RESOURCES**

The purpose of this chapter is to provide known salmon escapement information and habitat use within the Middle Fraser HMA. The first section provides an overview of salmon escapement and escapement trends by species. The second section identifies known salmon spawning and rearing habitat by watershed while the third and fourth sections briefly discuss steelhead and sturgeon values within the Middle Fraser HMA. The final section of this chapter provides an overview of Native and sports fisheries.

### **2.1 Salmon escapement and escapement trends**

The Middle Fraser HMA supports five species of Pacific salmon. Pink is the most abundant salmon species with an average annual escapement of 43,445 fish between 1981-1992 and a maximum historical escapement of 187,741 adults (Table 1). Sockeye is the second most abundant species with an average escapement of 6,050 fish between 1981-1992 and a historical maximum of 19,381. Chum salmon are produced primarily in the southern portion of the Middle Fraser HMA with an average escapement of 1,571 fish and a historical maximum of 4503 fish. Coho salmon is the fourth most abundant species in the study area with an average escapement of 802 fish and a historical maximum of 17,881 adults. Chinook escapement averaged 502 fish between 1981-1992 with a historical maximum of 1400 fish.

Escapement information has been obtained primarily from DFO's stock management data summaries (DFO 1994) and the Fish Habitat Inventory and Information Program (FHIIP) for the Chilliwack, Lillooet, Williams Lake and Quesnel subdistricts. Escapement trends are determined by assessing whether the 1981-1992 average escapement differs from the 1969-1980 average escapements by greater than 20%. Therefore, an increasing escapement trend is identified when the 1981-1992 average escapement exceeds the 1969-1980 average escapement by greater than 20%. A difference of less than 20% is considered to be a static escapement trend.

Escapement data is collected primarily from fishery officers who periodically inspect the stream during the spawning cycle at major spawning sites on foot, by air or by boat (Fraser et. al. 1982). It should be noted that the reliability of escapement estimates is highly variable due to bias in visual estimates, accessibility to spawning sites, weather, visibility and sufficient manpower (Fraser et. al. 1982). Of all the salmon species, coho salmon escapement estimates are probably the most unreliable.

TABLE 1. 1981-1992 average and *maximum historical* escapement by species (DFO 1994).

<b>Stream</b>	<b>Sockeye</b>	<b>Chinook</b>	<b>Coho</b>	<b>Pink</b>	<b>Chum</b>
Coquihalla R	76 (310)		48 (200)	30,972 (118,921)	413 (1200)
Kawkawa Lake	25 (50)		11 (22)	100 (200)	425 (800)
Sucker Creek	98 (750)		73 (2000)	1,156 (5720)	501 (1,775)
Steven Creek	124 (600)		17 (40)	5 (20)	31 (65)
Menz Creek	16 (72)		57 (250)	50 (200)	12 (50)
Kopp Creek	194 (700)		24 (79)	7 (35)	25 (60)
American Creek	0 (3)		3 (25)	770 (4,412)	36 (120)
Emory Creek	5 (25)		na	444 (1,539)	17 (50)
Gordon Creek	na		5 (20)	10 (30)	na
Yale Creek	26 (104)		na (25)	291 (1,734)	33 (100)
Spuzzum Creek	8 (48)		na (75)	1,936 (10,496)	31 (110)
Anderson River	na	na (25)	8 (40)	442 (1,895)	41 (150)
Nahatlatch River	5,465 (16,606)	69 (400)	527 (15000)	5,516 (35,100)	na
Stein River	na	na (25)	29 (105)	572 (4,243)	na
Texas Creek	na		na	20 (50)	6 (23)
Churn Creek	13 (113)	50 (250)	na	858 (2,366)	na
Williams Lake R	na		na	na	na
Narcosli Creek	na	139 (300)	na	96 (330)	na
Baker Creek	na	244 (400)	na	200 (450)	na
<b>TOTAL</b>	<b>6,050 (19,381)</b>	<b>502 (1400)</b>	<b>802 (17,881)</b>	<b>43,445 (187,741)</b>	<b>1,571 (4,503)</b>

### 2.1.1 Sockeye

The Nahatlatch River produces the largest proportion (90.3%) of sockeye within the Middle Fraser HMA (DFO 1994)(Table 1). In the Nahatlatch system, average sockeye escapement between 1981-1992 equaled 5,465 fish with a historical maximum of 16,606 sockeye (Table 2). The second largest producer of sockeye is the Kawkawa Lake watershed which produces 7.6 % (457 fish) of the average sockeye escapement with a historical maximum of 2172 fish. Smaller sockeye stocks are produced in the Coquihalla River, Emory Creek, Yale Creek, American Creek and Spuzzum Creek.

Escapement trend data is limited to the Nahatlatch River and Sucker Creek, a tributary to Kawkawa Lake. In the Nahatlatch River, sockeye escapement is increasing when average escapement values between 1969-1980 are compared to 1981-1992 (Table 2). Little historical (1969-1980) information on Kawkawa Lake and most of the upstream tributaries is available and therefore, no escapement trends have been identified except for Sucker Creek. Average historical escapements indicate that sockeye escapement is increasing in Sucker Creek.

TABLE 2. Sockeye escapement and escapement trends to 1992 (DFO 1994).

Stream	Historical maximum	1981-1992 average	1981-1992 maximum	1969-1980 average	Escapement Trend
Coquihalla R	310	76	310	na	na
Kawkawa Lake	50	25	50	na	na
Sucker Creek	750	98	475	44	Increasing
Steven Creek	600	124	600	na	na
Menz Creek	72	16	72	na	na
Kopp Creek	700	194	700	na	na
American Creek	3	0	3	na	na
Emory Creek	25	5	25	na	na
Gordon Creek	na	na	na	na	na
Yale Creek	104	26	104	na	na
Spuzzum Creek	48	8	48	na	na
Anderson River	na	na	na	na	na
Nahatlatch River	16,606	5,465	16,606	839	Increasing
Stein River	na	na	na	na	na
Texas Creek	na	na	na	na	na
Churn Creek	113	13	113	na	na
Williams Lake R	na	na	na	na	na
Narcosli Creek	na	na	na	na	na
Baker Creek	na	na	na	na	na
<b>TOTAL</b>	<b>19,381</b>	<b>6,050</b>	<b>19,106</b>	<b>883</b>	

### 2.1.2 Chinook

Chinook salmon are the most geographically widespread species in the Fraser River system and are the least abundant species produced in the Middle Fraser HMA (Birtwell et al 1988, DFO 1994). The average escapement of chinook to the study area totaled 502 adults between 1981-1992 (Table 3). The majority of chinook are produced in the northern portion of the Middle Fraser HMA where the largest chinook run occurs in Baker Creek. Average escapement to Baker Creek was 244 fish or 48.6% of the total chinook escapement to the Middle Fraser HMA between 1981-1992. The maximum historical chinook escapement for Baker Creek between 1981-1992 was 400 adults. Narcosli Creek produced 27.7% (139 fish) of the average escapement between 1981-1992 with the Nahatlatch River, Churn Creek and Stein River producing less than 70 fish annually (DFO 1994). Escapement trends are unknown for most chinook stocks due to the lack of average escapement values between 1969-1980.

TABLE 3. Chinook escapement and escapement trends for the Middle Fraser HMA (DFO 1994).

<b>Stream</b>	<b>Historical maximum</b>	<b>1981-1992 average</b>	<b>1981-1992 maximum</b>	<b>1969-1980 average</b>	<b>Escapement Trend</b>
Anderson River	25	na	na	na	unk
Nahatlatch River	400	69	240	63	Static
Stein River	25	na	na	9	unk
Churn Creek	250	50	250	na	unk
Narcosli Creek	300	139	300	na	unk
Baker Creek	400	244	400	na	unk
<b>TOTAL</b>	<b>1400</b>	<b>502</b>	<b>1190</b>	<b>72</b>	

*Chinook escapement information is unavailable for other streams within the Middle Fraser HMA.*

### 2.1.3 Coho

The largest coho run is produced in the Nahatlatch River and represents approximately 66% of the coho produced in the Middle Fraser HMA (DFO 1994). Between 1981 and 1992, the average coho escapement to the Nahatlatch River equaled 527 adults with a historical maximum run of 15,000 coho (Table 4). Between 1981-1992, an average of 182 (23%) coho adults returned to the Kawkawa Lake system with a total historical maximum run of 2,391 fish. The Coquihalla River and the Stein River produce less than 50 fish annually and very small numbers of coho (less than 10 spawners) return to American Creek, Gordon River and the Anderson River.

In the Nahatlatch River, coho exhibit an increasing escapement trend as the average escapement between 1981-1992 (527 fish) shows more than a 20% increase over the average escapement between 1969 to 1980 (410 fish) (DFO 1994). Escapement data for the Kawkawa Lake system indicates that coho stocks in Sucker Creek appear to be decreasing when the average historical escapement (1969-1980) is compared to the average recent escapement (1981-1992) (DFO 1994).

TABLE 4. Coho escapement and escapement trends for the Middle Fraser HMA (DFO 1994).

Stream	Historical maximum	1981-1992 average	1981-1992 maximum	1969-1980 average	Escapement Trend
Coquihalla R	200	48	100	35	Increasing
Kawkawa Lake	22	11	22	na	na
Sucker Creek	2000	73	200	555	Decreasing
Steven Creek	40	17	40	na	na
Menz Creek	250	57	250	na	na
Kopp Creek	79	24	79	na	na
American Creek	25	3	15	na	na
Emory Creek	na	na	na	na	na
Gordon Creek	20	5	20	na	na
Yale Creek	25	na	na	na	na
Spuzzum Creek	75	na	na	10	na
Anderson River	40	8	40	6	Static
Nahatlatch River	15000	527	1565	410	Increasing
Stein River	105	29	105	3	Increasing
Texas Creek	na	na	na	na	na
Churn Creek	na	na	na	na	na
Williams Lake R	na	na	na	na	na
Narcosli Creek	na	na	na	na	na
Baker Creek	na	na	na	na	na
<b>TOTAL</b>	<b>17,881</b>	<b>802</b>	<b>2436</b>	<b>1,019</b>	

## 2.1.4 Pink

Pink are the most abundant salmon species in the Middle Fraser HMA and return in the odd cycle year. The majority of pink salmon are produced in the Coquihalla River where the average escapement between 1981-1992 equaled 30,972 or 71.3% of the total pink run within the study area (Table 5). The maximum historical pink escapement was 118,921 for the Coquihalla River system. Smaller pink stocks are produced annually in the Nahatlatch River (5,516 fish), Spuzzum Creek (1,936) and the Kawkawa Lake system (1,318). Small numbers of pink salmon ranging from 10 to 850 fish are produced in the remaining systems within the study area (Table 5).

Pink salmon exhibit an increasing escapement trend in the majority of watersheds within the study area when average escapement values between 1969-1980 are compared to 1981-1992 escapements (DFO 1994). All historical maximum escapements for pink salmon have occurred between 1981-1992. Although historical pink escapement information is currently unavailable for Baker Creek, pink salmon escapement has been observed to be increasing in the last few years (Rosenberger pers. comm. 1996).

TABLE 5. Pink escapement and escapement trend information (DFO 1994).

Stream	Historical maximum	1981-1992 average	1981-1992 maximum	1969-1980 average	Escapement Trend
Coquihalla R	118,921	30,972	118,921	4,674	Increasing
Kawkawa Lake	200	100	200	na	na
Sucker Creek	5720	1,156	5,720	140	Increasing
Steven Creek	20	5	20	na	na
Menz Creek	200	50	200	na	na
Kopp Creek	35	7	35	na	na
American Creek	4,412	770	4,412	48	Increasing
Emory Creek	1,539	444	1,539	na	na
Gordon Creek	30	10	30	na	na
Yale Creek	1,734	291	1,734	18	Increasing
Spuzzum Creek	10,496	1,936	10,496	17	Increasing
Anderson River	1,895	442	1,895	127	Increasing
Nahatlatch River	35,100	5,516	35,100	430	Increasing
Stein River	4,243	572	4,243	219	Increasing
Texas Creek	50	20	50	na	na
Churn Creek	2,366	858	2,366	320	Increasing
Williams Lake R	na	na*	na	na	na
Narcosli Creek	330	96	330	na	na
Baker Creek	450	200	450	na	na
<b>TOTAL</b>	<b>187,741</b>	<b>43,445</b>	<b>187,741</b>	<b>5,993</b>	

\* Williams Lake River pink escapement in 1993: 400 fish and in 1995: 185 fish.

### 2.1.5 Chum

The distribution of chum salmon is limited to the southern portion of the Middle Fraser HMA with the majority of chum produced in the Kawkawa Lake system and the Coquihalla River. The Kawkawa Lake watershed produced an average escapement of 994 or 63.3% of the total chum escapement to the study area between 1981-1992 with a maximum historical escapement of 2,750 adults (Table 6). The average escapement between 1981-1992 in the Coquihalla River equals 413 or 26.3% of the total chum production in the study area. Average escapements of less than 100 fish are reported for American Creek, Emory Creek, Yale Creek, Spuzzum Creek, Anderson River and Texas Creek (DFO 1994).

Average chum escapement to the Coquihalla River and Kawkawa Lake are increasing when the average historical escapement between 1969-1980 is compared to the average escapement between 1981-1992 (DFO 1994). There is no escapement trend information available for the remaining river systems within the study area.

TABLE 6. Chum escapement and escapement trend information (DFO 1994).

<b>Stream</b>	<b>Historical maximum</b>	<b>1981-1992 average</b>	<b>1981-1992 maximum</b>	<b>1969-1980 average</b>	<b>Escapement Trend</b>
Coquihalla R	1,200	413	1,200	125	Increasing
Kawkawa Lake	800	425	800	195	Increasing
Sucker Creek	1,775	501	1,775	na	na
Steven Creek	65	31	65	na	na
Menz Creek	50	12	50	na	na
Kopp Creek	60	25	60	na	na
American Creek	120	36	120	na	na
Emory Creek	50	17	50	na	na
Gordon Creek	na	na	na	na	na
Yale Creek	100	33	100	na	na
Spuzzum Creek	110	31	110	na	na
Anderson River	150	41	150	na	na
Nahatlatch River	na	na	na	na	na
Stein River	na	na	na	na	na
Texas Creek	23	6	23	na	na
Churn Creek	na	na	na	na	na
Williams Lake R.	na	na	na	na	na
Narcosli Creek	na	na	na	na	na
Baker Creek	na	na	na	na	na
<b>TOTAL</b>	<b>4,503</b>	<b>1,571</b>	<b>4,503</b>	<b>320</b>	

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## 2.2 Salmon spawning and rearing habitat

### 2.2.1 Fraser River mainstem

The Fraser River between Hope and Quesnel provides a critical migration corridor for upper Fraser River salmon stocks. Passage is particularly an important issue in the lower Fraser River through the Fraser Canyon where natural hydraulic conditions can limit the passage of fish upstream. Formidable series of rapids within the Fraser Canyon including Scuzzy Rapids and the Black Canyon create substantial obstacles to migrating salmon at certain water levels (Ricker 1989). Passage of salmon through Hell's Gate and Saddle Rock has been improved by the construction of fish passage facilities. In general, shorter, smaller fish are most affected by difficulties in migration as swimming speed is directly correlated to length (Ricker 1989).

In addition to natural hydraulic barriers, elevated water temperatures have been linked to an increase in pre-spawning mortality (Foreman et al 1995). A temperature monitoring study was conducted during 1993 and 1994 to assess the effects of tributary input on mainstem Fraser River water temperatures. Tributaries included in the study were the North Thompson, South Thompson, Nicola River, Bridge River, Chilcotin River, Quesnel River, West Road River, Nechako River and Siska Creek (Lauzier et al 1995). In order to predict high river temperatures, flow and temperature models have been developed for the Fraser and Thompson Rivers (Foreman et al 1995).

The Fraser River mainstem also provides important rearing habitat, primarily for chinook and coho salmon. Chinook juveniles from the upper Fraser watershed migrate 700-900 kilometers from their natal streams to the ocean and feed along the margins of the Fraser River during both summer and winter (Scrivener et al 1994). A study by Levings and Lauzier (1991) observed chinook juveniles rearing along the shorelines from Agassiz to Tete Jaune Cache, indicating that the entire mainstem was utilized as winter rearing habitat. Juvenile chinook continue to feed during fall and winter and are dependent on food supplies on the margin of the river when water levels and temperatures are decreasing. Therefore, overwintering survival of stream type chinook may be dependent on winter habitat conditions (Levings and Lauzier 1991). An ongoing research study to determine fish distribution in the mainstem Fraser River is focusing on mainstem rearing characteristics of juvenile chinook salmon between Hope and Shelly (Triton 1994). The objectives of the project are to characterize fish communities; identify sensitive rearing habitat and to document juvenile chinook abundance, biological features and habitat use.

The Fraser River mainstem also provides pink spawning habitat. Although pink spawning enumeration is not conducted on a site specific basis in the Fraser River mainstem, pink spawning has been observed from 1/2 kilometer downstream of Churn Creek to 5-6 kilometers upstream of the Gang Ranch, sporadically on both sides (Rosenberger pers. comm. 1996). Mainstem pink spawning has also been observed below Seton River on east bank in 1993 (Rosenberger pers. comm. 1996).

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Non salmon producing tributaries to the Fraser River provide important habitat characteristics essential to salmonid production in the Fraser River watershed. During the spring and summer, chinook juveniles rear in small, clear, nonnatal tributaries when the sediment load in the mainstem Fraser creates unsuitable rearing conditions (Scrivener et al 1994). Therefore, small non-salmonid producing tributaries as well as off channel habitat provide critical refuge habitat for rearing chinook. In the lower Fraser during May and June, a study by Murray and Rosenau (1989) observed that juvenile chinook migrated from 0.4 kilometers to 6.5 kilometers upstream in nonnatal tributaries to suitable rearing habitat. Therefore, small clear streams within the Middle Fraser HMA are an important component in the life cycle and production of “stream type” chinook salmon originating in the upper Fraser River. In addition, steep and flashy tributaries draining into the Fraser Canyon offer limited spawning and rearing habitat but these glacial fed streams provide critical cold water holding pools at their confluence with the Fraser mainstem. An adequate number of cold water refuge areas are believed to be essential for successful migration of adults through the Fraser canyon (Williams pers. comm. 1996).

### **2.2.2 Coquihalla River**

The distribution of salmon spawners in the Coquihalla River is limited by a 2.5 meter barrier located 6.4 kilometers upstream of the Fraser River confluence at Othello (Fig 2)(FHIP 1990a). Sockeye spawn in the lowermost river while coho, pink and chum spawn to the falls (FHIP 1990a). Upstream of Othello, the Coquihalla River supports steelhead trout and offers a wide diversity of fish habitat but lacks sufficient low gradient habitat for younger juvenile rearing and suitable spawning habitat (Ptolemy 1978). The current limitations to fish production in the Coquihalla River include the lack of off channel habitat, deposition of fine sediments which reduce egg to fry survival rates and decrease food production, loss of spawning gravels and lack of adequate riparian vegetation (Rood and Hamilton 1995a). The lower Coquihalla River is also confined by flood protection works and resembles a channelized river.

### **2.2.3 Kawkawa Creek**

In the Kawkawa Creek watershed sockeye, coho, pink and chum salmon spawn in Kawkawa Creek as well as four tributaries located upstream of the lake (FHIP 1990a). Sucker Creek is the main tributary draining the Ogilvie Mountains whereas flow in Kopp and Menz Creek are from a glaciofluvial aquifer to the east (Rood and Hamilton 1995a).

The tributaries upstream of the lake provide high value rearing habitat as they exhibit a typical groundwater dominated flow regime where discharge remains constant and equals 50-100 litres per second during the summer (Rood and Hamilton 1995a). An extensive coho deadpitch survey in 1977/78 collected scale samples that identified excellent freshwater growth of coho juveniles in this system (FHIP 1990a). The production of coho within the Kawkawa lake system appears to be limited by the quality and quantity of spawning habitat as the available rearing habitat in Kawkawa Lake is underutilized by coho salmon. (FHIP 1990a).

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Several enhancement projects have been undertaken in Kawkawa Creek. In 1984, spawning gravels and jump logs were placed in Kawkawa Creek and in 1987 the Rotary Club community project constructed a chinook spawning channel (FHIP 1990a). In order to limit the migration of coarse fish in Kawkawa Lake, a selective barrier was constructed downstream of the lake outlet (Rood and Hamilton 1995a).

#### **2.2.4 Nahatlatch River**

The Nahatlatch River supports sockeye, chinook, coho and pink salmon (Fig 3). The 6 kilometers of the mainstem Nahatlatch River immediately downstream of Frances Lake has an average gradient ranging from 1.3% to 2.8% and becomes entrenched in a narrow canyon before entering the Fraser River (NWH 1995). This lower reach provides spawning habitat for pink salmon and steelhead (Fig 4) (Hebden 1981). Mainstem areas between Frances, Hannah and Nahatlatch Lakes also provide spawning habitat for pink, chinook, coho and sockeye salmon (FHIP 1992). Frances Lake and Hannah Lake provide important rearing habitat for coho and sockeye salmon, and sockeye spawn at the mouth of Squakum Creek (Griffith 1995b). Anadromous migration in the mainstem is limited by a series of falls approximately 43 kilometers upstream of the Fraser River. Fish production in the Nahatlatch River appears to be limited to low water temperatures and low productivity of both stream and lake waters. (Griffith 1995b).

The middle Nahatlatch River between Nahatlatch Lake and the Mehatl Creek provides the most productive spawning habitat for sockeye, chinook and coho salmon and critical rearing habitat for coho and chinook (Fig 5) (Komori et al 1995). Sockeye primarily spawn in the 3 kilometer reach at Tachewana Creek whereas chinook spawn primarily upstream of Tachewana Creek (Fig 6) (FHIP 1992). This low gradient reach is characterized by a wide active floodplain with slow meandering flows, deep corner pools and an abundance of large woody debris (Fig 7). This reach is moderately sensitive to forest harvesting and previous floodplain harvesting has affected channel stability by increasing rates of bank erosion and channel widening where the riparian forest has been removed (NWH 1995).

The least stable reach of the Nahatlatch River from a hydrological perspective is immediately upstream of the falls where large gravel bars, bank erosion and channel shifting provide an important source of gravels which is carried through the falls to downstream chinook, sockeye and coho spawning areas. The main channel was unstable prior to forest harvesting but channel instability has increased due to inadequate bridge widths, harvesting to streambanks and blowdown of riparian leave strips (NWH 1995). Recommendations for instream restoration works are discussed in NWH (1995).

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### 2.2.5 Stein River

The Stein River supports pink, coho and chinook salmon. The most productive fish habitat is located from mile 10 upstream to Nesbitt Creek (mile 20) where the valley widens to 0.8 kilometers and the river is characterized by long flats, riffles, pool and numerous side channels (Fig 2)(Harding and Erickson 1974, MOF 1984). The extent of anadromous distribution is a 7 meter falls located approximately 7-8 kilometers downstream of Stein Lake or 42 kilometers upstream from the Fraser River confluence (FHIP 1992, MOF 1984). Movement into side tributaries by anadromous species within this 42 kilometer reach is limited by gradient obstructions close to the mainstem river with the exception of Scudamore Creek (MOF 1984).

The lower river from the Fraser River confluence to Earl Creek provides pink salmon spawning habitat (Harding and Erickson 1974, FHIPP 1992). The mainstem reach between mile 10 and mile 20 as well as the floodplain reaches of tributary streams within this section provide good spawning and rearing habitat for chinook and coho (MOF 1994). Chinook spawn in late August through early September in the mainstem Stein between mile 10 and mile 20 as well as in the lower section of Cottonwood Creek (Harding and Erickson 1974 Hebden 1981). Coho migrate into the Stein during the fall and spawn in the same reach from November to February (Hebden 1981, Harding and Erickson 1974).

### 2.2.6 Remaining streams of the Cascade and Coastal Range

The Cascade and Coastal Range streams include Kwoiek Creek, Spuzzum Creek, Yale Creek, Gordon Creek, Emory Creek, American Creek and the Anderson River. These systems will be discussed collectively as they share similar spawning and rearing characteristics. Most of these systems support chum, pink and coho spawners in the lowermost reaches and some provide off channel rearing habitat for migrating juvenile salmonids (Fig 2). The majority of these streams have limited salmon habitat but produce bull trout and rainbow trout in their upper reaches. The distribution of resident species is not well known and all streams less than 20% gradient are considered fish streams unless an adequate fisheries inventory proves otherwise (George pers. comm. 1996).

In the lower reaches of Kwoiek Creek, a side channel near the confluence of the Fraser River provides coho rearing habitat. The middle and upper reaches of Kwoiek Creek supports rainbow trout and bull trout (Griffith 1995a). A comprehensive inventory conducted by Griffith (1995a) outlines important habitat characteristics necessary to sustain rainbow trout and bull trout production in Kwoiek Creek.

On the west side of the Fraser River, American Creek, Emory Creek, Gordon Creek, Yale Creek and Spuzzum Creek share similar biophysical features. The total length of spawning habitat in these systems ranges from approximately 100-1000 meters depending on Fraser River flow levels. Some systems such as Yale Creek provide very limited spawning habitat due to turbulent stream flows and boulder substrates (FHIP 1990a). In most of these systems, coho, pink and

chum spawning is observed in the lower river from the Fraser River mainstem upstream to the Highway 1 bridge or the railway bridge (Fig 2). Upstream of the spawning reaches, most of these systems are flashy and steep with unsuitable substrates and stream gradients for salmon production. Spuzzum Creek has the greatest length of accessible salmon habitat where anadromous migration extends for 2.4 kilometers upstream of the Fraser River to a 3.7 meter high set of waterfalls. Coho spawn sporadically to the railway bridge but production is limited by boulder substrates, flooding and erosion.

The Anderson River is located on the east side of the Fraser River and supports coho and pink salmon. The distribution of salmon extends to 4.8 kilometers where a rock and log barrier is impassable to all salmon species. At some flow levels, a hydraulic barrier at the CN Railway bridge crossing limited the upstream migration of coho. In 1992, maintenance work on the railway bridge included the removal of the cement apron at the base of the bridge, thereby removing the partial barrier (Reid and Johansen pers. comm. 1996). Pink salmon spawn in the lower Anderson River on the Fraser River floodplain where the substrate is constantly eroding and depositing from fluctuating Fraser River flows.

### **2.2.7 Churn Creek**

Sockeye, pink and chinook salmon are produced in Churn Creek. Pink salmon spawn from the mouth upstream for approximately 4 kilometers whereas chinook and coho are believed to utilize spawning reaches from the mouth to middle reaches of the river (Fig 2)(FHIIP 1992). Stray sockeye from the Chilko River and Horsefly River are occasionally observed in Churn Creek. The remoteness of this system has made it difficult to enumerate Churn Creek on a regular basis but this system provides good habitat for chinook, coho and pink production (FHIIP 1992).

### **2.2.8 Williams Lake River**

Pink salmon spawn in the Williams Lake River near the confluence of the Fraser River upstream to the second beaverdam. In peak sockeye spawning years (1993 and 1997), sockeye spawners have been observed in the lower Williams Lake River and are likely strays from other systems such as the Horsefly River (Lawrence pers. comm. 1996). The Williams Lake River also provides coho rearing habitat from the Fraser River upstream to the outlet of Williams Lake where anadromous passage is restricted by a dam. The presence of spawning coho adults is unconfirmed in this system, therefore it is suspected that coho fry may be immigrating into the Williams Lake River to rear (Lawrence pers. comm. 1996).

### **2.2.9 Baker Creek**

Baker Creek supports pink and chinook salmon. The lowest 500 meters of the river contains relatively high proportions of gravels and pink salmon utilize the lowermost 1 kilometer for spawning (Fig 8). Riparian vegetation adjacent to pink spawning habitat is minimal and dominated by black cottonwood. This reach provides high value spawning habitat and medium

value rearing habitat according to Hickey and Trask (1994). Chinook spawning occurs in the lower 4-5 kilometers with primary chinook spawning habitat located between Chevans Creek upstream to the falls approximately 12 kilometers upstream of Mount Creek/Baker Creek confluence (Fig 2) (FISS 1994).



FIGURE 8. Typical pink spawning habitat in the lower reaches of Baker Creek (Hickey and Trask 1994).

#### 2.2.10 Narcosli Creek:

Similar to Baker Creek, Narcosli Creek supports pink and chinook salmon. Pink salmon spawn in the lowermost 2 kilometers where boulders are most abundant with some small pockets of gravel (FISS 1994). This reach has limited rearing and enhancement potential (FISS 1994). Chinook are more widely distributed than pink salmon and primarily spawn in the middle reaches of the river over a 23-25 kilometer stretch immediately downstream of Twan Creek. The upper limit of chinook spawning is 12.5 kilometers upstream of Twan Creek and 200 meters into Ramsey Creek (FISS 1994).

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## **2.3 Steelhead**

The following section provides a brief overview of the distribution and life history characteristics of three steelhead producing systems in the Middle Fraser HMA. The primary steelhead streams within the study area are the Nahatlatch River, Stein River and the Coquihalla River.

### **2.3.1 Nahatlatch River**

Nahatlatch steelhead are a winter run stock that moves into the Fraser River between December to March and spawns in the lower Nahatlatch during March-April (Caverhill pers. comm. 1997). In the Nahatlatch River steelhead stocks are not enumerated on a regular basis and steelhead escapement has been estimated to be less than 200 fish (Caverhill 1995, Hebden 1981).

Spawning primarily occurs downstream of Frances Lake with some spawning throughout the lower section of the river (Fig 2,3) (FHIP 1992). Log Creek and Kookipi Creek also provide rearing habitat for steelhead/rainbow trout (Komori et. al. 1995). The 6 kilometers reach in the mainstem Nahatlatch River immediately downstream of Frances Lake has an average gradient ranging from 1.3% to 2.8% and becomes entrenched in a narrow canyon before entering the Fraser River (NWH 1995).

The majority of steelhead in the Nahatlatch River spend three winters in freshwater before emigrating to saltwater for an additional 3 years before returning to spawn as 6 year olds with some repeat spawning (Caverhill 1995). In general, fish production in the Nahatlatch River appears to be limited by low water temperatures and low productivity of both stream and lake waters (Griffith 1995b).

### **2.3.2 Stein River**

Stein River steelhead are a winter run stock and escapement is estimated to be less than 100 fish (Caverhill 1995). Steelhead migrate into the Fraser River between December and March and spawn during late April to early May from mile 10 and Nesbitt Creek at mile 20 (Harding and Erickson 1974). The upper limit of steelhead distribution is a 7 meter falls located 7 to 8 kilometers downstream of Stein Lake (FHIP 1992). Similar to the Nahatlatch River, the majority of steelhead in the Stein River spend 2-3 years in freshwater and three years in the ocean before returning to spawn (Caverhill 1995, Hebden 1981)

### **2.3.3 Coquihalla River**

#### **2.3.3.1 Life history**

Coquihalla steelhead are a natural summer run steelhead stock that migrate into the Fraser River from mid May to early July and spawn the following March (Caverhill 1995, FHIP 1990a). Similar to winter steelhead stocks, they spend 2-3 years in freshwater but spend a slightly shorter

time in saltwater before returning to spawn as adults hold in the river for almost a year (Caverhill 1995). The Coquihalla stock represent one of five summer run steelhead stocks within the lower Fraser River (Caverhill 1994). The Coquihalla run is almost extinct and is susceptible to incidental capture in the early Stuart River sockeye net fishery.

### **2.3.3.2 Spawning and rearing habitat**

In the Coquihalla River mainstem, prime steelhead habitat is located from the canyon at Othello upstream to the Boston Bar Creek confluence and includes the lower reaches of most tributaries (Caverhill pers. comm. 1997). Upstream of Othello, the Coquihalla River exhibits a wide diversity of fish habitat with an abundance of parr habitat but limited availability of sufficient low gradient fry habitat and limited spawning area (Caverhill pers. comm. 1997, Ptolemy 1978). However, growth of trout in the Coquihalla River is relatively high compared to other similar streams in the south coast of B.C. (Ptolemy 1978). Sowaqua Creek is the main spawning tributary for steelhead while Karen and Ladner Creek also providing important spawning and rearing habitat (Whelen pers. comm. 1997).

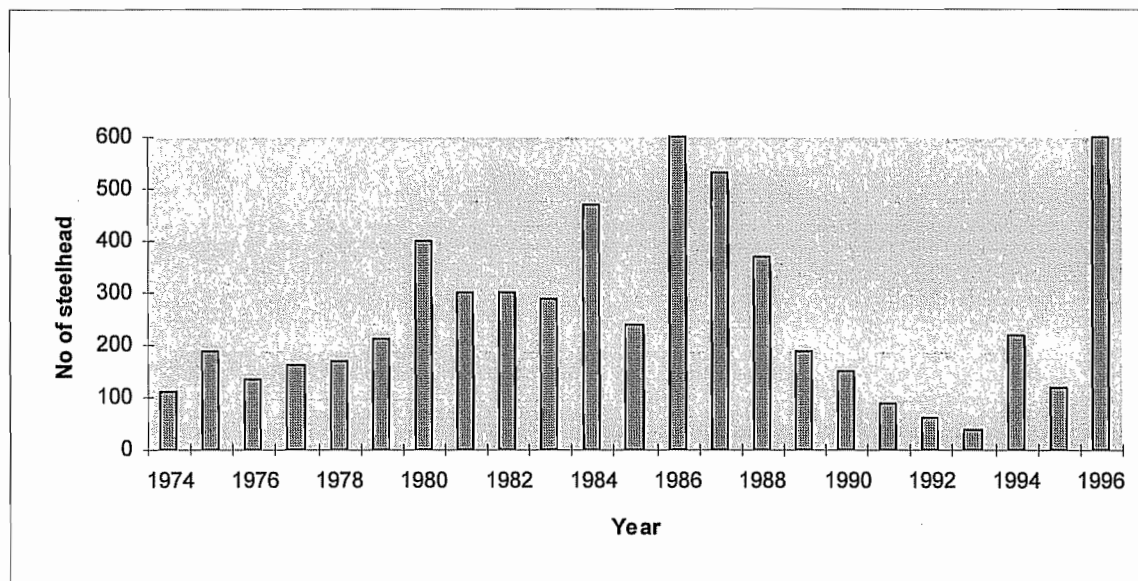
MELP has conducted several steelhead assessment projects in the Coquihalla River, primarily in the mainstem Coquihalla for a 23 kilometer section between Othello and Boston Bar Creek (Ptolemy 1986). Juvenile and adult assessment and monitoring studies have been conducted annually over the past 18 years. Habitat assessment studies indicate that habitat capacity had declined by 65% since 1978 and 1994 (Caverhill 1994).

### **2.3.3.3 Abundance**

In general, steelhead stocks on the Pacific Coast have declined over the past decade (Caverhill 1995). Both natural marine conditions including food availability, predators and large scale oceanic changes as well as freshwater habitat loss from natural and resource development activities have attributed to declining stocks. In addition, interception from harvest fisheries and competition from hatchery stocks has also been a contributing factor to the decline of natural steelhead stocks (Caverhill 1995).

The Coquihalla steelhead run has been intensively enumerated by regular adult snorkel counts that have been conducted for the past 16 years. Between 1989 to 1995, the annual escapement averaged approximately 100 fish which was only sufficient to seed fry habitat to only 10 % of fry capacity (Caverhill 1995). In 1996, steelhead escapement increased and 600 steelhead adults were enumerated (Fig 9). The habitat capacity of the Coquihalla River has been estimated to exceed 1000 fish (Caverhill 1994).

FIGURE 9. Coquihalla summer steelhead escapement (Caverhill 1995, pers. comm. 1997).



#### 2.3.3.4 Enhancement, Mitigation and Habitat Restoration

Primary reasons for declining steelhead stocks are related to habitat impacts from past development and the harvest of returning adult steelhead (Caverhill 1994). MELP staff continue to examine productivity; effectiveness of instream mitigation from the highway and pipeline construction; sedimentation and salmonid capacity. MELP has an ongoing program to monitor steelhead stocks in the Coquihalla and exercises management options to ensure wild fish production maintenance and enhancement (DFO/MOE 1980).

Steelhead enhancement projects include the construction and operation of a semi natural rearing pond to increase annual steelhead smolt output of the Coquihalla River. The operation of the pond stocked with hatchery smolts was later discontinued based on economic restrictions as well as concern for smolt residualism where up to 20% of the smolts remained in the river and were thought to compete with wild steelhead juveniles (Caverhill 1994). An evaluation of pond production found that it was unsuccessful in terms of producing sufficient numbers of smolts to meaningfully increase adult returns during the mid 1980's (Caverhill 1994, Sebastian 1979). Steelhead fry and parr from Coquihalla broodstock have been stocked since 1981, but increases to adult returns have not been exceptional because the quality of rearing habitat is generally of low quality (Caverhill 1994).

To mitigate the impacts of the construction of Highway 5 construction, a variety of instream structures were placed to increase habitat complexity for juvenile and adult steelhead trout. Instream works in the Coquihalla River included the creation of holding areas through the construction of rock spurs, placement of boulder clusters and the construction of a weir and diversion channel (Miles 1995) (Fig 10). Mitigative works have been attempted to compensate

for the loss of parr and adult habitat within the Coquihalla River but most instream works have been unsuccessful (Caverhill pers. comm. 1997) (Figs 11, 12). The physical behavior of these structures was monitored for a period of 8 to 14 years and results indicated that 41% of the structures in the Coquihalla River were either buried, washed away or relocated following a 35-40 year return period flood (Miles 1995).



FIGURE 10. Upstream view on the “Middle” highway diversion channel showing spurs and boulder placement. June 21, 1996. (Photo by M. Miles).

Several restoration projects funded by the BC Watershed Restoration Program (WRP) are ongoing in the Coquihalla watershed (Whelen pers. comm. 1997, Neuman 1996). In Sowaqua Creek and Silverhope Creek, a WRP Level 1 and 2 habitat assessment procedure were conducted in 1996/97 and in the upper Coquihalla watershed, a reconnaissance level fisheries inventory and habitat assessment will be completed in 1997. In Spring Creek, 1996 assessment work included a WRP Level 1 fisheries and habitat assessment and 1996 instream restoration works included a channel improvement project using large woody debris and boulders to restore spawning and rearing habitat in the mainstem. Additional site protection works in Spring Creek included the creation of a log jam to protect the lower river from the effects of high flows in the Coquihalla mainstem. In Karen Creek, a Level 1 fish and habitat assessment was conducted in 1996. Instream works in Karen Creek during 1996 included the restoration of an off channel spawning and rearing channel to provide overwintering habitat for steelhead and bull trout (Caverhill 1997) (Fig 13).



FIGURE 13. Downstream view of Karen Creek spawning and rearing channel located behind extensive dyke on the left bank. June 21, 1996. (Photo by M. Miles).

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## 2.4 Sturgeon

The largest known population of white sturgeon (*Acipenser transmontanus*) in B.C. is found in the Fraser River (Echols 1995). Another smaller species known as the green sturgeon (*A. medirostris*) is also found in the lower Fraser River but identification between the two species is difficult (Echols 1995). The distribution of sturgeon in the Fraser River is relatively unknown but known sturgeon populations are found in the Nechako River and in the Fraser River mainstem to Prince George (Echols 1995). Sturgeon are a long lived species reaching over 100 years of age and a length of 6 meters.

Sturgeon has been an important Native and commercial species since the 1800's and has been fished by the sports fishery since the 1960's (Echols 1995). However by 1991 white sturgeon were declared "vulnerable" according to the Status of Endangered Wildlife in Canada listing and classified as a "red listed endangered species" by the Ministry of Environment, Lands and Parks (MELP) (Echols 1995).

In 1994, DFO and MELP were concerned with the effectiveness of regulations alone to conserve the sturgeon population in the Fraser River and imposed a retention ban on the harvest of sturgeon. All commercial and recreational fisheries in the Fraser River must release all sturgeon in accordance with the 1994 retention ban and aboriginal fisheries in the Fraser River have agreed to a voluntary release of sturgeon (Echols 1995). To more clearly understand the status of white sturgeon in the Fraser River, MELP is conducting tagging studies in the middle and upper Fraser River (Echols 1995). MELP and DFO are currently working jointly to strengthen research and management initiatives on Fraser River white sturgeon.

## 2.5 Native and sport fisheries

The mainstem Fraser River between Prince George and Hope provides important Native fishing opportunities (Rosenberger pers. comm. 1996). The Fraser River between Hope and Prince George is divided into upper and lower sections at Sawmill Creek. The lower Fraser River is harvested more intensively with gillnets on restricted days of the week, therefore requiring more intensive management by DFO (Rosenberger pers. comm. 1996). Conversely, the upper Fraser River is a slower paced, 7 day fishery and is generally managed by DFO on a less intensive level. Salmon are harvested primarily by dipnetting with river conditions and access determining the use of traditional fishing sites.

The *lower* Fraser River from Hope to Sawmill Creek is fished by the Stolo people and constitutes the largest fishery in the Fraser River within the study area. Approximately 200,000-300,000 sockeye are harvested annually with a portion of their catch sold commercially (Rosenberger pers. comm. 1996). This catch only represents a portion of the total Stolo catch as they also fish in the Fraser River downstream of Hope, outside the Middle Fraser study area. The largest harvest area in the *upper river* is located between Sawmill Creek and Texas Creek (Rosenberger pers. comm. 1996). The Nlaka'pamux people primarily fish with gillnets, with some dipnet

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fishing. Approximately 100,000 sockeye, 4,000-5,000 chinook and a few steelhead, pink and coho are harvested each year. The second largest harvest area in the *upper* Fraser River occurs from Texas Creek to Kelley Creek (Rosenberger pers. comm. 1996). In this reach the Stl'atl'imx people primarily harvest fish by dipnetting with some gillnetting. Approximately 35,000 to 50,000 sockeye, some chinook and small numbers of coho and steelhead are harvested annually. A less intensive Native fishery occurs from Kelley Creek to Prince George (Rosenberger pers. comm. 1996). This fishery is spread through this reach and is almost an exclusive dipnet fishery with little gillnetting and usually operates 7 days a week. Approximately 10,000-20,000 sockeye and a few chinook are taken each year (Rosenberger pers. comm. 1996).

The Fraser River mainstem and the Coquihalla River also provides a catch and release wild steelhead sport fishery. Popular fishing sites are located near Lillooet from the confluence of the Seton River/Fraser River downstream for approximately 1.2 kilometers to the tailrace of the BC Hydro generating station (Hebden 1981). These areas are recognized by anglers as good fishing waters due to relatively clear discharge from the Seton-Cayoosh watershed. Steelhead stocks most often captured are probably from the Chilko River, Bridge River, Seton River and Nahatlatch River (Hebden 1981). There are a number of recreational fisheries throughout the study area.

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### **3.0 BIOPHYSICAL FEATURES**

The Middle Fraser HMA covers a wide range of physiographic, geologic and climatic conditions. Annual precipitation varies throughout the HMA and ranges from 300 millimeters in the northern areas to 2000 millimeters in the south. In the southern portion of the HMA, most of the watersheds have flashy water regimes and headwater areas are characterized by steep gradients (Rood and Hamilton 1995a). Conversely, in the northern portion of the HMA, streams are characterized by lower gradient reaches.

#### **3.1 Physiographic description**

The Middle Fraser HMA includes medium and small sized tributaries flowing into the Fraser River between Hope and Quesnel. The largest watersheds within the HMA include the Williams Lake River (2240 km<sup>2</sup>), Narcosli Creek (1700 km<sup>2</sup>), Baker Creek (1570 km<sup>2</sup>), Nahatlatch River (1256 km<sup>2</sup>), Stein River (1084 km<sup>2</sup>), Churn Creek (992 km<sup>2</sup>), Coquihalla River (932 km<sup>2</sup>) and the Anderson River (500 km<sup>2</sup>). The remaining watersheds in the HMA are less than 250 km<sup>2</sup> in drainage area (Rood and Hamilton 1995a).

Within the southern portion of the HMA, the Fraser River flows along a major fault system that separates the Coast Mountains to the west, from the Cascade Mountains to the east (Fig 14) (Rood and Hamilton 1995a). The Fraser Valley is generally deep and narrow, with some wider valleys where benches of glacial drift and non-glacial sediments are found up to several hundred meters above the river level (Ryder and Church 1986 in Rood and Hamilton 1995a). The highest peaks are 2900 meters in elevation and located along the divide between the Stein River and Kwoiek Creek. Peak elevations generally decline in the southernmost portion of the HMA. Active glacier and ice fields are primarily concentrated along the divide between Kwoiek Creek and the Nahatlatch River (Rood and Hamilton 1995a).

Upstream of Churn Creek the Fraser River crosses the Fraser Plateau and the Fraser Basin. (Rood and Hamilton 1995a). The William Lake River, and the lower reaches of Baker and Narcosli Creek lie in the Fraser Basin where low relief terrain is characterized by poorly organized drainage patterns. The middle reaches of Baker and Narcosli Creek and the lower reaches of Churn Creek are located on the Fraser Plateau, which is flat to gently rolling, at elevations of 1200 to 1500 meters (Rood and Hamilton 1995a). The upper reaches of Baker and Narcosli Creeks lie within the Chilcotin Plateau which consists of gently rolling, continuous uplands with elevations between 1300 and 1600 meters. Within this area, steep escarpments exist along creeks and major river valleys (Rood and Hamilton 1995b).

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### 3.2 Hydrology and Stream Pattern

Hydrologic characteristics are variable within the Middle Fraser HMA with precipitation ranging from 300-2000 millimeters per year. In the northeastern portion of the HMA, the Fraser Basin is very dry with 30-50 millimeters of precipitation appearing as runoff. Flows are greatest during snowmelt in May and June and decline quickly during August, September and October with summer flows limited to larger river systems. Low summer flows are further minimized by water diversions for agriculture (Rood and Hamilton 1995a).

In the northwestern portion of the HMA, annual normal precipitation ranges from 350 to 450 millimeters of which 40% falls as snow in the Chilcotin Plateau (Rood and Hamilton 1995b). In the Baker and Narcosli Creek area, 40% of the precipitation falls in June, July and August as rain. Mean annual runoff values vary from 30 to 60 millimeters (Rood and Hamilton 1995b).

Watersheds in the southern portion of the HMA are located within a transitional zone between the coastal and interior type of hydrologic regime. These systems often have two freshets, one in the spring from snowmelt and another during the fall from intense rainfall or rain on snow events. Average streamflows are highest during the summer (Rood and Hamilton 1995a).

A typical salmon bearing stream in the southern portion of the Middle Fraser HMA starts in a steep upland area where sediments are provided to the channel by snow avalanches, debris slides, debris flow, glacial erosion and stream erosion of valley walls and channel banks. Channel widening and downcutting are the most likely channel responses to disturbance in these systems (Rood and Hamilton 1995a). Many of the streams in southern portion of the HMA have an alluvial fan at their confluence with the Fraser River and gradients are typically moderately steep (5%) on these fans (Rood and Hamilton 1995a). Above the fans, the mainstem salmon streams are often steep or flow through narrow, steep bedrock canyons before entering a hanging valley where gradients are less. The uppermost portion of these streams are often very steep and inaccessible to anadromous species (Rood and Hamilton 1995a). The hydraulic conditions at the mouth of these streams vary in response to the water level in the Fraser River. Increase of 8-10 meters in the Fraser often drowns out the lower reaches of salmon bearing streams. As the Fraser River levels drop in the fall, flows are again concentrated in the channel of the salmon stream and fall storms mobilize bed material on the fan and re-shape the channel (Rood and Hamilton 1995a).

A number of salmon streams within the Middle Fraser HMA had water gauging stations but most were operated for only a short period of time. The only two salmon streams with nearly complete gauging records from 1981-1990 are the Coquihalla River and Williams Lake River (Rood and Hamilton 1995a).

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## 4.0 RESOURCE USE SUMMARY

The following section is a summary of resource development activities and a discussion of the known and potential impacts of resource development on fisheries values in the Middle Fraser HMA. This is not a comprehensive review of all resource activities but instead focuses on the primary resource issues that have impacted or have the potential to impact fisheries values on a watershed basis.

The Middle Fraser HMA is relatively undeveloped compared to other Habitat Management Areas within the Fraser River basin. However, significant impacts to the fisheries resource from linear and urban development have occurred in the Fraser River mainstem and the Coquihalla River. In general, urbanization and agriculture have had the greatest impacts on fisheries resources in the northern section of the Middle Fraser HMA. Forestry development is prevalent throughout the study area.

### 4.1 Forestry

Information on the impacts of forest development on salmon values within the Middle Fraser HMA have been identified by DFO and MELP staff and a hydrological analysis conducted by Rood and Hamilton (1995a). The rate of harvesting in the Middle Fraser HMA salmon streams has increased in recent years with the majority of cutblocks harvested in the last 10 years (Rood and Hamilton 1995a). Rood and Hamilton (1995) expressed the habitat sensitivity of salmon streams through various indices that were calculated from hydrologic, water use and land use data collected for the streams. The sensitivity indices indicate the level of concern for those aspects of the hydrologic regime that affect habitat and which can be altered by human activities. The most sensitive streams are defined as those with the most extreme indices or those whose indices exceed a pre-determined critical value (Rood and Hamilton 1995a:25). The critical value used to indicate when a fisheries management concern is raised occurs when total or recent harvesting encompasses greater than 20% of the watershed. The percentage cut of 20% is often used to represent the point where effects on the hydrologic regime often become apparent and where changes in sediment regime of the stream may result (Rood and Hamilton 1995:28). However, site specific impacts often occur when the total percentage logged is less than 20%.

According to this sensitivity analysis conducted by Rood and Hamilton (1995a, 1995b), watersheds with the greatest impacts from forest harvesting activities are Gordon Creek and the Anderson drainage including Utzlius Creek and the upper Anderson River. Recent and proposed logging equals 22% in Gordon Creek and ranges between 15-23% in the Anderson River watershed (Table 7). The remaining streams have recent and proposed forest harvesting to 1997 that ranges from 0-12%. Those remaining streams with the largest recent and proposed cuts include Churn Creek (12%), Williams Lake River (10%), Knife Creek (12%) and Narcosli Creek (10%) (Rood and Hamilton 1995a.).

TABLE 7. Status of logging development in the Middle Fraser HMA (Rood and Hamilton 1995a, 1995b).

Stream Name	Recent <sup>1</sup> Logging/Basin (%)	Total Logging/Basin (%)	Recent and Proposed <sup>2</sup> Logging (%)
Coquihalla River	3	4	4
Sowaqua Creek	2	2	6
Kawkawa Creek	0	0	0
American Creek	6	6	9
Emory Creek	6	7	7
Gordon Creek	22	22	22
Yale Creek	5	5	5
Spuzzum Creek	4	7	6
Anderson River	12	15	20
Lower Anderson	11	16	19
Upper Anderson	13	13	23
Utzlius Creek	15	23	21
East Anderson	6	8	15
Nahatlatch River	2	2	3
Lower Nahatlatch	2	2	3
Upper Nahatlatch	1	1	4
Log Creek	6	6	6
Kookipi Creek	2	2	4
Mehatl Creek	0	2	0
Stein River	0	0	0
Kwoiek Creek	<i>data not available</i>		
Churn Creek	2	3	12
William Lake River	6	12	10
Knife Creek	6	11	12
Narcosli Creek	5	11	10
Baker Creek	3	11	7

<sup>1</sup> Harvested areas less than 10 years old

<sup>2</sup> Proposed harvesting to 1997

The results of the Rood and Hamilton (1995a, 1995b) analysis indicate that the majority of streams have less than 20% of the total watershed area logged, implying that the hydrologic and sediment regime may be unaffected by forest development. However, a more detailed assessment on a sub-basin level through the application of the watershed assessment procedure may reveal more significant impacts of forest harvesting on fisheries values. A high level of concern has been expressed by DFO Habitat and Enhancement staff regarding site specific impacts and/or rate of cut concerns related to forestry development in the Nahatlatch River,

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Churn Creek and the Anderson River. In the northern portion of the HMA, DFO is concerned with ECA status in Deserter Creek, a tributary of Narcosli Creek, where a watershed assessment is currently being conducted (Rowland and MacDonald 1996). MELP staff has expressed some concern for the impacts of forestry development on fisheries values in the Coquihalla River. Details of forestry development in these watersheds are discussed in more detail in the following sections.

#### **4.1.1 Nahatlatch River**

In the Nahatlatch River, site specific impacts from forest development on fisheries values include narrow or non-existent riparian leave strips, channel bank erosion, historical logging of riparian habitat and subsequent aggradation and channel widening in salmon spawning and rearing areas (NWH 1995). Additional site specific impacts include channel avulsion and increased sediment supply resulting from alluvial fans that have been destabilized from logging (NWH 1995). Although the total watershed area logged equals 2%, forest harvesting has been concentrated in Log Creek, Kookipi Creek, the upper Nahatlatch River. In Log Creek, Rood and Hamilton (1995a) determined that 6% of the total basin has been logged which represents greater than 30% of the Coastal Western Hemlock (CWH) and Interior Douglas Fir (IDF) biogeoclimatic zones. As rain on snow floods may potentially be increased by forest harvesting, logging a large proportion of the rain on snow zone (CWH and IDF) has the potential to impact the natural hydrologic regime even if a small proportion of the total basin area has been logged. Additional site specific impacts in Nahatlatch River tributaries include the degradation of riparian habitat (Fig 15, 16).

In 1994, DFO and MELP developed site specific forest development guidelines as outlined in the Nahatlatch Riparian Management Plan to assist in the protection of fish and fish habitat from resource development activities (Komori et al 1995). Resource development in the Nahatlatch River currently receives direction from MOF and the Nahatlatch River Integrated Resource Management Planning Process. The planning team consists of MOF, MELP, DFO, the Boothroyd Band, Cattermole Timber, J.S. Jones and International Forest Products. Major licensees in the Anderson River/Uztilius Creek and the Nahatlatch River are Cattermole Timber, JS Jones and the Ministry of Forests Small Business Program (George pers. comm. 1996).

In addition to the Nahatlatch Riparian Management Plan and the Integrated Resource Management planning process, MELP is striving to maintain biodiversity values in the Nahatlatch watershed at the landscape level and stand level. Landscape level biodiversity management includes the establishment of Forest Ecosystem Networks to ensure connectivity of leave areas and seral stage distribution targets. Stand level biodiversity management includes the designation of wildlife tree patches, riparian management areas and coarse woody debris retention to ensure that forest stand structure and species diversity is maintained (George pers. comm. 1996). The designation of the Mehatl watershed as a provincial park in 1996 will assist in sustaining biodiversity values within the Nahatlatch River area.

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### **4.1.2 Churn Creek**

The rate of forest harvesting in Churn Creek is increasing in the upper watershed. Approximately 2.8% of the total basin area was logged by 1991 with an additional 10.2% proposed to 1997. DFO and MELP have both expressed concern over harvesting in upper Churn Creek (Rood and Hamilton 1995a). Site specific impacts from forest harvesting that have occurred to date include road encroachments, road failures that have reached the mainstem, and harvesting on unstable soils (Rowland and MacDonald 1996). The valley walls throughout Churn Creek are unstable and the mainstem channel is naturally unstable in the lower river. Therefore, small changes in peak flows combined with a high degree of natural instability may amplify the likelihood of slope and road failures, sedimentation, and channel stability in Churn Creek.

The Ministry of Forests developed a Local Resource Use Plan (LRUP) for Churn Creek in consultation with DFO, MELP and other stakeholder groups (Lawrence pers. comm. 1996). The Hungry Valley located in the headwaters of West Churn Creek is also in the process of developing an LRUP.

### **4.1.3 Anderson River**

In 1995, the total area logged ranged between 8% to 23% in the Anderson River watershed (Table 7). The total area of recent and proposed logging to 1997 ranges from 15-23% of the watershed area and therefore has the potential to affect the hydrologic characteristics (Rood and Hamilton 1995a). Site specific impacts that have occurred to date include cutblocks that extend to the stream channel and the resulting loss of riparian vegetation. The removal of riparian forest in the middle reaches of the Anderson River is responsible for existing channel erosion problems (Rood and Hamilton 1995a).

DFO is concerned that forest harvesting may have negative impacts on downstream salmon habitat (Reid and Johansen pers. comm. 1996). Prior the extent of current logging activity, a study conducted in 1983 concluded that water quality in the Anderson River was being modified by logging activity (Whitfield 1983 in Birtwell et al 1988).

### **4.1.4 Gordon Creek**

In general, an equivalent clearcut area (ECA) of greater than 20% implies that the rate of cut may have significant effects on the natural hydrologic regime of the watershed. The Gordon River watershed currently has an equivalent clearcut area (ECA) of 22% with no further harvesting planned to 1997 (Rood and Hamilton 1995a). Although salmon habitat values are limited to the lowermost few hundred meters of Gordon Creek, DFO is concerned with downstream impacts resulting from logging in the upper watershed. The hydrological impacts of forest harvesting should be assessed through the application of the Coastal Watershed Assessment Procedure.

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#### **4.1.5 Coquihalla River**

MELP and DFO are concerned that the cumulative effect of forest harvesting may increase peak flows and exacerbate existing problems with channel bank erosion, increased sediment loads and flooding problems in the mainstem Coquihalla River. Sowaqua Creek is the main spawning tributary for steelhead in the Coquihalla watershed and site specific impacts within the Sowaqua basin include numerous road failures and degraded riparian habitat (Whelen pers. comm. 1997).

#### **4.2 Agriculture**

In the northern portion of the study area, the most extensive agricultural development is found in Baker Creek, Narcosli Creek, Williams Lake River, Knife Creek and Churn Creek. Approximately 76% of available Crown rangeland in the Fraser River basin is located in the Kamloops and Cariboo districts (McDougall 1984 in Birtwell et al 1988). Agricultural capability in the Quesnel area is generally low due to adverse climate and topography but lower elevations areas along major rivers show the highest capability. The majority of agriculture is forage based, supporting cattle and dairy operations with some better sites supporting field crops and cereal grain production (Hickey and Trask 1994). One of the larger ranches in the Middle Fraser HMA is the Gang Ranch in Churn Creek which operates an extensive open range land operation. In Williams Lake River, Knife Creek and Churn Creek, water storage structures for irrigation are used to meet water demands in low flow periods (Rood and Hamilton 1995a).

#### **Impacts on the fisheries resource**

Agriculture has the potential to alter the natural hydrologic regime by extracting surface and ground water for stock watering, domestic use and irrigation (Rood and Hamilton 1995a). In addition to naturally occurring low flow regimes, the demand for water by agricultural operations can amplify minimum flow problems. Water withdrawal for agricultural purposes can reduce the dilution factor in the mainstem Fraser River and increase the impacts of wastewater effluents on salmonids. Extensive agricultural development can also increase peak flows as a result of the conversion of forested land to pasture land. Other impacts of agricultural development on fisheries values include degraded riparian habitat, stream encroachment by cattle causing destabilized streambanks and decreased water quality (Pylypiuk et al 1996).

Rood and Hamilton (1995) expressed the habitat sensitivity of salmon streams through various indices that were calculated from hydrologic, water use and land use data collected for the streams (Table 8). The sensitivity indices indicate the level of concern for those aspects of the hydrologic regime that affect habitat and which can be altered by human activities. The most sensitive streams are defined as those with the most extreme indices (Rood and Hamilton 1995a, 1995b). Within the Middle Fraser HMA, potential water demand in August expressed as a percent of the mean summer 7 day low is extremely high for the Williams Lake River (212%) and Knife Creek (296%) (Table 8). Water demand in Narcosli Creek and Baker Creek range from 17-20% of the mean August 7 day low flow whereas the remaining streams within the study

areas have very low potential water demand (0-3%) during August. At this time, major surface water extractions for irrigation from salmon streams occur in Williams Lake River, Knife Creek, Baker Creek and Narcosli Creek. Water demands on Williams Lake River and Knife Creek amount to most of the natural late summer flows and both these systems are fully recorded (Rood and Hamilton 1995a).

TABLE 8. Status of water demand and peak flows for the Middle Fraser HMA (Rood and Hamilton 1995a, 1995b).

Stream Name	Aug summer water use <sup>1</sup> (%)	summer 7 day low flow <sup>2</sup> (%)	winter 7 day low flows <sup>3</sup> (%)	mean annual flood /mean annual flow <sup>4</sup>
Coquihalla River	0	20	26	8
Sowaqua Creek	<i>information</i>	<i>unavailable</i>		
Kawkawa Creek	1	74	124	
Sucker Creek	0	75	125	
Steven Creek	0	75	125	
Kopp Creek	2	73	123	
Menz Creek	0	75	125	0
American Creek	0	7	4	16
Emory Creek	0	7	8	13
Gordon Creek	0	7	8	19
Yale Creek	3	5	7	20
Spuzzum Creek	1	5	7	14
Anderson River	0	9	5	9
Nahatlatch River	0	33	20	6
Stein River	3	29	21	4
Kwoiek Creek				
Churn Creek	1	47	26	6
William Lake River	212	10	6	3
Knife Creek	296	1	24	14
Narcosli Creek	20	21	27	8
Baker Creek	17	18	21	8

*Shading indicates salmon streams with the most extreme (25%) values.*

- 1** Potential demand in August as a percent of the mean summer 7 day low flow. Expresses the maximum portion of flow during the rearing season that is used for water demand
- 2** Actual summer 7 day average low flow as a percent of mean annual flow. Expresses the ability of the system to resist water removal; low values indicate streams with low natural 7 day low flows
- 3** Actual winter 7 day average low flow as a percent of mean annual flow.
- 4** Mean annual flood as a ratio of mean annual flow. Expresses the peakiness of the stream hydrograph and the potential for scour and erosion.

The most sensitive streams based on naturally occurring summer low flows are American Creek, Emory Creek, Gordon Creek, Yale Creek, Knife Creek, and Spuzzum Creek (Rood and Hamilton 1995a). These systems are sensitive to water removal as the average 7 day low flow as a percentage of mean annual flow ranges from 5-7% (Table 8). The most sensitive streams based on winter flows are American Creek, Yale Creek, Spuzzum Creek, Anderson River and Williams Lake River (Rood and Hamilton 1995a). Streams with the highest potential for scour and erosion due to mean annual floods are American Creek, Gordon Creek, Yale Creek, Spuzzum Creek and Knife Creek (Table 8).

In Narcosli Creek, agricultural development occurs throughout the watershed from Deserter Creek upstream to Twan Creek. DFO has expressed a high level of concern for water demand issues and degradation of riparian areas as well as cattle fording, cattle watering, riparian grazing, streambank destabilization, dyke construction and road access issues (Rowland and MacDonald 1996, Pylypiuk 1996).

In the William Lake River watershed, DFO has identified a high concern for the impacts of agricultural activities on salmon values (Rowland and MacDonald 1996). Agricultural activities extend throughout the drainage with significant impacts from grazing and fording upstream of Williams Lake in the San Jose River. Water withdrawal concerns are high and the river is fully recorded with no further licenses to be issued. Water quality issues are also a high concern for DFO as overwintering of cattle and the operation of feedlots adjacent to the San Jose River are causing water quality problems (Rowland and MacDonald 1996).

### **4.3 Urban Development**

Within the Middle Fraser HMA, Quesnel is the largest settlement area with a population of approximately 20,000 residents (Triton 1991). The lower portion of Baker Creek flows through the city of Quesnel. The second largest community is Williams Lake which is located on the William Lake River and provides residence for 10,400 people (Rowland and MacDonald 1996). The town of Hope is adjacent to the Coquihalla River/Fraser River confluence and provides residence for approximately 7000 people (B.C. Statistics). In addition, several small communities are located along the Fraser River mainstem (Fig 17).

Urban centers within the Middle Fraser HMA are generally resource based where the population fluctuates with changes in employment demands from forestry, mining, agriculture and pulp mill industries. Future increases in the population of Quesnel are expected to be low (1.2%) as no major industrial development is being considered (Triton 1991).

### **Impacts to the fisheries resource**

The most common impacts of urban development on fish habitat is the armoring of river banks and channelization of natural meander patterns (Henderson 1991). Ongoing maintenance of these modifications often requires dredging which can result in the direct mortality of juvenile

salmon and loss of spawning gravels (Henderson 1991). Major impacts from urban development in the Middle Fraser HMA include instream and riparian impacts including channelization, loss of stream complexity, encroachment, bank stabilization practices using rip rap, loss of riparian vegetation and migration barriers. Additional impacts of urban development on fisheries resources include changes to natural hydrologic regime primarily through extraction by waterworks (Rood and Hamilton 1995a). Water quality can also be reduced from storm drain runoff and snow disposal practices.

Impacts from urban development in Baker Creek include bank stabilization practices including the placement of rip rap and channelization as well as dyking activities which have impacted both instream and riparian habitat (Rowland and MacDonald 1996). Additional impacts of urban development include the reduction in water quality through storm drain runoff and potential chlorine spills from swimming pools (Rowland and MacDonald 1996).

Impacts from urbanization in the Williams Lake River include degradation of riparian areas where urban refuse is deposited. Water quality is considered a high concern for DFO as storm sewer discharge, sewage disposal and snow disposal practices are reducing water quality in the Williams Lake River and the mainstem Fraser River. In addition, leachate from the landfill is a potential source of water quality problems and needs further investigation.

Urban encroachment has occurred since 1969 in coho and sockeye spawning habitat in Kawkawa Creek (FHIIP 1990A). The community of East Kawkawa Lake is located on alluvial fan upstream of Kawkawa Lake on groundwater fed creeks (Stanley 1987). These creeks provide significant spawning and rearing habitat for both salmon and trout species (Letay pers. comm. 1996). Impacts of urban development on fisheries resources includes channelization, removal of natural riparian vegetation, alteration of the streambed for flood control works and inadequate sized culverts creating migration barriers (Letay pers. comm. 1996). In addition to these problems, residential development around the lake impacts water quality and quantity in Kawkawa Lake and tributaries (Rood and Hamilton 1995a).

#### **4.4 Linear Development**

Linear development has significantly impacted fisheries values in the Fraser River mainstem corridor and the Coquihalla River watershed. Linear development within the Middle Fraser HMA includes 2 major highways, 2 railway lines, a gas pipeline, an oil pipeline, hydro transmission lines and an extensive network of secondary highways and logging roads (Fig 17).

The construction of railways and highways can negatively effect salmon production through sedimentation, rock slides and improper bridge/culvert installation (Henderson 1991). The single largest deleterious impact on Fraser River salmon occurred as the result of rock dumping and a slide during the construction of the Canadian Northern Railroad in the Hell's Gate area between 1912 and 1915 (Fraser et al 1982). These events in conjunction with overfishing resulted in a drastic reduction in upper Fraser River runs in subsequent years. Although fishways were constructed to alleviate the blockage, passage of adults is still difficult in years with low flows (Henderson 1991:144).

#### **Impacts to the fisheries resource**

Linear development has the greatest impact on fisheries resources relative to other resource development activities in the Fraser River mainstem and the Coquihalla River watershed (Reid and Johansen pers. comm. 1996, Caverhill pers. comm. 1997). Linear development has negatively affected fisheries values through stream encroachment at bridge crossings and along major highways, railway maintenance procedures that sidecast rock and debris, slope and road failures and major stream diversions for road or pipeline construction.

Within the Coquihalla River watershed, linear development includes a 4 lane highway (Highway 5), Trans Mountain Pipeline, West Coast Energy gas pipeline and the B.C. Telephone lightguide (Miles 1995, Reid and Johansen pers. comm. 1996) (Fig 18). Several major diversions and channel encroachments have occurred as a result of Highway 5 construction between Othello and Boston Bar Creek. Habitat usability and absolute capacity for juvenile steelhead has generally been reduced at major diversions in the mainstem (Ptolemy 1986). The presence of the highway and pipelines have also resulted in permanent losses of fish habitat and degraded the quality of spawning and rearing habitat (Caverhill 1994). Linear development with the Coquihalla corridor has required constant maintenance and repair from flood damages, particularly in floodplain areas and/or at bridge sites. At this time, there are 13 bridge crossings and 6 pipeline crossings over the Coquihalla River (Caverhill pers. comm. 1997). Linear development in the Coquihalla valley exacerbates the impacts of flood flows and results in a constant loss of riparian function, high rates of bedload movement and loss of fish habitat (Fig 19). In the lower river adjacent to salmon habitat values, the Coquihalla River has been diverted and confined by construction of Highway 5 and a gas/oil pipeline with extensive rip rap placement to assist in stabilizing the river (Reid and Johansen pers. comm. 1996). Increased bedload movement from the upper river to the lower river has increased flooding and erosion problems adjacent to Hope (Reid and Johansen

pers. comm. 1996). In 1985, accelerated highway construction was largely responsible for elevated levels of suspended sediment in the mainstem Coquihalla River (Ptolemy 1986). As discussed in section 2.3.3.4, mitigative instream works for habitat improvement have been largely unsuccessful over the long term (Miles, 1995).

DFO is concerned with maintaining a salmon migration corridor through the Fraser canyon. In the Fraser River corridor, linear development includes the Trans Canada Highway, B.C. Railway, Canadian National Railway, Canadian Pacific Railway and power transmissions lines. Site specific impacts in the upper river include side channel alienation, loss of riparian habitat and channelization in small tributaries. In the lower river, the primary impact of linear development results from railway maintenance practices where rock and debris are sidecasted into the Fraser Canyon. Sidecasted materials can infill critical holding areas or create additional hydraulic barriers that can potentially delay migration and increase the chance of pre-spawn mortality of migrating salmon (Reid and Johansen pers. comm. 1996).



FIGURE 18. Upstream view of the Coquihalla mainstem at Ladner Creek bridge illustrating oil/gas pipelines, B.C. Tel right of way, 2 industrial roads and a major 4 lane highway. June 21, 1996. (Photo by M. Miles).

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#### **4.5 Mineral Resources and Placer Mining**

Major development of mineral resources in the Middle Fraser River includes Carolin Mines on Ladner Creek in the Coquihalla River during the mid 1970's and Gibraltar Copper Mine at McLeese Lake (Caverhill 1994, Rowland and MacDonald 1996, FHIIP 1990a). In Churn Creek, Black Dome gold mine on Fairless Creek in the upper watershed may be re-opening under new ownership (Rowland and MacDonald 1996).

The development of placer operations is widespread throughout the Fraser River mainstem from Prince George and is concentrated in the Bridge River and Cariboo areas (Birtwell et al 1988) as well as Churn Creek (Rowland and MacDonald 1996). The current extent of placer mining impacts are unknown but DFO is concerned with increased sediment discharges and alienation of fish habitat (Birtwell et al 1988).

#### **Impacts to the fisheries resource**

In 1982, cyanide was spilled from the mine tailings pond in Ladner Creek, killing both juvenile and adult fish in the Coquihalla River. The spill event affected several age classes and therefore reduced adult returns over the following decade (Caverhill 1994).

In the mainstem Fraser River, water quality may be affected by active acid leaching of waste rock dumps including the tailing ponds in Fairless Creek in upper Churn Creek. Water quality in Cuisson Creek and Lewis Creek is currently being monitored and ongoing assessment is recommended by DFO (Rowland and MacDonald 1996).

#### **4.6 Pulpmills and Other Development**

Within the Fraser River system, there are 5 bleached kraft pulpmills and 1 chemi-thermomechanical pulp mill (Servizi 1989, Birtwell et al 1988). Pulpmill development within the study area is concentrated at Quesnel where two pulp and paper mills; Cariboo Pulp and Paper and Quesnel River Pulp discharge effluent into the Fraser River. One of the mills is a kraft mill (Cariboo Pulp and Paper) whereas the other is a bleached chemi-thermomechanical pulp mill (Quesnel River Pulp). The kraft mill has the greater potential to impact water quality and fish habitat due to a greater volume of effluent and the production of chlorinated organics, dioxins and furans (Triton 1991). The bleached chemi-thermomechanical (BCTMP) method uses heat and physical processes rather than chemicals to liberate pulp fibers. BCTMP eliminates the production of dioxins, furans and chlorophenols by using hydrogen peroxide rather than chlorinated compounds in the bleaching process (Triton 1991). Pulpmills also discharge a large volume of warm water and the effects of this are unknown (Nener 1997).

There are no applications for large or medium-sized hydroelectric development projects in the Middle Fraser HMA. Several small hydro projects have been proposed, particularly for Kwoiek Creek, but no development has occurred within the HMA (Rood and Hamilton 1995a).

Industrial development adjacent to Williams Lake River consists of several sawmills where impacts to water quality results from surface runoff. Other impacts in the Williams Lake River include major bank slumping, resulting from past disposal of industrial debris, and storm water run-off causing siltation and channel destabilization (Rowland and MacDonald 1996).

### **Impacts to the fisheries resource**

DFO has expressed a high level of concern for the effects of pulpmill effluent on water quality parameters in the mainstem Fraser River (Rowland and MacDonald 1996). Overall, the daily volume of industrial and municipal wastewater discharged into the Fraser River has increased 3 fold between 1965 and 1989, largely from the addition of 6 pulpmills (Servizi 1989).

Pulp mill effluent contains chlorinated guaicols, chlorophenols, dioxins, furans and other potentially detrimental substances that have been detected in fish, sediment and water samples several hundred kilometers downstream from the mills (Triton 1991, Birtwell et al 1988). A review by Servizi in 1989 examined whether salmon stocks were adequately protected from the effects of industrial wastewaters and concluded that coho were at risk to the effects of wastewater in some urban streams. The study also identified that there was significant potential for wastewater impacts to overwintering chinook juveniles residing in or near dilution zones (Servizi 1989). The effects of wastewaters are believed to increase during low flow periods during the winter and could have serious impacts on pink, chum and juvenile chinook salmon (Birtwell et al 1988). In 1992, the Canadian Environmental Protection Act partially resolved problems associated with the release of dioxins and furans when they required pulpmills to upgrade their systems to meet new regulations for these substances. However, the longterm effects of lower concentrations of substances released in pulpmill effluent are unknown (Nener 1997). More research is also needed to determine the extent of the accumulated effects of pollutants on salmon stocks (Servizi 1989).

Other impacts to water quality from pulp mills are increased suspended sediment loads, increased biological oxygen demand (BOD), reduced dissolved oxygen (DO) levels, unsuitable pH levels and elevated temperatures (Triton 1991). Secondary treatment practices in pulpmills largely addresses BOD and DO levels but more research is needed to determine the effect on increased water temperatures on adult and juvenile salmon (Nener 1997).

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## 5.0 WATERSHED MANAGEMENT PRIORITIES AND RECOMMENDATIONS

Management priorities and recommendation have been developed for each salmon bearing watershed within the Middle Fraser HMA. Management priorities and recommendations for each system are referenced by number but the numbers do not reflect the importance of one priority or recommendation over another.

### 5.1 Fraser River mainstem

#### 5.1.1 Description

The Fraser River is approximately 1,250 kilometers in length and drains an area of 240,000 square kilometers (Birtwell et al 1988, Fraser et al 1982). The Fraser River has a total mean annual discharge of 2700 cubic meters per second and drains approximately 25% of the province (Dorcey 1991, Birtwell et al 1988). The Fraser River is the largest, most valuable salmon producing system in British Columbia, supporting all six species of anadromous Pacific salmon including steelhead. Approximately one-third of the total average annual salmon catch in B.C is produced in the Fraser system with a commercial wholesale salmon catch valued at \$125 million in 1987 (Birtwell et al 1988, Northcote and Larkin, 1989, Henderson 1991). The Fraser River sustains over 67% of the province's population which has led to widespread impacts on both aquatic and terrestrial ecosystems.

Approximately 750 kilometers of the Fraser River between Prince George and Hope lies within the Middle Fraser HMA (Fraser et al 1982). Within the HMA, there are 14 pink, 8 chum, 9 coho, 6 chinook and 8 sockeye producing systems (DFO 1994). The Fraser River mainstem provides a critical migration corridor for upper river stocks in addition to spawning and rearing habitat for salmon throughout. Within the Middle Fraser HMA, the Fraser River is characterized by a wide, meandering river pattern as it flows through the Fraser Basin from Prince George to Williams Lake (Fig 2). Downstream, the Fraser River becomes increasingly more narrow, with a higher gradient as it flows in a southeasterly direction between the Camelsfoot Range and Marble Range north of Lillooet. Below Lillooet, the Fraser River is incised in the Fraser Canyon as it flows between the Coast Mountains and the Cascade Mountain to Hope.

Non salmon producing tributaries to the Fraser provide important habitat characteristics essential for salmonid production in the Fraser River watershed. Small, low gradient tributaries provide critical rearing habitat during the spring and summer when sediment loads are high in the mainstem Fraser. In addition, steep and flashy tributaries draining into the Fraser canyon provide limited spawning and rearing habitat but these glacial fed streams provide critical cold water holding pools at their confluence with the Fraser mainstem. Cold water refuge areas are believed to be essential for successful migration of adults through the Fraser canyon (Williams pers. comm. 1996). Therefore, managing resource and urban development in tributary streams is a critical component of sustaining fisheries values in the mainstem Fraser River.

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## 5.1.2 Management Priorities and Recommendations

### **Management Priority #1: To facilitate upstream passage of migrating salmon spawners.**

The successful passage of adults through the Fraser Canyon is dependent on flow levels as river hydraulics are known to create partial barriers and increase the chance of pre-spawn mortality due to migration delays (Reid and Johansen pers. comm. 1996). River hydraulics can also be altered by railway maintenance practices where rock and debris are sidecasted into the river when no other alternative exists. Blasted materials or natural failures can potentially infill critical resting areas and result in increased migration mortality in salmon. DFO has established a Memorandum of Understanding with Canadian Pacific Railway (CPR) regarding preferred maintenance practices.

In addition to natural hydraulic barriers, elevated water temperatures can increase migration mortality. Therefore, an adequate number of cold water holding pools at the outlets of glacial fed tributaries are believed to be essential for successful migration of adults through the Fraser canyon (Williams pers. comm. 1996). A study on the early Stuart sockeye run determined that throughout their upstream migration, sockeye used the most energy while passing through the Fraser Canyon where islands or gravel bars create confusing and fast currents (DFO 1997). In average conditions, sockeye use 65% of their energy resources for migration and, when either temperature or river discharge is high, an average sockeye would use 75% of its energy budget. In years when both discharge and water temperatures are high, the average sockeye would run out of energy and die prior to reaching the spawning grounds.

*Management Recommendation 1-1: Identify and map locations where fish passage is difficult or vulnerable to natural debris slides. In these areas, assess slope stability to assist in predicting future passage problems.*

*Management Recommendation 1-2: Manage land use activities in salmon and non salmon producing tributary streams to maintain natural hydrologic characteristics, suitable water temperatures and water quality. Stream flows and water temperatures from glacial fed tributaries provide critical cold water refuge areas in the mainstem Fraser River that are believed to be critical to successful upstream migration of adult salmon.*

*Management Recommendation 1-3: Continue to monitor water temperatures during the adult migration period and identify glacial fed tributaries that provide critical cold water refuge areas in the mainstem Fraser.*

*Management Recommendation 1-4: Develop a Memorandum of Understanding (MOU) between DFO and Canadian National Railway (CNR) similar to the existing MOU with CPR to minimize the impacts of railway maintenance procedures on fish passage through the Fraser Canyon.*

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**Management Priority #2: To protect valuable rearing habitat in the mainstem Fraser River and non salmon producing tributaries.**

The Fraser River mainstem provides important rearing habitat, primarily for chinook and coho salmon. Chinook juveniles from the upper Fraser watershed migrate 700-900 kilometers from their natal streams to the ocean and feed along the margins of the Fraser River during both summer and winter (Scrivener et al 1994). A study by Levings and Lauzier (1991) observed chinook juveniles rearing along the shorelines from Agassiz to Tete Jaune Cache, indicating that the entire mainstem was utilized as winter rearing habitat. Juvenile chinook continue to feed during fall and winter and are dependent on food supplies on the margin of the river when water levels and temperatures are decreasing.

During the spring and summer, chinook juveniles rear in small, clear, nonnatal tributaries when the sediment load in the mainstem Fraser creates unsuitable rearing conditions (Scrivener et al 1994). In the lower Fraser during May and June, a study by Murray and Rosenau (1989) observed that juvenile chinook migrated from 0.4 kilometers to 6.5 kilometers upstream in nonnatal tributaries to suitable rearing habitat. Therefore, small non-salmonid producing tributaries as well as off channel habitat provide critical refuge habitat for rearing chinook. Managing resource and urban development in tributary streams is a critical component of sustaining fisheries values in the mainstem Fraser River.

*Management Recommendation 2-1: Manage land use activities in salmon and non salmon producing tributary streams to ensure that riparian habitat, instream habitat, stream temperatures and the natural hydrologic regime are sustained.*

*Management Recommendation 2-2: Identify and document rearing habitat in the mainstem Fraser River and accessible low gradient tributaries.*

Urban development has negatively impacted instream and riparian habitat adjacent to Quesnel, Williams Lake and Hope. To minimize further impacts of urban development in Quesnel, a foreshore classification and recommendations were developed. The application of the classification will assist in minimizing the impacts of urban development on fish habitat.

*Management Recommendation 2-3: Develop and implement a foreshore classification and recommendations for urban and resource development activities in Williams Lake, Hope and other smaller urban centers that have the potential to negatively affect fish or fish habitat.*

*Management Recommendation 2-4: When site specific guidelines are unavailable, apply the Land Development Guidelines for foreshore development as a minimum.*

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**Management Priority #3: To minimize the effects of pulpmills effluent on juvenile salmonids rearing in the Fraser River mainstem.**

Elevated wastewater discharges into the Fraser River has created concern for water quality and its effects on rearing salmonids (Servizi 1989). More specifically, many upper Fraser River chinook stocks overwinter in the Fraser mainstem and the effects of pulpmill effluent on chinook juveniles in this critical low flow, low temperature period are being investigated. Pulp mills also discharge large volumes of warm water and the effects of this are unknown (Nener 1997).

*Management Recommendation 3-1: Continue water quality monitoring and investigation of sublethal effects of pulpmill effluent on rearing juvenile salmonids.*

*Management Recommendation 3-2: Examine the **cumulative** effects of wastewater discharges from pulpmill effluent and non point sources of pollution on salmon.*

*Management Recommendation 3-3: Determine the effects of warm water discharges on migrating adult salmon and rearing juvenile salmon in the Fraser River mainstem.*

**Management Priority #4: Protect and conserve sturgeon populations in the Fraser River.**

DFO and MELP, concerned with the ability of existing regulations to conserve the sturgeon population in the Fraser River, imposed a retention ban in 1994 on the harvest of sturgeon. MELP and DFO are working jointly to strengthen research and management initiatives on Fraser River white sturgeon. To more clearly understand the status of white sturgeon in the Fraser River, MELP is conducting tagging studies in the middle and upper Fraser River to compliment the completed study in the lower Fraser (Echols 1995).

*Management Recommendation 4-1: Implement as interim management strategies to assist in the recovery and research on Fraser River sturgeon species (Echols 1995).*

- 1. Continue with the retention ban on all commercial and recreation caught sturgeon in the Fraser River.*
- 2. Investigate the feasibility of reducing incidental catches of sturgeon in B.C. salmon fisheries through different management strategies such as selected time and area closures and/or gear restrictions.*
- 3. Increase public awareness of the problems of poaching and illegal sale of sturgeon in B.C. and encourage the reporting of such activities to fishery enforcement agencies.*
- 4. Continue to fund and encourage further research on the FR white sturgeon, and use the incoming information for the development of improved conservation strategies.*
- 5. Develop a system for differentiating between catches of white and green sturgeon in order to maintain separate records when fishing on sturgeon is reopened.*

## **5.2 Coastal Mountains**

Salmon streams draining the Coastal Mountains within the Middle Fraser HMA include the Nahatlatch River, Stein River, Kwoiek Creek, Spuzzum Creek, Yale Creek, Gordon Creek, Emory Creek and American Creek.

Management issues and recommendations are provided for the Nahatlatch River and the Stein River watershed. Most of the smaller tributaries draining the Coastal Mountains (American Creek, Emory Creek, Gordon Creek, Yale Creek, Spuzzum Creek, Kwoiek River and Texas Creek) are generally steep and spawning/rearing habitat is typically limited to lower reaches. The management of resource development activities in these watersheds is largely dependent upon guidelines such as the Forest Practices Code and the Land Development Guidelines.

### **5.2.1 Nahatlatch River**

#### **5.2.1.1 Description**

The Nahatlatch River is the largest producer of salmon within the Middle Fraser HMA and produces sockeye, chinook, coho and pink salmon. The Nahatlatch River is a fourth order stream draining an area of 125,600 hectares. This system is glacial fed and flows in a southeasterly direction for approximately 83 kilometers to the Fraser River near Boston Bar. The three major lakes within the drainage are Nahatlatch Lake, Hannah Lake and Frances Lake (Fig 3). The upper river is comprised of meandering, pool-riffle habitat while the lower section of river below Frances Lake steepens into a rapid, run, pool complex and flows through a major canyon en route to the Fraser River (Hebden 1981).

The Nahatlatch watershed sustains a diverse mixture of resource values. The river supports many important fish species, most notable are the salmon, trout and char stocks that are either migratory or resident in nature. Wildlife values include mule deer, elk, black and grizzly bears, cougar, goats and a variety of other furbearing animals, birds, small mammals, amphibians and reptiles. A significant quantity of pine mushrooms are also produced in the Nahatlatch watershed. Overall, the presence of a wide variety of habitat, forest types and unroaded sub-drainages identify this area as having potentially high biological diversity. In addition to ecological attributes, commercial and public recreation in the lower Nahatlatch River has shown an increasing trend over that past decade. From an economic perspective, the Nahatlatch also has significant timber value as most of the remaining old growth timber in the Chilliwack Forest District is located here. In 1996, Mehatl Creek was designated as a park by the Protected Areas Strategy process.

The Nahatlatch River has been traditionally used by the Nlaka'pamux people for fishing, hunting, gathering and spiritual or ceremonial activities. Historical features include lakeshore camp sites, rock shelters along old trails, bark-stripped cedar trees and a lakeshore pictograph site (Deva

Consultants 1994). The Nahatlatch River continues to be an important river to the Nlaka'pamux Nation, particularly for the Boothroyd Band.

Forest harvesting is the primary resource development activity in the Nahatlatch Watershed and is managed through higher level planning initiatives such as the Nahatlatch Integrated Resource Planning group. Operational forest management activities are addressed through the five year forest development plan review process and onsite assessments when required.

### **5.2.1.2 Management Priorities and Recommendations**

**Management Priority #1: To minimize the impacts of forest harvesting on fish habitat, channel morphology and the natural hydrologic regime.**

In the Nahatlatch River, site specific impacts from forest development on fisheries values include narrow or non-existent riparian leave strips, channel bank erosion in areas where the riparian forest has been removed and subsequent aggradation and channel widening has occurred in downstream salmon spawning and rearing areas (NWH 1995). Additional site specific impacts include channel avulsion and increased sediment supply resulting from alluvial fans that have been destabilized from logging (NWH 1995). Although the total watershed area logged equals 2% for the entire watershed, forest harvesting has been concentrated in Log Creek, Kookipi Creek and the upper Nahatlatch River in rain on snow zones thereby having the potential to affect the natural hydrological regime. A Coastal Watershed Assessment Procedure (CWAP) is currently being conducted on Log Creek.

*Recommendation 1-1: MOF should prioritize Kookipi Creek for a CWAP in 1997 as requested by MELP (George pers. comm. 1996). DFO has suggested a CWAP should also include the upper Nahatlatch River at the sub-basin level.*

*Recommendation 1-2: Forest development guidelines developed by MELP and DFO as outlined in the Nahatlatch Riparian Management Plan should be implemented by MOF to assist in the protection of fish and fish habitat from resource development activities.*

*Recommendation 1-3: Conduct restoration prescriptions in the mainstem Nahatlatch River upstream of the cascades near the Mehatl/Nahatlatch confluence as outlined by NWH (1995).*

*Recommendation 1-4: Determine the current utilization by salmon species by implementing a more comprehensive adult and juvenile enumeration program.*

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## 5.2.2 Stein River

### 5.2.2.1 Description

The Stein River is a tributary to the Fraser and flows for 64 kilometers in an easterly direction before joining the Fraser 5.5 miles north of Lytton (Harding and Erickson 1974, Hebden 1981). The Stein is a medium sized river having a low flow of less than 30 cfs, a normal flow of between 100-200 cfs and a high flow of 1000-2000 cfs. The watershed encompasses an area of 108,400 hectares with glaciers and four lakes located in headwater areas (Rood and Hamilton 1995a, Hebden 1981). Rutledge Creek glaciers provide a major water source; glacial water makes the river very murky and cold all summer long with temperatures of 6.7 Celcius in September and 4 Celcius in April.

Coho, pink and chinook salmon as well as steelhead/rainbow trout, dolly varden, and rocky mountain whitefish are produced in the Stein River. Fish production in the Stein River is limited by the glacial waters, high flushing rate and lack of accessible tributaries to anadromous salmonids (Hebden 1981). The lower section is steep in gradient with rapids, chutes interspersed with holding pools. The middle section offers lower gradient habitat where spawning gravels, sloughs and side channels are common. The upper reach is steep in gradient and inaccessible to anadromous migrating salmonids due to an impassable barrier. Likewise, the tributaries of the Stein are steep in gradient and all with the exception of Rutledge Creek contain impassable barriers at or near their confluence with the Stein (Hebden 1981). Due to glacial nature of the Stein, the production of juveniles is concentrated in warmer, clearer waters found in side and back channels which are critical for fish production (Harding and Erickson 1974).

The Stein River is an undeveloped watershed with significant salmon values and has recently been designated as a park thereby requiring little management attention by DFO to protect fisheries values from resource development.

### 5.2.2.2 Management Priorities and Recommendations

**Management Priority #1: Utilize the Stein River as control watershed for research and monitoring projects that evaluate the impacts of resource development on fish and fish habitat.**

The Stein River is unique because it is a large unlogged watershed on the west side of the Fraser River. The undeveloped state of the Stein watershed will be longterm as it has recently been declared a park as part of the provincial Protected Areas Strategy.

*Management Recommendation #1: The lack of resource development in the Stein provides a opportunity to utilize the Stein as a control watershed when comparing the impacts of resource use in adjacent drainages.*

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*Management Recommendation #2: The Water Management Branch suggests that a WSC gauge would provide valuable information on the natural hydrologic regime for this region (Rood and Hamilton 1995a).*

### **5.2.3 Gordon Creek, Emory Creek, American Creek, Yale Creek, Spuzzum Creek, Texas Creek, and Kwoiek River**

#### **5.2.3.1 Description**

These streams are all located on the west side of the Fraser River and flow into the Fraser Canyon. They share similar hydrological, geomorphological and fisheries values and are therefore discussed collectively. In most of these systems, salmon spawning and rearing habitat is limited to the lowermost few hundred meters.

#### **5.2.3.2 Management Priorities and Recommendations**

**Management Priority #1: To maintain sufficient instream flows during summer and winter low flow periods.**

Salmon streams along the west side of the Fraser Valley between Hope and Spuzzum have flashy regimes and natural low summer and winter flows in relation to the mean annual flow. There is some potential for future increased water demand.

*Management Recommendation 1-1: Assess instream flow needs and regular monitoring of withdrawals to establish the actual and licensed demand. Low flow agreements, or restrictive licensing may be needed to maintain instream flows. An appropriate water management plan may need to be developed in conjunction with other agencies.*

**Management Priority #2: To protect salmon habitat values from downstream impacts of forestry development in the upper watershed.**

Known salmon values are concentrated in the lower reaches of Kwoiek River, Spuzzum Creek, Anderson River, Yale Creek, Gordon Creek, Emory Creek and American Creek.

*Management Recommendation 2-2: Apply the Forest Practices Code Riparian Management Guidelines and Fish Stream Identification guidelines to minimize the impacts of forest development activities on salmon habitat in downstream tributary reaches in the Fraser River mainstem.*

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**Management Priority #3: To protect known trout stocks and trout habitat in Kwoiek River.**

*Management Recommendation 3-1: The sportfishery for bull trout in Kwoiek Lake should be changed to a catch and release fishery for conservation purposes.*

*Management Recommendation 3-2: Remove the debris plug on Kwoiek Creek at the inlet to Kokwaskey Lake to improve spawning opportunities for rainbow trout.*

*Management Recommendation 3-3: Control siltation from slide areas and roads in the small tributary upstream of Kwoiek Lake (see Griffiths 1995a).*

### **5.3 Cascade Mountains**

Salmon streams within the Cascade Mountain Range include the Coquihalla River, Kawkawa Lake and the Anderson River.

#### **5.3.1 Coquihalla River**

##### **5.3.1.1 Description**

The Coquihalla River drains an area of 93,200 hectares and supports sockeye, chinook, pink, chum and steelhead salmon. A series of waterfalls at Othello limits the extent of anadromous salmonids with the exception of summer steelhead. During 1996, the lower obstruction was washed out during high flows when house sized boulders were dislodged (Caverhill pers. comm. 1997). The mainstem Coquihalla River is steep below the falls with average gradients of 5%. Although bedload transport is frequent, there is no evidence of long-term aggradation along the main channel (Rood and Hamilton 1995a).

##### **5.3.1.2 Management Priorities and Recommendations**

**Management Priority #1: To address encroachment, channelization and flooding problems in the lower Coquihalla River at Hope.**

Channel stability in the Coquihalla River has been evaluated by Rood and Hamilton (1995a). The lower Coquihalla River has been dyked and riprapped with encroachment by urban and linear development at several sites (Rood and Hamilton 1995a). Documented channel response identified by Rood and Hamilton (1995a) includes channel bank erosion as well as scour and sedimentation of bedload materials. A recent flood study indicates that existing dykes are inadequate for the 200 year flood. Various plans to manage floods and modify dykes are being considered (Rood and Hamilton 1995a)

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*Recommendation 1-1: Restrict further linear development to minimize negative impacts of linear development on fisheries values in the Coquihalla River valley.*

*Recommendation 1-2: Prevent further encroachment and channelization in the lower river by developing and implementing an all encompassing flood hazard management plan for the lower river adjacent to Hope rather than on a site by site basis.*

*Recommendation 1-3: Promote and implement the application of the Land Development Guidelines for urban development within the District of Hope.*

**Management Priority #2: To minimize the impacts of maintenance activities of linear development on steelhead habitat.**

Within the Coquihalla River watershed, linear development includes a 4 lane highway (Highway 5), Trans Mountain Pipeline, West Coast Energy gas pipeline and the B.C. Telephone lightguide (Reid and Johansen pers. comm. 1996). The presence of Highway 5 and gas/oil pipelines have resulted in permanent losses of fish habitat and require a constant process of maintenance and repair from flood damages, particularly in floodplain areas and/or at bridge sites. At this time, there are 13 bridge crossings and 6 pipeline crossings over the Coquihalla River (Caverhill pers. comm. 1997). Increased peak flows from forestry related activities exacerbate the impacts of flood flows. At this time, each company is responsible for the repair and maintenance of their development and work independently with no consideration of the downstream or upstream impacts.

*Recommendation 2-1: In order to minimize continual impact on fish habitat and permanent loss of riparian function, the repair and maintenance activities need to be coordinated amongst Ministry of Highways, Trans Mountain Pipeline, West Coast Energy, B.C. Tel and any other companies with linear development in the Coquihalla corridor. The coordinator would work with the linear development and forestry companies to minimize impacts on fish habitat and coordinate and monitor mitigative and resource development activities to ensure negative impacts on one another are minimized.*

*Recommendation 2-2: Mitigative activities in the mainstem Coquihalla should prioritize sites where floodplain habitat and bedrock controlled holding pools for steelhead can be restored.*

*Recommendation 2-3: The Coquihalla watershed has been identified by DFO and MELP as a high priority area for a review of the current state of the watershed and the cumulative impacts of resource development activities on fisheries resources at the Coquihalla Environmental Workshop in April 1995.*

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## 5.3.2 Kawkawa Creek

### 5.3.2.1 Description

The Kawkawa Creek watershed includes Kawkawa Creek downstream of Kawkawa Lake as well as four groundwater fed tributaries upstream of the lake. The Kawkawa system encompasses 900 hectares of low gradient habitat that produces coho, pink, chum and sockeye salmon. Sucker Creek is the main tributary draining the Ogilvie Mountains whereas flow in Kopp Creek, Steven Creek and Menz Creek are from a glaciofluvial aquifer to the east (Rood and Hamilton 1995a).

### 5.3.2.2 Management Priorities and Recommendations

**Management Priority #1: To minimize the impacts of urban development on water quality, water quantity and fish habitat.**

Residential development around the lake has impacted water quantity and quantity as well as fish habitat in Kawkawa Lake and tributaries (Rood and Hamilton 1995a). Flooding and erosion occurs in these channels as a result of sediment and debris deposition (Rood and Hamilton 1995a).

*Management Recommendation 1-1: Assess and evaluate the current and anticipated impacts of urban growth on salmon values. Promote the application of the Land Development Guidelines as a minimum.*

Despite stability of groundwater fed systems such as Kopp Creek and other small tributaries to Kawkawa Lake, small flows of less than 90 litres/second can be significantly affected by domestic waterworks licenses and development of groundwater wells.

*Management Recommendation 1-2: Further study of low flows in these small systems is needed, particularly the proportion of groundwater contributions should be researched. Further licensing of these streams should be opposed until the system has been studied in more detail (Rood and Hamilton 1995a).*

Menz Creek is being affected by the development of a gravel pit along the south margin of the watershed and is locally eroding sand and gravel deposits. (Rood and Hamilton 1995a).

*Management Recommendation 1-3: Determine the impacts of urban development and erosion problems on fish habitat in Menz Creek and implement mitigation measures if necessary.*

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### 5.3.3 Anderson River

#### 5.3.3.1 Description

The Anderson River watershed is 58,700 hectares and drains in a northwesterly direction into the Fraser River approximately 3 kilometers south of Boston Bar. The Anderson River drainage has 2 major tributaries; Uztilus Creek and the East Anderson River. Salmon values include coho salmon spawning to 4.8 kilometers during high water years and pink spawning as well as coho and chinook rearing in the lower river below the CN Rail bridge. The lower reach of the river where spawning occurs is flooded by the Fraser River during freshet when fine sediments and sand are constantly deposited. The Anderson River is considered to be unstable across its fan (Rood and Hamilton 1995a).

Forestry is the primary resource development activity in the Anderson River watershed and approximately 20% of the total basin area will be logged by 1997 (Rood and Hamilton 1995a). Impacts to fisheries values resulting from forestry activities include the removal of natural vegetation in the middle portion of the Anderson River watershed. This results in channel erosion, and in many reaches, cutblocks extend to the margins of the channel and riparian vegetation has been removed (Rood and Hamilton 1995a). In addition, landslides and road failures were reported after December flood conditions in 1980 (Rood and Hamilton 1995a).

#### 5.3.3.2 Management Priorities and Recommendations

##### **Management Priority #1: To assess the impacts of forest harvesting on fisheries values**

Forestry is a primary resource development concern in the Anderson River watershed. MELP is concerned with current rate of cut (George pers. comm. 1996). However, due to an overestimation in mature existing forested landbase by 23% during the Timber Supply Review process, MOF will be implementing a immediate reduction of 25% in the Annual Allowable Cut throughout the Chilliwack TSA. The reduction in the current rate of cut, in conjunction with spotted owl special resource management zones and deer winter range requirements, will assist in reducing the current rate of cut in the Anderson River (George pers. comm. 1996).

*Management Recommendation 1-1: MELP and DFO recommends a Coastal Watershed Assessment Procedure be conducted on the Anderson watershed.*

Two log jams located in the lower 3-4 kilometers of the Anderson River may be a possible barrier to migrating salmonids. Conversely, these log jams may be providing good fish habitat.

*Management Recommendation 1-2: Determine whether these log jams are creating fish passage problems and facilitate passage if necessary.*

## 5.4 Interior Plateau

The Interior Plateau region is located in the northern portion of the Middle Fraser HMA and includes Churn Creek, Williams Lake River, Narcosli Creek and Baker Creek. These systems are lower gradient streams with flat to gently rolling terrain.

### 5.4.1 Churn Creek

#### 5.4.1.1 Description

Churn Creek drains an area of 99,200 hectares and flows in an easterly direction, entering the Fraser River approximately 80 kilometers south of Williams Lake. Pink, sockeye and chinook salmon are produced in Churn Creek. The valley walls along lower Churn Creek are naturally unstable and contribute lacustrine sediments to the mainstem when they fail. Channel stability problems in lower Churn Creek include channel bank erosion and sedimentation of bedload materials (Rood and Hamilton 1995a). Most failures result from toe erosion during the spring freshet but erosion during occasional fall floods can reduce the survival of incubating pink salmon eggs (Rood and Hamilton 1995a).

Resource development activities in the Churn Creek watershed include forestry, agriculture and mining development. Forest development has been minimal (2.8% of total basin area) but an additional 10.2% of the total watershed area will be harvested by 1997. The majority of agricultural activities consist of open range grazing by the Gang Ranch which holds several water licenses on the upper river. However, flows in Churn Creek are not significantly affected by water consumption by the Gang Ranch (Rood and Hamilton 1995a).

#### 5.4.1.2 Management Priorities and Recommendations

**Management Priority #1: Assess the extent and impacts of placer mining and hard rock mining on water quality.**

Occasional increases in turbidity in Churn Creek may be associated with placer mining development (Lawrence pers. comm. 1995). The extent of the impacts of placer mining on water quality are currently unknown.

*Recommendation 1-1: Determine natural and resource development induced sources of turbidity in Churn Creek.*

The Black Dome Mine in the upper watershed has recently been purchased and may re-open (Rood and Hamilton 1995a). There are concerns regarding water quality problems and the stability of the tailing ponds in Fairless Creek.

*Management Recommendation 1-3: Determine the stability of the tailing ponds in Fairless Creek and develop mitigation strategies if necessary.*

**Management Priority #2: Determine the impacts of forestry development on fisheries values at the sub-basin level.**

The increasing rate of forest development in combination with naturally unstable soils, high sediment loads during the spring freshet and existing channel instability may have significant impacts to the fisheries resource.

*Management Recommendation 2-1: Assess the extent of forest development to 1997 on a sub-basin level through the application of the Watershed Assessment Procedure to determine whether the accelerated rate of cut may impact salmon values.*

*Management Recommendation 2-2: Develop a detailed riparian management plan for the Churn Creek watershed identifying areas requiring site specific prescriptions for forest development activities if required.*

*Management Recommendation 2-3: Conduct a overview reconnaissance to identify potential sources of stream sediments and determine if a detailed stream channel stability assessment is required.*

**Management Priority #3. Assess the effects of agricultural development on fisheries values**

*Management Recommendation 3-1: Assess the impacts of ranching on riparian areas and water quality. Develop a detailed riparian management plan for the Churn Creek watershed identifying areas requiring site specific prescriptions for agricultural activities if required.*

*Management Recommendation 3-2: Develop a water management plan that includes a determination of water demand, fisheries maintenance flows, water storage opportunities and the potential impacts of additional water extraction.*

## **5.4.2 Williams Lake River**

### **5.4.2.1 Description**

The Williams Lake River watershed is 224,000 hectares in area and includes two large lakes: Williams Lake and Lac La Hache. The Williams Lake River flows between the Fraser River and Williams Lake, and is known as the San Jose River between Williams Lake and Lac La Hache.

Anadromous use is mostly limited to pink salmon spawning in the lower reaches of the Williams Lake River near the Fraser River confluence. Below Williams Lake, the Williams Lake River flows in a gully which is mostly undeveloped but used for recreation purposes (Rood and

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Hamilton 1995a). The Rotary Club has removed garbage from the river and constructed trails along the river (Rood and Hamilton 1995a).

#### **5.4.2.2 Management Priorities and Recommendations**

**Management Priority #1:** Ensure agricultural activities maintain adequate summer stream flows for trout species upstream of Williams Lake.

Most of the water is extracted upstream of Williams Lake out of the San Jose River. The San Jose River is regulated by storage of Lac La Hache Lake, with long stretches of the river going dry during droughts (Rood and Hamilton 1995a). During the dry season there is no outflow from Williams Lake, causing much of the stream bed of the Williams Lake River to go dry and become anoxic. Flows in Williams Lake watershed are extremely variable in the late summer (Rood and Hamilton 1995a). During droughts, Knife Creek in the upper watershed continues to flow even though the San Jose River may be dry. Agricultural demand for water is high and the creek is fully recorded but a recent appeal may lead to the issuing of more licenses. Knife Creek is not used by salmon, but is considered an important trout stream (Rood and Hamilton 1995a)

*Management Recommendation 1-1: Very low flows in July and August are common in Williams Lake River system, despite significant storage development. Investigate the feasibility of improving summer flows by developing further storage or modifying the manner in which existing storage is managed. Monitor water withdrawals to determine actual versus licensed water use. Develop a Water Management Plan that includes a determination of water demand, base flows for fisheries values, water storage opportunities and potential impacts of water extraction.*

**Management Priority #2: Minimize the impacts of urban and agricultural development on riparian habitat.**

Significant areas of riparian habitat have been disturbed in the middle portion of the Williams Lake River and Knife Creek from urban and agricultural activities (Rood and Hamilton 1995a).

*Recommendation 2-1: Develop a detailed riparian management plan for the Williams Lake River watershed identifying areas that require site specific prescriptions to minimize the impacts of urban and agricultural development on fisheries values.*

**Management Priority #3: Restore access for anadromous fish species upstream of Williams Lake.**

A control structure operated by Ducks Unlimited at the outlet of Williams Lake has no provision for upstream fish passage.

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*Management Recommendation 3-1: Assess the feasibility of modifying the control structure at the outlet of Williams Lake to allow fish passage.*

**Management Priority #4: Minimize the impacts of agricultural and urban development on water quality.**

Overwintering of cattle and feedlots along the San Jose River are known to cause water quality problems (Rood and Hamilton 1995a). In the Williams Lake River, storm sewers discharge directly to the river and snow is dumped into the gully causing water quality problems (Rood and Hamilton 1995a). Leachates from landfill may also be affecting water quality in the lower river.

*Management Recommendation 4-1: DFO should investigate and monitor pollution sources that are degrading water quality in the San Jose River and in Williams Lake.*

*Management Recommendation 4-2: Apply the Land Development Guidelines to urban and industrial developments as a minimum.*

## **5.5 Chilcotin Plateau**

### **5.5.1 Narcosli Creek**

#### **5.5.1.1 Description**

Narcosli Creek encompasses an area of 170,000 hectares and flows north into the Fraser River approximately 10 kilometers downstream of Quesnel. Chinook spawners utilize the middle reaches while pink salmon spawn in the lower reaches of Narcosli Creek. The surrounding terrain is a flat to gently rolling plateau with a low resistance to change. Agriculture and forestry are the two primary resource development activities in this basin.

#### **5.5.1.2 Management Priorities and Recommendations**

**Management Priority #1: Minimize the impacts of agricultural development on water quality and riparian areas**

Agricultural activities extend throughout the watershed but are concentrated between Deserter Creek upstream to Twan creek. Riparian areas have been degraded from fording by cattle and other agricultural activities. Several large water licenses are issued but no water shortages or restrictions are evident.

*Management Recommendation 1-1: Continue implementation of a detailed Riparian Management Plan for the Narcosli watershed identifying areas requiring site specific prescriptions for agricultural activities.*

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*Management Recommendation 1-2: Address problems associated with the removal of riparian vegetation and bank de-stabilization from cattle fording and watering by constructing exclusion fencing and re-planting riparian areas. For immediate remedial action, riparian areas can be restored by slope stabilization with rock rip rap or tree revetments techniques.*

*Management Recommendation 1-3: In the long term, develop a Water Management Plan that includes a determination of water demand, base flows for fisheries values, water storage opportunities and potential impacts of water extraction and water temperature concerns. Further water withdrawals should be opposed until actual licensed demand is established and water management options are reviewed.*

**Management Priority #2: Assess the site specific and watershed based impacts of forestry development.**

By 1997, 16.3% of the total watershed area will be harvested in Narcosli Creek. MELP is concerned with logging practices in the upper watershed. DFO is concerned with the hydrologic impacts of logging in Deserter Creek where a watershed assessment is being conducted. To date, the impacts of forest harvesting on riparian habitat have not been assessed.

*Management Recommendation 2-1: Determine the current level of impacts from forestry activities on riparian habitat and ECA values at the sub-basin level in the Narcosli watershed from the Watershed Assessment that is currently underway. Develop site specific guidelines to protect fisheries values where necessary.*

## **5.5.2 Baker Creek**

### **5.5.2.1 Description**

The Baker Creek watershed drains an area of 157,000 hectares and flows into the Fraser River at Quesnel. Baker Creek supports chinook and pink salmon. The lower 6.9 kilometers from confluence to Pinnacles Provincial Park has been rated as high salmonid habitat value (Hickey and Trask 1994). Details on biophysical survey and habitat values rating for the lower river are available in Hickey and Trask (1994).

Urban development is the primary resource use that has affected fisheries values to date. The Baker Creek Enhancement Project is a community based process with the objective to enhance both the lower and upper reaches of the watershed using DFO streamkeeper's handbook (BCES 1994, 1996).

Forest development in Baker Creek will equal 14.6% of the total watershed area by 1997 (Rood and Hamilton 1995b). Some site specific impacts have been observed in riparian areas. The impacts of forestry activities on fisheries values are currently being assessed by the application of the Interior Watershed Assessment Procedure in the Baker Creek watershed. Agricultural

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activities occur throughout the watershed but no water shortages or restrictions have been reported (Rood and Hamilton 1995b).

### **5.5.2.2 Management Priorities and Recommendations**

#### **Management Priority #1: Rehabilitate the impacts of urban development on instream and riparian areas in the lower reaches of Baker Creek.**

Lower Baker Creek flows through Quesnel and has been altered by dyking and bank stabilization practices as well as the construction of pipeline crossings (Rood and Hamilton 1995b). DFO is primarily concerned with the impacts to riparian areas from urban development.

*Management Recommendation 1-1: Continue restoration of riparian areas through urban reaches of Baker Creek.*

*Management Recommendation 1-2: Support and expand the community project (Baker Creek Fisheries Enhancement Society) for a recreational park in the lower river to include restoration opportunities throughout the watershed. In addition, incorporate a minimum flow assessment and water management plan into the Baker Creek Enhancement Project.*

#### **Management Priority #2: Ensure that water withdrawal for agricultural activities does not create low flow problems for fish.**

There is potential for high September water use for irrigation when instream flow requirements are critical for salmon production.

*Management Recommendation 2-1: The Baker Creek Enhancement Community Project should develop a Water Management Plan (WMP) that includes a determination of base flows necessary to sustain fisheries values, water storage opportunities and potential impacts of agricultural and urban water extraction. The WMP should also include an assessment of high water temperature problems.*

*Management Recommendation 2-2: Determine actual licence demand and review water management options prior to approving new licenses.*

#### **Management Priority #3: To identify the impacts on urban, agricultural and forestry development on fisheries values.**

*Management Recommendation 3-1: Initiate a watershed inventory and assessment for the development of a Watershed Restoration Plan.*

*Management Recommendation 3-2: Implement a Water Drainage Management Plan for sensitive soils and stream crossings.*

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