San Juan and Gordon River Watersheds
Habitat Status Report

(Final)

Prepared For:

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EXECUTIVE SUMMARY

Canada's Wild Salmon Policy (WSP) was adopted in 2005 and has the overall goal to "restore and maintain healthy and diverse salmon populations and their habitats for the benefit and enjoyment of the people of Canada in perpetuity" (DFO 2005). Strategy 2 of the WSP involves the assessment of habitat status, and Step 1 of this assessment calls for a review available literature to document the characteristics and condition of habitat within a given Conservation Unit (CU). The purpose of this report was to provide a Strategy 2/Step 1 report summarizing the state of habitat within the San Juan and Gordon River Watersheds. The report will serve to provide guidance with respect to future restoration efforts by the San Juan Watershed Round Table. Specific objectives included: 1) summarize characteristics and condition of habitat in the study watersheds, 2) identify factors limiting fish production, and high value habitats needing protection, 3) select habitat indicators that can be used to monitor the ongoing status of habitat, 4) outline priorities for habitat protection, rehabilitation, or restoration, 5) outline data gaps in our ability to address the previous objectives.

The review drew upon a large number of reports made available by various members of the Round Table and collated and converted to digital format by the Pacheedaht First Nation. In addition, interviews were conducted with persons knowledgeable of the study watersheds. The characteristics and condition of habitat were summarized in terms of hillslope condition, riparian condition, channel condition, and estuarine condition. Following this, limiting and high value habitats were identified for each of the 5 Pacific salmon species. Wild Salmon Policy pressure and state indicators were selected that best address the issues identified with respect to habitat condition in the study watersheds. Lastly, recommendations were made as to the direction of future restoration efforts.

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ACKNOWLEDGEMENTS

The authors would like to acknowledge members of the San Juan Round Watershed Table for their input, comments, and background information that made this report possible. Special thanks to Margaret Wright of DFO, and the Pacheedaht First Nation for collating a vast selection of the background information and providing us with electronic copies. Thanks also to Helen and Jeff Jones and Maurice Tremblay for relating to us information based on a long history of involvement within the San Juan and Gordon Watersheds.

This report was funded by DFO's Wild Salmon Policy under the capable direction of Margaret Wright.

1. INTRODUCTION

Canada's policy for the conservation of wild pacific salmon was adopted in 2005. The overall goal of the Wild Salmon Policy (WSP) is to "restore and maintain healthy and diverse salmon populations and their habitats for the benefit and enjoyment of the people of Canada in perpetuity" (DFO 2005). The approach for achieving this goal includes 3 components: 1) safeguard the genetic diversity of wild Pacific salmon, 2) maintain habitat and ecosystem integrity, and 3) manage fisheries for sustainable benefits. The Policy is to be implemented through a set of 6 strategies, each with a series of action steps (see Table 1 in DFO 2005). Strategy 2 of the WSP involves the assessment of habitat status, and Step 1 of this assessment calls for a review available literature to document the characteristics and condition of habitat within a given Conservation Unit.

The purpose of this report was to compile an overview (Strategy 2, Step 1) on the characteristics and condition of fish habitat within the San Juan and Gordon River Watersheds. These 2 watersheds together encompass the Port of San Juan Chinook Conservation Unit. Other salmon species occurring within these watersheds include coho, pink, chum, and sockeye salmon, though each of these form only part of Conservation Units that encompass larger geographic areas than the study watersheds. The geographic boundaries of these larger conservation units can be viewed using DFO's online Mapster tool (http://www.pac.dfo-mpo.gc.ca/gis-sig/maps-cartes-eng.htm) and clicking the box for a given species under the conservation Unit layer.

The specific objectives of this overview report were as follows:

1. Use available literature and interviews with knowledgeable people to summarize the characteristics and condition of fish habitat within the San Juan and Gordon Watersheds.
2. Identify factors that are limiting fish production and high value habitats that are important to production and that may require protection.
3. Identify potential habitat indicators and benchmarks that can be used to monitor the status of fish habitat within these watershed over time.
4. Based on knowledge acquired, outline priorities for habitat protection, rehabilitation, and restoration. If possible, identify specific rehabilitation or restoration projects that target degraded key habitats.
5. Outline any data gaps with respect to our understanding of limiting or high value habitats.

Tasks undertaken to achieve the above objectives included the following:

- Acquire, review, and synthesize habitat information for the study watersheds.
- Expand and update information in the literature through interviews with persons knowledgeable of the study watersheds.

- Complete the Habitat Status Template Tables (Excel spreadsheet) provided by DFO for each of the 5 species of Pacific salmon.
- Prepare a report (this document) that lists sources of information and summarizes findings in terms of the 5 objectives listed above.

2. BACKGROUND

2.1 Study Area

The San Juan Watershed is located in south-western Vancouver Island approximately 75 km west of Victoria (Figure 1). The San Juan River originates in the Seymour Ranges and flows in a south-westerly direction to empty into the southeast corner of Port San Juan adjacent to the town of Port Renfrew. The watershed has a drainage area of 670 km^2, mainstem length of 60 km, and mean annual discharge of 48.7 m^3/s[1]. The most significant tributaries in the watershed include Renfrew (Granite), Harris, Lens, and Fleet Creeks. There are a number of small lakes on the system including Fairy Lake (32 ha), Lizard Lake (8 ha), Pixie Lake (5.8 ha), Dimple Lake (3.5 ha), Doe Lake (2 ha), and Maid Lake (13 ha).

The Gordon River Watershed is located to the north and adjacent to the San Juan Watershed. Its headwater are located in the highlands south of Lake Cowichan and it flows in a southerly direction to empty into northeast corner of Port San Juan. The Gordon Watershed has a drainage area of 308 km^2 and mainstem length of 50 km. There is no Water Survey Canada gauging station on the Gordon River, however, Lightly et al. (1997) estimated the mean annual discharge to be 28.5 m^3/s based on discharge records from 6 other gauged rivers on the west coast of Vancouver Island. The most significant tributaries in the watershed include Braden, Bugaboo, Loup, and Hauk/Hinne Creeks. There are 2 small lakes in the watershed located in the headwaters of Baird Creek (area 5.5 ha) and a small unnamed creek on river right 3.2 km above the Baird Creek confluence (area 8.6 ha).

[1] Watershed areas and mainstem lengths were based on the Provincial Watershed Atlas GIS database files downloaded and queried in ArcView. Mean annual discharge was from Water Survey Canada (2011).

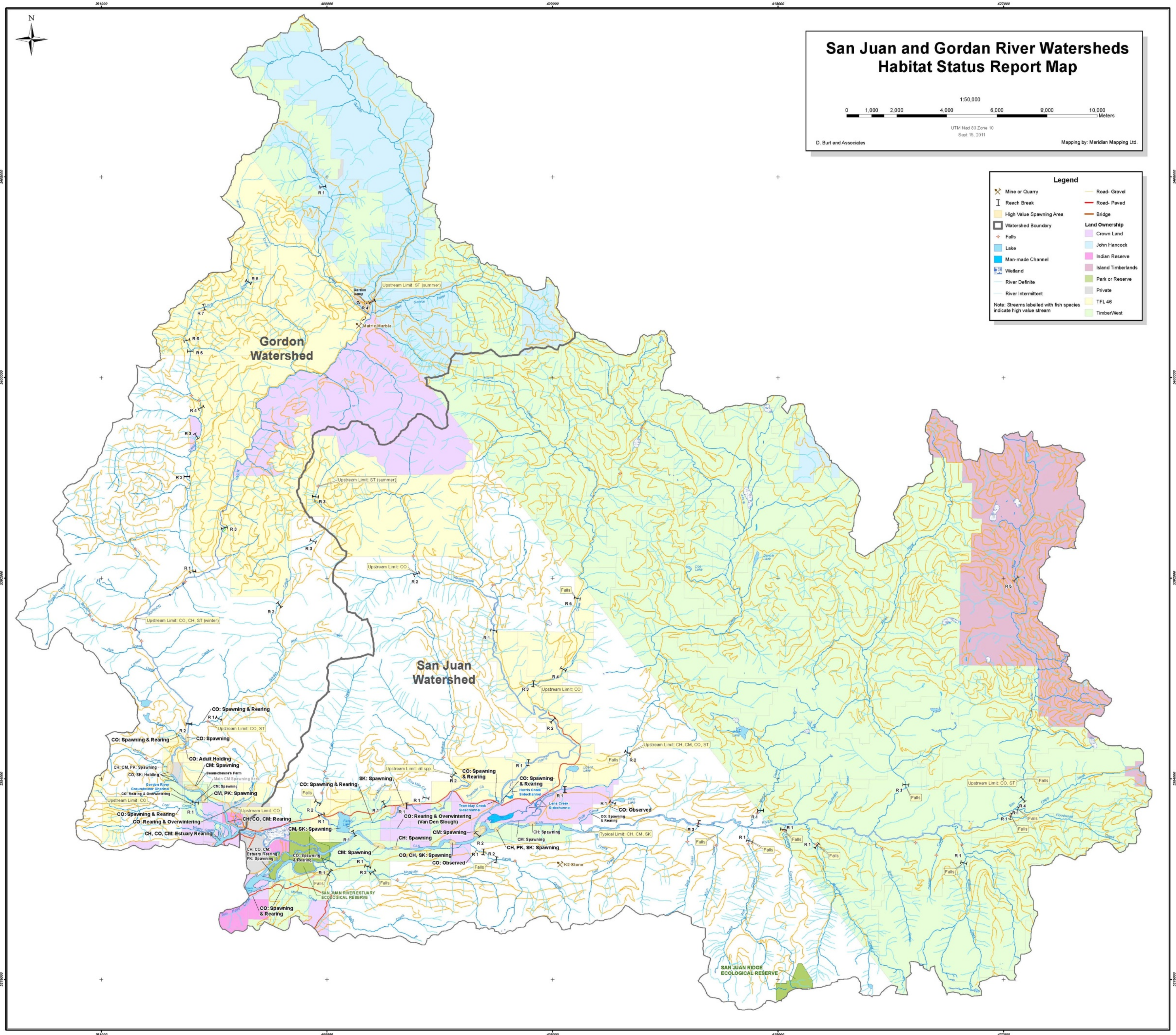

Figure 1. Map of the San Juan and Gordon River Watersheds. Note: this is a reduced version of the large format (38 x 33 in.) map produced for this project.

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2.2 Land Ownership

Land ownership within the San Juan and Gordon Watersheds is illustrated in Figure 1 while Table 1 summarizes the area (hectares) occupied by each land owner. Roughly 98% of the San Juan Watershed and 99% of the Gordon Watershed is managed for forest harvest.

Table 1. Summary of land ownership in the San Juan and Gordon Watersheds.

Owner	Area (hectares)	Percent of Total Area
San Juan Watershed		
TimberWest Forest Corp. (Managed Forest Unit, Private Land)	34,310.52	51%
TFL 46 (Crown, managed by Teal-Jones Group)	15,604.61	23%
Crown Land (Small Business Forest Enterprise Program)	11,943.95	18%
Island Timberlands (Managed Forest Unit, Private Land)	4,158.23	6%
Private	551.89	0.8%
John Hancock Mutual Life Insurance (Managed Forest Unit, Private Land)	243.34	0.4%
Park	270.63	0.4%
Indian Reserve	169.15	0.3%
Total	**67,252.32**	
Gordon Watershed		
TFL 46 and Timber Licence T0910 (Crown, managed by Teal-Jones Group)	16,668.48	54%
Crown Land (Small Business Forest Enterprise Program)	5,457.03	18%
John Hancock Mutual Life Insurance (Managed Forest Unit, Private Land)	5,303.68	17%
TimberWest Forest Corp. (Managed Forest Unit, Private Land)	3,165.46	10%
Private	146.42	0.5%
Indian Reserve	49.07	0.2%
Total	**30,790.14**	

Note: data provided courtesy of TimberWest GIS department

2.3 Fish Species, Distribution, and Relative Abundance

Common and scientific names of salmonid and non-salmonid fish species occurring in the San Juan and Gordon Watersheds are provided in Table 2. In terms of Pacific salmon, all 5 species are found in the study watersheds (chinook, coho, pink, chum, and sockeye salmon), however, at present, only chinook, coho, and chum occur as major runs in the San Juan watershed, and only coho in the Gordon Watershed. Trout species occurring in these watersheds include summer and winter run steelhead, their resident counterpart (rainbow trout), as well as sea-run and resident cutthroat trout. Char are also found in select locations and include Dolly Varden char, and an introduced population of brook trout (*Salvelinus fontinalis*) in upper Lens Creek (Harding et al. 1996).

Table 2. Fish species reported to occur in the San Juan and Gordon Watersheds (note: larger bullets indicate major runs).

Common Name	Abbreviation	Scientific Name	Comments	San Juan	Gordon
Anadromous Salmonids:					
Chinook Salmon	CH	*Oncorhynchus tshawytscha*		●	•
Coho Salmon	CO	*Oncorhynchus kisutch*		●	●
Pink Salmon	PK	*Oncorhynchus gorbuscha*		•	•
Chum Salmon	CM	*Oncorhynchus keta*		•	•
Sockeye Salmon	SK	*Oncorhynchus nerka*		•	•
Steelhead Trout	ST	*Oncorhynchus mykiss*	Anadromous form of *O. mykiss*	•	●
Sea-run Cutthroat Trout	ACT	*Oncorhynchus clarki*	Anadromous form of *O. clarki*	•	•
Resident Salmonids:					
Rainbow Trout	RB	*Oncorhynchus mykiss*	Resident form of *O. mykiss*	•	•
Cutthroat Trout	CT	*Oncorhynchus clarki*	Resident form of *O. clarki*	•	•
Dolly Varden	DV	*Salvelinus malma*	Resident char spp.	•	•
Brook Trout	EB	*Salvelinus fontinalis*	Introduced spp., upper Lens Creek only	•	
Non-Salmonids:					
Coastrange Sculpin	CAL	*Cottus aleuticus*	Resident in fresh and brackish waters	•	?
Prickly Sculpin	CAS	*Cottus asper*		•	•
Threespine Stickleback	TSB	*Gasterosteus aculeatus*	Fresh, brackish, and marine waters	•	•
Lamprey (spp. uncertain)	L	*Lampetra spp.*		•	•
Green Sturgeon	GSG	*Acipenser medirostris*	Tidal regions of lower river	•	•

References:
Burns (1979)
Harding et al. (1996)
Helen and Jeff Jones (Pacheedaht First Nation, pers. comm.)
Lightly et al. (1997)

Though the focus of this document is on the 5 species of Pacific salmon managed by DFO, it should be noted that the study watersheds support significant and highly valued populations of trout, which are managed by the Province of BC. For an overview on trout species the reader is asked to consult EBA (EBA 2001a, b). The following paragraphs provide a synopsis of the distribution and stock status of the 5 Pacific salmon species. Distributions are also given in terms of upstream limits of adult migration in Figure 1.

Chinook Salmon

FISS records indicated that chinook salmon spawn in the San Juan and Gordon Rivers from mid September to the end of November (MOE 2011). Local knowledge places peak spawning from the last week in September to the first week in October (Maurice Tremblay, San Juan Enhancement Society, pers. comm.). This is consistent with Holtby and Ciruna (2007) who, using DFO's SEDS database determined that mean spawning "day of year" for these stocks is day 270.9 (September 29). This was about 29 days earlier than other chinook stocks south of Nootka Sound, and this timing, along with genetic structure was used to separate the San Juan/Gordon River chinook stock into a separate conservation unit (Port San Juan Chinook Conservation Unit).

The general consensus in the literature is that Port San Juan chinook exhibit an ocean-type life history, i.e., juveniles smolt during the spring or early summer following emergence (as opposed to stream-type juveniles which spend at least one winter in freshwater before smolting) (Harding et al. 1996, Lightly et al. 1997, Maurice Tremblay, San Juan Enhancement Society, pers. comm.). The duration of freshwater rearing by ocean-type chinook can vary from hours to up to 3 months (Healey 1991), however, there are only limited data on the duration of freshwater rearing by Port San Juan chinook. Capture of downstream migrants by rotary screw trap upstream of the Fairy Lake outlet indicated a high incidence of fry in the 50-60 mm size range, indicating that some juveniles underwent initial rearing in the river followed by migration to the lower river tidal reaches (Maurice Tremblay, San Juan Enhancement Society, pers. comm.). Larger sized fish were believed to avoid the trap so this monitoring did not provide insight on chinook that may have remained in the river until smolting. Heavy use by chinook juveniles has been observed in the various channels in the tidal and estuarine sections of lower river so this area is undoubtedly an important rearing zone for juvenile chinook. Seining at various sites in the estuary in 2001 indicated that juveniles remained in this area until mid August (Helen Jones, Pacheedaht First Nation, pers. comm.). To add to the variance of Port San Juan chinook life history, there is evidence of occasional occurrence of stream-type juveniles. This includes the finding of 1^+ juveniles in Lens Creek Sidechannel of the San Juan system, and in minnow trap captures in the mainstem Gordon River below Grierson Creek (Helen and Jeff Jones, Pacheedaht First Nation, pers. comm.).

The FISS database indicates an historic distribution for chinook that includes the San Juan mainstem up to Sam Creek (22.2 km), in Harris Creek from its mouth to a point 22.2 km upstream, and in the lower 550 m of Hemmingsen Creek. Actual upstream limit in Harris Creek is more likely to be to the top of Reach 3 (11.7 km) since this is the upstream limit for coho and steelhead. Local knowledge indicates that chinook also occur in a 1.1 km section of lower Renfrew Creek upstream of

Fairy Lake (Helen and Jeff Jones, Pacheedaht First Nation, pers. comm.). For the Gordon River, the FISS records indicate a distribution extending from the mouth to the Bugaboo Creek confluence (11.9 km), and in Bugaboo Creek up to a 6 m falls located 340 m above the confluence.

Annual escapements of chinook salmon to the San Juan and Gordon Rivers since 1954 are shown in Figures 2 and 3, respectively (Chart A). In the case of the San Juan, annual returns have improved from the low numbers that began in the mid 1970's and continued to the early 1990's. Over the past 12 years (1999–2010), the San Juan escapement has ranged from 420 to 4,515 and averaged 1,726 fish (Figure 2, Chart A). In the case of the Gordon River, chinook returns diminished from an average of 570 fish during the 1960's and early 70's and have remained low since that time. Currently, the average for 1999 to 2010 is 55 fish (Figure 3, note: no data for 2003–2007 and 2010).

Coho

Genetic analysis summarized in Holtby and Ciruna (2007) resulted in placement of San Juan and Gordon River coho stocks in the Juan de Fuca-Pachena Conservation Unit (JdF Coho CU). This CU extends from the southern edge of Barkley Sound to immediately north of the Jordan River. The FISS database indicates that San Juan and Gordon River coho spawn from mid September to mid January (MOE 2011). Holtby and Ciruna (2007) found that peak spawning of coho stocks within the JdF CU was day 314.7, which equates to November 12. However, local knowledge suggests that there may be two runs of coho to the San Juan and Gordon systems: an early run of smaller fish (average ~ 11 lbs) that arrives in the estuary in late August to early September, and a later run of larger fish (average ~ 18 lbs) that arrives around the third week of September (Helen Jones, Pacheedaht First Nation, pers. comm.). In support of this, snorkel surveys in the San Juan system have observed a large component of smaller coloured coho spawning in Harris Creek in October among silver bright larger coho that are still holding in pools. This suggests that some of these early run coho use the Harris system and spawn earlier than indicated by Holtby and Ciruna.

Most coho in the study watersheds exhibit a freshwater life history typical of southern Vancouver Island, that is, they emerge from the gravel in the spring and rear for one year in freshwater (or in the estuary) before smolting as a 1^+ fish the following spring. Heavy use of the estuarine section was confirmed by a 2001 seining program which found substantial numbers of coho fry in this area throughout the sampling period (April 25 – September 11) (Helen Jones, Pacheedaht First Nation, pers. comm.). There is also some evidence that a small percentage of fish remain in the system for an extra year and smolt in the second spring as 2^+ fish (e.g., Ship Environmental Consultants (1986) found 1^+ coho at sites in the estuary and in Renfrew Creek in September 1985).

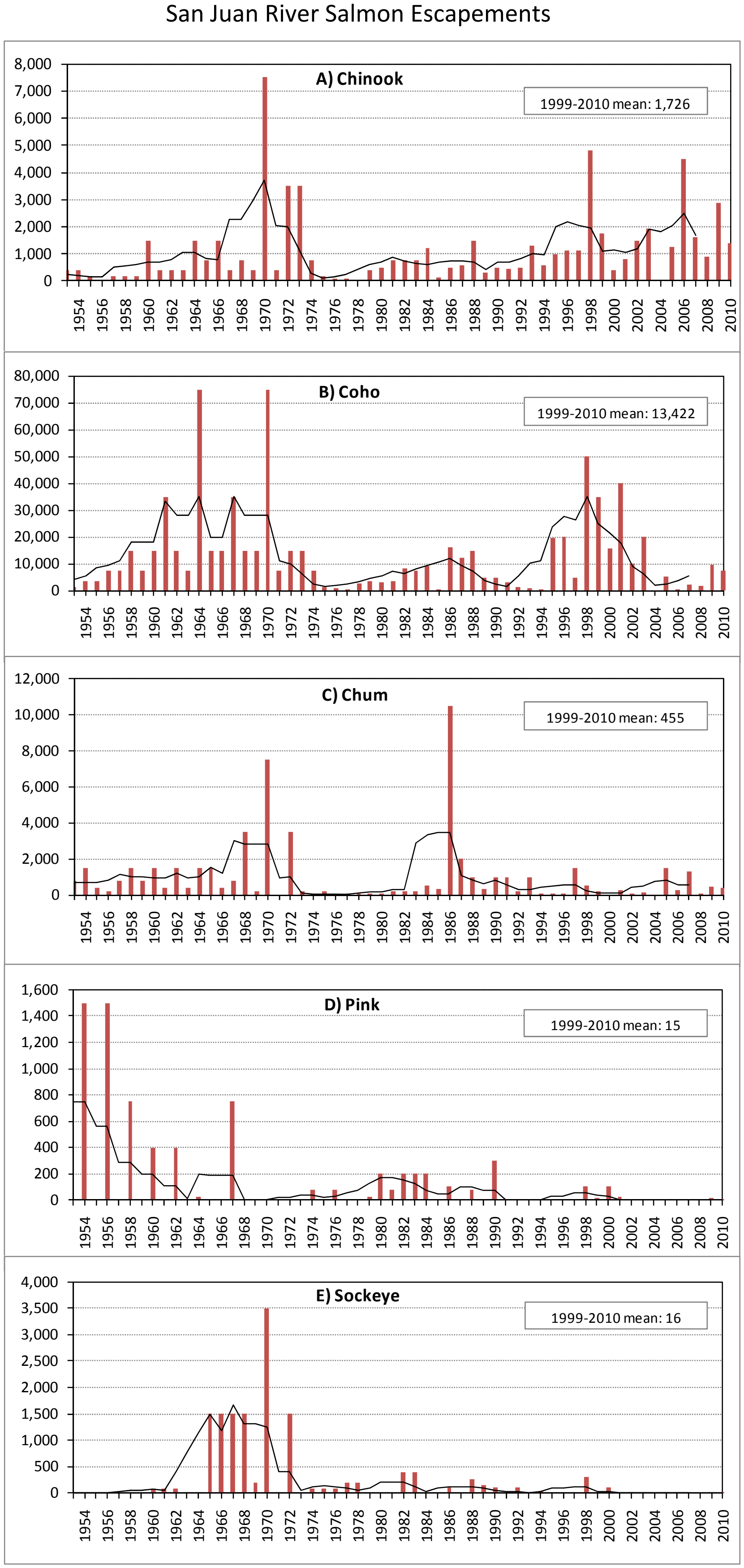

Figure 2. Annual salmon escapement estimates and 4-year moving averages for the San Juan River. Source: DFO nuSEDS online database (DFO 2011).

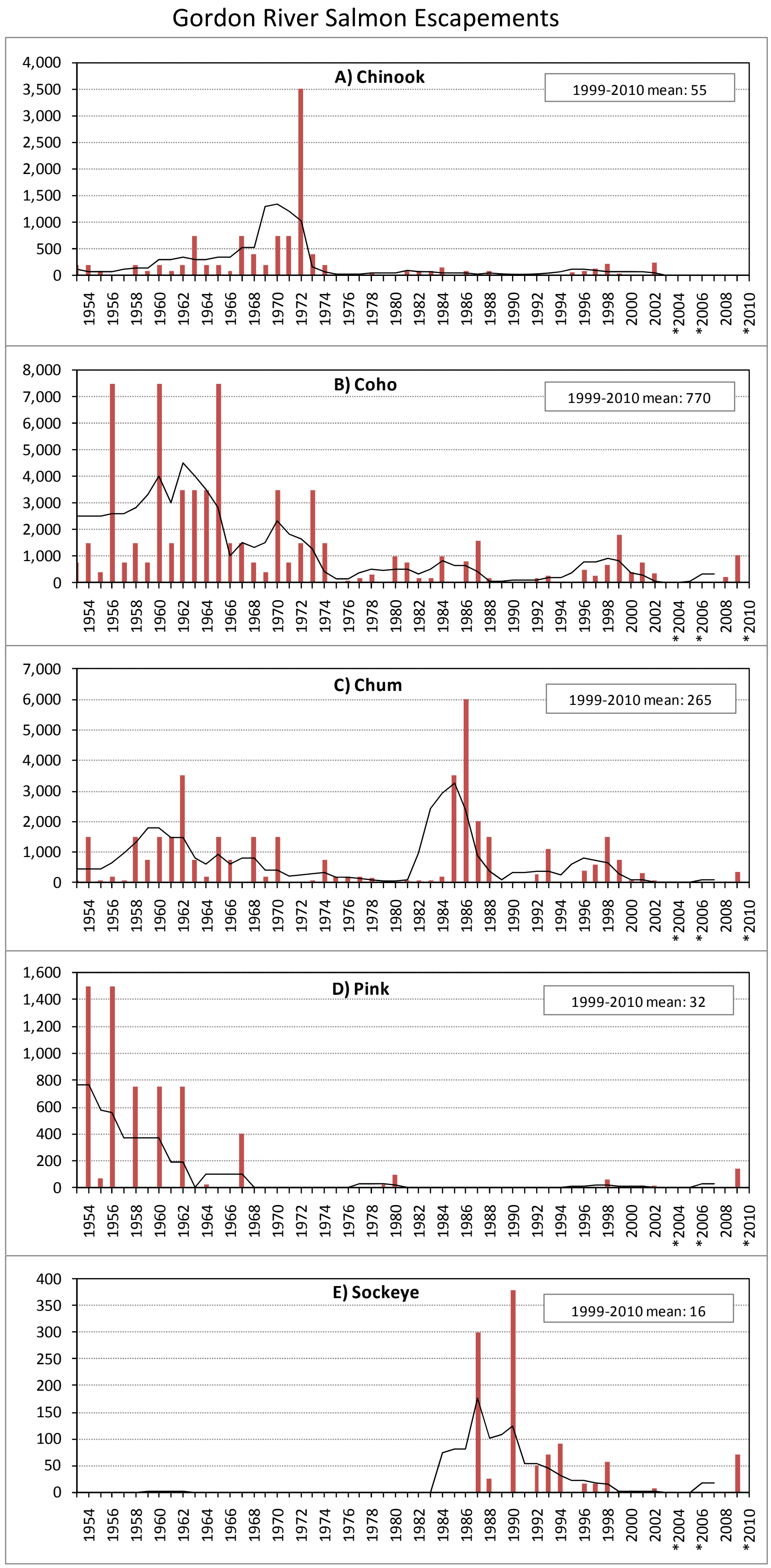

Figure 3. Annual salmon escapement estimates and 4-year moving averages for the Gordon River. Source: DFO nuSEDS online database (DFO 2011). Note: the stream was not inspected or there were no data for years 2003–2007 and 2010.

The historic distribution of coho spawning and rearing reported in the FISS database for the San Juan Watershed includes the mainstem to the Williams Creek confluence (33.8 km), Fleet River (2.8 km), Lens Creek (6.3 km), Harris River (22.2 km), Hemmingsen River (11.2 km), Renfrew Creek (8.3 km), as well as another 11 smaller tributaries. Some modifications to this distribution are probably warranted. In the Harris system, Bocking (2000) placed the upstream limit for coho at the top of Reach 3 and in Hemmingsen at the top of Reach 2. Within the San Juan mainstem, the upstream limit is probably not at Williams Creek but at an 8 m falls located approximately 4.5 km further upstream (Mike McCulloch, MOE and Dave Lindsay, TimberWest, pers. comm.). In the Gordon system, the database shows an historic distribution that includes the mainstem up to the Hauk Creek confluence (32.0 km), the lower 8.4 km of Loup Creek, 1.1 km of an unnamed Loup Creek tributary, and the lower 334 m of Bugaboo Creek. This appears to be an overly optimistic mainstem distribution in that in most years adult coho are restricted to Bugaboo Falls located 450 m upstream of the Bugaboo Creek confluence (Burt and Madsen 1996, Lightly et al. 1997).

Annual escapements of coho salmon to the San Juan and Gordon Rivers since 1954 are shown in Figures 2 and 3, respectively (Chart B). Escapements to the San Juan show 3 modes during the period of record with the latest mode spanning 1995 to 2003 and peaking at 50,000 fish in 1998. Currently, escapements appear to be in a low period though there may be evidence of an improving trend in the 2009 and 2010 numbers. Over the past 12 years (1999–2010), the San Juan escapement has averaged 13,422 fish (Figure 2, Chart B). In the case of the Gordon River, coho returns were strongest during the 1950s to early 1970's (average 2,500) but have remained comparatively lower since that time. Currently, the average for 1999 to 2010 is 770 fish (Figure 3, Chart B, note: there was no data for 2003–2007 and 2010).

Chum

Holtby and Ciruna (2007) classified West Coast Vancouver Island chum populations from Brooks Peninsula south to Sheringham Point (which includes San Juan and Gordon River chum) as one large conservation unit called the Southwest Vancouver Island Chum Conservation Unit (SWVI Chum CU). The FISS database indicates that San Juan and Gordon River chum spawn from mid October to the end of November (MOE 2011). Holtby and Ciruna (2007) determined that the average day of peak spawning for the SWVI Chum CU is day 300.6, which equates to October 29. Local knowledge concurs with this timing and places peak spawning in late October (Helen and Jeff Jones, Pacheedaht First Nation, pers. comm.). In addition to the fall run described above, local knowledge indicates that both the San Juan and Gordon Rivers support a small annual return of summer-run chum (10–15 fish per year in each river). These fish enter the rivers in August and spawning has been observed in mid August (Maurice Tremblay, San Juan Enhancement Society, pers. comm.). This may suggest a remnant population similar to the US summer-run chum of the Hood Canal and Juan de Fuca Strait (discussed in Holtby and Ciruna 2007).

Holtby and Ciruna (2007) reported that chum salmon fry typically migrate to the estuary soon after emergence and that they remain in the estuary or near-shore for their first summer before moving offshore. Data from the 2001 seining in the San Juan Estuary suggest that chum fry arrive in the estuary in late April and move offshore by early June (Helen Jones, Pacheedaht First Nation, pers. comm.).

The FISS database indicates that chum salmon occur in the San Juan mainstem as far upstream as the Sam Creek confluence (22.2 km), in the lower sections of the following creeks: Lens Creek (2.5 km), Harris Creek (1.8 km), Renfrew Creek (7.3 km[2]), Four Mile Creek (400 m), and Fairy Creek (780 m). Local knowledge suggests that the upstream limit in the San Juan mainstem is up to Pixie Creek in most years as opposed to the Sam Creek confluence (Helen and Jeff Jones, Pacheedaht First Nation and Mike McCulloch, MOE, pers. comm.). In the Gordon system, the FISS only reports a distribution up to just beyond the Coal Creek confluence (2.7 km), however, local knowledge shows that spawning occurs up the just above the Grierson Creek confluence (Helen and Jeff Jones, Pacheedaht First Nation, pers. comm. of the mainstem).

Annual escapements of chum salmon to the San Juan and Gordon Rivers since 1954 are shown in Figures 2 and 3, respectively (Chart C). Escapements to the San Juan have generally been ≤ 1,500 fish for the period of record with 4 years where escapements exceeded 2,000 fish (Figure 2, Chart C). The average for the last 12 years (1999–2010) is 455 fish. In the case of the Gordon River, chum returns have declined since about the year 2000. The average for the past 12 years is 265 fish, though it is important to note that no counts were completed for years 2003–2007 and 2010 (Figure 3, Chart C).

Pink

Pink salmon have a fixed two-year life cycle and as a result, there is reproductive isolation of odd and even-year runs (Heard 1991). This led Holtby and Ciruna (2007) to classify pink salmon populations between Brooks Peninsula to just North of the Jordan River as two distinct conservations units: West Vancouver Island Odd-Year Pink CU (WVI PKO CU), and West Vancouver Island Even-year Pink CU (WVI PKE CU). In the case of San Juan and Gordon River pink salmon, the even-year pink run is the dominant population. The FISS database indicates that San Juan and Gordon River pink adults enter the river from late August to early September but no period is given for spawning (MOE 2011). Holtby and Ciruna (2007) calculated that the average day of peak spawning for the WVI Pink CU (odd and even years combined) is day 268.3, which equates to September 26.

Pink salmon emerge from the gravel in the spring and migrate directly to the estuary. Unlike chum fry which rely heavily on estuaries for juvenile rearing, pink fry generally move through the estuary fairly quickly to marine habitats along the coastline (Heard 1991).

The FISS database shows an historic distribution limited to the lower 8.2 km of the San Juan mainstem while no distribution is given for the Gordon River. Local knowledge, however, indicates that pink salmon occur in the San Juan mainstem up to mid way between Harris and Lens Creek

[2] The distribution in Renfrew Creek was reduced from 8.2 km down to 7.3 km due to identification of an anadromous barrier at this point by Griffith (1997a).

confluences (an additional 4.8 km), and in the Gordon River up to just beyond the Grierson Creek confluence (5.3 km) (Helen and Jeff Jones, Pacheedaht First Nation, pers. comm.).

Annual escapement of pink salmon to the San Juan and Gordon Rivers since 1954 are shown in Figures 2 and 3, respectively (Chart D). In both rivers the even-year run has been the dominant return. In the case of the San Juan, escapements declined after 1967 and have been particularly low since 1991. The mean for the last 12 years (1999–2010) is only 15 fish (Figure 2, Chart D). Pink escapements to the Gordon River have followed a similar pattern with a decline to very low levels after 1967. The average for the last 12 years is 32 fish (Figure 3, Chart D) but even this is inflated due to lack of data for 2003–2007, 2010 combined with a comparatively higher escapement of 140 fish in 2009. The true average for recent years is more comparable to the San Juan (15 fish).

Sockeye

The San Juan and Gordon Rivers both support a small run of river-type sockeye (those that spawn in streams), while the San Juan also supports a small run of lake-type sockeye that spawns in Fairy Lake. For river-type sockeye, Holtby and Ciruna (2007) grouped all stocks from Brooks Peninsula to the southwest tip of Vancouver Island into one conservation unit called West Coast Vancouver Island Sockeye-River Conservation Unit (WCVI SK-River CU), thus river-type sockeye of the San Juan and Gordon Rivers belong to this CU. For most lake-type sockeye in BC, genetic studies led Holtby and Ciruna (2007) to designated individual lakes as the conservation unit. Thus, sockeye stocks spawning in Fairy Lake were designated Fairy L_13_07 Sockeye-Lake CU.

The FISS database indicates a sockeye distribution in the San Juan system that includes the mainstem from the mouth to the Harris Creek confluence (12.1 km), in the first 780 m of Fairy Creek, and the lower 7.3 km of Renfrew Creek. Local knowledge, however, extends their distribution in the mainstem to mid way between Harris and Lens Creek confluences (an additional 1 km), and decreases their distribution in Renfrew Creek to the top of Reach 2 (1.3 km less than indicated by the FISS) (Helen and Jeff Jones, Pacheedaht First Nation and Dave Lindsay, TimberWest, pers. comm.). In terms of the lake-type stocks, spawning has been observed around the perimeter of Fairy Lake where there is upwelling (Maurice Tremblay, San Juan Enhancement Society, pers. comm.). With respect to the Gordon River, the FISS database provides no account of sockeye distribution in this system though escapement records indicate their occurrence, and spawners have been observed as far upstream as the Grierson Creek confluence (Helen and Jeff Jones, Pacheedaht First Nation, pers. comm.).

The FISS database indicates that San Juan sockeye spawn from June to the end of October (MOE 2011). Holtby and Ciruna (2007) calculated that the average day of spawning for the WVI Sockeye-River CU is day 292.4, which equates to October 20. For lake-type sockeye in the West Vancouver Island Joint Adaptive Zone (WVI+WVI JAZ), the mean day of spawning is 265.2 which equates to September 23. Local knowledge indicates that sockeye enter the tidal sections of the San Juan and Gordon Rivers in May, hold for a period in these areas, and spawn from roughly mid

September to late October (Maurice Tremblay, San Juan Enhancement Society and Helen and Jeff Jones, Pacheedaht First Nation, pers. comm.).

We found little specific information on the duration of sockeye fry rearing in the San Juan and Gordon systems following emergence. Burgner (1991) indicated that the typical pattern for lake-type sockeye is to rear for one year in the lake before smolting the following spring. However, in the case of Fairy Lake, gill netting in May 1981 (FISS database) and in August 1996 (Griffith 1997b) failed to capture juvenile sockeye. In addition, water temperatures in Fairy Lake get quite high in the summer (≥ 24°C, Maurice Tremblay, San Juan Enhancement Society, pers. comm.) and given the shallowness of the lake there is unlikely to be a cold water refuge zone at depth. Thus, it is possible that progeny from Fairy Lake spawners leave the lake at the onset of high water temperatures and adopt a river-type rearing strategy. For river-type sockeye, Burgner (1991) indicated that nursery locations are highly varied, with some migrating to the estuary soon after emergence, others remaining in the river for a period of time but still emigrating to sea in their first year, and still others overwintering in spring-fed sites, sidechannels, or sloughs before migrating to the ocean the following spring.

Annual escapement of Sockeye salmon to the San Juan and Gordon Rivers since 1954 are shown in Figures 2 and 3, respectively (Chart E). In the case of the San Juan, escapements have been very low since 1973 with a mean of only 16 fish for the last 12 years (Figure 2, Chart E). For the Gordon River, escapement trends are uncertain as counts were not made in most years up to 1987. Initial counts peaked at 380 fish but have since declined to a current 12-year average of 16 fish. The 2009 counts was somewhat better at 70 fish (Figure 3, Chart E).

3. DATA COLLECTION METHODS

In order to describe the condition of habitat in the San Juan and Gordon River watersheds, existing literature was acquired, online datasets were accessed, and interviews were conducted with persons knowledgeable of the watersheds. The majority of references were obtained from documents supplied by members of San Juan Round Table. These had been previously retrieved, organized, and scanned to pdf in a recent project conducted by the Pacheedaht First Nation, copies of which were supplied to us through Helen Jones. In addition, references were sought through the Ministry of Environment and Ministry of Forests libraries, the Department of Fisheries and Oceans, TimberWest and the Pacheedaht Nation. The internet search involved accessing EcoCat, FISS and Mapster online databases.

Further information was obtained through personal interviews with individuals who possessed knowledge of the study watersheds through related work experience in the Port Renfrew area. Persons interviewed are shown in Table 3 while interview questions can be found in Appendix A.

Table 3. List of persons interviewed for supplemental information.

Name	Company	Date	Location	Contact Number
Mike McCulloch	BC Ministry of Environment	February 21	MOE office, Nanaimo	250.751.3156
Tom Rutherford	BC Conservation Foundation	February 24	Duncan DFO office	250.746.9372
Bob Gallaugher	Sport Fish Advisory Board	February 24	Duncan DFO office	250. 746.5469
Brad Rushton	DFO, Habitat Management	February 24	Duncan DFO office	250.746.9717
Dave Lindsay	TimberWest	February 25	TimberWest office, Nanaimo	250. 729.3775
Mike Wright	MC Wright and Associates	March 8	Nanaimo	250.753.1055
Helen Jones	Pacheedaht First Nation	March 16	Port Renfrew	250.647.5521
Jeff Jones	Pacheedaht First Nation	March 16	Port Renfrew	250.647.5521
Maurice Tremblay	San Juan Enhancement Soc.	March 16	Port Renfrew	250.647.5568
Erika Blake	DFO, Community Advisor	March 29	Duncan	250.746.5137

Detailed habitat status information was extracted from the references obtained, with priority given to the most recent and comprehensive studies. Relevant information was used to populate a Habitat Status Table (Excel spreadsheet) supplied by DFO. In order to conform to this spreadsheet, the data were synthesized and condensed by life stage for each salmon species (chinook, coho, chum, pink, and sockeye salmon). Data gaps were identified where pertinent information could not be located by either literature review or personal communications. The Habitat Status Tables were modified slightly from the original template and included the following header topics:

- Possible limiting factors
- Known high value habitats
- Performance indicators for known limiting factors
- Performance indicators status
- Information gaps
- Possible measures to address limiting factors
- Possible measures to maintain productivity
- Habitat protection and restoration measures undertaken

As outlined in the report *Canada's Policy for Conservation of Wild Pacific Salmon: Stream, Lake and Estuarine Habitat Indicators* (Stalberg et al. 2009), habitat pressure and state indicators relevant to the San Juan and Gordon River watersheds were identified and incorporated into the spreadsheet (under performance indicators).

Much of the existing literature described the types and amounts of various physical habitat features but did not specify which salmon life stage pertained to that habitat. Thus, when possible, salmon life histories and species-specific habitat requirements were obtained from existing reports and local knowledge; however when this was lacking, the DFO document, *Habitat Requirements for Ten Pacific Salmon Life History Strategies* (Diewert 2007) was consulted. The completed Habitat Status Tables are provided for the San Juan system in Appendix B and for the Gordon system in Appendix C.

4. CURRENT STATE OF HABITAT

4.1 San Juan Watershed

4.1.1 Hillslope Condition

The north side of the San Juan Valley is rugged and composed of intrusive igneous rock. All major tributaries of the San Juan River occur on this side and have cut large valleys into the surrounding terrain. The south side of the San Juan Valley differs in that the valley walls rise quickly to a rolling plateau composed of more erodible sedimentary rock. Tributaries on this side tend to smaller, shorter, and have not cut as deeply into the surrounding rock. Because of these differences, tributaries on the north side tend to have greater accessible lengths for fish than those on the south side (EBA 2001b, Ship Environmental Consultants 1986).

Historically, the main land use activity in the San Juan Watershed has been forest harvest. In recent years there has also been a stone quarry operation on the south side of the San Juan River between Bavis and Red Creeks. Muller (1997) reviewed this history and indicated that logging initially started on the San Juan delta in the early 1900's and over time, progressed up the valley and tributaries, and then up the side hills. Based on a 1987 air photo mosaic, NHC (1994) estimated that roughly 25% of the San Juan Watershed had been logged in the previous 20–30 years. By the mid 1990's portions of most subbasins had been logged and were in various stages of reforestation (Muller 1997).

Assessments of terrain stability and sediment sources in the San Juan Watershed were conducted in 1994 by NHC (1994) and in 1996 by Chatterton (1996). The assessment by NHC involved review of 1952–1992 air photos and identification/analysis of disturbed areas ≥ 300 m^2. They identified 128 landslides on forested terrain and 428 on logged terrain. The most serious landslide types in terms of sediment delivery were debris slides and debris flows (torrents). Debris slides tended to originate from road networks and debris flows from within clearcuts. In terms of sediment delivery, 60% of the landslides identified delivered sediments directly to the stream channel. Overall, it was estimated that at that time, about 2/3 of the total watershed sediment supply was delivered from landslides related to forest harvest activities (mainly from clearcuts and roads).

The terrain stability assessment by Chatterton (1996) used air photos to identify landslide and gully features in the San Juan Watershed following Forest Practice Code terrain and gully assessment procedures. This was followed by a helicopter reconnaissance to assess the accuracy and correct air photo interpretations. Dates of air photos used, and of the helicopter reconnaissance were not provided in Chatterton's report. In total, Chatterton identified 904 landslides, of which 670 (74%) were related to past forest activities. High risk landslides were identified as those with potential to deliver sediment directly to the river channel, or potential to deliver high amounts of sediment. In this category Chatterton identified 203 slides (22%) associated with logging activities (clearcuts and roads), and 14 (1.5%) in forested terrains. In terms of these high risk slides, subbasins with the greatest number included the Upper San Juan River (51 high risk slides), Hemmingsen Creek (34 slides), lower Lens Creek (30), Williams Creek (23), Renfrew Creek (17), Fleet River (14), Floodwood Creek (12), and upper Harris Creek (8).

In the 2001 San Juan River Watershed Restoration Plan (EBA 2001b), it was reported that 82 sites in Hemmingsen Creek subbasin and 31 sites in the Mosquito Creek subbasin underwent rehabilitation treatment during 1997/98 under Forest Renewal BC funding (FRBC). Among the 82 sites treated on Hemmingsen subbasin, 21 were high risk slides, 10 were moderate risk slides, and 6 were gullies identified by Chatterton (1996). Among the 31 sites treated in the Mosquito subbasin, 3 were high risk slides, 7 were moderate risk slides, and 2 were gullies identified by Chatterton. In the years following these works, substantial effort and funds have been put towards slide treatment and deactivation of sensitive roads on both Crown and private lands (Dave Lindsey, TimberWest Ltd., pers. comm.). Despite these recent efforts, follow-up assessments to identify new sensitive sites, the success of past treatments, and to updated the status of sediment delivery from San Juan hillslopes have not been completed.

4.1.2 Riparian Habitat Condition

In 1997, Muller (1997) conducted an overview assessment on riparian corridors along the San Juan River, and Renfrew, Harris, Hemmingsen, and Lens Creeks west of the E & N line (Esquimalt and Nanaimo Railway Land Grant Line). The flood plain of the San Juan River and lower portions of the studied tributaries were deemed to have excellent structural biodiversity and contained extensive stands of hardwood and mixed hardwood and conifer trees (Red Alder, Bigleaf Maple, Black Cottonwood, and Sitka Spruce), along with a very dense understory of shrub and herb communities (salmonberry, elderberry, stink current, and others). In the upper reaches of the San Juan River, and in tributary reaches above the flood plain, riparian zones were found to be in relatively stable condition and composed of either galleries of old growth conifers, or advanced young coniferous forest. Shrubs were generally present under the more open old growth stands, but were in the process of being shaded out or absent in dense unspaced young conifer stands. Thus, areas with old growth strips along the river were deemed to have high biodiversity offering good wildlife values (herb and shrub forage), snags, coarse woody debris, and channel shading, while riparian zones with dense second growth conifers were judged as possessing reduced biodiversity having limited or none of these features. The exceptions where riparian zones were unstable, included portions of Lens Creek near the E & N boundary, and in upper Hemmingsen Creek.

Muller acknowledged that there were serious sediment problems in the San Juan system, in particular in the floodplain section of the mainstem. However, he concluded that much of the riparian habitat in the examined reaches were recovering well, were relatively stable, and not a major source of sediment input. He indicated that much of the sediment input sources were from locations upstream of his study area, in particular in steeper stream sections and steep slopes where natural bank failures, grading, road building, and slides contribute fines to streams lower down. Reaches not covered by his study included the upper 2/3 of Reach 4 and above in the San Juan mainstem, Reach 6 and above in Harris Creek, Reach 4 in Hemmingsen Creek, and Reach 4 and above in Lens Creek.

At the time of Muller's survey, road deactivation and rehabilitation activities (willow bioengineering, legume planting, shrub and tree planting) were ongoing at some unstable sediment source sites. He recommended that these continue and be expanded as a priority since they target the source of the problem and will have greater benefit than other types of restoration options. Other riparian restoration activities suggested by Muller included revegetation of river bars, release of Sitka Spruce and other conifers, release of cottonwood, planting of large conifer stock, spacing to increase stem size for future coarse woody debris, and commercial thinning in areas that have lost the lower herb and shrub layer. Muller provided a list of recommended locations and associated riparian treatment strategies for each location.

Riparian restoration works were completed for several sites identified by Muller during 1998 and 1999 (EBA 2001b). Sites were located along the lower San Juan River, as well as in Lens, Harris, Bavis, and Renfrew Creeks. Prescriptions included the various activities described above and resulted in treatment of a combined total of 19.2 ha.

4.1.3 Stream Channel Condition

Information on the state of fish habitat in the San Juan Watershed are available from a number of sources though they are somewhat dated. The first significant assessment on the system was by Burns (1979) and involved completion of Resource Inventory Branch site and reach cards as well as photo documentation. These data were collected over a broad geographic area that included the mainstem and most major and minor tributaries. In August and September 1985, Ship Environmental Consultants (1986) conducted an inventory and assessment of salmonid habitat, standing crop of rearing juveniles, and estimation of potential carrying capacity of rearing habitat. Their study covered the mainstem and 9 tributaries but was not as geographically encompassing as the inventory by Burns. In 1994, Northwest Hydraulic Consultants (NHC 1994) conducted an assessment of changes in channel morphology over the period 1950 to 1992 using historic air photos and related findings to forest harvest activities and potential effects on fish habitat. In 1996, Harding et al. (1996) conducted a Level 1 Fish Habitat Survey of the lower San Juan Watershed under spring conditions (Level 1 methodologies are described in Johnston and Slaney 1996). Their study focussed on the broad floodplain region downstream of the San Juan Main logging road bridge crossing, and included the mainstem, offchannel habitats, and the lower portion of tributaries lying on the floodplain. This was followed up by another Level 1 survey by Griffith (1997a) in later summer 1996 in order to capture conditions at low flows. This last survey encompassed the entire watershed and 9 lakes.

Previous fish habitat and channel surveys have divided the San Juan Watershed into two broad morphologic categories (similar geographically to the riparian survey described above). One category includes the lower gradient unconfined water courses that lie on the broad San Juan floodplain. Geographically, this encompasses the lower 11 km of the San Juan mainstem (Reach 2 and Reach 3 up to Red Creek) and the bottom portion of tributaries where they cross the floodplain or lie on their own low gradient delta (e.g., Reaches 1 and 2 in Harris and Lens Creeks, and Reach 1 in Renfrew Creek). The second morphologic category is the higher gradient more confined water courses that lie outside the San Juan Valley floodplain and includes the San Juan mainstem and tributaries upstream of Red Creek, and lower mainstem tributaries upstream of the floodplain. In terms of stream length, water courses outside the floodplain constitute a much larger proportion of the watershed than those within the floodplain. These two categories of streams will be discussed separately here because of their very different features and condition of habitat.

The characteristics of water courses outside the floodplain are described in detail in Griffith (1997a) and NHC (1994). The extensive habitat surveys by Griffith (1997a), indicated that stream gradients in this part of the watershed generally ranged from 1 – 4.5%. Though streams in this morphologic grouping were considered "higher" gradient, this range is surprisingly low for such a large portion of the watershed. This suggests that a large part of the San Juan watershed contains very favourable gradients for salmonid habitation.

Griffith's (1997a) data indicated that sidechannels were rare in this region of the watershed but did occasionally occur where channels were less confined by valley walls. Banks were generally found to be stable and this was attributed to a composition of cobbles and boulders or bedrock in combination with well developed riparian zones of second growth, old growth, or dense grass/shrub vegetation. Areas of localized bank disturbance and erosion were noted and these were due to logging activities (e.g., slides), or where the bank composition switched to more erodible materials (generally sand and gravel). Habitat types were typically riffle-pool sequences becoming stepped cascade-pool sequences in steeper gradients. Substrates were dominated by boulders and cobbles. Spawning gravels tended to occur at the tailout of pools and glides, or in patches where hydraulics allowed accumulation. Despite the transport capability of these reaches, evidence of elevated sediment delivery was noted at most survey sites and included embedding of cobble/boulder substrates with sand and small gravel, and intrusion of sand into potential spawning beds. These results suggest that in 1996, there was ongoing delivery of sediments to these stream channels during freshet events.

How channels in this area had responded to forest harvest activities and how they had changed over time, was investigated through analysis of historical air photos by NHC (1994). They examined Harris Creek and the San Juan mainstem in detail and mapped out changes in channel morphology from 1955 to 1992. Results showed that for Harris Creek upstream of the Hemmingsen Creek confluence, and for the San Juan mainstem upstream of Lens Creek confluence, there were only minor changes in channel morphology over the 37 years examined. The main change was an increase in bar area between 1955 and 1968/70, primarily in the form of sidebars. In upper Harris Creek there was one location where the channel avulsed, and another where a meander bend was cut off and abandoned, both of which occurred between 1955 and 1970. Other than these, channel width and alignment remained relatively unchanged in these regions. NHC suggested these results were as expected for a channel with increased sediment supply yet is laterally constrained by steep valley walls and relatively stable banks. They also indicated that bar area appeared to be decreasing and may be an indication that sediment supply was on the decrease (as of 1992). They concluded that the limited storage area for sediments in these reaches, combined with ample transport capacity associated with higher gradients, would help these areas of the watershed to recover more quickly once sediment delivery sources were curtailed or eliminated.

With respect to large woody debris in these parts of the watershed, Griffith (1997a) found that functional woody debris (i.e., pieces within the wetted channel) was scarce. It was apparent that most woody debris was either swept downstream to lower gradient sections during high flows, or was washed onto high water banks and bars where it became non-functional when flows receded. This was corroborated by NHC's (1994) air photo analysis. They found that Harris Creek experienced a large influx of woody debris and debris jams between 1955 and 1970, but by 1992 much of this had been flushed downstream to the fan on the lowermost reach, or into the San Juan mainstem. Similarly, the upper San Juan mainstem experienced an influx of woody debris pieces (no log jams) between 1955 and 1968, but again, the number of pieces declined by 1992 (from 68 to 18 pieces in Reach 4).

The work by Griffith (1997a) and NHC (1994) demonstrate that the greatest impact to stream channels in this region of the watershed is from excess delivery of sediment, primarily from hillslope disturbances associated with logging, but also from localized areas of bank erosion. Griffith speculated that the bank erosion he observed may have been a consequence of increased flashiness of flows due to diminished water retention associated with forest removal. NHC examined this possibility, but found that flow monitoring by Water Survey Canada was not initiated until after intensive logging had already occurred (WSC Station 08HA010, 1960–present). We would add that another possible explanation for the observed bank erosion is that aggradation of the stream bed may have increased the lateral hydraulic forces experienced during freshet events. In terms of fish habitat and production, impacts from increased sediment delivery were noted to include 1) intrusion of sand into spawning gravels with potential adverse effects on egg survival, 2) infilling of pools reducing their functionality for adult holding, and 3) embedding of boulders and cobbles in riffles with sand

and small gravel thereby reducing their ability to produce aquatic insects and provide cover for rearing trout.

On the positive side, both Griffith and NHC noted impacts from excess sediment delivery were not as severe as what had occurred in floodplain portions of the watershed. They also noted that the relative stability of banks combined with high transport capability would lead to more speedy recovery of these areas once sediment delivery sources were brought in check.

Information on the characteristics and state of habitat in water courses on the San Juan floodplain are provided in Griffith (1997a), Harding et al. (1996), and NHC (1994). Waterways in this part of the watershed were noted to be complex with multiple secondary channels, back channels, and offchannel wetlands (Harding et al. 1996). Gradients were low (≤ 0.5%) and consisted of glide-pool or riffle-pool sequences. Banks consisted of alluvial materials and were composed of fines, gravels, and cobbles. It was noted that riparian trees and understory vegetation had kept the banks relatively stable though there were sites where banks were being undermined causing localized instability and sediment release (Griffith 1997a, Harding et al. 1996). In terms of coarse woody debris, the main feature in this region was noted to be the large log jam located within the tidal section where the main channel splits into 3 distribution channels. Upstream of this point there were 3 additional log jams, but most woody debris was in the form of single pieces. These pieces were fairly abundant up to the "crossover" but become scarce above that point (Harding et al. 1996). The scarcity of woody debris above the crossover was believed to be due to inputs being carried downstream during freshet events. Spawning gravels were found to be abundant above the log jam (Reaches 2 and 3) but were visually assessed to be severely degraded by intrusion of fine sediments. Both Griffith (1997a) and Harding et al. (1996) noted that the quality of spawning gravels improved substantially above the Lens Creek confluence.

The studies by Griffith (1997a), Harding (1996), and NHC (1994) clearly indicated that, like upstream reaches, the greatest impact to stream channels in the floodplain region was from delivery of excess sediments, the majority of which originated from disturbances in the upper watershed. However, unlike the upstream reaches, the low gradients inherent to floodplain reaches encouraged deposition, and because supply greatly exceeded downstream transport, the sediments were accumulating within the stream channels. The impacts of sedimentation were most noted on the floodplain sections of Lens and Harris Creeks, and in the San Juan mainstem below the Lens Creek confluence. In their air photo analysis, NHC (1994) indicated the following changes to channel morphology below Lens Creek as a result of increased sediment supply:

- The mainstem has become much wider (by 50%) and straighter (less sinuous). Channel straightening has also resulted in a shorter overall length.
- Large bars have been deposited along the channel, and treed islands that once separated sidechannels from the main channel, have been eroded away and replaced with large bars. There has also been some erosion of banks. These changes have resulted in loss of riparian vegetation or its proximity to the wetted stream.

- Widening of the channel and aggradation of the stream bed has resulted in shallower depths during low flows.
- In places where sediment accumulations are more coarse and porous, flows may go subsurface during summer dry periods resulting in loss of wetted connectivity (particularly an issue for tributaries and secondary channels).
- Some secondary channels have disappeared though erosion, infilling with sediments, or blockage by log jams at their upstream connection with the mainstem. Others that are still functional have been degraded by fine sediments that are carried in and deposited during freshet events.

In terms of fish production, the above studies suggest that though the floodplain reaches have an abundance of spawning gravels, the quality of these gravels for egg incubation appears to have been degraded by accumulation of fine sediments (mostly sands according to the NHC study). Pools and deep runs, which serve as holding areas for adults, have experienced infilling. Sedimentation of secondary channels and backchannels has likely degraded the quantity and quality of these habitats for summer and overwinter rearing. In addition, aggradation of stream beds tends to increase the amount of subsurface flow and this can increase the incidence of juvenile stranding during the recession of flows in late summer. Thus, although the 1996 Level 1 habitat surveys (Griffith 1997a, Harding et al. 1996) suggested that certain features of habitat were in relatively good condition (stable and well developed riparian vegetation, relatively stable banks, complex channel network), it is apparent from the historical analysis by NHC (1994), that both the extent of these habitats, and their quality, is not what it was in the 1950's, and that the driving factor behind these changes is elevated sediment delivery.

4.1.4 Estuary Condition

Ship Environmental Consultants surveyed the San Juan River estuary in 1986 (Ship 1986) and found that the tidal influence extended all the way up to the Fairly Lake outlet, and thus considered this point to the mouth as the estuary (Reach 1). About 1.6 km below the Fairy Lake outlet, the river splits into 3 distribution channels, along with a number of cross-connecting channels. Ship estimated that the estuary contained 14 km of main channel and another 4 km of backchannel at low tide, and concluded that the estuary was a highly complex area.

In 1996 the San Juan River estuary was designated as an ecological reserve (ER 141). The reserve has an area of 191 ha and was established to serve as a benchmark for forest research and to protect early seral floodplain plant communities. Currently the estuary contains 50–70 year-old deciduous forest of alder and cottonwood with a few clumps of young forest on a ridge. Areas subject to frequent flooding have substrates of young alluvial sand and silt with plant communities of either black cottonwood, red alder, salmonberry and piggy-back plant, or red alder, stink currant, salmonberry, and lady fern. Areas with less frequent flooding have substrates of older alluvial sand

and gravel, and plant communities of Sitka spruce, red alder, and fern. In addition to these, half a dozen rare plant species have been found on the site (BC Parks 2011).

Though no longer practiced, the San Juan estuary was used extensively for log booming during the 1900's up to about 1982 (Maurice Tremblay, San Juan Enhancement Society, pers. comm.). Impacts from booming in estuaries typically include mechanical scouring of the estuary floor (dislodges and destroys benthic flora and fauna), and deposition of an anoxic organic layer. In terms of fish use, this generally results in a major reduction in the productive capacity of the estuary. Even after booming is curtailed the impacts can remain for decades or even centuries (Picard et al. 2003). In the San Juan estuary there is evidence that the affects of historic booming are still present today. For example, no significant eelgrass beds have re-established[3], and anoxic gasses are still known to bubble up from the estuary floor (Helen Jones, Pacheedaht First Nation, pers. comm.).

4.2 Gordon Watershed

4.2.1 Hillslope Condition

With the exception of the estuarine section (Reach 1), much of the Gordon River Watershed lies in rugged terrain. Hillslopes range from steep in the lower and mid sections, to moderately steep in upper sections. Underlying bedrock varies among four main formations and generally increases in age with upstream progression. In the lower river below Coal Creek, the underlying geology consists of highly fractured erodible metamorphic rock belonging to the Leech River gneisses complex. Upstream of this, rocks are less erodible and comprised of either intrusive granitic rocks belonging to the Island Intrusions and Westcoast Crystalline Complex, or volcanic rocks belonging to the Bonanza Formation. In the extreme northern part of the watershed, the underlying rock consists of the Karmatusen volcanic and Quatsino limestone formations (EBA 2001a, Golder Associates 1999).

As with the San Juan Watershed, the main land use in the Gordon Watershed has been forest harvest though there is one location on the Gordon River 600 m downstream of the Hauk Creek confluence where marble is being mined. Logging commenced in the lower portion of the watershed in the early 1900's and by 1945 was occurring in the middle and upper Gordon subbasins. By 1996, an estimated 72% of the watershed had been logged (Lightly et al. 1997). Several areas of active or recent logging were noted within the middle and upper watershed at that time.

Assessments of hillslope condition in the Gordon River Watershed include a Coastal Watershed Assessment Procedure (CWAP) based on conditions to July 1994 (Anonymous 1996), an assessment of landslides and stream channel changes by Chatwin et al. (1993), an assessment of landslides, gullies, and stream channel condition in the mid Gordon and Loup Creek subbasins by Golder

[3] One small bed was recently discovered (summer 2011) on the south side of the estuary upstream of the San Juan Bridge crossing (Helen Jones, Pacheedaht First Nation, pers. comm.).

Associates (1999), and a terrain and terrain stability mapping exercise by Chatterton (1998). Overall hillslope conditions based on these reports are summarized in Lightly et al. (1997) and EBA (2001a).

The terrain stability mapping by Chatterton (1998) indicated that post harvest landslides tended to occur in the mid to upper hillslope positions under moderately steep to steep relief angles. Moderately steep slopes tended to be composed of glacial till while steep locations tended to consist of colluvial deposits. Relatively stable locations included lower elevation valley bottoms and rounded ridge tops.

The landslide inventory by Chatwin et al. (1993) identified 492 slides in the Gordon Watershed of which 93% were associated with forest harvest activities. Roads were the biggest cause and accounted for 70% of identified landslides. Nearly one half of the landslides occurred in the Loup Creek subbasin with the remainder concentrated in the mainstem Gordon above the Loup Creek confluence, and in Hauk, Bugaboo, Braden, and Brown Creeks (Lightly et al. 1997). Interestingly, the inventory by Golder Associates (1999) identified 597 landslides in the Loup Creek and mid Gordon subbasins alone. No explanations were given in any of the reports for the greater number of landslides in the Golder inventory, but regardless, the overall conclusions were the similar: 73% of identified landslides originated from roads, 25% in clearcuts, and 2% were natural in origin.

The Gordon Watershed was also identified to have a high potential for delivering sediments to stream channels via surface erosion of non-point sources (EBA 2001a, Lightly et al. 1997). This was attributed to moderate to high road densities, unvegetated landslide scars, and in particular, the long section of the mainline road directly adjacent to the Gordon River mainstem. It was felt that road traffic and grading activities would continually add fine sediments to the Gordon Watershed.

The poor state of hillslope stability identified by these studies resulted in substantial effort directed toward road deactivation and landslide treatment in the ensuing years. However, as with the San Juan, there have been no follow-up studies to identify new sources of sediment, assess the success of existing rehabilitation actions, or monitor the extent to which the quantity of sediment and number of sources may have been reduced.

4.2.2 Riparian Habitat Condition

A riparian overview assessment was conducted on the Gordon Watershed in 1997 as part of the multidisciplinary study by Lightly et al. (1997). The assessment followed the Province's *Riparian Assessment and Prescriptions Procedures Field Guide* and relied on 1992 air photos in combination with a February 1997 helicopter overflight video to classify riparian vegetation as to species, structural stage, and age. The assessment indicated that the Gordon Watershed is ecologically diverse and spans six biogeoclimatic subzones within the Coastal Western Hemlock zone. These ranged from the very wet hypermaritime southern variant in the lowermost reaches of the Gordon mainstem, to the very dry maritime western variant in the lower elevation portions of the upper Gordon, East Gordon, and Hauk subbasins. The vegetation assemblage and condition for each of these six subzones are described in detail in Lightly et al. (1997). The following is a synopsis of key points.

The Gordon River floodplain occurs in the lower 5 km of the river and occupies an area of roughly 393 ha. Logging of this area began in the early 1900's and Lightly et al. (1997) estimated that 60% was previously logged and no riparian buffer was left adjacent to the various stream channels. Despite these early harvest practices, much of the area has recovered and the riparian zone now consists of conifer and mixed conifer-deciduous forests of about 80 years in age. Dominant tree species include Sitka spruce, western red cedar, and western hemlock. It was felt that the conifer forests in this area were now beginning to mimic mature forest ecology.

In reaches above the floodplain, logging began in the 1920's to 1950's depending on ease of access and proximity to either Port Renfrew or Lake Cowichan. Forest removal became particularly extensive in the 1970's with the advent of clearcut practices, and again no riparian buffer strips were left in the early years. Lightly et al. (1997) estimated that as of 1992 air photos, 72% of the Gordon Watershed had been previously logged, and 77% (44 km) of fish-bearing streams were logged to the stream bank. Exceptions included strips of old growth riparian conifers along some sections of the lower to mid Gordon River, and parts of Loup and Braden Creeks. Most riparian areas now consist of very young to young conifer or mixed conifer-alder forest. In many areas, alders dominant the riparian zone adjacent to the stream, with conifers becoming more plentiful with distance away from the stream edge.

Much of the Gordon River and its tributaries are relatively steep in gradient and confined within bedrock or boulder banks. These banks tend to have natural stability, and as a result, historic logging of riparian zones did not necessarily compromise bank integrity. In addition, the effects of riparian logging on recruitment of LWD to stream channels was not readily apparent as even under healthy riparian conditions, the high gradient, high energy of these channels tends to wash LWD elements downstream to lower gradient depositional reaches. The effects of riparian logging were noted for lower gradient alluvial reaches. These included erosion of banks, loss of LWD recruitment to the stream channel, and gradual depletion of existing instream LWD. These impacts were noted for various alluvial reaches including the floodplain section in the lower river, on the fans in the lowermost reaches of tributaries, and in the low gradient reaches around Gordon Camp.

In terms of riparian restoration initiatives, Lightly et al. (1998) suggested riparian planting (conifers and shrubs) in association with sidechannel initiatives in the lower river, and conifer plantings and conifer release as major initiatives in the Hauk, Hine, upper Gordon, and East Fork Gordon subbasins. These are all areas where LWD would be expected to occur (gradients are suitable) but lacking, and where current riparian vegetation is dominated by alder, which tends to be small and short-lived as LWD elements.

4.2.3 Stream Channel Condition

The characteristics of stream channels in the Gordon Watershed are described in the overview assessment by Lightly et al. (1997), while those of one of its major tributary, Loup Creek, are described in Burt and Madsen (1996). Both assessments were performed by fisheries biologist/fluvial geomorphologist teams and utilized a combination of historic air photos, helicopter overflights, and field reconnaissance to describe their study areas.

Detailed descriptions of stream channel and fish habitat characteristics in the Gordon Watershed (excluding Loup Creek) are provided on a reach by reach basis in Lightly et al. (1997, Table 14). Unfortunately, they used far too many reaches for practical assessment and description of the main channel types within the watershed (40 reaches in the mainstem alone)[4]. However, as a whole, stream channels in their assessment can be grouped into two broad categories (as with the San Juan): 1) low to moderate gradient alluvial channels, and 2) higher gradient, bedrock/boulder controlled channels. Channels in the first category include the floodplain section in the lower 6 km of the Gordon mainstem (up to mid way between the Baird and Braden Creek confluences), 3 km of mainstem in the vicinity of the Hauk Creek confluence, the upper Gordon mainstem from 7.5 km above Hauk Creek to the headwaters, the lower 2/3 of Hauk Creek, the lower reach of Hinne Creek, and the fans at the mouths of Baird, Grierson, Coal and Browns Creeks. Much of the remaining stream channels, and by far the largest portion of the Gordon Watershed, belong to the higher gradient, bedrock/boulder controlled category. This includes a long section of the Gordon River canyon extending from just above Baird Creek upstream to about 1.5 km below the Hauk Creek confluence.

In their overview assessment, Lightly et al. (1997) identified a number of adverse effects to stream channels as a result of forest harvest activities. Channel changes were most pronounced in the low gradient alluvial reaches, in particular, on the floodplain in the lower river and associated tributaries. Impacts noted for this region included:

- Bank erosion and channel widening.
- Aggradation of the streambed and development of elevated bars.
- Accumulation of fines in spawning beds in the mainstem, sidechannels, and low gradient sections of tributaries.
- Deposition of sediments at the entrances of sidechannels resulting in their isolation during low flows.
- Accumulation of cobbles and gravels in the lower reaches of tributaries resulting in subsurface flows during summer dry periods.

For alluvial channels in the upper watershed (Hauk Creek, lower Hinne Creek, upper Gordon River), the effects of excess sediment delivery were also noted, in particular, accumulations of gravel and cobble in low gradient sections. However, the main effect noted for this region was a shortage or absence of instream LWD. This was attributed to historic riparian harvesting in combination with replacement of riparian zones with smaller and short-lived deciduous tree species.

[4] For the map accompanying our report, we used the reach breaks given in Ship Environmental Consultants (1986) for the Gordon River, and those from Burt and Madsen (1996) for Loup Creek.

For the higher gradient bedrock controlled channels, the effects of forest harvest activities were less prevalent due to the stability of banks and because high stream power during freshets tends to transport sediment and debris through these reaches. Nevertheless, the presence of excess sediment delivery were noted in the form of infilling around cobbles and boulders in riffles habitats between Loup and Bugaboo Creeks, and possible infilling of the plunge pool at the base of Bugaboo falls (needed confirmation via empirical measurements).

In their assessment of the Loup Creek watershed, Burt and Madsen (1996) identified six morphologic channel types within the Loup Creek basin: 1) an alluvial fan at the mouth, 2) canyon units in the lower half of the mainstem and in Tributaries 1, 2, 3 and 5, 3) confined valley bottom units in the mid to upper mainstem and in Tributary 3, 4) short low gradient unconfined units in the upper mainstem and in the lower end of Tributary 6, 5) glacial trough units in Tributaries 1 and 3, and 6) high gradient headwater units in the upper portions of the mainstem and tributaries (For a map of channel type locations see Figure 9 in Burt and Madsen 1996). Areas least impacted by forest harvest activities were the canyon units and the alluvial fan at the mouth, and this was attributed to stable banks (bedrock in the canyons and old growth timber on the fan) combined with high transport capacity (moderate gradients within straight confined channels) which conduct sediments and debris downstream to the Gordon River. In contrast, the four other channel types showed varying degrees of impacts as follows:

- Confined Valley Bottom Channels—sideslopes in these units are composed of glacial till and highly prone to failure; 27 landslides and torrents were identified and deliver sediments and debris directly to the channel; channels are degrading and conduct these materials to downstream reaches.
- Moderate Gradient Glacial Troughs— Numerous debris torrents noted on high valley sidewalls; numerous failures associated with streamside harvesting; large amounts of mixed coarse and fines sediments and debris being delivered to the channel; channels have widened since 1977 and are severely aggraded; LWD and large boulders are buried under sediments or scoured from system; accumulation of coarse sediments in low gradient portions may result in flows going subsurface during summer dry periods.
- High Gradient Headwaters— Sideslope failures from roads and clearcuts have resulted in debris torrents; small creeks scoured down to bedrock; mixed sediments and debris are conducted to downstream channels.
- Low Gradient Unconfined Valley Bottom— Aggraded from landslides 20–30 years ago; operating as long term storage of sediments; erosion of banks and bars present but beginning to stabilize with alder growth; LWD contributions dominated by alder and thus short-lived.

4.2.4 Estuary Condition

Lightly et al. (1997) subdivided the lower Gordon River into Subreaches 1A (950 m long) and 1B (1,300 m long) giving Reach 1 a total length of 2.25 km. The upstream extent of Reach 1 was positioned 300 m above the Coal Creek confluence. Little is said in the text regarding the characteristics of this reach, however, review of their habitat summary table (Table 14) indicated the channel has an average width of 70 m, gradient of 0 to 0.1%, and structure of riffle/pool sequences with point and side bars along its length. The riparian zone is dominated by 80 year-old conifers and is beginning to exhibit mature forest ecology. There are some locations of bank erosion but stability of the riparian zones is helping to abate the extent of scour. The channel was indicated to show symptoms of vertical aggradation indicating surplus sediment supply. LWD pieces were identified as limited and those present tended to have been washed parallel to the banks by high flows.

Major impacts to the estuary began in the 1920's when the area began to be used as a booming grounds for the logging industry. In the 1950's a logging camp and dryland sort were constructed on the wetlands at the foot of Browns Creek. In addition, historic air photos show that an 80 m wide by 500 m long channel was excavated into the lower end of Browns Creek to provide a dumping channel for the dryland sort and facilitate transport of log booms out into the estuary. The booming channel emptied into a major sidechannel of the estuary and this too appeared to have been excavated to ensure sufficient depth. Sometime in the 1980's the dryland sort and dump were abandoned as were booming activities in the estuary. Currently, the artificial channel complex is used by the Port Renfrew Marina.

The above changes resulted in alteration to the lower reach of Browns Creek, loss of wetlands on the floodplain at the foot of Browns Creek, and loss of a major estuarine sidechannel. It is likely that these changes had significant impacts on salmonid species using Browns Creek, the sidechannel, and the estuary as a whole. Species potentially affected by changes to Browns Creek and the wetland include coho salmon and cutthroat trout, while all 5 species of salmon may have been affected by changes to the estuarine sidechannel.

As mentioned for the San Juan estuary, impacts from log booming may extend well past the cessation of booming activities. To reiterate, impacts from estuarine booming typically include mechanical scouring of the estuary floor resulting in destruction of benthic flora and fauna, and deposition of an anoxic organic layer. One positive note, is that in recent years small patches of eelgrass have begun to re-establish within the Gordon River estuary in sites protected from boat waves and high flow scour (Helen Jones, Pacheedaht First Nation, pers. comm.).

5. LIMITING HABITATS AND HIGH VALUE HABITATS

In the ensuing discussion, limiting habitats are those that are most likely to be the constraint or bottleneck to overall smolt production for a given species. For example, for species with extended freshwater rearing, the habitat most likely to limit overall smolt production may be summer rearing or overwintering refuges, while for species with little or no freshwater rearing it may be the quantity and quality of spawning habitat. Most regions of the San Juan Watershed have been impacted to varying degrees by forest harvest activities with impacts directly or indirectly related to excess sediment delivery and generally becoming more exacerbated with downstream progression. Thus, in the following text, habitats classified as "high value" are designated as such, not because of an absence of impacts, but rather because regardless of condition, they are heavily used by a given species and life stage. Whenever possible, high value habitats have been identified in the large format map compiled for this project, a reduced version of which is provided in Figure 1.

5.1 San Juan Watershed

5.1.1 Chinook Salmon

Limiting Habitats

The main chinook spawning grounds in the San Juan system include the mainstem from 2 km above the Fairy Lake outlet upstream to the Pixie Creek confluence (i.e., 2/3 of Reach 2 and 1/2 of Reach 3), in Harris Creek from its mouth to the top of Reach 3, and in first 560 m of Hemmingsen Creek (Griffith 1997a). As previously discussed, spawning gravels are abundant in most of these areas but are believed to be severely degraded by excess fines. High levels of substrate fines are well known to impact incubating eggs through reduced delivery of oxygen and removal of metabolic wastes, as well as impeding swim-up of alevins during emergence. Thus, one possible factor limiting the production of chinook smolts from the San Juan system is poor survival during the incubation and emergence periods. This seems entirely plausible considering that most suspended sediment and bedload movement occurs during winter freshets after chinook redds have been created. Thus, any gravel cleansing achieved by the action of spawning may be negated by intrusion of new fines into gravel interstitial spaces, or by the laying down of a new layer over the redds. The other possible limiting factor relates to the reduction in the quality of rearing habitat in the lower river and estuary. It is uncertain what proportion of chinook rear and smolt from freshwater relative to those that move down to the estuary for their main rearing and smolting, however, regardless of strategy, these combined areas are used by virtually all San Juan River chinook, probably for up to about 3 months before they move offshore to the marine environment. Thus, degradation of the lower river habitat from sedimentation and impacts to the estuary from historic log booming, may be factors limiting the number of chinook smolts that go out to sea.

High Value Habitats

High value habitats identified for chinook salmon include 4 spawning sites on the San Juan mainstem that over the years, have consistently supported relatively high number of chinook spawners. These include 2 sites below the Harris Creek confluence, 1 site above this confluence, and 1 site above the Lens Creek confluence (Helen and Jeff Jones, Pacheedaht First Nation, pers. comm.).

Another location that is undoubtedly a high value habitat, is the complex set of channels that comprise the estuarine reach. Rotary screw trap and beach seining results indicate that substantial numbers of chinook fry move down to this region in the spring where they rear for a number of months (into August) before moving offshore (Maurice Tremblay, San Juan Enhancement Society, pers. comm.; Helen and Jeff Jones, Pacheedaht First Nation, pers. comm.).

5.1.2 Coho Salmon

Limiting Habitats

Due to their extended period of freshwater rearing, habitats limiting the production of coho smolts are usually considered to be either summer rearing or overwinter refuge sites. In recent years, there has been greater belief that overwintering is the more limiting of the two habitats, and indeed, both Harding et al. (1996) and Griffith (1997a) suggested that availability of overwintering habitat was probably the main constraint to the production of coho smolts from the San Juan system. However, in the absence of information to validate this hypothesis for San Juan coho, it is probably wise to consider both habitats as potent bottlenecks to freshwater production. In terms of summer rearing, coho prefer lower gradient quiet waters, in particular where there is overhanging vegetation, instream woody debris, or cutbanks to provide cover. These conditions tend to occur in pools and alcoves in the mainstem, as well as in sidechannels, backchannels, and offchannel wetlands. For overwintering, fry seek out similar low velocity habitats but that also provide protection from high flows during winter freshets. Thus some of the habitats used for summer rearing are also suitable for overwintering. Examples of overwintering habitat include protected secondary channels (sidechannels and backchannels), wetlands, and mainstem sites that possess features that provide buffering from high flows (e.g., log jams).

In the San Juan system, the best habitats meeting both summer and winter rearing preferences occur in mainstem and tributary reaches on the floodplain. This includes the multi-channel network in the estuarine reach (Reach 1) as demonstrated by seining surveys which found heavy use of this area right through to at least September. As previously noted, these habitats have been highly impacted by sedimentation resulting in a variety of impacts including loss of habitat quality and areal extent, isolation from cover elements due to channel widening and bar development, diminished food supply from sedimentation of riffles, and possible stranding from dewatering of channels. Within the estuary, historic log booming has resulted in loss of benthic plant communities such as eelgrass which in turn support invertebrate communities (food source) and provide cover for rearing. These changes in habitat have undoubtedly reduced the smolt production capability of the San Juan system.

High Value Habitats

Perhaps the most important habitat for coho are the extensive sidechannels, backchannels, and wetlands occurring on the San Juan floodplain (Reaches 2 and 3). These areas are extensively used by juvenile coho for both summer rearing and overwintering. Ship Environmental Consultants (1986) felt that this area was the “best coho overwintering habitat found in the San Juan system.” One site identified by Harding et al. (1996) to be particularly important, both for summer rearing and overwintering, was Van den Slough. This channel was assessed to have a wetted length of 3.5 km and wetted area of 52,500 m^2. The key to its productivity was a 600–800 m wide forest buffer between it and the San Juan and Harris Creek channels which traps sediment during floods before it reaches the slough. They concluded that the "the importance of this channel cannot be overemphasized" and that all efforts should be made to preserve it and the forest buffer.

A number of tributaries to the San Juan River should also be considered high value habitats based on heavy use by rearing coho fry. These include Renfrew, Harris, Lens, and Pixie Creeks on the north side of the valley, as well as accessible lengths of some of their tributaries including Four Mile and Five Mile Creeks (tributaries of Renfrew Creek), and Tremblay Creek (tributary to Harris Creek) (EBA 2001b, Harding et al. 1996). On the south side of the valley, Harding et al (1996) considered Tom Baird and Murton Creeks to be of high value due to high use by rearing coho, good array of habitat features, and sustained flows throughout the summer dry period.

Lastly, the estuarine reach should be considered as high value habitat because of its heavy rearing use by coho fry. For example, beach seining in the estuary in 2001 indicated that coho fry were the most abundant rearing salmonid captured, and were present in the estuary from April to September (numbers peaked in May, June, and July, and gradually tapered off in subsequent months) (seining summary from Helen Jones, Pacheedaht First Nation).

5.1.3 Chum Salmon

Limiting Habitats

Chum salmon spawn in the mainstem from 1 km above the Fairy Lake outlet to the Sam Creek confluence, in the lower 2 reaches of Renfrew Creek, lower 400 m of Four Mile Creek, and in the lowermost reach of Harris and Lens Creeks. These areas occur on the low gradient floodplain morphologic region, and therefore, much of the spawning beds are degraded by excess fines. Thus, as in the case of chinook salmon, a potential constraint to chum production is elevated mortality of eggs during incubation and alevins during swim-up. With respect to rearing, beach seining in the estuary in 2001 indicated rearing use of this area from April to June with a peak in May. Duration of use by individual fry is probably in the range of 4 to 6 weeks before moving offshore to the marine environment (seining summary from Helen Jones, Pacheedaht First Nation). Thus, a second potential constraint to chum production relates to degradation of estuarine habitat as a result of historic log booming (as was previously discussed for chinook salmon).

High Value Habitats

High value habitats for chum salmon include spawning sites consistently occupied by this species, albeit it, in low numbers due to poor escapement. These include 2 mainstem sites, one upstream of Renfrew Creek and one immediately below Burl Creek, as well as tributary sites including one in Renfrew Creek just upstream of the Four Mile Creek confluence, and one in the lower end of Lens Creek (Helen and Jeff Jones, Pacheedaht First Nation, pers. comm.).

The 2001 beach seining in the estuary indicated that this was the main rearing area for chum fry prior to moving offshore. Thus, the estuary should also be considered a high value habitat for chum rearing (as it is for chinook and coho rearing).

5.1.4 Pink Salmon

Limiting Habitats

Pink salmon differ from other Pacific salmon in that after the fry emerge from the gravel they migrate directly to the marine environment with very little time spent in either the river or the estuary. This life history strategy suggests that the habitat most crucial to freshwater production is the quantity and quality of the spawning beds. The FISS database indicates that pink salmon spawn in the San Juan mainstem up to 1.6 km above Fairy Lake while local knowledge indicates that some spawning also occurs as far upstream as half way between the confluences of Harris and Lens Creeks. The downstream extent of spawning has not been documented, however, pink salmon are known to successfully spawn in intertidal sections of rivers, and in some cases the major proportion of the run may spawn in this zone (Heard 1991). Thus, it seems conceivable that given sufficient escapement, pink salmon could spawn well down into the distribution channels of the estuary.

Griffith (1997a) completed 7 habitat survey sites in the area potentially used by pink for spawning and found gravels to be generally abundant but highly degraded by excess fines. Local knowledge suggests that while sedimentation is an issue throughout the floodplain, it is particularly heavy in the San Juan mainstem up to 1.6 km above Fairy Lake (Helen and Jeff Jones, Pacheedaht First Nation, pers. comm.). Given available information, it seems likely that the most significant factor affecting the production of pink salmon is the quality rather than quantity of spawning gravel. As previously described for chinook and chum salmon, high levels of fines in spawning beds can have major adverse consequences on the survival of eggs and alevins.

High Value Habitats

Because pink salmon do not use the river or estuary for rearing, high value habitats for this species are sites selected for spawning. Unfortunately, little is known of precise spawning locations. What can be said, is that one of their spawning areas is probably among the multiple channels of the estuary and this region has already been identified as a high value habitat for all previous species discussed (albeit for rearing as opposed to spawning).

5.1.5 Sockeye Salmon

Limiting Habitats

The spawning distribution of river-type sockeye using the San Juan system includes the mainstem up to the Pixie Creek confluence, the lower end of Fairy Creek, and the lower 2 reaches of Renfrew Creek (FISS database and Helen and Jeff Jones, Pacheedaht First Nation, pers. comm.). Since this distribution lies on the floodplain portion of the watershed, spawning gravels are subject to the same sedimentation issues and associated effects on egg and alevin survival outlined for other species using this region. Thus, the quality of spawning gravels may be a main factor limiting the freshwater production of river-type sockeye in the San Juan system. Lake-type sockeye spawn in upwelling areas along the margin of Fairly Lake. Redds laid down at these locations may experience similar effects from sedimentation, in particular, particle sizes that are carried in suspension by Renfrew Creek but then settle upon entering the slack water in Fairy Lake.

River-type sockeye generally rear for a period in the river and/or estuary prior to moving offshore into the marine environment. Burgner (1991) indicated that rearing habitats occupied by river-type sockeye are variable, and may include the estuary as the main rearing area, a combination of the river followed by the estuary, or in the case of juveniles that decide to overwinter, spring-fed sites, sidechannels, or sloughs. Thus, another potential constraint to sockeye production is the quantity and quality of these habitats, though it is uncertain which of these are of most value to San Juan sockeye since their rearing duration and locations are unknown. For the lake-type sockeye of Fairy Lake, high summer water temperatures likely force any juveniles in the lake to leave and adopt a river-type rearing strategy.

High Value Habitats

High value habitats for San Juan sockeye are limited to spawning sites as rearing locations have not been specifically identified. Known spawning locations for river-type stocks include 2 mainstem sites, one below and one above the Harris Creek confluence, and one site in Renfrew Creek between Four Mile and Five Mile Creeks. The only spawning location for lake-type sockeye is Fairy Lake and so this represents a high value habitat for this stock.

5.2 Gordon Watershed

5.2.1 Chinook Salmon

Limiting Habitats

Although chinook have been observed in the Gordon mainstem as far upstream as Bugaboo Falls, and spawning observed in the canyon below the falls, the main spawning grounds are reported to be in the alluvial reaches from Baird Creek confluence downstream (Lightly et al. 1997). As indicated in the description on channel condition (Section 4.2.3), the quality of spawning beds in this part of the river have been severely degraded by deposition of fines. Thus, a possible major limitation to chinook production from the Gordon River system is poor survival of eggs and alevins during incubation, and impeded swim-up during emergence (similar to the incubation and emergence issues described for San Juan River chinook in Section 5.1.1). In addition, deposition of sediments at sidechannel entrances was reported to cut off access to some channels (Lightly et al. 1997) and this may reduce the overall amount of spawning habitat available to Gordon River chinook.

The second probable factor limiting the production of chinook smolts from the Gordon River has to do with the quantity and quality of rearing habitat. Like their San Juan River siblings, Gordon River chinook are thought to rear in the lower river and estuary. Reliance on these habitats probably extends for up to 3 months, though there is some evidence that a minor component rears in the river or estuary for one year to smolt as 1^+ fish (1^+ chinook have been captured in the river and large juveniles observed in the vicinity of the marina; Helen and Jeff Jones, Pacheedaht First Nation, pers. comm.). What may be of significance to chinook rearing is that the length of channel in the lower river, the number and length of sidechannels, and the size and complexity of the estuary, are all relatively small, particularly when compared with the San Juan system. In addition, the quality of rearing habitat in these areas has been reduced by sedimentation of substrates, and the extent of sidechannel habitat reduced by infilling of channel entrances. Also, the historic estuarine sidechannel that Browns Creek once flowed into has been cut off from the mainstem at its upper end and the quality of habitat may have been reduced by dredging, pollution, and boat traffic. Lastly, as described in the section on estuary condition (Section 4.2.4), the quality of habitat in the estuary has been impacted by historic log booming. Given all the above, it seems highly likely that the rearing capacity of the lower river and estuary has been substantially reduced from its historic capabilities.

High Value Habitats

High values habitats for Gordon River chinook salmon include two spawning beds on the lower river where chinook are known to spawn on an annual basis. These include one site in the Beauschesne's farm sidechannel and one in the Grierson Creek sidechannel (Maurice Tremblay, San Juan Enhancement Society, pers. comm., and Helen and Jeff Jones, Pacheedaht First Nation, pers. comm.). The Gordon River estuary should also be considered a high value habitat due to its importance to chinook rearing and smolt production.

5.2.2 Coho Salmon

Limiting Habitats

As discussed for San Juan coho (Section 5.1.2), factors limiting the freshwater production of coho tend to be related to the quantity and quality of summer rearing and/or overwintering refuge habitats. Preferred habitats for these life stages include sidechannels, backchannels, offchannel wetlands, and protected mainstem habitats with an abundance of cover (LWD, overhanging vegetation, and cutbanks). As a whole, these habitats are naturally in short supply in the Gordon River due to the relatively high gradient and confined nature of much of the river. Similar to the San Juan system, the region where these habitats do occur is in the alluvial reaches on the lower river floodplain, in the low gradient regions of tributaries on the floodplain, and in the estuary. However, compared with the San Juan, the Gordon River floodplain is much shorter and narrower, and the estuary smaller and considerably less complex. GIS calculations indicate that the floodplain reaches have a combined length of 6 km and the estuary an area of 65 ha (including the Coal Creek marina backchannel) with 3 or 4 short distribution channels cutting across the lowermost river bend. Thus, the overall extent of potential rearing and overwintering habitat appears to be a major constraint to coho production from the Gordon system.

In addition to limited supply, the quality of summer rearing and overwintering habitat within this region has been impacted by forest harvest activities. Impacts noted by Lightly et al. (1997) include infilling of sidechannels or their isolation by infilling of entrances, loss of existing LWD and recruitment of future LWD due to riparian harvesting, and diminished quantity and quality of pool habitats from sediment infilling. For lower river tributaries, gravels and cobbles were noted to be accumulating on the tributary fans resulting in flows going subsurface during summer dry periods.

High Value Habitats

High value habitats for coho adults include an important holding pool in the mainstem below Baird Creek and a spawning bed in the mainstem above Baird Creek. Other important spawning areas occur in the lower reach of Braden, Baird, and Coal Creeks. High value habitats for coho rearing include Pandora Island Sidechannel (located just above the mouth of Grierson Creek) and the lower reach of Braden, Baird, and Coal Creeks. Other important habitats providing both rearing and overwintering include the sidechannel network upstream of the Coal Creek confluence, the wetland channels at the foot of Browns Creek, the artificial backchannel used by the Port Renfrew Marina, and the various channels of the estuary (Lightly et al. 1998, Lightly et al. 1997, Helen and Jeff Jones, Pacheedaht First Nation, pers. comm.).

5.2.3 Chum Salmon

Limiting Habitats

Gordon River chum salmon spawn primarily in the mainstem reaches downstream of Baird Creek and in the upper half of the estuarine reach. As noted in the section on channel condition, spawning beds in this region are heavily impacted with fines, thus, poor survival of eggs and alevins during incubation and impeded swim-up during emergence, may be major factors limiting the production of chum from the Gordon River. In addition, the backchannel leading to the Port Renfrew Marina was historically a major estuarine distribution channel that was heavily used for spawning by chum salmon. This habitat was subsequently lost when the channel was cut-off from the mainstem, dredged, and converted to a backchannel for log transport and storage purposes (Helen and Jeff Jones, Pacheedaht First Nation, pers. comm.).

The other factor likely limiting chum production is fry rearing habitat, and the Gordon River estuary plays a vital role for this phase. Given that the Gordon River estuary is relatively small, has been degraded by sedimentation and historic log booming, and had a portion altered by dredging and dryland sort construction (Browns Creek area), it is highly likely that the rearing capacity of the estuary has been substantially diminished from its historic capabilities.

High Value Habitats

Though all areas used by chum salmon have been degraded to varying degrees, those areas that are used on a consistent annual basis should be considered as high value habitats. In terms of spawning, this includes gravel beds in the vicinity of 1) Pandora Island, 2) Beauschesne's Farm, 3) around the bend below Beauschesne's Farm, and 4) off the confluence of Coal Creek (Lightly et al. 1998, Lightly et al. 1997, Helen and Jeff Jones, Pacheedaht First Nation, pers. comm.). High value habitats for chum rearing are the estuary including the man-made backchannel used by the Port Renfrew Marina.

5.2.4 Pink Salmon

Limiting Habitats

Given that pinks tend to migrate to the marine environment soon after emergence (with little use of the estuary), the limiting habitat for the freshwater production is the quantity and quality of spawning habitat. Returns of pinks to the Gordon River have been very low since the 1960's, however, they have been observed spawning in small numbers in Pandora Sidechannel and at the bottom of the bend downstream of Beauschesne's Farm (Helen and Jeff Jones, Pacheedaht First Nation, pers. comm.). Historically they were known to make use of the channel leading to the Port Renfrew Marina, however, as with chum, this habitat was lost when the channel was dredged and converted to a backchannel for booming activities. Thus, factors limiting the production of pink salmon appear to be the poor quality of the spawning beds (due to sedimentation as described for chum salmon), and the loss of some of their historic spawning habitat.

High Value Habitats

High value habitats for pink salmon include the existing spawning beds described above (Pandora Sidechannel and downstream of Beauschesne's Farm).

5.2.5 Sockeye Salmon

Limiting Habitats

The Gordon River receives a small annual return of river-type sockeye, though the distribution of spawning and rearing of these fish is not well known. Small numbers have been observed holding downstream of Beauschesne's Farm and in the Pandora Sidechannel (Helen and Jeff Jones, Pacheedaht First Nation, pers. comm.). Spawning likely occurs in mainstem reaches on the floodplain, and thus incubation success is likely limited by gravel quality similar to other species spawning in this region. As with San Juan river-type sockeye, rearing strategies may be variable involving periods in both the river and estuary. Thus, smolt production may be impacted by degradation of these habitats as described for other species using the lower river and estuary.

High Value Habitats

High value habitats have not been specifically identified for Gordon River sockeye salmon.

6. POTENTIAL INDICATORS FOR MONITORING HABITAT STATUS

In both the San Juan and Gordon Watersheds, the loss and degradation of fish habitat, and disruption of ecosystem function are primarily a result of forest harvest activities and associated road networks. Most adverse effects described in previous sections can be tied back to 1) excess sediment delivery, and 2) historic harvest of riparian zones. In addition, in the case of the Gordon Watershed, changes in channel morphology from these two driving agents are suspected to be aggravated by increased peak flows (Lightly et al. 1997). Stalberg et al. (2009) provide a list of various pressure and state indicators to be used to assess and monitor habitat status of Conservation Units as part of the WSP program. Table 4 lists those pressure and state indicators believed to be most applicable to the San Juan and Gordon Watersheds based on impacts identified by this habitat status assessment.

Table 4. Summary of WSP indicators most applicable to habitat issues on the San Juan and Gordon River Watersheds.

Indicator Type	Indicator	Available Information
Pressure (stream)	Total land cover alteration (forestry)	**San Juan:** no stats by subbasin; NHC (1994) estimated 25% of watershed cut as of 1987. **Gordon:** % harvested and % ECA by subbasin within TFL 46 as of 1998 (Anonymous 1996, EBA 2001a).
Pressure (stream)	Watershed road development	**San Juan:** road length by name and subbasin as of 2001 (EBA 2001b) (TFL 46 only). **Gordon:** road length by name and subbasin as of 2001 (EBA 2001a) (TFL 46 only).
Pressure (stream)	Riparian disturbance	**San Juan:** riparian overview assessment of TFL 46 portion as of 1996 (Muller 1997) **Gordon:** riparian overview assessment of TFL 46 portion as of 1997 (Lightly et al. 1997)
State (stream)	Suspended sediment	**San Juan:** limited point samples at Station 08HD010 for 1988-1992 (Water Survey Canada website, www.wsc.ec.gc.ca/sedat/sedflo/index_e.cfm?cname=main_e.cfm) **Gordon:** none available
State (stream)	Stream discharge - Gordon River	**San Juan:** available for WSC Station 08HD010 for 1959 - present (http://www.wsc.ec.gc.ca/applications/H2O /index-eng.cfm) **Gordon:** no long-term monitoring; hydrometric parameters estimated from other gauged watersheds (Lightly et al. 1997)
State (lake)	Water temperature - Fairy Lake	**San Juan:** no continuous temperature monitoring **Gordon:** not applicable
Quantity (estuary)	Estuarine habitat area by type (riparian, sedge, eelgrass, mudflat)	**San Juan:** no data **Gordon:** limited riparian data available in Lightly et al. (1997)

Data gaps in WSP indicators fall into two categories: a) background data are available but have not been compiled, or b) data are not available and would required field assessment or monitoring to acquire. The following summarizes data gaps with respect to Table 4 indicators.

Total Land Cover Alteration— % harvested and % clearcut area (ECA) were calculated by subbasin for the Gordon River Watershed based on condition as of 1998. No similar calculations were found for the San Juan System. Given modern GIS databases for cut areas and stand age maintained for both crown and private forest lands, it is likely that these data could be calculated for both watersheds up to a near current year.

Watershed Road Development— Road length and deactivation status were compiled for portions of the San Juan and Gordon River Watersheds to 2001. These data could be updated with current GIS data sets for crown and private forest lands to provide the desired WSP metric (km/km^2 by subbasin) to a near current year status.

Riparian Disturbance— % riparian zone logged by historic forest harvest were assessed within TFL 46 portion of the watersheds. These data could be readily updated and remaining Private portions of the watersheds added to the database to bring it to a near current year status. This exercise may also reveal that some riparian areas previously designated as disturbed have recovered sufficiently to receive an alternative status. If private forest land owners do not currently have these data, they could be acquired through recent air photo imagery combined with reconnaissance level field verification. For this indicator, the WSP has designated the region within 30 m of the stream bank as the riparian zone (Stalberg et al. 2009).

Suspended Sediment— Total suspended sediment (TSS) data are limited to a small data set for the San Juan River at Station 08HD010. For this metric to be useful (mg/L) more intensive sampling would be required, in particular on the ascending and descending limbs of freshet events when most suspended sediment is generated. Typically this involves collection of water samples which are then sent to a lab for analysis. However, turbidity could be collect with a handheld meter coincident with the water samples to eventually build a regression relationship between TSS and turbidity. Once a statistical relationship is achieved, it would be possible to estimate TSS with a simple hand held turbidity meter (cheaper and quicker results).

Stream Discharge— The flow metric suggested by the WSP is 30-day minimum mean flow expressed as a percentage of the mean annual discharge (MAD). Long-term discharge data are available for the San Juan River near the mouth (Station 08HD010), and this yields a 30-day mean minimum flow (August) of 4.8 m^3/s or 9.8% MAD (based on years 1960–2009). A flow gauging station has never been installed on the Gordon River, however, Lightly et al. (1997) used nearby gauged rivers to estimate a mean August flow of 3.1 m^3/s which equates to 10.9% of their estimated MAD. While forest harvest activities may have resulted in a reduction of 30-day minimum flows, it is likely that low or subsurface flows in summer are more affected by aggradation of porous substrates than by reduced summer flows. In addition, it is probably more important to undertake flow analyses for the purpose of monitoring peak flows which can be used to track hydrologic recovery and sediment delivery rates.

Water Temperature— No long-term water temperature data are available for either the San Juan or Gordon River Watersheds as continuous water temperature monitoring devices have never been installed in these river systems. It would be particularly useful to install such a device in Fairy Lake as summer water temperatures are known to exceed 24 °C during periods when juvenile sockeye and coho may be rearing at this location.

Estuarine Habitat Area— Information on the amount of key estuarine habitat types (riparian, sedge, eelgrass, and mudflat) were not found in the literature and would require directed field studies to acquire. Given the importance of the San Juan and Gordon River estuaries to chinook, coho, and chum rearing this should be among the high priority data gaps to address.

7. DATA GAPS AND RECOMMENDED STUDIES TO ADDRESS THEM

Much of what is known on the state of habitat in the San Juan and Gordon Watersheds is based on studies conducted in the late 1990's. Though interviews with persons familiar with the watersheds were useful in compiling this report, information provided was generally insufficient to update the habitat status to current year(s). In addition, studies conducted in the late 1990's were followed by a host of restoration activities including slide rehabilitation, gully stabilization, road deactivation, riparian planting, riparian release, instream structure placements, and sidechannel construction. Thus, it is apparent that another round of assessments is required, not only to bring the knowledge of habitat condition up to date, but to determine how well past restoration activities have mitigated impacts, and to identify any new issues that may have arisen (e.g., new hillslope failures). The following recommendations do not all directly service WSP objectives, but they are certainly very pertinent to San Juan Round Table objectives. In addition, they are directly linked to the most significant issues in the San Juan and Gordon Watersheds.

Hillslope Condition— 15 or so years has gone by since the last landslide and road assessments, and so a follow-up assessment is recommended. Recent air photos and reconnaissance level field work may be needed to identify new slides and assess the recovery rate of old and previously treated slides. If not already undertaken, it is suggested that landslide data from previous inventories, and those from new assessments, be compiled into a GIS database. The database should include fields to track sediment volumes, treatment activities, and treatment success. A similar GIS database should be established for roads and deactivation status. Ideally, these databases would encompass full watersheds, regardless of land ownership.

Riparian Condition— Again, riparian data are dated and another assessment is warranted, though the focus this time should be on the status of conifer regeneration and whether further conifer plantings and release are needed (and where). Again, it is recommended that assessment results be tied into a GIS database.

Channel Condition— It is probably not necessary to undertake a full channel assessment as was done in the 1990's, but rather focus on the key channel issues: 1) aggradation of stream beds, 2) intrusion of fines in spawning beds, and 3) current status of LWD. Efforts should be focussed on the floodplain reaches as this is where impacts are most severe. For the first two issues it would probably be best to select a few key locations to be examined in detail rather than attempting to survey all floodplain reaches on a cursory level. Selected locations would serve as index sites for long term monitoring of sediment delivery (e.g., repeated every 3-5 years).

With regard to item 2 above, there is much talk in the literature and by interviewees that the lower river suffers from deposition of fine sediments and that this is likely impacting the quality of spawning gravel (the inference that survival of salmonid eggs and alevins in the gravel has been compromised). This may be a particularly important issue for those species using the lower mainstem downstream of the Lens Creek confluence (primarily chinook, chum, and pink salmon, but others as well). Two investigations are suggested to examine this issue: 1) undertake a more comprehensive analysis of particle composition for a select number of spawning beds in this region. This could involve methods similar to those used by NHC (1994) where larger particle sizes were measured in the field and smaller fractions taken back to a lab for sieving and weighing. 2) In concert with the above, undertake an incubation assessment using Scotty chambers similar to what has been done by DFO on artificial channels on the Puntledge River. The goal of these studies would be to provide more solid evidence (quantification) on both the physical extent of sediment problems in the lower river and the actual impacts this may be having on egg survival.

Estuarine Condition— Available information suggests that the San Juan and Gordon estuaries are highly important rearing zones for chinook, chum, and coho salmon, yet little is known of the aerial extent of key habitats (riparian, sedge, eelgrass, and mudflat). To address this, it is recommended that these habitats be described, quantified and mapped. In addition, the impacts of historic log booming on estuarine sediments and water quality are based on local knowledge and outside literature, and the extent of these impacts in the San Juan and Gordon estuaries have not been specifically investigated. Thus, it is recommended that future estuarine activities include a monitoring program to assess the physical and chemical composition of sediments (e.g. extent of wood waste layer, hydrogen sulphide concentrations) and the quality of water above these sediments.

Biological Studies— During the compilation of this report, it was surprising to find how little was known on the distribution of juvenile chinook rearing, the duration of freshwater use, and relative proportions using the river versus the estuary as the main rearing grounds. In addition, it was apparent that the estuaries are highly important rearing areas for chinook, chum, and coho salmon, but which parts of the estuaries are used by the different species (preferred habitats) are largely unknown. Thus, it is recommended that a weekly beach seining program be initiated in the lower reaches of the river and estuary during anticipated rearing periods with the goal of quantifying relative abundance and duration in the different areas of the river and estuary.

Another biological study may be warranted to determine the rearing strategy of lake-type sockeye in Fairly Lake. For example, given that water temperatures get quite high in the summer, do they rear in the lake for a period until temperatures get too high and then migrate into the San Juan mainstem?

8. RESTORATION RECOMMENDATIONS

The most significant factor affecting fish habitat in the San Juan and Gordon River systems is excess sediment supply. The effects of excess sediment supply are impacting all freshwater life stages of salmon and are felt most on the floodplain reaches, which happen to be the most important reaches for salmon production. These sediments are originating primarily from hillslope failures (slides, torrents, and gullies) associated with logged areas and road networks. Until these sediment sources are addressed, downstream channel issues will continue. On the other hand, stabilization of sediment sources has the potential to allow sediment delivery rates to move back into equilibrium, with resulting benefits throughout the watershed.

The second most important factor affecting fish habitat is harvest of riparian zones. This has resulted in replacement of these zones with deciduous trees species (mainly alder) and loss of mature conifer timber. Mature conifers are important for stabilization of stream banks, shading of the channel, and recruitment of LWD to stream channels.

Given this understanding, we suggest that future restoration activities adopt a top-down approach giving highest priority to upslope sediment sources and riparian zones. This is a long term approach, however, it is one that will ultimately provide the greatest benefit on the largest scale. The following are our recommendations for restoration activities in order of priority.

Landslide Treatment— Undertake treatment to stabilize existing landslides beginning with ones known or suspected of delivering significant quantities of sediment to river systems. Develop an annual monitoring program to catch any new failures as they occur and have a system in place to prioritize and treat them as soon as possible. If terrain assessments suggest a hillslope has a high probability of failing if logged, that location should be left alone. New landslides and restoration activities should be fed into a GIS database system (discussed in the *Data Gaps* section) so that treatment success and overall sediment reduction progress can be tracked.

Road Deactivation— Continue with road deactivation to eliminate or reduce sediments originating from these sources. Again activities should feed into a GIS database in order to track progress at sensitive sites and at subbasin and watershed scales.

Riparian Rehabilitation— Implement conifer planting and conifer release in order to encourage regeneration of these species and speed up the transition back to conifer dominance in riparian zones. Protect existing riparian zones.

Estuary Rehabilitation— Investigate the possibility of undertaking plantings of riparian vegetation, sedges, and eelgrass in the San Juan and Gordon estuaries. Activities of this nature in the Cowichan and Campbell River estuaries may offer guidance into approaches/techniques that offer the greatest success.

Nutrients— If not already practiced, salmon carcasses from hatchery operations can be trucked up the river and deposited in the channel in locations upstream of important spawning zones (e.g. at the top of floodplain zones. This will help to simulate natural supply of marine-derived nutrients which have been demonstrated to bolster trophic productivity with subsequent benefits to the growth and survival of rearing salmonids (Larkin and Slaney 1996).

Sidechannels— There may be further opportunities for complexing of existing sidechannels to improve their rearing and overwintering capability, or creation of new sidechannels in the San Juan and Gordon watersheds. However, it should be recognized that these only provide localized benefits and should never be done in place of watershed scale restoration efforts on the hillslope and riparian areas. In addition, sites would have to be selected and works done, such that no further damage is done to existing riparian zones.

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Appendix A. Questions asked during personal interviews.

1. Which streams or lakes are you most familiar with in terms of habitat condition (physical and/or water quality)?
2. Within these streams and rivers, where are the highly productive habitats located and for which species/life stages?
3. Over the entire watershed(s), what is the most limiting habitat type for specific life stages (adult, spawner, egg, fry, alevin, fry etc) of each species?
4. Which streams have the most limited habitat for salmon?
5. Are there seasonal limitations in habitat quality in any of these streams (e.g., overwintering habitat, low summer flows)?
6. How have adjacent upland activities in the watershed negatively affected salmon habitat and their survival, growth or reproduction?
7. What is the area of land cover alteration in the watershed? i.e. logging/road development ?
8. Have you observed or heard of salmon locations in the past where they are no longer present?
9. Are there obstructions to fish migration that are there now that were not there in the recent past (10 years)?
10. Are there any specific habitats in the estuary that should be noted as valuable/highly productive?
11. What habitat limitations exist in the estuarine environment?
12. Are there indicators of habitat degradation in the estuary, and what factors have contributed to estuarine habitat loss?
13. In areas where habitat restoration measures have been taken, what is the state of their functionality?
14. What restoration projects would you recommend to improve habitat quality to address limiting factors in which stream/river?

Appendix B. San Juan River habitat status tables (by Naomi Palfrey).

Chinook Conservation Unit - San Juan River Watershed Habitat Status

Species: Oncorhynchus tshawytscha

Life Stage	Known limiting factors	Known high value habitats	Performance Indicator(s) for habitat limiting factors	Performance Indicator(s) Status	Possible measures to address limiting factors	Possible measures to maintain productivity	Data Gaps	Habitat Protection & Restoration Measures Undertaken
Spawner/Egg/ Alevin	The San Juan channel has widened and straightened as a result of sedimentation from tributaries[15] and impact to off-channel habitat through access blocking[2]. Logging has caused hillslope erosion and bank instability, channel simplifications, reduction of critical instream LWD and loss of quality fish habitat[3]. In the San Juan River drainage there is a general decrease in flood response time to rainfall; increased amounts of unstable debris; increased streambank erosion; increased fines content of gravels and increased infilling of pools with fines[15]. Secondary channels have disappeared from erosion, infilling with fines and or blockage by woody debris[15]. Woody debris is limited in areas of the mainstem, Fairy, Lens, Five Mile, lower Renfrew, lower Harris and some reaches of Four Mile Creeks. Four Mile Creek subject to significant deposition of sands and gravels, created by upstream hillslope failures, and bank erosion at sites along the lower river. Lower Renfrew , lower Harris[13], and in San Juan River below Harris and Lens Creeks, junction increased deposition of sediment[1]. Unstable slope terrain in: Renfrew/Granite and Lens Creeks[2]. Non-deactivated roads in: San Juan, Renfrew/Granite Cr Harris and Lens Creeks[2]. Recently (2001) logged gullies in: Lower San Juan, Renfrew/Granite, Harris and Lens Creeks[2]. Landslides in: San Juan (54), Renfrew/Granite Cr (115), Lower Harris (8), Upper Harris (72), and Lower Lens (78). There are riparian impacts to: , Lower Lens, Upper Harris Creeks and Lower San Juan. Flooding in Sweeper Run Back Channel[1]. There is a loss of spawning areas in the mainstem due to aggradation and sub-surface flows as a result of heavy bedload deposition[17]. Frequent signs of bank failure downstream of Harris Creek[15]. Mainstem aggradation has limited[17] quality chinook spawning habitat in the watershed[21,] . In the lower mainstem and Harris Creek there are not an abundance of backchannels or side stream vegetation[21].	Renfrew/Granite Creek above Fairy lake[21] and Lens Relic Channel 1 has high quality spawning habitat[2]. Lower Harris[17,13] and Lens Creeks and San Juan mainstem contain the best habitat[13]. Annual spawning sites include the mainstem San Juan between Fairy Lake and Harris Creek, the mainstem just above Harris Creek, the mainstem above Lens Creek, and Renfrew Creek between Fairy Lake and 5 Mile Creek[21].	**Pressure indicators: R**oad density; % stream length channelization/floodplain connectivity; Stream discharge. **State indicators:** Water Chemistry (Suspended sediment); Accessible stream length/barriers; Accessible off-channel habitat area; Channel stability measures (pool:riffle, channel width:depth ratios, etc); Stream discharge measures (base & peak flows); Water temperature; Sediment, substrate; LWD, instream cover; Water chemistry (nutrients, D.O., pH, conductivity, contaminants).	Landslide inventory table, Flow data, Hillslope summary is available in San Juan Watershed Restoration Plan, EBA (2001)[2]. Water quality sampling has been performed[3]. Renfrew Creek (08HA069) 1997 - current Flow Data available. Flow data and sediment data for the mainstem San (08HA010) 1959 - current[23] is also available.	Renfrew/Granite Creek is a candidate for enhancement (reach 1)[1,2]. Bedload movement and bank scour should be addressed as a priority[1]. Revegetation planned across the floodplains of the San Juan River and Renfrew, Harris and Lens Creeks[1]. Placement of debris and stabilization in Fairy, Five Mile, and some reaches of Four Mile Creeks[1]. Develop groundwater-fed channels in Five Mile Creeks[1]. Development of a debris jam to buffer the effects of flood flows in Sweeper Run Back Channel[1]. Potential enhancement in Renfrew Relic Channel and Harris relic Channel further assessment was needed before excavation. Landslide and gullies rehabilitation prescriptions for the Lower Lens Creek sub-basin, the south San Juan Ridge and Renfrew Creek[2]. Removal of all barrier structures at road crossings and continue deactivating high risk roads[17]. Addition of LWD in Five Mile and Renfrew Creeks[16]. A beaver monitoring program is needed on built side channels[14]. Salmon stock assessment[14]. Increase stream complexity[14].	Increase the abundance of pool habitat (particularly at low flows) and adult holding habitat[1,2]. Additional gravel placement for spawning/incubation success[5]. Placement of LWD structures for cover and pool formation.	Need a updated terrain stability assessment[17]. A comprehensive document is needed that isolates where problem areas are within the watershed[17]. Need assessment of past restoration works to further recommendations for future restoration[18].	Riparian restoration in the San Juan River and Renfrew, Harris, Bavis and Lens Creeks (and in Halliday Creek including: log jam stabilization, LWD and rock placement, beaver dam removal, berm construction, side channel construction, Riffle-pool construction and Wattling, upwelling pool construction, pool excavation, debris jam modification, gravel bar planting and bank stabilization, conifer release, planting and girdling in various locations mentioned above)[1,2,5,6,16]. Twenty-four high risk landslides have been treated in the San Juan Watershed[2]. Between 1994 and 2001 a total of 106 km of forest road has been deactivated in: San Juan, Bavis Cr, Murton Cr, Falls Cr, Mosquito Cr, Sam Cr, Blakeney Cr, Renfrew/Granite Cr, Harris Cr, Hemmingsen Cr, Lower Lens Cr, Red Cr and Three Arm Cr[2,17]. In 1999 a side channel was constructed on the east side of lower Four Mile Cr[3,5]. A controlled gravity fed intake system provides consistent year-round flow from Lens Creek mainstem near the Lens Mainline bridge crossing[3].
Fry/Juvenile Summer (N/A for immediate ocean migrants, i.e.. pink, chum, some chinook & sockeye poplns)	Same as above in Spawner/Egg/Alevin column with the exception of flood events, weight being given to fish stranding during low flow periods[2]. Four Mile Creek and Renfrew Relic Channel dewater during low flows[1,2]. In the San Juan watershed major sub-basins inorganic nutrient levels may be limiting productivity[3] (Harris, Lens, Fleet)[3,15].	Chinook fry migrate down the mainstem San Juan River to the estuary[14]. Rotary screw trapping indicated that some fry rear for a period of time in the river before migrating to the estuary, however, whether some remain until smolting is unknown as smolts appeared to avoid the trap[23].	**Pressure indicators:** Total Land Cover Alterations; % stream length riparian zone alteration; road density; % stream length channelization/floodplain connectivity; Stream discharge. **State indicators:** Water Chemistry (Suspended sediment); Accessible stream length/barriers; Accessible off-channel habitat area; Channel stability measures (pool:riffle, channel width:depth ratios, etc); Stream discharge measures (base & peak flows); Water temperature; Sediment, substrate; LWD, instream cover; Water chemistry (nutrients, D.O., pH, conductivity, contaminants).	same as above.	Same as above A structure in Pete's Pond beaver dam that would allow unrestricted access between the lake and the outlet stream for juvenile recruits[3]. Improve summer rearing habitat through the creation of additional groundwater channels. Creation or enhancement of off-channel rearing habitat[1,2]. Increase the abundance of pool habitat (particularly at low flows)[1,2]. Monitor and maintain Lens Cr berm, as well as monitor for beaver activity[5,14].	Increase the abundance of pool habitat (particularly at low flows) and adult holding habitat[1,2]. Improvement of water quality by maintaining nutrient levels through fertillization[1,2,3,5]. Placement of LWD structures for cover and pool formation.	Unknown percentage of fry that immediately outmigrate vs. Those that rear in the system for the year.	Same as above. Stream enrichment in the San Juan River and in the Lower Harris, Renfrew and Lens Creeks[1,2,5]. Wetland outlet modifications have improved fish access to wetland in Lens Cr[5].
Fry/Juvenile Winter (N/A for immediate ocean migrants as above)	Same as above in Spawner/Egg/ Alevin column with emphasis on lack of cover and limited nutrients[21], high winter flows, scouring and deposition of sediments[14].	Chinook fry migrate down the mainstem San Juan River to the estuary[14]. One yr+ presmolts were trapped in Lens and Harris Creeks in March[21].	Same as above with exception to water temperature.	same as above.	A structure in Pete's Pond beaver dam that would allow unrestricted access between the lake and the outlet stream for juvenile recruits[3].	same as above.	Unknown percentage of fry that immediately outmigrate vs. Those that rear in the system for the year.	Same as above. Stream enrichment in the San Juan River and in the Lower Harris, Renfrew and Lens Creeks[1,2,5]. Wetland outlet modifications have improved fish access to wetland in Lens Cr[5].
Smolt	In the San Juan watershed major sub-basins, inorganic nutrient levels may be limiting productivity[3,18] (Harris, Lens, Fleet)[15]. Hemmingsen Cr has channel aggradation, loss of pools and in-stream LWD, there is also potential for fish stranding during low flows[2]. Red Cr main had a culvert that appeared to be a migration barrier[1].Some degree of stranding and isolation does occur in isolated areas after peak flows dissipate[3,15].	Migrate down the mainstem San Juan River to the estuary[14].	**Pressure indicators:** Total Land Cover Alterations; % stream length riparian zone alteration; road density; % stream length channelization/floodplain connectivity; % of estuary foreshore alteration and Stream discharge. **State indicators:** Water Chemistry (Suspended sediment); Accessible stream length/barriers; Channel stability measures (pool:riffle, channel width:depth ratios, etc); Stream discharge measures (base & peak flows); Sediment, substrate; LWD, instream cover; Water chemistry (nutrients, D.O., pH, conductivity, contaminants).	same as above.	Monitoring of wild fry outmigration[14]. Harris Creek (Hatchery) smolt trapping and monitoring[17].	Improvement of water quality by increasing nutrient levels[1,2,5]. Monitor and maintain Lens Cr berm, as well as monitor for beaver activity[5].	Unknown specifics on mainstem and estuarine[14] use. Need more investigations of what habitat did and does exist[17].	Same as above. Beaver dam removal and berm construction in Lens Creek and wetland outlet modification[1,2,5,6].
Marine Coastal	There is degradation of estuarine habitat in the form of aggradation and deposition[17,18]. There is a lack of eelgrass and deposition of sediments in the estuary, as well as negative influences from boat wash[21].	Sedge meadows and eelgrass locations are really productive rearing areas[17]. Juveniles rear in the tidally influenced lower river (seined in May and June) and estuary[21].	**Pressure indicators:** Total Land Cover Alterations; % of estuary foreshore alteration. % estuary foreshore altered (carex, typha, riparian zone); % surface area disturbed inshore (eel grass zone); % surface area disturbed offshore (e.g., log booms – subtidal); Amount of vessel traffic **State indicators:** Accessible off-channel habitat area; Water Chemistry (Suspended sediment); Estuarine habitat area; River or stream discharge; Marine riparian vegetation; Spatial distribution of wetlands, mudflats, Fish.	unknown		Protect the sedge meadows and eelgrass locations that are really productive rearing areas[17].	Unknown specifics on estuarine use[14]. Need more investigations of what habitat did and does exist[17].	Unknown
~~Marine Offshore~~								
Returning Adult Migration	Same as above in Spawner/Egg/Alevin column. A series of steep cascades located 11 km from the mouth of Harris Cr is a barrier for all fish in most years[3,5]. Access issues on Baird Creek (log pile on bedrock) and on Stanley Creek (blocked culvert) [21]. A beaver dam across the outlet of Pete's Pond was thought to severely restrict fish passage[14,20]. Significant Log jam on the mainstem may be restricting upward migration of salmon during low flow periods, and predation is a problem[14].	Mainstem San Juan River.[1] Mainstem Harris Cr[17]. Chinook have been observed holding at the confluence of Harris and Hemmingsen Creek[21].	**Pressure indicators: R**oad density; % stream length channelization/floodplain connectivity; Stream discharge. **State indicators:** Water Chemistry (Suspended sediment); Accessible stream length/barriers; Accessible off-channel habitat area; Channel stability measures (pool:riffle, channel width:depth ratios, etc); Stream discharge measures (base & peak flows); Water temperature; Sediment, substrate; LWD, instream cover.	same as Spawner/Egg/ Alevin column.	Placement of debris in Pixie Cr, Dump Cr, Halliday Cr, Lens Cr, and upper Falls Cr, Five Mile Cr, and some reaches of Four Mile Cr. Harris Cr and Tremblay Cr debris placement and stabilization. Culvert replacement at Red Cr main (Stanley Cr). Gravel placement for spawning success[5]. A structure in Pete's Pond beaver dam that would allow unrestricted access between the lake and the outlet stream for adult spawners[3].	Increase the abundance of: pool habitat (particularly at low flows) and adult holding habitat. Additional gravel placement for spawning success[5].	Same as in Spawner/Egg/ Alevin column. Unknown component of Hatchery returning adults vs. wild[22].	Same as above. Wetland outlet modifications have improved fish access to wetland in Lens Cr[5].

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Chum Conservation Unit - San Juan River Watershed Habitat Status

Species: Oncorhynchus keta

Life Stage	Known limiting factors	Known high value habitats	Performance Indicator(s) for habitat limiting factors	Performance Indicator(s) Status	Possible measures to address limiting factors	Possible measures to maintain productivity	Data Gaps	Habitat Protection & Restoration Measures Undertaken
Spawner/Egg/ Alevin	In the San Juan River drainage there is a general decrease in flood response time to rainfall; increased amounts of unstable debris; increased streambank erosion; increased fines content of gravels and increased infilling of pools with fines[15]. Secondary channels have disappeared from erosion, infilling with fines and or blockage by woody debris[15]. Inorganic nutrient levels may be limiting productivity in the San Juan watershed [3,18]. Wood debris is limited in Fairy Cr, Lens Cr, Five Mile Cr, lower Renfrew Cr and lower Harris Cr. Lower Renfrew Cr, lower Harris Cr, and in San Juan River below Harris and Lens Cr, junction increased deposition of sediment[1]. San Juan channel has widened and straightened as a result of sedimentation from tributaries[15] and impact to off-channel habitat through access blocking[2]. Unstable slope terrain in: Renfrew/Granite Cr and Lens Creeks[2]. 185 km (in 2001) of non-deactivated roads in the San Juan, Renfrew/Granite, Harris and Lens Creeks[2]. Logging has caused hillslope erosion and bank instability, channel simplifications, reduction of critical instream LWD and loss of quality fish habitat[3]. Recently (2001) logged gullies in: Lower San Juan River, Renfrew/Granite, Harris and Lens Creeks[2]. Landslides in: San Juan (54), Renfrew/Granite Cr (115), Lower Harris (8) and Lower Lens (78). There is riparian impacts to Lower Lens Creek and Lower San Juan river. Flooding in Sweeper Run Back Channel[1]. Frequent signs of bank failure downstream of Harris Creek[15]. Chum spawning habitat quality is limiting production[21]. Spawning habitat is effected by increased bedload movement and sediment deposition and high flow events[13].	Lower mainstem San Juan. In reach 1 chum salmon were observed spawning areas with superior patches of gravel[15]. Chum spawn on the mainstem a few hundred meters above where the Fairy Lake drainage confluences with the mainstem, and in the lower 200 m of Fairy Creek, above 5 Mile Creek (on Renfrew Creek), Lower Lens Creek and on the mainstem at the confluence with Pixie Creek[21].	**Pressure indicators: R**oad density; % stream length channelization/floodplain connectivity; Stream discharge. **State indicators:** Water Chemistry (Suspended sediment); Accessible stream length/barriers; Accessible off-channel habitat area; Channel stability measures (pool:riffle, channel width:depth ratios, etc); Stream discharge measures (base & peak flows); Water temperature; Sediment, substrate; LWD, instream cover; Water chemistry (nutrients, D.O., pH, conductivity, contaminants).	Landslide inventory table, Flow data, Hillslope summary is available in San Juan Watershed Restoration Plan, EBA (2001)[2]. Water quality sampling has been performed[3]. Renfrew Creek (08HA069) 1997 - current Flow Data available. Flow data and sediment data for the mainstem San (08HA010) 1959 - current[23] is also available.	Bedload movement and bank scour should be addressed before instream enhancement[1]. Revegetation planned across the floodplains of the San Juan River and Renfrew, Harris and Lens Creeks[1]. Potential enhancement in Renfrew Relic Channel and Harris relic Channel further assessment was needed before excavation. Forty-six km of road deactivation[2]. Landslide and gullies rehabilitation prescriptions for the Lower Lens Creek sub-basin, the south San Juan Ridge and Renfrew Creek. Gravel placement for spawning/incubation success including[1,5]. Removal of all barrier structures at road crossings and continue deactivating high risk roads[17]. Harris Creek (Hatchery) smolt trapping and monitoring[17]. Salmon stock assessment[14]. Increase stream complexity[14].	Increase the abundance of pool habitat (particularly at low flows) and adult holding habitat[1,2]. Improvement of water quality by maintaining nutrient levels through fertillization[1,2,3,5]. Additional gravel placement for spawning/incubation success[5].		Riparian restoration in the San Juan River and Renfrew, Harris and Lens Creeks (including: log jam stabilization, LWD and rock placement, beaver dam removal, berm construction, side channel construction, Riffle-pool construction and Wattling, upwelling pool construction, pool excavation, debris jam modification, gravel bar planting and bank stabilization, conifer release, planting and girdling)[1,2,5,6]. Twenty-four high risk landslides have been treated in the San Juan Watershed[2]. Between 1994 and 2001 a total of 106 km of forest road has been deactivated in the San Juan watershed. Stream enrichment in the San Juan River in 2001/02 and in the Lower Harris, Renfrew and Lens Creeks[1,2,5].
Fry/Juvenile Summer (N/A for immediate ocean migrants, i.e.. pink, chum, some chinook & sockeye	N/A	N/A	N/A	same as above.	N/A	N/A		N/A
Fry/Juvenile Winter (N/A for immediate ocean migrants as above)	N/A	N/A	N/A	same as above.	N/A	N/A		N/A
Smolt	Same as above. There is degradation of estuarine habitat in the form of aggradation and deposition[17,18].	Sedge meadows and eelgrass locations are really productive rearing areas[17].	**Pressure indicators:** Total Land Cover Alterations; % stream length riparian zone alteration; road density; % stream length channelization/floodplain connectivity; % of estuary foreshore alteration and Stream discharge. **State indicators:** Water Chemistry (Suspended sediment); Accessible stream length/barriers; Channel stability measures (pool:riffle, channel width:depth ratios, etc); Stream discharge measures (base & peak flows); Sediment, substrate; LWD, instream cover; Water chemistry (nutrients, D.O., pH, conductivity, contaminants).	same as above.	A habitat assessment should be done to determine where Chum are currently using habitat.	Same as above	Not much information on locations and habitat use.	Same as Spawner/Egg/ Alevin column.
Marine Coastal	There is degradation of estuarine habitat in the form of aggradation and deposition[17,18].	Sedge meadows and eelgrass locations are really productive rearing areas[17].	**Pressure indicators:** Total Land Cover Alterations; % of estuary foreshore alteration. % estuary foreshore altered (carex, typha, riparian zone); % surface area disturbed inshore (eel grass zone); % surface area disturbed offshore (e.g., log booms – subtidal); Amount of vessel traffic **State indicators:** Accessible off-channel habitat area; Water Chemistry (Suspended sediment); Estuarine habitat area; River or stream discharge; Marine riparian vegetation; Spatial distribution of wetlands, mudflats, Fish.	Unknown	Unknown	Protect the sedge meadows and eelgrass locations that are really productive rearing areas[17].	Unknown specifics on estuarine use[14]. Need more investigations of what habitat did and does exist[17].	Unknown
~~**Marine Offshore**~~								
Returning Adult Migration	Same as above with emphasis on low water flows that may affect returning spawners reach their natal streams, and reduce spawning habitat throughout the watershed.	Same as Spawner/Egg/ Alevin column.	**Pressure indicators: R**oad density; % stream length channelization/floodplain connectivity; Stream discharge. **State indicators:** Water Chemistry (Suspended sediment); Accessible stream length/barriers; Accessible off-channel habitat area; Channel stability measures (pool:riffle, channel width:depth ratios, etc); Stream discharge measures (base & peak flows); Water temperature; Sediment, substrate; LWD, instream cover.	Same as Spawner/Egg/ Alevin column.	Same as above in Spawner/Egg/Alevin column. Monitoring of known spawning areas.	Increase the abundance of pool habitat (particularly at low flows) and adult holding habitat[1,2]. Additional gravel placement for spawning/incubation success[5].		Same as above in Spawner/Egg/Alevin column.

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21. Helen and Jeff Jones. Personal Communications March, 2011

Coho Conservation Unit - San Juan River Watershed Habitat Status

Species: Oncorhynchus kisutch

Life Stage	Known limiting factors	Known high value habitats	Performance Indicator(s) for habitat limiting factors	Performance Indicator(s) Status	Possible measures to address limiting factors	Possible measures to maintain productivity	Data Gaps	Habitat Protection & Restoration Measures Undertaken
Spawner/Egg/ Alevin	In the San Juan River drainage there is a general decrease in flood response time to rainfall; increased amounts of unstable debris; increased streambank erosion; increased fines content of gravels and increased infilling of pools with fines15. Secondary channels have disappeared from erosion, infilling with fines and or blockage by woody debris15. The most limiting habitat issue for coho is lost connectivity, channel aggradation and loss of riparian17. There is limited woody debris in Fairy Cr, Pixie Cr, Mosquito Cr, Halliday Cr, Lens Cr, Tremblay Cr, upper Falls Cr, Five Mile Cr, and some reaches of Four Mile Cr, lower Renfrew Cr and lower Harris Cr. Four Mile Cr subject to significant deposition of sands and gravels, created by upstream hillslope failures, and bank erosion at sites along the lower river. Lower Renfrew Cr, lower Harris Cr, and in San Juan River below Harris and Lens Cr, junction increased deposition of sediment1. San Juan channel has widened and straightened as a result of sedimentation from tributaries15 and impact to off-channel habitat through access blocking2. Hemmingsen Cr has channel aggradation, loss of pools and in-stream LWD, there is also potential for fish stranding during low flows2. There were road failures in Three Arm and Bavis Creeks contributing large amounts of sediment upstream of Co spawning and rearing grounds17. Unstable slope terrain in: Falls Cr, Bavis Cr, Red Cr, Sam Cr, Three Arm Cr, Blakeney Cr and Renfrew/Granite Cr, Hemmingsen Cr and Lens Cr2. 185 km (in 2001) of non-deactivated roads in: San Juan, Falls Cr, Bavis Cr, Red Cr, Three Arm Cr, Sam Cr, Blakeney Cr, Renfrew/Granite Cr, Harris Cr, Hemmingsen Cr and Lens Cr2. Logging has caused hillslope erosion and bank instability, channel simplifications, reduction of critical instream LWD and loss of quality fish habitat3. Recently (2001) logged gullies in: Lower San Juan, Murton Cr, Falls Cr, Mosquito Cr, Bavis Cr, Red Cr, Sam Cr, Three Arm Cr, Renfrew/Granite Cr, Harris Cr, Hemmingsen Cr and Lens Cr2. Landslides in: San Juan (54), Hemmingsen Cr (163), Falls Cr (3), Mosquito Cr (17), Bavis Cr (20), Red Cr (14), Sam Cr (7), Three Arm Cr (29), Blakeney Cr (55), Renfrew/Granite Cr (115), Lower Harris (8), Upper Harris (72), Hemmingsen Cr (163), Lower Lens (78). There is riparian impacts to: Hemmingsen Cr, Lower Lens Cr, Upper Harris Cr and Lower San Juan. There is periodic flooding in Sweeper Run Back Channel1. Crompton Slough lacks complex cover for fish in its larger open water areas3. There is a loss of connectivity between habitats; spawners often access above road areas in high flows which become isolated after the peak and spawners dry up17. There is a loss of spawning areas due to sub-surface flows as a result of heavy bedload deposition17. Frequent signs of bank failure downstream of Harris Creek15. Red Main, Mosquito and Bavis Creeks have had a lot of habitat disturbance17. In Blowdown Creek beside the road, Coho spawners frequently migrate there and are trapped to dry up21.	Productive tributaries to the San Juan include: mainstem, Harris, Renfrew and Lens Creeks and tributaries: Four Mile, Five Mile and Tremblay, J.J. Baird, and Murton Creeks[1,2,16]. Van Den Slough is considered the most important secondary channel. Stink Current Back Channel is one of the most productive channels on the San Juan[1,2]. Approximately 92.5% of all coho habitat is within six river systems: Fleet, Renfrew, Lens, Hemmingsen and Harris Creeks, and the San Juan mainstem[7]. Coho have been observed spawning in lower Murton Creek, Lower Defiance Creek, middle Falls Creek, lower Bavis Creek, confluence of Hemmingsen and Harris Creeks, below the Harris Creek bridge, lower Lens Creek and in Pixie Creek from the road down[21].	**Pressure indicators: R**oad density; % stream length channelization/floodplain connectivity; Stream discharge. **State indicators:** Water Chemistry (Suspended sediment); Accessible stream length/barriers; Accessible off-channel habitat area; Channel stability measures (pool:riffle, channel width:depth ratios, etc); Stream discharge measures (base & peak flows); Water temperature; Sediment, substrate; LWD, instream cover; Water chemistry (nutrients, D.O., pH, conductivity, contaminants).	Landslide inventory table, Flow data, Hillslope summary is available in San Juan Watershed Restoration Plan, EBA (2001)[2]. Water quality sampling has been performed[3]. Renfrew Creek (08HA069) 1997 - current Flow Data available. Flow data and sediment data for the mainstem San (08HA010) 1959 - current[23] is also available.	Bedload movement and bank scour should be addressed before instream enhancement[1]. Revegetation planned across the floodplains of the San Juan River and Renfrew, Harris and Lens Creeks[1]. Placement of debris and stabilization in Fairy Cr, Pixie Cr, Dump Cr, Halliday Cr, and upper Falls Cr, Five Mile Cr, and some reaches of Four Mile Cr; Stink Current Back Channel and Tremblay Cr[1]. Develop groundwater-fed channels in lower Blowdown Cr and Five Mile Cr[1]. Development of a debris jam to buffer the effects of flood flows in Sweeper Run Back Channel[1]. Potential enhancement in Renfrew Relic Channel and Harris relic Channel further assessment was needed before excavation. Gravel placement in Stink Current Creek[1]. Forty-six km of road deactivation[2]. Landslide and gullies rehabilitation prescriptions for the Lower Lens Cr sub-basin, the south San Juan Ridge, Renfrew Cr and Hemmingsen Cr[2]. Riparian and stand management treatments along upper Hemmingsen Cr[2]. Gravel placement for spawning/incubation success including Stink Current Cr[1,5]. Potential sites were identified in Crompton Slough for tree bundling[3]. Off-channel habitat can be developed in Harris beneath the highway, and access above the road can be blocked to spawners trying to migrate (dries up)[17]. Removal of all barrier structures at road crossings and continue deactivating high risk roads[17]. Harris Creek (Hatchery) smolt trapping and monitoring[17]. Addition of LWD in Five Mile, Renfrew, Georges channel, Mosquito and Coal Creek[16]. A beaver monitoring program is needed on built side channels[14]. Salmon stock assessment and coho standing stock density[14]. Increase stream complexity[14].	Increase the abundance of pool habitat (particularly at low flows) and adult holding habitat[1,2]. Improvement of water quality by maintaining nutrient levels through fertillization[1,2,3,5]. Additional gravel placement for spawning/incubation success[5].	Need an updated terrain stability assessment[17]. A comprehensive document is needed that isolates where problem areas are within the watershed[17]. Need assessment of past restoration works to further recommendations for future restoration[18].	Riparian restoration in the San Juan River and Renfrew (including mainstem, Five Mile Creek, Georges channel and upwelling pools), Mosquito, Harris, Bavis and Lens Creeks (including: log jam stabilization, LWD and rock placement, beaver dam removal, berm construction, side channel construction, Riffle-pool construction and Wattling, upwelling pool construction, pool excavation, debris jam modification, gravel bar planting and bank stabilization, conifer release, planting and girdling)[1,2,5,6,12]. Twenty-four high risk landslides have been treated, and 113 sites (seeding, planting, bioengineering and hydroseeding have been limited to the Hemmingsen Cr and Mosquito Cr, sub-basins) in the San Juan Watershed[2]. Between 1994 and 2001 a total of 106 km of forest road has been deactivated in: San Juan, Bavis Cr, Murton Cr, Falls Cr, Mosquito Cr, Sam Cr, Blakeney Cr, Renfrew/Granite Cr, Harris Cr, Hemmingsen Cr, Lower Lens Cr, Red Cr and Three Arm Cr[2]. Stream enrichment in the San Juan River in 2001/02 and in the Lower Harris, Hemmingsen, Renfrew and Lens Creeks[1,2,5]. Gravel (specific to coho) placement in Lens Cr sidechannel (in 2002)[5]. Wetland outlet modifications have improved fish access to wetland in Lens Cr[5]. In 1999 a side channel was constructed on the east side of lower Four Mile Cr[3,5]. A controlled gravity fed intake system provides consistent year-round flow from Lens Creek mainstem near the Lens Mainline bridge crossing[3]. In 1997 three coniferous tree bundles were anchored in Crompton Slough[3]. Off channel habitat was created in Georges channel (Renfrew Creek), Tremblay and Coal Creeks[16]. Addition of LWD in Five Mile, Renfrew, Georges channel, Mosquito and Coal Creek[16].
Fry/Juvenile Summer (N/A for immediate ocean migrants, i.e.. pink, chum, some chinook & sockeye poplns)	Same as above in Spawner/Egg/Alevin column with the exception of flood events, weight being given to fish stranding during low flow periods[2]. Four Mile Cr, Renfrew Relic Channel and Blowout Cr and Mosquito Cr dewater during low flows[1,2]. In the San Juan watershed inorganic nutrient levels may be limiting productivity[3,15,18] (Harris, Lens, Fleet)[3,15]. Relatively limited distribution and abundance of low gradient habitats with complex woody and pool cover[15,19]. A beaver dam across the outlet of Pete's Pond was thought to severely restrict fish passage[14,20].	Approximately 92.5% of all coho habitat is within six river systems: Fleet, Renfrew, Lens, Hemmingsen and Harris Creeks, and the San Juan mainstem[7]. J.J. Baird Craven Den Slough, Harris Cr, Renfrew Cr, Lens Cr, Four Mile, Five Mile, Tremblay Cr, Murton Cr., Pixie Cr. Relic Channel Complex has significant summer habitat[1,13]. Lower Lens Side channel has successful rearing[13]. Pool habitat is abundant in reaches 5 and 6 at low flows and good for rearing purposes (fry)[15]. Coho fry have been observed in lower Murton Creek, lower mosquito Creek, in the mainstem San Juan above the confluence with Lens Creek, in mainstem at the confluence with Pixie Creek, Harris Creek side channel and below the confluence of Harris and Hemmingsen Creeks [21]. Granite Creek has highly productive habitat for juvenile coho[21].	**Pressure indicators:** Total Land Cover Alterations; % stream length riparian zone alteration; road density; % stream length channelization/floodplain connectivity; Stream discharge. **State indicators:** Water Chemistry (Suspended sediment); Accessible stream length/barriers; Accessible off-channel habitat area; Channel stability measures (pool:riffle, channel width:depth ratios, etc); Stream discharge measures (base & peak flows); Water temperature; Sediment, substrate; LWD, instream cover; Water chemistry (nutrients, D.O., pH, conductivity, contaminants).	same as above.	Same as above. Dewatering creeks should be assessed so to not trap fish in summer[1]. Construction of a structure to facilitate the emigration of fish from Pixie Lake[19]. Off channel habitat should keep being addressed[17].	Improve summer rearing habitat through the creation of additional groundwater channels. In the Tremblay Cr wetland, further summer assessment needed[1]. Creation or enhancement of off-channel rearing habitat[1,2]. Maintain the existing (1996) buffer strip between the Van Den slough and the San Juan River and Harris Creek[1]. Increase the abundance of pool habitat (particularly at low flows)[1,2]. Monitor and maintain Lens Cr berm, as well as monitor for beaver activity[5].	same as above.	Same as above. A structure in Pete's Pond beaver dam that would allow unrestricted access between the lake and the outlet stream for adult spawners and juvenile recruits[3].
Fry/Juvenile Winter (N/A for immediate ocean migrants as above)	Same as above in Spawner/Egg/Alevin column with weight on winter high flows and flooding[1]. Relatively limited distribution and abundance of low gradient habitats with complex woody cover[15,19]. Over-winter mainstem rearing is limited[21]. A beaver dam across the outlet of Pete's Pond was thought to severely restrict fish passage[14,20].	Approximately 92.5% of all coho habitat is within six river systems: Fleet, Renfrew, Lens, Hemmingsen and Harris Creeks, and the San Juan mainstem[7].Harris Relic Channel Complex and Crossover Relic Channel has significant over-wintering populations. Tremblay Cr has a large wetland providing high quality over-wintering habitat[1]. Murton Cr, J.J. Baird Cr, Renfrew Cr, Mosquito Cr, Bavis Creek, Stink Current Creek, Pixie Cr. Relic Channel Complex has significant over-wintering populations[1]. Numerous Co fry were observed in April 1996 in all these locations and these streams do not dewater during the low-flow period1. Other accessible habitat include Falls and Mosquito Creeks[1,2]. Pool habitat is abundant at low flows in reaches 5 and 6 and good for rearing purposes (fry)[15]. Coho fry have been observed in lower Murton Creek, lower mosquito Creek, in the mainstem San Juan above the confluence with Lens Creek, in mainstem at the confluence with Pixie Creek, Harris Creek side channel and below the confluence of Harris and Hemmingsen Creeks [21]. Granite Creek has highly productive habitat for juvenile coho[21].	Same as above with exception to water temperature.	same as above.	Revegetation planned across the floodplains of the San Juan River and Renfrew, Harris and Lens Creeks[1]. Placement of debris in Fairy Cr, Pixie Cr, Dump Cr, Halliday Cr, Lens Cr, and upper Falls Cr, Five Mile Cr, and some reaches of Four Mile Cr. Harris Cr and Tremblay Cr debris placement and stabilization. Construction of a structure to facilitate the emigration of fish from Pixie Lake and or breaching of the beaver dam[19]. Monitoring of wild fry outmigration[14].	Creation or enhancement of off-channel, 0ver-wintering and rearing habitat[1,2]. Maintain the existing (1996) buffer strip between the Van Den slough and the San Juan River and Harris Creek[1]. Improvement of water quality by increasing nutrient levels[1,2,5]. Increase the abundance of pool habitat (particularly at low flows)[1,2]. Monitor and maintain Lens Cr berm, as well as monitor for beaver activity[5].	same as above.	Same as above and including the creation of overwintering channels in the San Juan River and Renfrew, Harris, Bavis and Lens Creeks[1,2,5,6]. A structure in Pete's Pond beaver dam that would allow unrestricted access between the lake and the outlet stream for juvenile recruits[3].
Smolt	Same as above in Spawner/Egg/Alevin column and Red Cr main (trib of Stanley Cr) had a culvert that appeared to be a migration barrier[1].In the San Juan watershed major sub-basins, inorganic nutrient levels may be limiting productivity[3,18] (Harris, Lens, Fleet)[15]. Some degree of stranding and isolation does occur in isolated areas after peak flows dissipate[3,15]. Relatively limited distribution and abundance of low gradient habitats with complex woody cover[15,19].	Approximately 92.5% of all coho habitat is within six river systems: Fleet, Renfrew, Lens, Hemmingsen and Harris Creeks, and the San Juan mainstem7. Renfrew Cr, Mosquito Creek, Bavis Creek[1]. Approximately 92.5% of all coho habitat is within six river systems: Fleet, Renfrew, Lens, Hemmingsen and Harris Creeks, and the San Juan mainstem[7]. The largest coho producing area is the San Juan mainstem which accounted for 38% of the total maximum smolt production. The next most important systems include Harris, Hemmingsen, Lens and Renfrew (between 9 and 6% of production)[7]. Pool habitat is abundant and well suited to parr in reaches 1, 2, 5 and 6 at low flows[15].	**Pressure indicators:** Total Land Cover Alterations; % stream length riparian zone alteration; road density; % stream length channelization/floodplain connectivity; % of estuary foreshore alteration and Stream discharge. **State indicators:** Water Chemistry (Suspended sediment); Accessible stream length/barriers; Channel stability measures (pool:riffle, channel width:depth ratios, etc); Stream discharge measures (base & peak flows); Sediment, substrate; LWD, instream cover; Water chemistry (nutrients, D.O., pH, conductivity, contaminants).	same as above.	Same as above. Culvert replacement at Red Cr main (Stanley Cr)[1]. Construction of a structure to facilitate the emigration of fish from Pixie Lake[19].	Improvement of water quality by increasing nutrient levels[1,2,5]. A bypass structure in Pixie Lake would increase coho production, allowing smolts to emigrate unimpeded[3]. Monitor and maintain Lens Cr berm, as well as monitor for beaver activity[5].	Unknown specifics on estuarine use[14]. Need more investigations of what habitat did and does exist[17].	Same as above. Riparian restoration with weight on beaver dam removal and berm construction in Lens Creek and wetland outlet modification[1,2,5,6]. A fish counting fence was constructed in 2002 at the outlet of Lens Cr to enumerate out-migrating coho smolts[5,10].
Marine Coastal	There is degradation of estuarine habitat in the form of aggradation and deposition[17,18].	Sedge meadows and eelgrass locations are really productive rearing areas[17].	**Pressure indicators:** Total Land Cover Alterations; % of estuary foreshore alteration. % estuary foreshore altered (carex, typha, riparian zone); % surface area disturbed inshore (eel grass zone); % surface area disturbed offshore (e.g., log booms – subtidal); Amount of vessel traffic **State indicators:** Accessible off-channel habitat area; Water Chemistry (Suspended sediment); Estuarine habitat area; River or stream discharge; Marine riparian vegetation; Spatial distribution of wetlands, mudflats, Fish.	unknown	unknown	Protect the sedge meadows and eelgrass locations that are really productive rearing areas[17].	Unknown specifics on estuarine use[14]. Need more investigations of what habitat did and does exist[17].	unknown
~~**Marine Offshore**~~								
Returning Adult Migration	Same as above in Spawner/Egg/Alevin column. A series of steep cascades located 11 km from the mouth of Harris Cr is a barrier for all fish in most years[3,5]. Three obstructions were identified on Pixie Creek: a beaver dam across the outlet; a restricting culvert under the Bear Creek main and a 5.2 m falls[19]. Red Cr main had a culvert that appeared to be a migration barrier[1]. Adult holding potential was considered poor within reaches 5 and 6[15]. A beaver dam across the outlet of Pete's Pond was thought to severely restrict fish passage[14,20]. There is a beaver dam on Lens Creek side channel acting as a barrier to fish migration[14].	Approximately 92.5% of all coho habitat is within six river systems: Fleet, Renfrew, Lens, Hemmingsen and Harris Creeks, and the San Juan mainstem[7]. Burl Cr, Murton Cr, J.J. Baird Cr, Renfrew Cr, Mosquito Creek, Bavis Creek, Falls Cr., Lens Cr, Mosquito Cr.[1] Deep pools in reach 4 provide excellent holding potential for adult fish[15].	**Pressure indicators: R**oad density; % stream length channelization/floodplain connectivity; Stream discharge. **State indicators:** Water Chemistry (Suspended sediment); Accessible stream length/barriers; Accessible off-channel habitat area; Channel stability measures (pool:riffle, channel width:depth ratios, etc); Stream discharge measures (base & peak flows); Water temperature; Sediment, substrate; LWD, instream cover.	same as Spawner/Egg/ Alevin column.	Placement of debris in Pixie Cr, Dump Cr, Halliday Cr, Lens Cr, and upper Falls Cr, Five Mile Cr, and some reaches of Four Mile Cr. Harris Cr and Tremblay Cr debris placement and stabilization. Culvert replacement at Red Cr main (Stanley Cr). Gravel placement in Stink Current Creek[1]. Gravel placement for spawning success[5].	Increase the abundance of: pool habitat (particularly at low flows) and adult holding habitat. Improvement of water quality by increasing nutrient levels[1,2,5]. Additional gravel placement for spawning success[5].	Need assessment of past restoration works to further recommendations for future restoration[18]. Unknown component of Hatchery returning adults vs. wild[22].	Same as above in Spawner/Egg/Alevin column. A structure in Pete's Pond beaver dam that would allow unrestricted access between the lake and the outlet stream for adult spawners and juvenile recruits[3].

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Pink Conservation Unit - San Juan River Watershed Habitat Status

Species: Oncorhynchus gorbuscha

Life Stage	Known limiting factors	Known high value habitats	Performance Indicator(s) for habitat limiting factors	Performance Indicator(s) Status	Possible measures to address limiting factors	Possible measures to maintain productivity	Data Gaps	Habitat Protection & Restoration Measures Undertaken
Spawner/Egg/ Alevin	In the San Juan River drainage there is a general decrease in flood response time to rainfall; increased amounts of unstable debris; increased streambank erosion; increased fines content of gravels and increased infilling of pools with fines[15]. Secondary channels have disappeared from erosion, infilling with fines and or blockage by woody debris[15]. Inorganic nutrient levels may be limiting productivity in the San Juan watershed [3]. Limited woody debris in Fairy Cr and lower Renfrew Creek. Bank erosion at sites along the lower river. Lower Renfrew Cr and in San Juan River below Harris and Lens Cr, junction increased deposition of sediment[1]. San Juan channel has widened and straightened as a result of sedimentation from tributaries[15] and impact to off-channel habitat through access blocking[2]. Unstable slope terrain in Renfrew/Granite Cr. Non-deactivated roads in San Juan River and Renfrew/Granite Creek[2]. Logging has caused hillslope erosion and bank instability, channel simplifications, reduction of critical instream LWD and loss of quality fish habitat[3]. Recently (2001) logged gullies in: Lower San Juan and Renfrew/Granite Creek[2]. Landslides in: San Juan (54) and Renfrew/Granite Creek. There is riparian impacts to the Lower San Juan River. Low numbers of pink salmon spawners and lack of available habitat is limiting production[21]. Spawning habitat is effected by increased bedload movement and sediment deposition and high flow events[13].	Lower mainstem San Juan. Pink salmon have been observed spawning on the mainstem San Juan between Harris and Lens Creeks[21]. Spawning occurs in even years, and has been observed below and 100m above Fairy Lake[22].	**Pressure indicators: R**oad density; % stream length channelization/floodplain connectivity; Stream discharge. **State indicators:** Water Chemistry (Suspended sediment); Accessible stream length/barriers; Accessible off-channel habitat area; Channel stability measures (pool:riffle, channel width:depth ratios, etc); Stream discharge measures (base & peak flows); Water temperature; Sediment, substrate; LWD, instream cover; Water chemistry (nutrients, D.O., pH, conductivity, contaminants).	Landslide inventory table, Flow data, Hillslope summary is available in San Juan Watershed Restoration Plan, EBA (2001)[2]. Water quality sampling has been performed[3]. Renfrew Creek (08HA069) 1997 - current Flow Data available. Flow data and sediment data for the mainstem San (08HA010) 1959 - current[23] is also available.	Bedload movement and bank scour should be addressed before instream enhancement[1]. Revegetation planned across the floodplains of the San Juan River[1]. Salmon stock assessment[14]. Increase stream complexity[14].	Increase the abundance of pool habitat (particularly at low flows) and adult holding habitat[1,2]. Improvement of water quality by maintaining nutrient levels through fertillization[1,2,3,5]. Additional gravel placement for spawning/incubation success[5].		Riparian restoration in the San Juan River[1]. Twenty-four high risk landslides have been treated in the San Juan Watershed[2]. Between 1994 and 2001 a total of 106 km of forest road has been deactivated in the San Juan watershed[2]. Stream enrichment in the San Juan River in 2001/02[1].
Fry/Juvenile Summer (N/A for immediate ocean migrants, i.e.. pink, chum, some chinook & sockeye poplns)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Fry/Juvenile Winter (N/A for immediate ocean migrants as above)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Smolt	Pink smolts emerge in the spring and migrate to the estuary/nearshore zone of ocean immediately[11].		**Pressure indicators:** Total Land Cover Alterations; % stream length riparian zone alteration; road density; % stream length channelization/floodplain connectivity; % of estuary foreshore alteration and Stream discharge. **State indicators:** Water Chemistry (Suspended sediment); Accessible stream length/barriers; Channel stability measures (pool:riffle, channel width:depth ratios, etc); Stream discharge measures (base & peak flows); Sediment, substrate; LWD, instream cover; Water chemistry (nutrients, D.O., pH, conductivity, contaminants).	same as above.	Same as above in Spawner/Egg/Alevin column. Removal of all barrier structures at road crossings and continue deactivating high risk roads[17].	Same as above in Spawner/Egg/Alevin column.		Same as above in Spawner/Egg/Alevin column.
Marine Coastal	There is degradation of estuarine habitat in the form of aggradation and deposition[17,18].	Sedge meadows and eelgrass locations are really productive rearing areas[17].	**Pressure indicators:** Total Land Cover Alterations; % of estuary foreshore alteration. % estuary foreshore altered (carex, typha, riparian zone); % surface area disturbed inshore (eel grass zone); % surface area disturbed offshore (e.g., log booms – subtidal); Amount of vessel traffic **State indicators:** Accessible off-channel habitat area; Water Chemistry (Suspended sediment); Estuarine habitat area; River or stream discharge; Marine riparian vegetation; Spatial distribution of wetlands, mudflats, Fish.	unknown	unknown	unknown	Unknown specifics on estuarine use[14]. Need more investigations of what habitat did and does exist[17].	Unknown
~~Marine Offshore~~								
Returning Adult Migration	Same as above with emphasis on low water flows that may affect returning spawners reach their natal streams, and reduce spawning habitat throughout the watershed. A series of steep cascades located 11 km from the mouth of Harris Cr is a barrier for all fish in most years[3,5].	mainstem San Juan River[13,14].	**Pressure indicators: R**oad density; % stream length channelization/floodplain connectivity; Stream discharge. **State indicators:** Water Chemistry (Suspended sediment); Accessible stream length/barriers; Accessible off-channel habitat area; Channel stability measures (pool:riffle, channel width:depth ratios, etc); Stream discharge measures (base & peak flows); Water temperature; Sediment, substrate; LWD, instream cover.	same as Spawner/Egg/ Alevin column.	Same as above in Spawner/Egg/Alevin column. Removal of all barrier structures at road crossings and continue deactivating high risk roads[17]. Monitoring of known spawning areas.	Increase the abundance of pool habitat (particularly at low flows) and adult holding habitat[1,2]. Additional gravel placement for spawning/incubation success[5].		Same as above in Spawner/Egg/Alevin column.

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Sockeye Conservation Unit - San Juan River Watershed Habitat Status

Species: Oncorhynchus nerka

Life Stage	Known limiting factors	Known high value habitats	Performance Indicator(s) for habitat limiting factors	Performance Indicator(s) Status	Possible measures to address limiting factors	Possible measures to maintain productivity	Data Gaps	Habitat Protection & Restoration Measures Undertaken
Spawner/Egg/ Alevin	The lower sections of the San Juan River has the most limited habitat for salmon[18]. In the San Juan River drainage there is a general decrease in flood response time to rainfall; increased amounts of unstable debris; increased streambank erosion; increased fines content of gravels and increased infilling of pools with fines[15].The San Juan River channel has widened and straightened as a result of sedimentation from tributaries[15] and impact to off-channel habitat through access blocking[2]. Secondary channels have disappeared from erosion, infilling with fines and or blockage by woody debris[15]. Logging has caused hillslope erosion and bank instability, channel simplifications, reduction of critical instream LWD and loss of quality fish habitat[3]. Recently (2001) logged gullies in: Lower San Juan, Renfrew/Granite Cr, Harris Cr and Lens Cr[2]. Landslides in: San Juan (54), Renfrew/Granite Cr (115), Lower Harris (8) and Lower Lens (78). There is riparian impacts to: Lower Lens Cr and Lower San Juan. There is a loss of spawning areas due to sub-surface flows as a result of heavy bedload deposition[17]. Frequent signs of bank failure downstream of Harris Creek[15]. Lack of quality spawning habitat is limiting for sockeye salmon[18,20]. Past logging has increased sediment load[20]. High summer temperatures in Fairy Lake, up to 24° [22], and has very small productive capacity[18].	Observed in the mainstem San Juan[14,18]. Fairy Lake has a small population of sockeye[17,10], and spawn there in July[20] on top of upwellings and along the shore[22]. Sockeye have been observed spawning in lower Renfrew Creek[14] (river Sockeye spawning in November[20]), on the mainstem San Juan below and above the confluence with Harris Creek and in the mainstem between Harris and Lens Creeks[20]. One sockeye observed in the Harris Creek side channel[20].	**Pressure indicators: R**oad density; % stream length channelization/floodplain connectivity; Stream discharge. **State indicators:** Water Chemistry (Suspended sediment); Accessible stream length/barriers; Accessible off-channel habitat area; Channel stability measures (pool:riffle, channel width:depth ratios, etc); Stream discharge measures (base & peak flows); Water temperature; Sediment, substrate; LWD, instream cover; Water chemistry (nutrients, D.O., pH, conductivity, contaminants).	Landslide inventory table, Flow data, Hillslope summary is available in San Juan Watershed Restoration Plan, EBA (2001)[2]. Water quality sampling has been performed[3]. Renfrew Creek (08HA069) 1997 - current Flow Data available. Flow data and sediment data for the mainstem San (08HA010) 1959 - current[23] is also available.	Bedload movement and bank scour should be addressed before instream enhancement[1]. Revegetation planned across the floodplains of the San Juan River and Renfrew, Harris and Lens Creeks[1]. Placement of debris in system of use. Landslide and gullies rehabilitation prescriptions for the Lower Lens Cr sub-basin, the south San Juan Ridge and Renfrew Cr[2]. Riparian and stand management treatments along mainstem. Gravel placement for spawning/incubation success including Stink Current Cr[1,5]. Salmon stock assessment[14]. Increase stream complexity[14]. Increase fry recruitment, spawning channel or spawning ground improvement.	Increase the abundance of pool habitat (particularly at low flows) and adult holding habitat[1,2]. Improvement of water quality by maintaining nutrient levels through fertillization[1,2,3,5]. Additional gravel placement for spawning/incubation success[5]. Increase fry recruitment, spawning channel or spawning ground improvement.	Unknown areas of spawning and rearing	Riparian restoration in the San Juan River and Renfrew, Harris and Lens Creeks (including: log jam stabilization, LWD and rock placement, beaver dam removal, berm construction, side channel construction, Riffle-pool construction and Wattling, upwelling pool construction, pool excavation, debris jam modification, gravel bar planting and bank stabilization, conifer release, planting and girdling)[1,2,5,6]. Twenty-four high risk landslides have been treated in the San Juan Watershed[2]. Between 1994 and 2001 a total of 106 km of forest road has been deactivated in the San Juan watershed[2].
Fry/Juvenile Summer (N/A for immediate ocean migrants, i.e.. pink, chum, some chinook & sockeye poplns)	Unknown if they rear in freshwater for one year or immediately outmigrate.	Unknown if they rear in freshwater for one year or immediately outmigrate.	Same as above.	Same as above.	Same as above	Same as above	Unknown rearing areas.	Same as above in Spawner/Egg/ Alevin column. Stream enrichment in the San Juan River in 2001/02 and in the Lower Harris, Hemmingsen, Renfrew and Lens Creeks[1,2,5,18].
Fry/Juvenile Winter (N/A for immediate ocean migrants as above)	Unknown if they rear in freshwater for one year or immediately outmigrate.	Unknown if they rear in freshwater for one year or immediately outmigrate.	Same as above.	Same as above.	Same as above	Same as above	Unknown rearing areas.	Same as above in Spawner/Egg/ Alevin column. Stream enrichment in the San Juan River in 2001/02 and in the Lower Harris, Hemmingsen, Renfrew and Lens Creeks[1,2,5,18].
Smolt	Low nutrient levels are a limiting factor[1,2,3,5].	Observed in the mainstem San Juan[14,18].	**Pressure indicators:** Total Land Cover Alterations; % stream length riparian zone alteration; road density; % stream length channelization/floodplain connectivity; % of estuary foreshore alteration and Stream discharge. **State indicators:** Water Chemistry (Suspended sediment); Accessible stream length/barriers; Channel stability measures (pool:riffle, channel width:depth ratios, etc); Stream discharge measures (base & peak flows); Sediment, substrate; LWD, instream cover; Water chemistry (nutrients, D.O., pH, conductivity, contaminants).	same as above.	Same as above with emphasis on abundant streamside vegetation, woody debris and large substrate material[9]. Improvement of water quality by maintaining nutrient levels through fertillization[1,2,3,5].	Same as above with emphasis on streamside vegetation, woody debris and large substrate material[9]. Improvement of water quality by maintaining nutrient levels through fertillization[1,2,3,5].		Same as above in Spawner/Egg/ Alevin column. Stream enrichment in the San Juan River in 2001/02 and in the Lower Harris, Hemmingsen, Renfrew and Lens Creeks[1,2,5,18].
Marine Coastal	There is degradation of estuarine habitat in the form of aggradation and deposition[17,18].	Sedge meadows and eelgrass locations are really productive rearing areas[17].	**Pressure indicators:** Total Land Cover Alterations; % of estuary foreshore alteration. % estuary foreshore altered (carex, typha, riparian zone); % surface area disturbed inshore (eel grass zone); % surface area disturbed offshore (e.g., log booms – subtidal); Amount of boat traffic **State indicators:** Accessible off-channel habitat area; Water Chemistry (Suspended sediment); Estuarine habitat area; River or stream discharge; Marine riparian vegetation; Spatial distribution of wetlands, mudflats, Fish.	unknown	Unknown	Protect the sedge meadows and eelgrass locations that are really productive rearing areas[17].	Unknown specifics on estuarine use[14]. Need more investigations of what habitat did and does exist[17].	Unknown
~~Marine Offshore~~								
Returning Adult Migration	A series of steep cascades located 11 km from the mouth of Harris Cr is a barrier for all fish in most years[3,5]. In the San Juan River drainage there is increased fines content of gravels and increased infilling of pools with fines[15].	Observed in the mainstem San Juan[14,18].	**Pressure indicators: R**oad density; % stream length channelization/floodplain connectivity; Stream discharge. **State indicators:** Water Chemistry (Suspended sediment); Accessible stream length/barriers; Accessible off-channel habitat area; Channel stability measures (pool:riffle, channel width:depth ratios, etc); Stream discharge measures (base & peak flows); Water temperature; Sediment, substrate; LWD, instream cover.	same as Spawner/Egg/ Alevin column.	Same as above in Spawner/Egg/Alevin column. Monitoring of known spawning areas.	Increase the abundance of pool habitat (particularly at low flows) and adult holding habitat[1,2]. Additional gravel placement for spawning/incubation success[5].	Unknown spawning areas.	Same as above in Spawner/Egg/Alevin column.

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Appendix C. Gordon River Watershed habitat status tables (by Naomi Palfrey).

Chinook Conservation Unit - Gordon River Watershed Habitat Status

Species: Oncorhynchus tshawytscha

Life Stage	Known limiting factors	Known high value habitats	Performance Indicator(s) for habitat limiting factors	Performance Indicator(s) Status	Possible measures to address limiting factors	Possible measures to maintain productivity	Data Gaps	Habitat Protection & Restoration Measures Undertaken
Spawner/Egg/ Alevin	Limiting factors to salmon production in the Gordon River watershed include: limited cover and habitat, particularly in the form of in-stream LWD and boulders; limited overall abundance of pool habitat, particularly at low flows; channel widening; limited adult holding habitat with adequate pool depth and cover; and limited nutrients,[7] mainly in the lower Gordon[9]. Approximately 75% of the watershed has been logged[1]. Reduced quality and stability of gravel[1]. Woody debris is absent from the following Creeks: Hauk, Lower Hinne, Lower Coal, Baird, Grierson and Browns, and in the Gordon River mainstem km 6 to above Gordon Camp and in the upper Gordon[1]. Browns and Grierson Creeks are substantially aggraded[1]. Channel widening, bank erosion and aggradation are evident in the lower river (reaches 1 and 2)[1]. Some significant vertical aggradation below Loup Creek resulting in infilling of pools and riffle areas between Loup and Bugaboo Creeks and accumulation of cobble and gravel in lower reaches of tributaries[1]. Accumulated fines in the spawning gravel; high peak flows in fall/winter. Possible infilling of pools in lower mainstem[1]. Infiltration of coarse sediment in Coal, Baird and Grierson Creeks[1]. Lower reach of Browns Creek dewaters during low summer flow[1]. There was 279 road related landslides of which 219 went into a waterway, and 157 clearcut related landslides of which 138 went into a waterway in the Gordon River watershed in 1996[2]. Heavy winter flows have scoured and deposited sediment into spawning areas[10].	Valuable habitat in reach 2 (side-channels, Gordon Bridge area up to Braden Creek, Pandora Island, Pandora side-channel)[1]. Anadromous use in Gordon River floodplain up to Bugaboo Falls[4,5]. Fry likely rear near stream margins in the lower river[1,6]. Adults have been observed in the mainstem at the confluence of Grierson Creek and lower Grierson Creek[10].	**Pressure indicators:** Road density; % stream length channelization/floodplain connectivity; Stream discharge. **State indicators:** Water Chemistry (Suspended sediment); Accessible stream length/barriers; Accessible off-channel habitat area; Channel stability measures (pool:riffle, channel width:depth ratios, etc); Stream discharge measures (base & peak flows); Water temperature; Sediment, substrate; LWD, instream cover; Water chemistry (nutrients, D.O., pH, conductivity, contaminants).	unknown	Hillslope and Gully stability, vegetation planting, development and restoration of side and back channels in floodplains[1,7]. Restoration/relocation of Browns Creek[1]. Addition of LWD and riparian planting in Hauk, upper Braden, Hinne Creeks, and East Gordon River[1]. Landslide and gully rehabilitation needs to be done in upper and mid Gordon[1]. Instream rehabilitation (restoring hydraulic diversity, bank stability and cover) in low gradient alluvial reaches of: Hauk Creek (reaches 1, 2 and 3); Hinne Creek (reaches 1 and 2); Gordon River above Gordon Camp; East Gordon River (reaches 1- 4)[1]. Side channel development in the lower reaches of Hauk and Hinne Creeks[1].	In the upper watershed areas: enhance riparian coniferous vegetation, construct natural channel hydraulic and habitat characteristics and remove small woody debris jams[1]. Monitoring the plunge pool below Bugaboo falls for infilling[1].		Extensive rehabilitation and revegetation have taken place in the Loup Creek watershed tributaries 1, 2 and 3 treating failed culverts, gullies and landslides and deactivating roads[1,4]. Road deactivation is nearly compete in the Mount Bolduc area. On the Mid Gordon half the roads were deactivated, and the other half were to be completed in 1997[1]. Deactivation of Truck Route 8 in the East Gordon River[1].
Fry/Juvenile Summer (N/A for immediate ocean migrants, i.e.. pink, chum, some chinook & sockeye poplns)	Same as above with emphasis on lack of cover and limited nutrients. Chinook rearing habitat is limited in the Gordon[10].	Chinook fry rear in the lower 5 km of mainstem and in Browns Creek backchannel. 1+ juveniles were minnow trapped at the confluence of Grierson Creek[10].	**Pressure indicators:** Total Land Cover Alterations; % stream length riparian zone alteration; road density; % stream length channelization/floodplain connectivity; Stream discharge. **State indicators:** Water Chemistry (Suspended sediment); Accessible stream length/barriers; Accessible off-channel habitat area; Channel stability measures (pool:riffle, channel width:depth ratios, etc); Stream discharge measures (base & peak flows); Water temperature; Sediment, substrate; LWD, instream cover; Water chemistry (nutrients, D.O., pH, conductivity, contaminants).	unknown	Same as above. Mainstem fertilization program[9].	Same as above. Stream fertillization[1].		Same as above
Fry/Juvenile Winter (N/A for immediate ocean migrants as above)	Same as above with emphasis on lack of cover and limited nutrients. Chinook rearing habitat is limited in the Gordon[10]. High winter peak flows[1].	capture of 1+ chinook fry in the lower mainstem suggests some chinook fry overwinter in the Gordon system prior to smolting[10].	Same as above with exception to water temperature.	unknown	Same as above. Mainstem fertilization program[9].	Same as above		Same as above
Smolt	Lack of riparian function in the upper Gordon River, the East Gordon River, Hauk, Hinne and upper Braden Creek[1]. Woody debris is absent from the following Creeks: Hauk, Loup, Lower Hinne, Lower Coal, Baird, Grierson and Browns, and in the Gordon River mainstem km 6 to above Gordon Camp and in the upper Gordon[1]. Inorganic nutrient levels may be limiting productivity[9]. Possible infilling of pools in lower mainstem[1].	Estuarine area and lower river is tidally influenced and used[1, 4,5,6].	**Pressure indicators:** Total Land Cover Alterations; % stream length riparian zone alteration; road density; % stream length channelization/floodplain connectivity; % of estuary foreshore alteration and Stream discharge. **State indicators:** Water Chemistry (Suspended sediment); Accessible stream length/barriers; Channel stability measures (pool:riffle, channel width:depth ratios, etc); Stream discharge measures (base & peak flows); Sediment, substrate; LWD, instream cover; Water chemistry (nutrients, D.O., pH, conductivity, contaminants).	unknown	Same as above. Mainstem fertilization program[9].	mitigate sedimentation from upstream sources.		Extensive rehabilitation and revegetation have taken place in the Loup Creek watershed tributaries 1, 2 and 3 treating failed culverts, gullies and landslides and deactivating roads[1].
Marine Coastal	Not a real estuary, but lower river is tidally influenced[10]. The estuary, once an intricate system of tidal pools is now represented by an isolated wetland[1]. There is degradation of estuarine habitat in the form of aggradation and deposition[8,9] Pollution in the form of hydrogen sulphide turnover negatively effecting creatures in the area as residual issues from the log sort[10], and pollutants leeching from the garbage dump[11]. Dredging from the log booms has decreased the amount of available eelgrass habitat[10]. High winter flows are a detriment to eelgrass growth[10].	Estuarine area and lower river is tidally influenced and utillized[1,4,5,6,8]. Juveniles use the lower river which is tidally influenced and the marina for rearing[10].	**Pressure indicators:** Total Land Cover Alterations; % of estuary foreshore alteration. % estuary foreshore altered (carex, typha, riparian zone); % surface area disturbed inshore (eel grass zone); % surface area disturbed offshore (e.g., log booms – subtidal); Amount of vessel traffic **State indicators:** Accessible off-channel habitat area; Water Chemistry (Suspended sediment); Estuarine habitat area; River or stream discharge; Marine riparian vegetation; Spatial distribution of wetlands, mudflats, Fish.	unknown		Protect the sedge meadows and eelgrass locations that are really productive rearing areas[8].	Unknown specifics on estuarine use[5].	
~~**Marine Offshore**~~								
Returning Adult Migration	Same as above in Spawner/Egg/Alevin column. Aggradation in Reach 2 of the Gordon mainstem below Grierson Cr. has produced bars that dewater during low flows that restrict adult migration and cause potential predation issues[1,5]. Some significant vertical aggradation below Loup Creek resulting in: preventing upstream migration of fish during summer and early fall flows, infilling of pools and riffle areas between Loup and Bugaboo Creeks, potential infilling of pool below Bugaboo falls and accumulation of cobble and gravel in lower reaches of tributaries[1]. There is a loss of adult holding habitat as a result of infilled pools[7].	Pools in Lower Gordon to Bugaboo[1]. Gordon Bridge area up to Braden Creek, Pandora Island, including side-channel[1]. Mainstem Gordon River[8]. Adults have been observed in the mainstem at the confluence of Grierson Creek and lower Grierson Creek[10].	**Pressure indicators:** Road density; % stream length channelization/floodplain connectivity; Stream discharge. **State indicators:** Water Chemistry (Suspended sediment); Accessible stream length/barriers; Accessible off-channel habitat area; Channel stability measures (pool:riffle, channel width:depth ratios, etc); Stream discharge measures (base & peak flows); Water temperature; Sediment, substrate; LWD, instream cover.	unknown	Hillslope and Gully stability, vegetation planting, development and restoration of side and back channels in floodplains. Restoration/relocation of Browns Creek[1]. Addition of LWD and riparian planting in Hauk, upper Braden and Hinne Creeks, and East Gordon River[1]. Landslide and gully rehabilitation needs to be done in upper and mid Gordon[1]. Instream rehabilitation (restoring hydraulic diversity, bank stability and cover) in Hauk Creek (reaches 1, 2 and 3); Hinne Creek (reaches 1 and 2); Gordon River above Gordon Camp; East Gordon River (reaches 1- 4)[1]. Side channel development in the lower reaches of Hauk and Hinne Creeks[1]. Continuation of road deactivation and blocked access issues dealt with[8].	Same as above in Spawner/Egg/ Alevin column.	Unknown if chinook adults are holding the Gordon River and then leaving for the San Juan system[10].	Extensive rehabilitation and revegetation have taken place in the Loup Creek watershed tributaries 1, 2 and 3 treating failed culverts, gullies and landslides and deactivating roads[1]. Road deactivation is nearly compete in the Mount Bolduc area. On the Mid Gordon half the roads were deactivated[1]. Deactivation of Truck Route 8 in the East Gordon River[1].

References:

1. David and M Lightly, A. Chapman and R. Furness. (1997). An Overview Assessment of the Fisheries Resources, Fish Habitat, Hydrology and Riparian Habitat in the Gordon River Watershed, Vancouver Island B.C. 36 p.
2. Anonymous. (1996).Gordon River Coastal Watershed Assessment Report.
3. Aquaterra Environmental Services. (1999). San Juan and Gordon River Monitoring of Watershed Restoration Projects. 27 p.
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Chum Conservation Unit - Gordon River Watershed Habitat Status

Species: Oncorhynchus keta

Life Stage	Known limiting factors	Known high value habitats	Performance Indicator(s) for habitat limiting factors	Performance Indicator(s) Status	Possible measures to address limiting factors	Possible measures to maintain productivity	Data Gaps	Habitat Protection & Restoration Measures Undertaken
Spawner/Egg/ Alevin	Limiting factors to salmon production in the Gordon River watershed include: limited cover and habitat, particularly in the form of in-stream LWD and boulders; limited overall abundance of pool habitat, particularly at low flows; limited adult holding habitat as a result of infilled pools[1], loss of in-stream LWD, and channel widening; limited adult holding habitat with adequate pool depth and cover; and limited nutrients,[7] mainly in the lower Gordon[9]. Approximately 75% of the watershed has been logged, some of the effects of which are sediment deposition in the lower river, high summer water temperatures and seduced surface flows[1]. Unstable slope terrain in the mainstem of the Gordon River, Loup, Braden, Bugaboo, lower mainstem of Hauk and Browns Creeks[1]. Fines in the spawning gravel; high peak flows in fall/winter. Infiltration of coarse sediment in Coal, Baird and Grierson Creeks[1] and in the lower Gordon mainstem[4]. There was 279 road related landslides of which 219 went into a waterway, and 157 clearcut related landslides of which 138 went into a waterway in the Gordon River watershed in 1996[2]. Quality of spawning habitat is limiting for chum salmon[10].	Important areas for early chum is the side channel in reach 2, areas for late chum also include below the bar in Reach 2, the estuary and Browns Creek backchannel. Pandora Island, including side-channel and below Beauschesne Farm[1]. Chum use the lower Gordon River mainstem[4,9]. Chum have been observed spawning in lower Browns Creek, lower mainstem Gordon River, at and above the confluence with Coal Creek[10]. Highly productive chum habitat in lower Grierson Creek[10].	**Pressure indicators:** Road density; % stream length channelization/floodplain connectivity; Stream discharge. **State indicators:** Water Chemistry (Suspended sediment); Accessible stream length/barriers; Accessible off-channel habitat area; Channel stability measures (pool:riffle, channel width:depth ratios, etc); Stream discharge measures (base & peak flows); Water temperature; Sediment, substrate; LWD, instream cover; Water chemistry (nutrients, D.O., pH, conductivity, contaminants).	unknown	Hillslope and Gully stability, vegetation planting, development and restoration of side and back channels in floodplains[1,7]. Restoration/relocation of Browns Creek[1]. Addition of LWD and riparian planting in Hauk, upper Braden, Hinne Creeks, and East Gordon River[1]. Landslide and gully rehabilitation needs to be done in upper and mid Gordon[1]. Instream rehabilitation (restoring habitat characteristics of hydraulic diversity, bank stability and cover) in Hauk Creek (reaches 1, 2 and 3); Hinne Creek (reaches 1 and 2); Gordon River above camp (reaches 33 - 40); East Gordon River (reaches 1- 4)[1]. Side channel development in the lower reaches of Hauk and Hinne Creeks[1].	Hillslope and Gully stability, vegetation planting and protection of side and back channels in floodplains.	Need to have a spawning and rearing assessment[8].	Extensive rehabilitation and revegetation have taken place in the Loup Creek watershed tributaries 1, 2 and 3 treating failed culverts, gullies and landslides and deactivating roads[1,4]. Road deactivation is nearly compete in the Mount Bolduc area. On the Mid Gordon half the roads were deactivated, and the other half were to be completed in 1997[1]. Deactivation of Truck Route 8 in the East Gordon River[1]. Addition of LWD in Five Mile, Renfrew, Georges channel, Mosquito and Coal Creeks[3]. 6000m² of off channel habitat was created in 1999 by construction of the Chu-Wit Cha-Uck Gordon River Groundwater Channel[6].
Fry/Juvenile Summer (N/A for immediate ocean migrants, i.e.. pink, chum, some chinook & sockeye poplns)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Fry/Juvenile Winter (N/A for immediate ocean migrants as above)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Smolt	Limiting factors to salmon production in the Gordon River watershed include: limited cover and habitat, particularly in the form of in-stream LWD and boulders; limited overall abundance of pool habitat, particularly at low flows; loss of in-stream LWD, and channel widening; limited habitat with adequate pool depth[1] and cover; and limited nutrients[7.9].		**Pressure indicators:** Total Land Cover Alterations; % stream length riparian zone alteration; road density; % stream length channelization/floodplain connectivity; % of estuary foreshore alteration and Stream discharge. **State indicators:** Water Chemistry (Suspended sediment); Accessible stream length/barriers; Channel stability measures (pool:riffle, channel width:depth ratios, etc); Stream discharge measures (base & peak flows); Sediment, substrate; LWD, instream cover; Water chemistry (nutrients, D.O., pH, conductivity, contaminants).	unknown	Hillslope and Gully stability, vegetation planting, development and restoration of side and back channels in floodplains[1]. Instream rehabilitation (restoring habitat characteristics of hydraulic diversity, bank stability and cover)[1]. Mainstem fertilization program[9].	Hillslope and Gully stability, vegetation planting and protection of side and back channels in floodplains. Mainstem fertilization program[9].		Mainstem fertilization program every 2 years[9].
Marine Coastal	Not a real estuary, but lower river is tidally influenced[10]. The estuary, once an intricate system of tidal pools is now represented by an isolated wetland[1]. There is degradation of estuarine habitat in the form of aggradation and deposition[8,9] Pollution in the form of hydrogen sulphide turnover negatively effecting creatures in the area as residual issues from the log sort[10], and pollutants leeching from the garbage dump[11]. Dredging from the log booms has decreased the amount of available eelgrass habitat[10]. High winter flows are a detriment to eelgrass growth[10].	Estuarine area and lower river is tidally influenced and utillized[1, 4,5,6,8].	**Pressure indicators:** Total Land Cover Alterations; % of estuary foreshore alteration. % estuary foreshore altered (carex, typha, riparian zone); % surface area disturbed inshore (eel grass zone); % surface area disturbed offshore (e.g., log booms – subtidal); Amount of vessel traffic **State indicators:** Accessible off-channel habitat area; Water Chemistry (Suspended sediment); Estuarine habitat area; River or stream discharge; Marine riparian vegetation; Spatial distribution of wetlands, mudflats, Fish.	unknown	unknown	Protect the sedge meadows and eelgrass locations that are really productive rearing areas[8].	Unknown specifics on estuarine use[5].	Same as above in Spawner/Egg/ Alevin column.
~~**Marine Offshore**~~								
Returning Adult Migration	Same as above in Spawner/Egg/ Alevin column. Gravel deposition in the lower river results in most flows being sub-surface, which will hamper upstream migration and reduce the spawning area[1]. Aggradation in Reach 2 of the Gordon has produced a bars that dewater at low flows and restrict access to upstream holding areas. This can increase predation losses[5] and expose fish to high temperatures[1]. Lower reach of Browns Creek dewaters during low summer flow[1].	There is a summer run (July) and a fall run (Oct.)[10]. Important areas for early chum are lower Gordon mainstem to Baird Cr. Important areas for late chum include the estuary to Baird Cr. and off Browns Creek.	**Pressure indicators:** Road density; % stream length channelization/floodplain connectivity; Stream discharge. **State indicators:** Water Chemistry (Suspended sediment); Accessible stream length/barriers; Accessible off-channel habitat area; Channel stability measures (pool:riffle, channel width:depth ratios, etc); Stream discharge measures (base & peak flows); Water temperature; Sediment, substrate; LWD, instream cover.	unknown	Hillslope and Gully stability, vegetation planting, development and restoration of side and back channels in floodplains. Restoration/relocation of Browns Creek[1]. Addition of LWD and riparian planting in Hauk, upper Braden and Hinne Creeks, and East Gordon River[1]. Landslide and gully rehabilitation needs to be done in upper and mid Gordon[1]. Instream rehabilitation (restoring habitat characteristics of hydraulic diversity, bank stability and cover) in Hauk Creek (reaches 1, 2 and 3); Hinne Creek (reaches 1 and 2); Gordon River above Gordon Camp; East Gordon River (reaches 1- 4)[1]. Side channel development in the lower reaches of Hauk and Hinne Creeks[1].	Hillslope and Gully stability, vegetation planting and protection of side and back channels in floodplains.	Need to have a spawning assessment[8].	Same as above in Spawner/Egg/ Alevin column.

References:

1. David and M Lightly, A. Chapman and R. Furness. (1997). An Overview Assessment of the Fisheries Resources, Fish Habitat, Hydrology and Riparian Habitat in the Gordon River Watershed, Vancouver Island B.C. 36 p.
2. Anonymous. (1996).Gordon River Coastal Watershed Assessment Report.
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Coho Conservation Unit - Gordon River Watershed Habitat Status

Species: Oncorhynchus kisutch

Life Stage	Known limiting factors	Known high value habitats	Performance Indicator(s) for habitat limiting factors	Performance Indicator(s) Status	Possible measures to address limiting factors	Possible measures to maintain productivity	Data Gaps	Habitat Protection & Restoration Measures Undertaken
Spawner/Egg/ Alevin	Limiting factors to salmon production in the Gordon River watershed include: limited cover and habitat, particularly in the form of in-stream LWD and boulders; Limited overall abundance of pool habitat, particularly at low flows and adult holding habitat as a result of infilled pools, loss of in-stream LWD, and channel widening; limited adult holding habitat with adequate pool depth and cover[7,9] mainly in the lower Gordon[9]. Approximately 75% of the watershed has been logged, some of the effects of which are sediment deposition in the lower river, high summer water temperatures and seduced surface flows[1]. Woody debris is absent from the following Creeks: Hauk, Lower Hinne, Lower Coal, Baird, Grierson and Browns, and in the Gordon River mainstem km 6 to above Gordon Camp and in the upper Gordon[1]. Browns and Grierson Creeks are substantially aggraded[1]. Channel widening, bank erosion and aggradation are evident in the lower river (reaches 2 and 3)[1]. Fines in the spawning gravel; high peak flows in fall/winter. Possible infilling of pools in lower mainstem[1]. Infiltration of coarse sediment in Coal, Baird and Grierson Creeks[1.] Lower reach of Browns Creek dewaters during low summer flow[1]. There was 279 road related landslides of which 219 went into a waterway, and 157 clearcut related landslides of which 138 went into a waterway in the Gordon River watershed in 1996[2]. Habitat degradation has reduced spawning efficiency and incubation success[9]. Browns Creek was diverted during the 1950's destroying productive habitat[1].	Gordon mainstem from Gordon River Bridge area and upstream of the Baird Cr. confluence. High value tributaries: Browns, Coal, Baird, lower Braden Creeks[1,4]. Lower 5 km of the Gordon River contains the best coho habitat, but its not high quality[9]. Coho have been observed spawning in Browns Creek and in the mainstem around the confluence of Baird Creek[10].	**Pressure indicators: R**oad density; % stream length channelization/floodplain connectivity; Stream discharge. **State indicators:** Water Chemistry (Suspended sediment); Accessible stream length/barriers; Accessible off-channel habitat area; Channel stability measures (pool:riffle, channel width:depth ratios, etc); Stream discharge measures (base & peak flows); Water temperature; Sediment, substrate; LWD, instream cover; Water chemistry (nutrients, D.O., pH, conductivity, contaminants).	unknown	Hillslope and Gully stability, vegetation planting, development and restoration of side and back channels in floodplains. Restoration/relocation of Browns Creek[4]. Addition of LWD and riparian planting in Hauk, upper Braden and Hinne Creeks, and East Gordon River[1]. Landslide and gully rehabilitation needs to be done in upper and mid Gordon[1]. Instream rehabilitation (restoring habitat characteristics of hydraulic diversity, bank stability and cover) in Hauk Creek (reaches 1, 2 and 3); Hinne Creek (reaches 1 and 2); Gordon River above camp (reaches 33 - 40); East Gordon River (reaches 1- 4)[1]. Side channel development in the lower reaches of Hauk and Hinne Creeks[1].	Protect side channel habitat.		Extensive rehabilitation and revegetation have taken place in the Loup Creek watershed tributaries 1, 2 and 3 treating failed culverts, gullies and landslides and deactivating roads[1,4]. Road deactivation is nearly compete in the Mount Bolduc area. On the Mid Gordon half the roads were deactivated, and the other half were to be completed in 1997[1]. Deactivation of Truck Route 8 in the East Gordon River[1]. $6000m^2$ of off channel habitat was created in 1999 for the Chu-Wit Cha-Uck Gordon River Groundwater Channel[6]. Off channel habitat was excavated in Coal Creek[3].
Fry/Juvenile Summer (N/A for immediate ocean migrants, i.e.. pink, chum, some chinook & sockeye poplns)	Same as above. Limited juvenile rearing and overwintering habitat and limited nutrients[7,9]. Some significant vertical aggradation below Loup Creek resulting in infilling of pools and riffle areas between Loup and Bugaboo Creeks, potential infilling of pool below Bugaboo falls, accumulation of cobble and gravel in lower reaches of tributaries contributing to dewatering during low flows and the closing off of entrances to side and back channels in the lower river[1]. There were 279 road related landslides and 157 clearcut related landslides in the Gordon River watershed by 1996[2].	Coho rearing in mainstem reaches 1 and 2, associated sidechannels, and in lower river tributaries (lower Coal, Baird, Grierson and Braden Creeks)[1,4]. Coho fry have been observed rearing in Browns, Coal, lower Grierson and lower Wiggs Creeks[10].	**Pressure indicators:** Total Land Cover Alterations; % stream length riparian zone alteration; road density; % stream length channelization/floodplain connectivity; Stream discharge. **State indicators:** Water Chemistry (Suspended sediment); Accessible stream length/barriers; Accessible off-channel habitat area; Channel stability measures (pool:riffle, channel width:depth ratios, etc); Stream discharge measures (base & peak flows); Water temperature; Sediment, substrate; LWD, instream cover; Water chemistry (nutrients, D.O., pH, conductivity, contaminants).	unknown	Same as above. Further side channel developments in tributaries such as Halliday Creek for coho fry refugia. Fairy Lake Creek side channel construction connecting Fairy Lake to Fairy Creek[10]. Harris Creek flood channel on both sides below the bridge[10]. Mainstem fertilization program[9].	Same as above.		Same as above. $6000m^2$ of off channel habitat was created in 1999 for the Chu-Wit Cha-Uck Gordon River Groundwater Channel[6]. Mainstem fertilization program every 2 years[9].
Fry/Juvenile Winter (N/A for immediate ocean migrants as above)	Same as above. High fall and winter peak flows, limited cover and refuge available[1].		Same as above with exception to water temperature.	unknown	Same as above.	Same as above.		Same as above. Mainstem fertilization program every 2 years[9].
Smolt	Lack of riparian function in the upper Gordon River, the East Gordon River, Hauk, Hinne and upper Braden Creek[1]. Woody debris is absent from the following Creeks: Hauk, Loup, Lower Hinne, Lower Coal, Baird, Grierson and Browns, and in the Gordon River mainstem km 6 to above Gordon Camp and in the upper Gordon[1]. Inorganic nutrient levels may be limiting productivity[9]. Possible infilling of pools in lower mainstem[1].	Estuarine area and lower river is tidally influenced and used[1, 4,5,6].	**Pressure indicators:** Total Land Cover Alterations; % stream length riparian zone alteration; road density; % stream length channelization/floodplain connectivity; % of estuary foreshore alteration and Stream discharge. **State indicators:** Water Chemistry (Suspended sediment); Accessible stream length/barriers; Channel stability measures (pool:riffle, channel width:depth ratios, etc); Stream discharge measures (base & peak flows); Sediment, substrate; LWD, instream cover; Water chemistry (nutrients, D.O., pH, conductivity, contaminants).	unknown	Hillslope and Gully stability, vegetation planting, development and restoration of side and back channels in floodplains[1]. Instream rehabilitation (restoring habitat characteristics of hydraulic diversity, bank stability and cover)[1]. Mainstem fertilization program[9].			Same as above. Mainstem fertilization program every 2 years[9].
Marine Coastal	Not a real estuary, but lower river is tidally influenced[10]. The estuary, once an intricate system of tidal pools is now represented by an isolated wetland[1]. There is degradation of estuarine habitat in the form of aggradation and deposition[8,9] Pollution in the form of hydrogen sulphide turnover negatively effecting creatures in the area as residual issues from the log sort[10], and pollutants leeching from the garbage dump[12]. Dredging from the log booms has decreased the amount of available eelgrass habitat[10]. High winter flows are a detriment to eelgrass growth[10].	Estuarine area and lower river is tidally influenced and utillized[1, 4,5,6,8]. Juveniles use the lower river which is tidally influenced and the marina for rearing[10].	**Pressure indicators:** Total Land Cover Alterations; % of estuary foreshore alteration. % estuary foreshore altered (carex, typha, riparian zone); % surface area disturbed inshore (eel grass zone); % surface area disturbed offshore (e.g., log booms – subtidal); Amount of vessel traffic **State indicators:** Accessible off-channel habitat area; Water Chemistry (Suspended sediment); Estuarine habitat area; River or stream discharge; Marine riparian vegetation; Spatial distribution of wetlands, mudflats, Fish.	unknown	Same as above in Spawner/Egg/ Alevin column.	Protect the sedge meadows and eelgrass locations that are really productive rearing areas[8].	Unknown specifics on tidally influenced areas of use[5].	Unknown
~~**Marine Offshore**~~								
Returning Adult Migration	Same as above in Spawner/Egg/Alevin column. Low to med flows can possibly delay the early part of the run as some tributaries run dry[1]. Access to upper holding areas may be delayed resulting in predation[5] and poaching[1]. Some significant vertical aggradation below Loup Creek resulting in: impeded upstream migration during summer and early fall flows, infilling of pools and riffle areas between Loup and Bugaboo Creeks, potential infilling of pool below Bugaboo falls, accumulation of cobble and gravel in lower reaches of tributaries contributing to dewatering during low flows and the closing off of entrances to side and back channels in the lower river[1].	Pools in Lower Gordon to Bugaboo and Browns Creek[1]. Mainstem, back and side channels throughout the Gordon River Watershed[4,5].	**Pressure indicators: R**oad density; % stream length channelization/floodplain connectivity; Stream discharge. **State indicators:** Water Chemistry (Suspended sediment); Accessible stream length/barriers; Accessible off-channel habitat area; Channel stability measures (pool:riffle, channel width:depth ratios, etc); Stream discharge measures (base & peak flows); Water temperature; Sediment, substrate; LWD, instream cover.	unknown	Same as above in Spawner/Egg/ Alevin column. Continuation of road deactivation and blocked access issues dealt with[8].			Extensive rehabilitation and revegetation have taken place in the Loup Creek watershed tributaries 1, 2 and 3 treating failed culverts, gullies and landslides and deactivating roads[1,4]. Road deactivation is nearly compete in the Mount Bolduc area. On the Mid Gordon half the roads were deactivated, and the other half were to be completed in 1997[1]. Deactivation of Truck Route 8 in the East Gordon River[1].

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1. David and M Lightly, A. Chapman and R. Furness. (1997). An Overview Assessment of the Fisheries Resources, Fish Habitat, Hydrology and Riparian Habitat in the Gordon River Watershed, Vancouver Island B.C. 36 p.
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5. Tom Rutherford, BC Conservation Foundation. Personal Communications February, 2011
6. The Pacheedaht First Nation. (2000) Habitat Restoration and Salmon Enhancement Program Project Report.
7. EBA Engineering Consultants LTD. (2001). Gordon River Watershed Restoration Plan.
8. Mike Wright and Associates. Personal Communications March, 2011
9. Mike McCulloch, BC Ministry of Environment. Personal Communications February, 2011
10. Helen and Jeff Jones. Personal Communications March, 2011
11. Maurice Tremblay. Personal Communications March, 2011
12. Bob Gallaugher. Personal Communications February, 2011

Pink Conservation Unit - Gordon River Watershed Habitat Status

Species: Oncorhynchus gorbuscha

Life Stage	Known limiting factors	Known high value habitats	Performance Indicator(s) for habitat limiting factors	Performance Indicator(s) Status	Possible measures to address limiting factors	Possible measures to maintain productivity	Data Gaps	Habitat Protection & Restoration Measures Undertaken
Spawner/Egg/ Alevin	Limiting factors to salmon production in the Gordon River watershed include: Limited cover and habitat, particularly in the form of in-stream LWD and boulders; limited overall abundance of pool habitat, particularly at low flows; limited juvenile over-wintering and rearing, and adult holding habitat as a result of infilled pools, channel widening; limited adult holding habitat with adequate pool depth and cover mainly in the lower Gordon[9]. Approximately 75% of the watershed has been logged, some of the effects of which are sediment deposition in the lower river, high summer water temperatures and seduced surface flows[1]. Unstable slope terrain in the mainstem of the Gordon River, Loup, Braden, Bugaboo, lower mainstem of Hauk and Browns Creeks[1].Fines in the spawning gravel; high peak flows in fall/winter. Possible infilling of pools in lower mainstem[1]. Infiltration of coarse sediment in Coal, Baird and Grierson Creeks[1] and in the lower Gordon mainstem[4]. Lower reach of Browns Creek dewaters during low summer flow[1]. There was 279 road related landslides of which 219 went into a waterway, and 157 clearcut related landslides of which 138 went into a waterway in the Gordon River watershed in 1996[2]. Low numbers of return spawners and lack of available habitat is limiting production[10].	Have been observed holding in the tidal influenced portion of the Gordon[1]. Pink salmon have been observed spawning in the mainstem just above the confluence with Coal Creek[10].	**Pressure indicators: R**oad density; % stream length channelization/floodplain connectivity; Stream discharge. **State indicators:** Water Chemistry (Suspended sediment); Accessible stream length/barriers; Accessible off-channel habitat area; Channel stability measures (pool:riffle, channel width:depth ratios, etc); Stream discharge measures (base & peak flows); Water temperature; Sediment, substrate; LWD, instream cover; Water chemistry (nutrients, D.O., pH, conductivity, contaminants).	Unknown	Hillslope and Gully stability, vegetation planting. Restoration/relocation of Browns Creek[1]. Addition of LWD and riparian planting, landslide and gully rehabilitation needs to be done in upper and mid Gordon[1]. Instream rehabilitation (restoring habitat characteristics of hydraulic diversity, bank stability and cover)[1].	Hillslope and Gully stability, vegetation planting and protection of side and back channels in floodplains.	Need to have a spawning and rearing assessment[8].	Extensive rehabilitation and revegetation have taken place in the Loup Creek watershed tributaries 1, 2 and 3 treating failed culverts, gullies and landslides and deactivating roads[1,4]. Road deactivation is nearly compete in the Mount Bolduc area. On the Mid Gordon half the roads were deactivated, and the other half were to be completed in 1997[1]. Deactivation of Truck Route 8 in the East Gordon River[1]. 6000m^2 of off channel habitat was created in 1999 by the Chu-Wit Cha-Uck Gordon River Groundwater Channel[6]. Off channel habitat was excavated in Coal Creek[3].
Fry/Juvenile Summer (N/A for immediate ocean migrants, i.e.. pink, chum, some chinook & sockeye poplns)	N/A	N/A	N/A	Unknown	N/A	N/A	N/A	N/A
Fry/Juvenile Winter (N/A for immediate ocean migrants as above)	N/A	N/A	N/A	Unknown	N/A	N/A	N/A	N/A
Smolt	Limiting factors to salmon production in the Gordon River watershed include: limited cover and habitat, particularly in the form of in-stream LWD and boulders; limited overall abundance of pool habitat, particularly at low flows; loss of in-stream LWD, and channel widening; limited habitat with adequate pool depth[1] and cover; and inorganic nutrient levels may be limiting productivity[7,9].	Assumed estuary use[4,5].	**Pressure indicators:** Total Land Cover Alterations; % stream length riparian zone alteration; road density; % stream length channelization/floodplain connectivity; % of estuary foreshore alteration and Stream discharge. **State indicators:** Water Chemistry (Suspended sediment); Accessible stream length/barriers; Channel stability measures (pool:riffle, channel width:depth ratios, etc); Stream discharge measures (base & peak flows); Sediment, substrate; LWD, instream cover; Water chemistry (nutrients, D.O., pH, conductivity, contaminants).	Unknown	Same as Spawner/Egg/ Alevin column. Mainstem fertilization program[9].	Hillslope and Gully stability, vegetation planting and protection of side and back channels in floodplains. Mainstem fertilization program[9].	unknown habitat utilization	Mainstem fertilization program every 2 years[9].
Marine Coastal	Not a real estuary, but lower river is tidally influenced[10]. The estuary, once an intricate system of tidal pools is now represented by an isolated wetland[1]. There is degradation of estuarine habitat in the form of aggradation and deposition[8,9] Pollution in the form of hydrogen sulphide turnover negatively effecting creatures in the area (residual affect from the log booming)[10], and pollutants leeching from the garbage dump[11]. Dredging from the log booms has decreased the amount of available eelgrass habitat[10]. High winter flows are a detriment to eelgrass growth[10].	Estuarine area and lower river is tidally influenced and utillized[1,4,5,6,8].	**Pressure indicators:** Total Land Cover Alterations; % of estuary foreshore alteration. % estuary foreshore altered (carex, typha, riparian zone); % surface area disturbed inshore (eel grass zone); % surface area disturbed offshore (e.g., log booms – subtidal); Amount of vessel traffic **State indicators:** Accessible off-channel habitat area; Water Chemistry (Suspended sediment); Estuarine habitat area; River or stream discharge; Marine riparian vegetation; Spatial distribution of wetlands, mudflats, Fish.	Unknown	Unknown	Protect the sedge meadows and eelgrass locations that are really productive rearing areas[8].	Unknown specifics on estuarine use[5].	Unknown
~~Marine Offshore~~								
Returning Adult Migration	Same as above in Spawner/Egg/ Alevin column.	Pink salmon have been observed holding at the confluence of Grierson Creek and the mainstem Gordon River[10].	**Pressure indicators: R**oad density; % stream length channelization/floodplain connectivity; Stream discharge. **State indicators:** Water Chemistry (Suspended sediment); Accessible stream length/barriers; Accessible off-channel habitat area; Channel stability measures (pool:riffle, channel width:depth ratios, etc); Stream discharge measures (base & peak flows); Water temperature; Sediment, substrate; LWD, instream cover.	Same as Spawner/Egg/ Alevin column.	Same as Spawner/Egg/ Alevin column.	Same as Spawner/Egg/ Alevin column.	Need to have a spawning assessment[8].	Same as Spawner/Egg/ Alevin column.

References:

1. David and M Lightly, A. Chapman and R. Furness. (1997). An Overview Assessment of the Fisheries Resources, Fish Habitat, Hydrology and Riparian Habitat in the Gordon River Watershed, Vancouver Island B.C. 36 p.
2. Anonymous. (1996).Gordon River Coastal Watershed Assessment Report.
3. Aquaterra Environmental Services. (1999). San Juan and Gordon River Monitoring of Watershed Restoration Projects. 27 p.
4. Dave Lindsay, TimberWest. Personal Communications February, 2011
5. Tom Rutherford, BC Conservation Foundation. Personal Communications February, 2011
6. The Pacheedaht First Nation. (2000) Habitat Restoration and Salmon Enhancement Program Project Report.
7. EBA Engineering Consultants LTD. (2001). Gordon River Watershed Restoration Plan.
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Sockeye Conservation Unit - Gordon River Watershed Habitat Status

Species: Oncorhynchus nerka

Life Stage	Known limiting factors	Known high value habitats	Performance Indicator(s) for habitat limiting factors	Performance Indicator(s) Status	Possible measures to address limiting factors	Possible measures to maintain productivity	Data Gaps	Habitat Protection & Restoration Measures Undertaken
Spawner/Egg/ Alevin	Limiting factors to salmon production in the Gordon River watershed include: limited cover and habitat, particularly in the form of in-stream LWD and boulders; limited overall abundance of pool habitat, particularly at low flows; limited juvenile over-wintering and rearing, and adult holding habitat as a result of infilled pools, channel widening; limited adult holding habitat with adequate pool depth and cover; and limited nutrients,[7] mainly in the lower Gordon[9]. Approximately 75% of the watershed has been logged, some of the effects of which are sediment deposition in the lower river, high summer water temperatures and seduced surface flows[1]. Fines in the spawning gravel; high peak flows in fall/winter. Possible infilling of pools in lower mainstem[1]. There was 279 road related landslides of which 219 went into a waterway, and 157 clearcut related landslides of which 138 went into a waterway in the Gordon River watershed in 1996[2]. There is a lack of rearing habitat and cover for sockeye salmon[10].	Have been observed in the lower reaches of the Gordon River[1]. Spawning and incubation probably in pool tailouts in the lower river[1]. Sockeye salmon have been observed spawning in the Gordon River at the confluence of Grierson Creek and in lower Coal Creek[10].	**Pressure indicators: R**oad density; % stream length channelization/floodplain connectivity; Stream discharge. **State indicators:** Water Chemistry (Suspended sediment); Accessible stream length/barriers; Accessible off-channel habitat area; Channel stability measures (pool:riffle, channel width:depth ratios, etc); Stream discharge measures (base & peak flows); Water temperature; Sediment, substrate; LWD, instream cover; Water chemistry (nutrients, D.O., pH, conductivity, contaminants).	Unknown	Hillslope and Gully stability, vegetation planting, development and restoration of side and back channels in floodplains[1]. Landslide and gully rehabilitation needs to be done in upper and mid Gordon[1]. Instream rehabilitation (restoring habitat characteristics of hydraulic diversity, bank stability and cover)[1]. Mainstem fertilization program [9].	Because sockeye is so unique in this system the species needs assessment and protection of current habitat[8].	Unknown spawning and rearing areas[5,8].	Extensive rehabilitation and revegetation have taken place in the Loup Creek watershed tributaries 1, 2 and 3 treating failed culverts, gullies and landslides and deactivating roads[1,4]. Road deactivation is nearly compete in the Mount Bolduc area. On the Mid Gordon half the roads were deactivated, and the other half were to be completed in 1997[1]. Deactivation of Truck Route 8 in the East Gordon River[1]. 6000m^2 of off channel habitat was created in 1999 for the Chu-Wit Cha-Uck, Gordon River channel[6]. Off channel habitat was excavated in Coal Creek[3].
Fry/Juvenile Summer (N/A for immediate ocean migrants, i.e.. pink, chum, some chinook & sockeye poplns)	N/A	Unknown if they rear in freshwater for one year or immediately outmigrate.	N/A	Unknown	N/A	N/A	N/A	N/A
Fry/Juvenile Winter (N/A for immediate ocean migrants as above)	N/A	Unknown if they rear in freshwater for one year or immediately outmigrate.	N/A	unknown	N/A	N/A	N/A	N/A
Smolt	Possible infilling of pools in lower mainstem[1]. Inorganic nutrient levels may be limiting productivity[9]. There is a lack of rearing habitat and cover for sockeye salmon[10].	Probably utilize pools in the lower river[1].	**Pressure indicators:** Total Land Cover Alterations; % stream length riparian zone alteration; road density; % stream length channelization/floodplain connectivity; % of estuary foreshore alteration and Stream discharge. **State indicators:** Water Chemistry (Suspended sediment); Accessible stream length/barriers; Channel stability measures (pool:riffle, channel width:depth ratios, etc); Stream discharge measures (base & peak flows); Sediment, substrate; LWD, instream cover; Water chemistry (nutrients, D.O., pH, conductivity, contaminants).	Unknown	Hillslope and Gully stability, vegetation planting, development and restoration of side and back channels in floodplains[1]. Instream rehabilitation (restoring habitat characteristics of hydraulic diversity, bank stability and cover)[1]. Mainstem fertilization program[9].	Hillslope and Gully stability, vegetation planting and protection of side and back channels in floodplains. Mainstem fertilization program[9].	unknown habitat utilization	same as Spawner/Egg/ Alevin column. Mainstem fertilization program every 2 years[9].
Marine Coastal	Not a real estuary, but lower river is tidally influenced[10]. The estuary, once an intricate system of tidal pools is now represented by an isolated wetland[1]. There is degradation of estuarine habitat in the form of aggradation and deposition[8,9] Pollution in the form of hydrogen sulphide turnover negatively effecting creatures in the area as residual issues from the log sort[10], and pollutants leeching from the garbage dump[11]. Dredging from the log booms has decreased the amount of available eelgrass habitat[10]. High winter flows are a detriment to eelgrass growth[10].	Estuarine area and lower river is tidally influenced and utillized[1,4,5,6,8].	**Pressure indicators:** Total Land Cover Alterations; % of estuary foreshore alteration. % estuary foreshore altered (carex, typha, riparian zone); % surface area disturbed inshore (eel grass zone); % surface area disturbed offshore (e.g., log booms – subtidal); boat traffic **State indicators:** Accessible off-channel habitat area; Water Chemistry (Suspended sediment); Estuarine habitat area; River or stream discharge; Marine riparian vegetation; Spatial distribution of wetlands, mudflats, Fish.	Unknown	Mitigate sediment entering the mainstem Gordon.	Protect the sedge meadows and eelgrass locations that are really productive rearing areas[8].	Unknown specifics on estuarine use[5].	Unknown
~~Marine Offshore~~								
Returning Adult Migration	Same as Spawner/Egg/ Alevin column. Aggradation in Reach 2 on the Gordon has produced a bar - partial barrier during low flows. Access to upper holding areas restricted - predation a problem[1].	Important areas for upstream migration and holding include the Lower Gordon to Bugaboo and pools in the lower river[1]. Sockeye have been observed holding in the mainstem above the confluence of Coal Creek[10].	**Pressure indicators: R**oad density; % stream length channelization/floodplain connectivity; Stream discharge. **State indicators:** Water Chemistry (Suspended sediment); Accessible stream length/barriers; Accessible off-channel habitat area; Channel stability measures (pool:riffle, channel width:depth ratios, etc); Stream discharge measures (base & peak flows); Water temperature; Sediment, substrate; LWD, instream cover.	Same as Spawner/Egg/ Alevin column.	Same as Spawner/Egg/ Alevin column.	Same as Spawner/Egg/ Alevin column.	Need to have a rearing and spawning assessment[8].	Same as Spawner/Egg/ Alevin column.

References:

1. David and M Lightly, A. Chapman and R. Furness. (1997). An Overview Assessment of the Fisheries Resources, Fish Habitat, Hydrology and Riparian Habitat in the Gordon River Watershed, Vancouver Island B.C. 36 p.
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6. The Pacheedaht First Nation. (2000) Habitat Restoration and Salmon Enhancement Program Project Report.
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11. Bob Gallaugher. Personal Communications February, 2011