Bedwell River Habitat Status Report

For

Resource Restoration Unit
Fisheries and Oceans Canada
1965 Island Diesel Way
Nanaimo, B.C. V9S 5W8

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By

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Executive Summary

The Bedwell River was chosen by DFO as one of the priority watersheds for Strategy 2 implementation of the Wild Salmon Policy. Strategy 2 outlines steps for the assessment of habitats within the different conservation units. Within the Bedwell River five different conservation units were identified including; Southwest Vancouver Island Chinook, Southwest Vancouver Island Chum, Clayoquot Sound Coho, West Vancouver Island Pink and West Vancouver Island Sockeye.

It was beyond the requirements of the project to analyze any raw or unpublished data but we were able to access and analyze existing data from online data bases and any existing habitat reports. It was determined that the most severe limiting factors in salmon production result from historic resource extraction practices and their associated lingering effects. From the late 1800's to the mid 1970's this watershed included 15 active mines as well as extensive river valley logging. The result of these practices have led to severe channel instability, which has led to an over widened channel within a vast floodplain. It has reduced the instream habitat complexity and water quality available to all life stages of salmon. Currently, the watershed is primarily held with 68% in Strathcona Provincial Park, 30% in Tree Farm License 57 with the remaining 2% held in private lands and Indian Reserves. Since 1974 all resource operations have been dormant and are unlikely to recommence in the near future.

Introduction:

Canada's Wild Salmon Policy was introduced to ensure the conservation of wild salmon.
The Policy's goal is to restore and maintain healthy and diverse salmon populations and their habitats by protecting the genetic diversity of wild salmon populations, maintaining habitat and ecosystem integrity, and managing fisheries for sustainable benefits (DFO, 2005).

Implementation of the Wild Salmon Policy (WSP) is based on identified Conservation Units (CU's) for all species of Pacific Salmon. A CU can be defined as a group of wild salmon sufficiently isolated from other groups that, if extirpated, is very unlikely to recolonize naturally within an acceptable timeframe, e.g., a human lifetime or a specified number of salmon generations (Stalberg et al., 2009). In the Bedwell River watershed there are five identified conservation units; (Holtby & Ciruna, 2007)

1. Southwest Coast Vancouver Island Chinook
2. Southwest Coast Vancouver Island Chum
3. Clayoquot Coho
4. West Vancouver Island Pink
5. West Vancouver Island Sockeye.

There are six strategies identified under the WSP to achieve its goals. Below is a list of the strategies identified in the Policy (DFO, 2005).

Strategy 1 – Standardized Monitoring of Wild Salmon Status
Strategy 2 – Assessment of Habitat Status
Strategy 3 – Inclusion of Ecosystem Values and Monitoring
Strategy 4 – Integrated Strategic Planning
Strategy 5 – Annual Program Delivery
Strategy 6 – Performance Review

Strategy 2 of the Policy involves the assessment of habitat status. Specific habitats within the CU that are considered highly productive are identified, as well as those habitat factors that could be limiting production This information is used to develop programs to monitor habitat status and inform integrated strategic planning. Strategy 2 identifies four steps:

1) Document habitat characteristics within Conservation Units
2) Select indicators and develop benchmarks for habitat assessment
3) Monitor and assess habitat status
4) Establish linkages to develop an integrated data system for watershed management.

The goal of this report is to provide a summary of the current knowledge regarding Habitat Status for the Bedwell River Watershed. A Watershed scale was selected over an entire CU to expedite and explore the pilot nature of the project, and for the practicality of acquiring information on multiple CU species through single interviews with local watershed–based personnel. Stalberg et al. (2009) developed a multi stage approach of the habitat status indicators, metrics, benchmarks to provide a standardized pool of "pressure-state indicators". The scope of work for the project included the following objectives:

1. Obtain and review habitat information for the systems of interest in the Bedwell River watershed;
2. Complete Habitat Status Template Tables provided by DFO for 5 species of Pacific Salmon;
3. Identify appropriate indicators and benchmarks (or thresholds), where possible, in conjunction with DFO; and
4. Prepare a report documenting the data sources and results obtained (this report) outlining the methodology used.

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Survey Methods:

This Bedwell River status report was prepared by the steps outlined in Table 1. Relevant information was collected through a variety sources including online data bases, publications and personal interviews.

Table 1. Web Based Information Search Sites.

Name and Type	Purpose	Source
Community Mapping Network: • Sensitive Habitat & Mapping (SHIM) • BC Wetlands	to access sensitive habitats and species distributions	http://cmnbc.ca/
Mapster	to access distribution maps, conservation units, WSP policy	http://www.canbcdw.pac.dfo-mpo.gc.ca/ows/imf.jsp?site=mapster
Fisheries Information Summary System (FISS)	to access fish habitat data, historical escapement, watershed codes	http://www.env,gov.bc.ca/fish/fiss/index.html
Hectares BC	to access summarized data on natural resources including terrestrial ecosystems and climate	http://www.hectaresbc.org/app/habc/HaBC.html
Cross-Linked Information Resources • BC Species and Ecosystems Explorer • Biodiversity/Environmental Information Resources • Environmental Protection Information Resources • Ecocat • Ministry of Forests and Range Library • Species Inventory Web explorer	Umbrella search to access files throughout a variety of catalogues	http://www.env.gov.bc.ca/clir/

Personal interviews were conducted to enable the collection of local knowledge and access to un-published and historic data. Interviews were requested with a wide range of people, including Fisheries and Oceans staff, BC Natural Resources staff, First Nations Biologists and Fisheries Guardians and private land owners. Table 2 identifies the people targeted with interviews listed in the appendix and quoted (pers. comm.) through- out the text.

Table 2: List of local interview contacts.

Interviewee	Occupation	Information
Doug Palfrey	Clayoquot Stock Assessment expert	Jan. 24, 2011, interview
John Caton	Clayoquot Wilderness Resort Operator	Jan. 24, 2011, interview
Katie Beach	NTC Fisheries Biologist	Provided estuary beach seine data
Brad Rushton	DFO Habitat	Declined, no data available
Randy Stennes	DFO Enforcement	Declined, no data available
Dianna Dobson	DFO Stock Assessment	Provided stock assessment data
M.C. Wright	Consulting Biologist M.C. Wright & Associates	Feb. 8, 2011, data reports, informal interview
John Winpenny	Barkley Forest Products, Logging Contractor	Nov. 3, 2010, interview
Brad Taylor	Iisaak Forestry Engineer	Jan. 24, 2010, interview

Darrell Frank	AFN Fisheries	No reply

The literature and interview information was collected, interpreted and synthesized into the Habitat Status Report template provided by DFO. Important information includes the known limiting factors, known high value habitats, information gaps, possible measures to address limiting factors, possible measures to maintain productivity, and habitat protection and restoration measures undertaken. Based on the collected information, habitat pressures and status indicators were chosen from the list of indicators provided by DFO (Stalberg et al. 2009). These parameters were developed by a DFO habitat working group and are intended provide a working guidebook for in-depth monitoring of habitat conditions in the watershed. Information gaps were identified through personal interviews where possible.

Where the data was available, analysis of the parameters was conducted using the "Fish Habitat Assessment Procedures," (Johnston and Slaney, 1996)

In this report several figures from GIS data were prepared that describe watershed area, ownership, forest age and stream reaches were prepared by a GIS specialist Heather Prencipe. It is hoped that the extra effort and expense of integrating this data into GIS offers better presentation as well as useful basis for further work in the watershed.

This project concentrated primarily on the freshwater limiting habitat conditions and was not able to determine limiting factors outside of the watershed (i.e. offshore marine). Recently there has been a substantial decline in salmon returns to systems where habitat has not changed since in the mid 1980's. Studies to determine the linkage between ocean survival and salmon returns are on-going within DFO.

Watershed Information:

The Bedwell River is located in Clayoquot Sound approximately 24km to the northeast of Tofino along the west coast of Vancouver Island (Figure 1). Bedwell Inlet is one of the six major inlets located within Clayoquot Sound (Tofino, Bedwell, Herbert (Mooyeha R.), Shelter (Megin R.), Sydney and Stewardson). This remote watershed is located within the traditional territory of the Ahousaht First Nation. It is accessible by boat or air to the mouth of the river where the Clayoquot Wilderness Resort is located. From the mouth, access up the watershed is by foot or horseback along old logging/mining roads, trails or the river bed. Above the Lodge property, there are historic indicators (roads, clearings, bridges) of industrial development (logging, mining) among the overgrown trees. The last logging operations operated in the mid 1970's (Brown et al. 1987).

The Bedwell River is nestled between the year round snow pack and glaciers of Mount Tom Taylor (1801m) and Big Interior Mountain (1751m) in Strathcona Provincial Park. The river channel starts out at Bedwell Lake (68ha) at 930m elevation. It drops quickly to a valley floor of approximately 300m elevation and flows southwest for approximately 28.7km to the head of Bedwell Inlet. The identified (13) and unidentified tributaries are mostly short and steep.

Ursus Creek is the largest and most productive tributary in the watershed (Brown et al. 1987). The Bedwell River mainstem offers 7km of anadromous fish access with Ursus Creek offering an additional 11km more. The total area of the Bedwell/Ursus Watershed is approximately 21,050ha. The Ursus sub basin occupies 7,200ha (34%) of the watershed and the Bedwell River occupies 13,850ha (66%) area (BC MOE, 2006).

The geology of the area is dominated by a U shaped valley bottom with fluvial sediments and steep rocky sidewalls covered by colluvium and till. This morphology promotes erosion, landslides and debris flows as common process on a large scale (Clayoquot Sound TPC, 2006). The fish accessible lower reach has a mean gradient of 1% (Brown et al 1987), while the lower reach of the Ursus has a mean gradient of 0.6% (M.C. Wright & Assoc., 1996). The substrate is predominately cobble and gravel

which are suitable to spawning for Chinook, Coho, Chum and Sockeye although they have been reported as highly mobile in recent years[1].

The climate of the Bedwell Watershed is typical of the west coast of Vancouver Island. It is historically mild and extremely wet. On average, annual precipitation exceeds 3000mm at lower elevations with a mean daily temperature between 5Cº to 15Cº (Clayoquot Sound TPC, 2006). The region is located in the Coastal Western Hemlock biogeoclimatic zone (Clayoquot Sound TPC, 2006). The most abundant vegetation includes Western Red Cedar, Western Hemlock, Sitka Spruce, Red Alder, Salmonberry, and Salal (Triton, 1993).

The land is titled by four owners (Figure 2). The upper watershed is Crown Land within Strathcona Provincial Park (58%). The second largest parcel to the south is Tree Farm License 57 (30%) held by Iisaak Forest Resources Ltd. The remaining 2% of land is split under private ownership of Clayoquot Wilderness Resort and Ahousaht Indian (Oinimitis) Reserve #14 (Brown *et al*., 1987).

Human development activities in the watershed centered on resource extraction. Logging and mineral extraction were prevalent from the late 1800's to 1974 (Triton, 1993). Brown *et al*. (1987) reported only 2% of the total area was logged, but it occurred almost entirely along the riparian area of the Bedwell River from the ocean to headwater (Bedwell Lake). There are 14 dormant mineral claims within the watershed with the remains of the mines still present (Sargent, 1940). The mining began in 1856 and the big mines were closed by 1946 (B.C Parks). The exact date the last prospector stopped removing ore is not recorded, but mine equipment was removed in the 1970's (John Winpenny, pers. comm.) and no mines were operating when Clayoquot Wilderness Resort established in 1993(John Caton, pers. comm.). The Clayoquot Wilderness Resort is a seasonally operated facility offering summer accommodation, wilderness tours and fishing since 1993. The Strathcona Provincial Park area has no facilities or development other than wilderness trails that follow the Ursus and Bedwell to their headwaters and beyond.

[1] *pers. comm. John Caton, Clayoquot Wilderness Lodge*

Figure 1: Bedwell/Ursus River Watershed

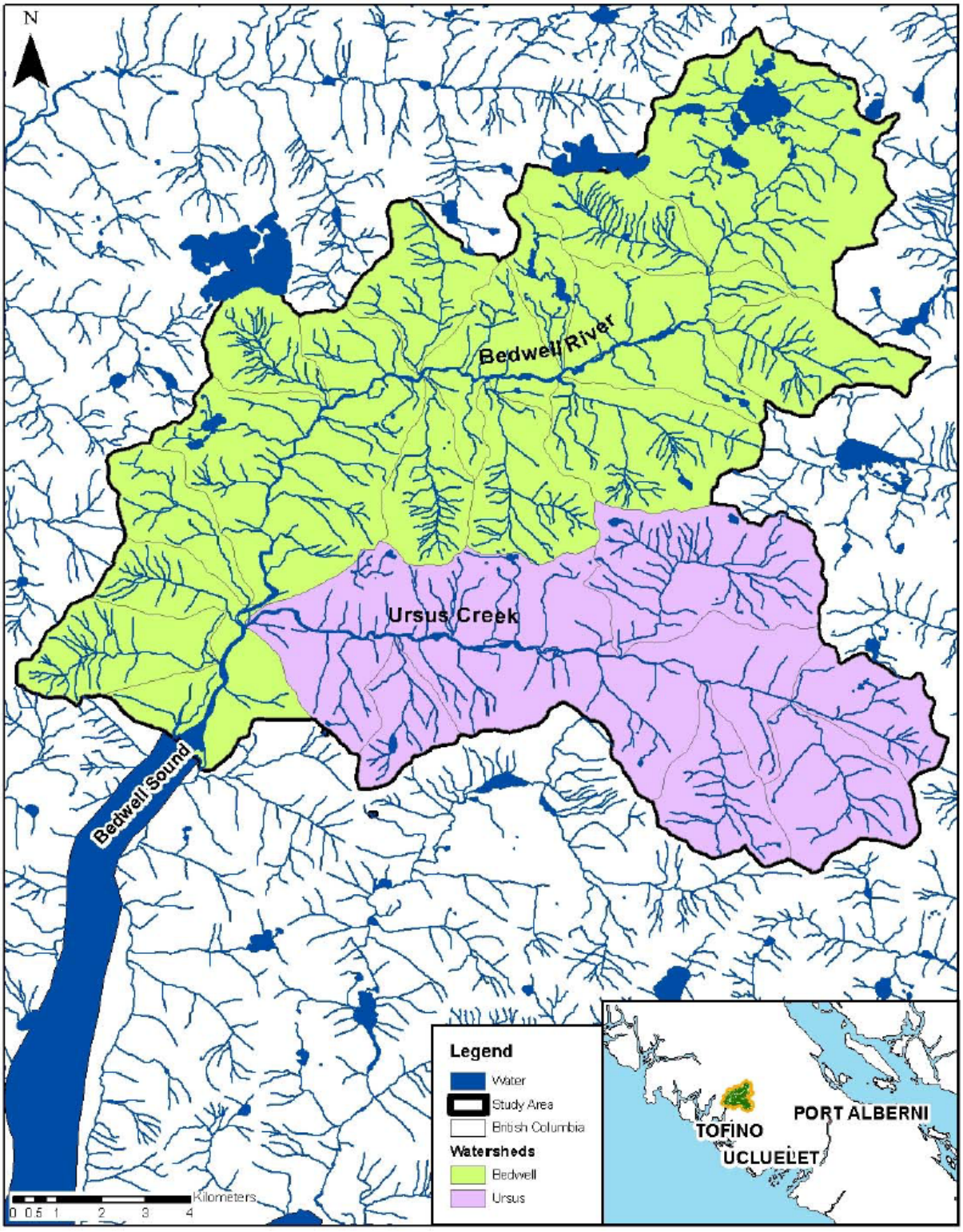
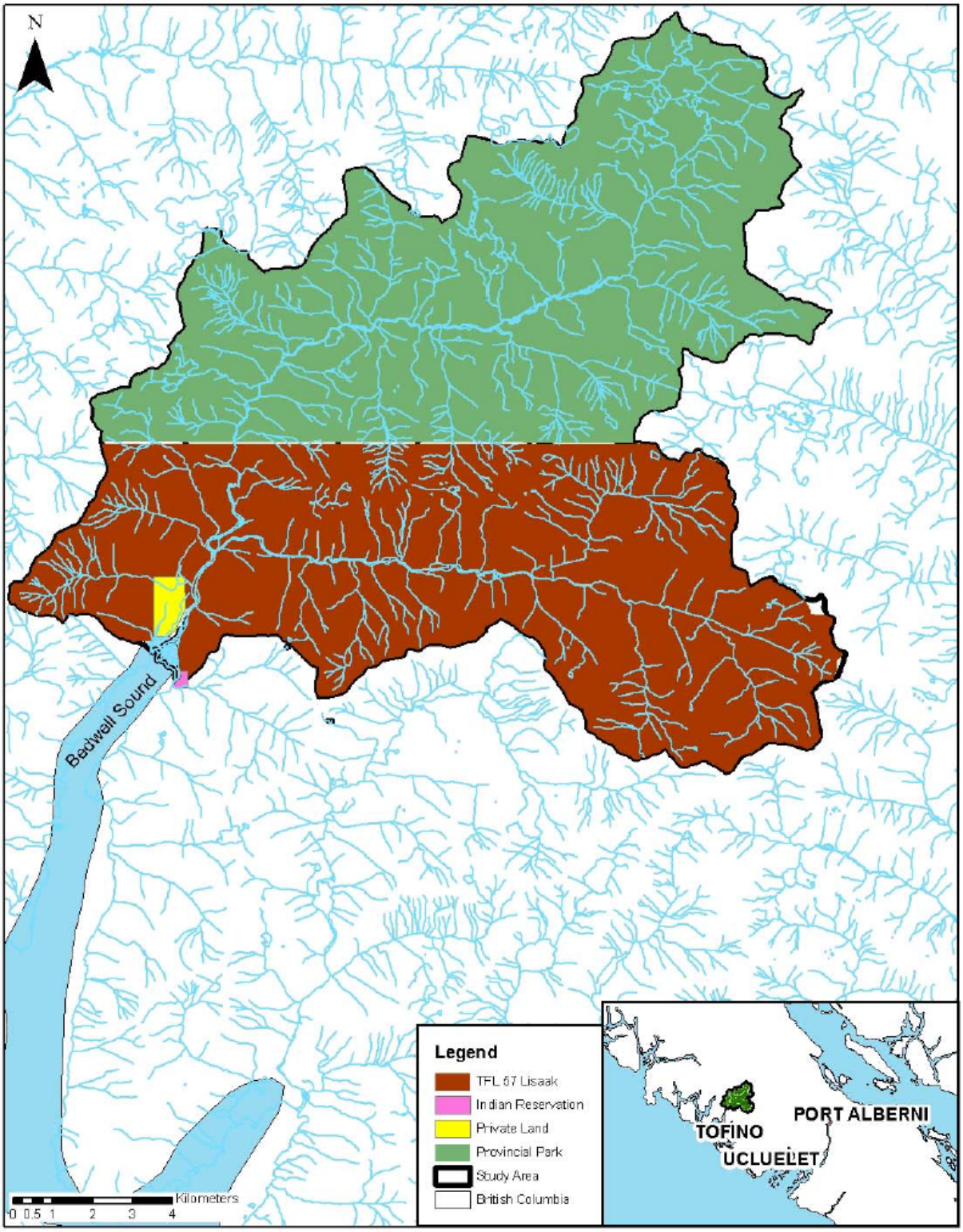


Figure 2. Bedwell River Study Area Land Ownership.



Results

The Bedwell River watershed by all account is in a state of regeneration from human industrial impacts. From the late 1800's to the mid 1980's this watershed was used extensively for resource extraction including logging and mining. These activities included cross stream yarding in the logging industry, and aggregate gravel mining which caused extensive habitat damage. Since the 1980's there has been little human activity in the watershed with the exception of the Clayoquot Wilderness Resort near the mouth and BC Parks in the remote headwaters. Currently, the remainder of the watershed is located in Tree Farm License 57 held by Iisaak Forest Products[2] and in the short term have no plans to log this area.

Table 3 provides a summary of known high value habitats and limited habitats for each salmon species. Doug Palfrey, hatchery manager for the Tofino Salmon Enhancement Society, provided most of the species location and usage information as he has assessed the river for over 25 years. The Marker locations in Table 3 are a reference to orange triangular signs spaced at approximately 500m intervals along the river. These reference locations were established by M.C. Wright & Associates in 1996, and have been maintained annually by D. Palfrey for salmon stock assessment since then.

Five species of Pacific Salmon are found in this watershed; Chinook, Chum, Coho, Pink and River Type Sockeye (M.C. Wright 1996). Chinook are found in the mainstem of the lower 7km of the Bedwell River and 11km of Ursus Creek. Coho are found throughout the anadromous accessible Bedwell - Ursus watershed including the small tributaries and off channels. Coho access approximately 2km further up Ursus Creek than other fish species can. Chum Salmon are found in the lower mainstem areas, smaller tributaries and low gradient off channel habitat. River Type Sockeye are observed primarily in the lower Ursus. Pink Salmon are found throughout the lower Bedwell and tidal channels in the estuary but only in limited numbers, typical of most other Clayoquot Sound streams[3]. Resident Coastal Cutthroat and Rainbow Trout are found in the headwater areas (Lewis 1999).

Table 3. Summary of Habitat Knowledge

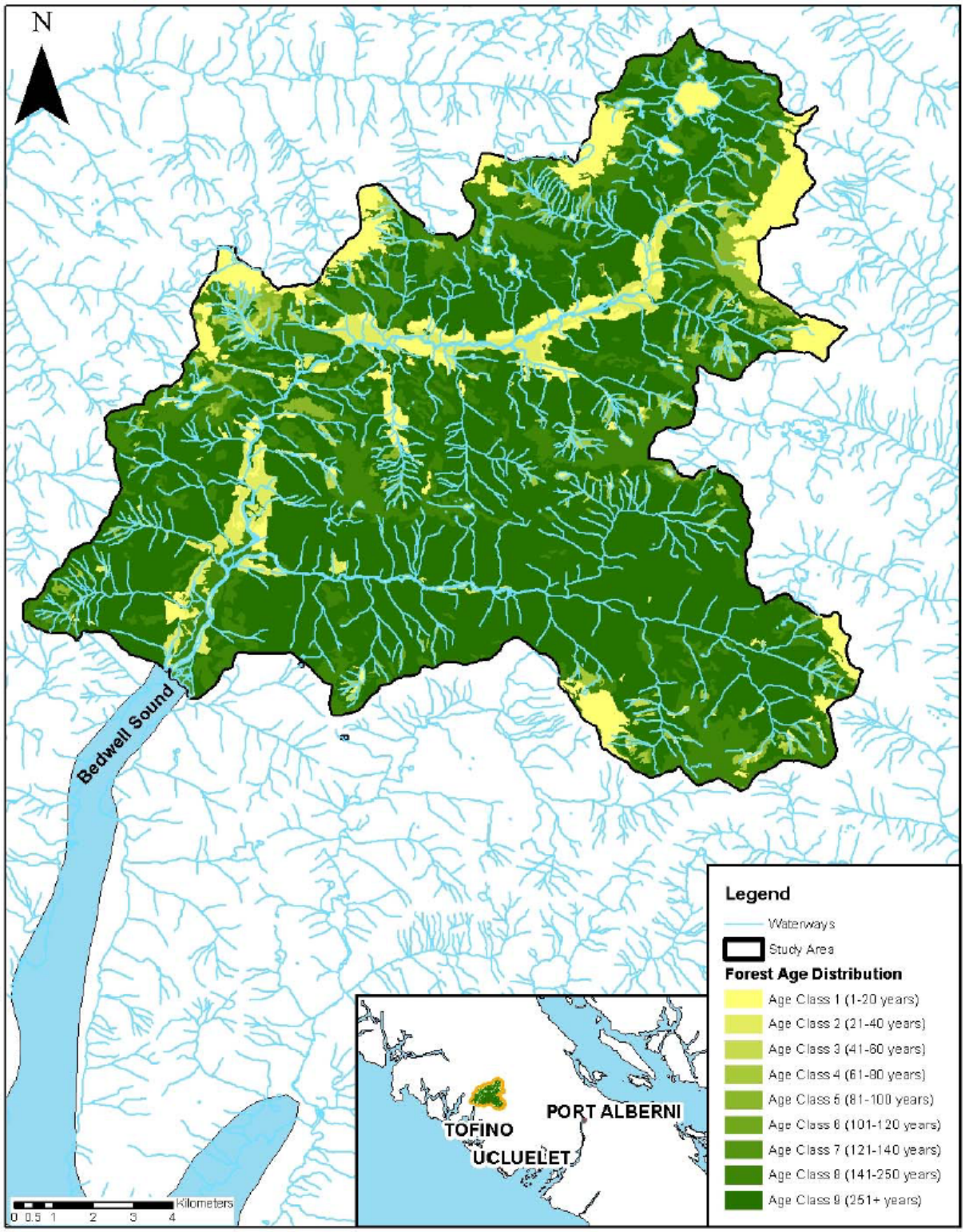
Species	Known High Value Habitats	Limited Habitats
Chinook	Adequate adult holding and spawning from Marker 8 to 12 on Bedwell. Abundant spawning gravels from Marker 9 on Bedwell but is unstable during peak flows. Deep holding pool at confluence of Penny Creek. Ursus provides excellent spawning (Marker 4-5-6) and rearing throughout (M3). Good complexity in the estuary with numerous channels and dense vegetation.	Limited pools that support adult holding, channel is primarily glide habitat. Lack of instream LWD and boulder cover. Spawning gravel stability throughout Bedwell & Ursus. Access to spawning grounds is difficult during low flow.
Chum	Clayoquot Wilderness P Channel and relic side channel produce up to 50% of return. They provide excellent stable spawning and rearing habitat. Abundant spawning gravel in Bedwell below Ursus confluences. Ursus Creek in between Marker 2-4, 6 provides good spawning opportunities Excellent fry rearing in estuary.	Spawning gravel stability throughout Bedwell/Ursus. Access to spawning grounds difficult during low flow. Limited pools to support adult holding, primarily glide habitat. Lack of LWD cover.
Coho	Clayoquot Wilderness P Channel and relic side channel provide excellent stable spawning and	Spawning gravel stability throughout Bedwell/Ursus

[2] Pers. comm. Brad Taylor, Iisaak Forest Resources
[3] Pers. Comm. Doug Palfrey, Tofino Salmon Enhancement Society

	rearing habitat. Abundant spawning gravel in Bedwell below Ursus confluences. Ursus Creek in between Marker 2-4, 6 Excellent smolt rearing in estuary	Access to spawning grounds difficult during low flow. Limited pools that support fry/adult, channel is primarily glide habitat. Lack of LWD cover habitat.
Pink	Clayoquot Wilderness Side Channel and relic side channel produce up to 50% of return. They provide excellent stable spawning and rearing habitat. Abundant spawning gravel in Bedwell below Ursus confluences. Ursus Creek in between Marker 2-4, 6 Excellent fry rearing in estuary	Spawning gravel stability throughout Bedwell/Ursus Access to spawning grounds difficult during low flow. Limited pools that support adult holding, channel is primarily glide habitat. Lack of instream LWD
Sockeye	Clayoquot Wilderness Side Channel and relic side channel produce up to 50% of return. These provide excellent stable spawning and rearing habitat. Abundant spawning gravel in Bedwell below Ursus confluences. Ursus Creek in between Marker 2-4, 6 Excellent smolt rearing in estuary	Spawning gravel stability throughout Bedwell/Ursus Access to spawning ground is difficult during low flow. Limited pools that support adult holding, channel is primarily glide habitat. Lack of instream LWD

In 1987, T.G. Brown *et al* published the Watershed Data Base for Clayoquot Sound. The intent of their work was to draw the forestry use and fisheries status information into one publication that would allow integration with research to establish foundations for management decisions. This information would prove invaluable for later use in Forest Renewal – Watershed Restoration Program enacted by the BC government in the 1990's. Brown found that the majority of logging in the Bedwell Watershed was during the period from 1946 to 1968. Recent forest age analysis information was provided from the Ministry of Natural Resource Operations (Dan Sirk, Land Information Coordinator) that allowed the location of historic logging activity to be portrayed in Figure 3. The Riparian age distribution in this figure clearly shows that the logging followed the river valley bottom from the ocean to Bedwell Lake. Logging has almost entirely eliminated the old growth riparian stands on either side of the river. This ecological factor plays a critical role in the habitat status of the Bedwell River.

Figure 3: Riparian Age Distribution



Bedwell River Mainstem:

Reach 1 (0-2.5km):

Overview:
This 2.5km long, low gradient reach begins at the tidal confluence and progresses upstream on an average gradient of 1% (Fig. 4). The riparian areas of this reach were logged completely, ending approximately 40 years ago. The area is currently a regenerating coniferous forest (Figure 3). The result of logging and mining operations is an over-widened channel with limited LWD. This reach has been described as "one long run within a wide floodplain" (Triton, 1993). Floodplains and widths increased as disturbances led to sediment forming gravel bars higher than the weak (logged off) banks. Although the substrates consist primarily of gravels and cobbles which offer adequate spawning opportunities, the gravels are highly mobile and result in limited spawning success. There is limited instream diversity within this reach with minimal pool depth; two pools were recorded by M.C. Wright (1995). This reach supports Chinook, Coho, Chum, Pink and River Type Sockeye Salmon, as well as Resident Cutthroat Trout and Steelhead.

This reach has lost its hardened banks that are normally defined by tree roots in healthy streams. The result is over widened channels that has significantly reduced width and depth of water in summer. The 1995 summer monitoring data resulted in an average channel width of 73.3m with a summer wetted width of 61m which reflects the loss of confinement and flow due to braiding, erosion and sediments (M.C. Wright, 1996). They also undertook transects in 1995 with floodplain widths of over 100m. The riparian zone consists of second growth forest with an even age canopy (Figure 3) made of Western Hemlock, Western Red Cedar and Red Alder. The stumps in the riparian area were mainly western Red Cedar left behind from the logging and mining period.

The data from Wright (1996) and Triton (1993) was compared to diagnostic standards in Fish Habitat Assessment Procedures (Johnston & Slaney, 1996). The reach scored poorly in numerous habitat categories including; pool area/cover, boulder cover, fines, erosion, and wetted area (Table 1). The channel's relatively low average gradient of 1% is optimal for salmon and trout habitat in a healthy environment.

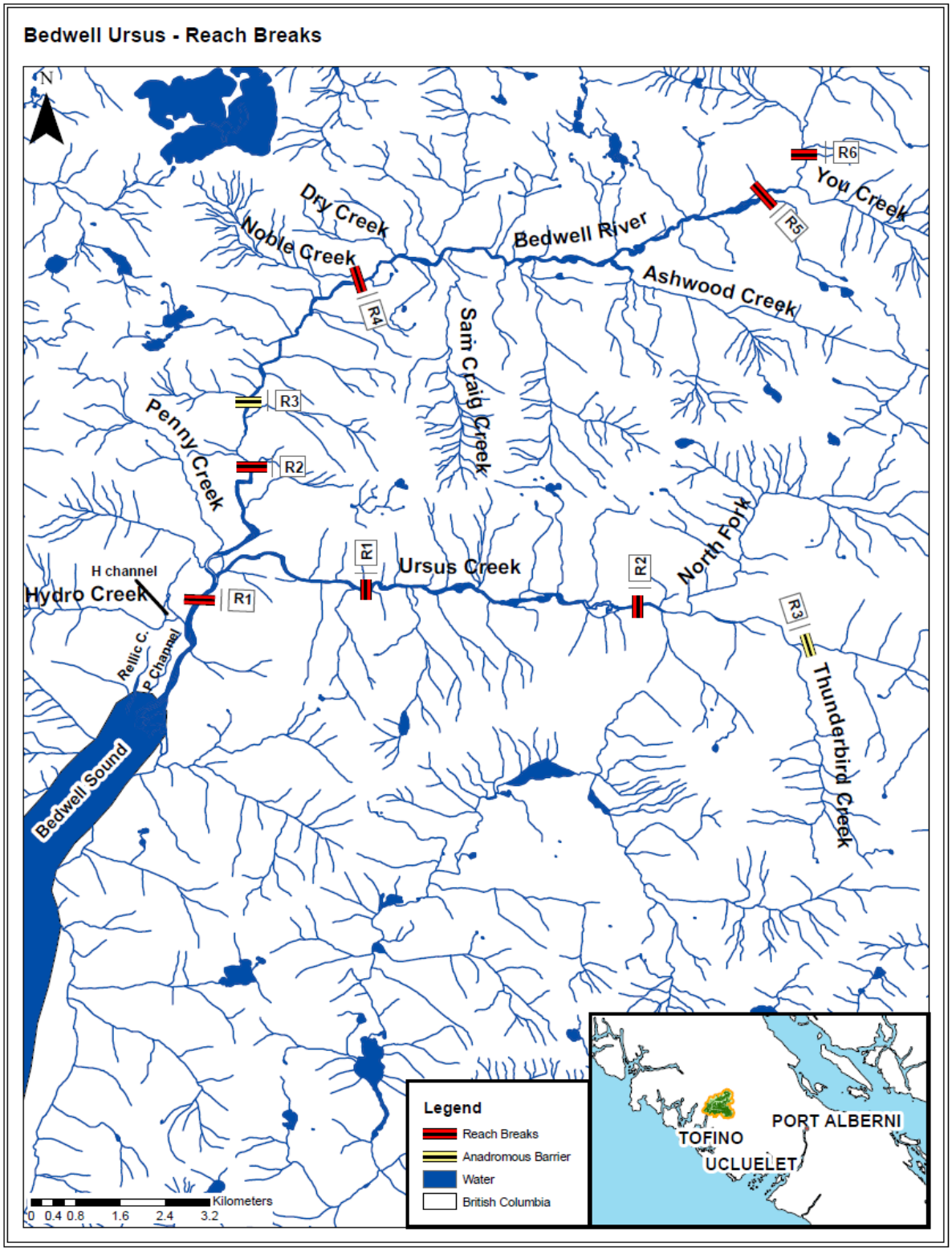
Table 1.) Bedwell River Reach 1 Habitat Data Summary of Results.

Habitat Parameter[4]	Result
Percent Pool Area	**Poor**
Large Woody Debris/Bankfull Channel Width	**Poor**
Average Percent Cover in Pools	**Poor**
Average Percent Boulder Cover	**Poor**
Percent Crown Cover	Fair
Substrate (Percent Fines)	Fair
Percent Erosion Sites	**Poor**
Obstructions	Good
Percent Altered Stream Sites	Fair
% Wetted Area (Wetted Area/Total Area)	**Poor**
% Off Channel Area	Good
Dissolved Oxygen	Good
PH	Good

[4] Johnston & Slaney, 1996

Result	Fair

Figure 4: Reach Break Locations



Known High Value Habitats:
This reach offers excellent off channel rearing and spawning for Chum, Coho and Pink located primarily on the Clayoquot Wilderness Resort property. There are three channels; the Relic Channel, the H and P Channels (Figure 5). The mainstem offers adequate adult migration and some holding during low flow periods. The substrates present are appropriate sized for Chum and Chinook spawning.

Possible Limiting Factors:
This reach has been subject to channel degradation and lateral channel movement caused from historic resource extraction. Instream disturbances included placer mining techniques as well as cross stream yarding and valley bottom road construction during first pass logging. Results from the disturbances have resulted in an over widened channel which features elevated and unstable gravel bars. These gravel depositions have increased the width and braiding of the floodplain. Based on air photo interpretation, gravel bars remain relatively non vegetated and mobile during high flow events, which leads to the reduction in spawning success. Pool depth and frequency, as well as associated LWD, is extremely limited (M.C. Wright, 1995). Bank erosion is prevalent along this reach. Summer and winter fry rearing is limited as the mainstem lacks pool depth and LWD cover, while most tributaries and flood channels become intermittent during drought periods.

Completed Restoration Activities:
The Clayoquot Wilderness Resort has undertaken two side channel projects (H and P Channels) since 2004. They offer spawning and rearing primarily for Chum and Coho salmon but offer some rearing for Sockeye and Chinook as well. These channels account for nearly 50% of the Chum production in this reach (Palfrey, pers. comm.) and offer an exceptional educational tool to the many resort guests in the form of the eco tours. The resort also runs a kids program which salvages stranded fry during the summer and moves them into stable habitat (Caton, pers. comm.). The channels are described separately below.

Reach 2 (2.5-5.9km):

Overview:
This 3.4km long reach is the most actively used spawning area within the Bedwell Mainstem (Fig. 4). It has a mean gradient of 2% and includes the two most important tributaries, Ursus and Penny Creeks (Triton, 1993). The average channel width is 68.3m while the wetted width is 41.0m. The substrates consist of primarily boulders and larger cobbles but have some stable spawning gravel (M.C. Wright, 1995; Palfrey, pers. comm.). The thalweg is well confined within this reach during low flows but extends across the vast floodplain during high water (M.C. Wright, 1995). This area was intensively logged with the majority of the river valley being removed within a short timeframe. This area also contained a mineral rights claim (L1186, Sargent, 1940). It was also reported by Brown *et. al* (1989) that cross stream yarding occurred between 1950 and 1974. There is limited instream diversity within this reach with minimal pool depth. This reach supports Chinook, Coho, Chum, Pink and River Type Sockeye Salmon, as well as Resident Cutthroat Trout and Steelhead.

Above the Ursus River confluence the channel begins to increase in gradient and becomes heavily braided (Triton, 1993). The smaller substrates have accumulated in the pool tail outs while the floodplain is littered with larger cobbles. Instream cover in this reach increases with LWD jams, boulder complexes, undercut banks, and overhanging vegetation (MC Wright, 1998). The upper boundary of this reach extends to the base of the canyon where a series of bedrock chutes are present. These chutes have been reported as a migration to fish passage at low flow (Brown et al, 1979).

This channel has lost its hardened banks that are defined by living tree roots in healthy streams. The summer wetted width of 41.0m compared to a channel width of 68.3m reflects the loss of water to sediments (M.C. Wright, 1995). The second growth forest is an even age closed canopy (Figure 3) made of Western Hemlock, Western Red Cedar and Red Alder. The stumps in the riparian area were mainly western Red Cedar left behind from the first pass logging and mining period. There is a valley bottom road present along the western bank.

Table 2.) Bedwell River Reach 2 Habitat Data Summary of Results.

Habitat Parameter	Result
Percent Pool Area	**Poor**
Large Woody Debris/Bankfull Channel Width	**Poor**
Average Percent Cover in Pools	**Poor**
Average Percent Boulder Cover	**Poor**
Percent Crown Cover	Fair
Substrate (Percent Fines)	Fair
Percent Erosion Sites	**Poor**
Obstructions	Good
Percent Altered Stream Sites	Fair
% Wetted Area (Wetted Area/Total Area)	**Poor**
% Off Channel Area	Good
Dissolved Oxygen	Good
PH	Good
Result	**Fair**

Known High Value Habitats:
This reach offers excellent off channel rearing and spawning for Chum, and Coho. There is a high value off channel area which overflows out of the Bedwell and into the Ursus near the confluence (Figure 5). There are a few lateral scour pools to allow for adult holding and migration during low flow periods. The substrates present are appropriate sized for spawning. One of the best pools is located at the Penny Creek confluence (MC Wright, 1995).

Possible Limiting Factors:
This reach has been subject to channel degradation and lateral channel movement caused from historic resource extraction. Results from the riparian disturbances have resulted in an over widened channel which features elevated and unstable gravel bars. These gravel depositions have increased the width of the floodplain to over 100m and created multiple channels. Based on air photo interpretation the gravel bars are poorly vegetated due to movement during high flow events, which has led to the reduction in spawning success and pool infilling. Pool depth, frequency and LWD are extremely limited. Triton (1993) reports only boulder habitat in this reach, while Wright (1995) observed two LWD jams near the Penny Creek and the Ursus River confluences. Bank erosion is prevalent along this reach. The riparian vegetation is second growth. Summer and winter fry rearing is limited as the mainstem lacks pool depth and LWD cover, while most tributaries are extremely steep and flood channels become intermittent during drought periods.

Completed Restoration Activities:
There are no completed restoration activities to date. The Clayoquot Wilderness Resort runs a kids program which salvages stranded fry during the summer and moves them into stable wetted habitat (J. Caton, pers. comm.).

Reach 3 (5.9-8km):

Overview:
This 2.1km long reach originates at the Strathcona Park boundary and has not been studied to the extent of the lower reaches. This reach ends at the anadromous barrier and is primarily located in a bedrock canyon. The steep sidewalls have created deep pools and large chutes. This reach is primarily used by a few Chinook but primarily Coho for spawning and rearing. Since 1993 only 1 adult

Chinook has been observed in this reach, while Coho are able to migrate throughout given their later migration timing.

Known High Value Habitats:
This reach offers rearing and spawning for Chinook and Coho. There are deep plunge pools which allow for adult holding and migration during moderate flow periods. It offers good perennial rearing for juvenile Coho.

Possible Limiting Factors:
Given the topography of this reach, spawning area is limited. Fish access is limited. The steep narrow canyon walls limit refuge during high flows in winter.

Completed Restoration Activities:
There are no completed restoration activities to date.

Reaches 4, 5 & 6 (8-km):

Overview:
These upper reaches are located above anadromous access and have not been studied as extensively as the lower reaches. The majority of this area was extensively logged including cross stream yarding. The old logging road follows the valley bottom and crosses the river several times. This area features a steep side walled canyon with large falls and deep plunge pools (R4) followed by a long low gradient reach (R5) which is full of unstable LWD and a wide braided channel. Reach 6 is predominately a bedrock canyon where the channel quickly rises in elevation up to Bedwell Lake (930m elevation). This area features numerous large tributaries (Ashwood, Blaney, Dry, Noble, and Sam Craig Creeks) of which Noble Creek was historically stocked with Cutthroat Trout (BC MOE Records). This area also had native populations of both Cutthroat and Rainbow Trout (Brown et al, 1989). This reach is located entirely within Strathcona Park.

Known High Value Habitats:
This area offers rearing and spawning for resident Cutthroat and Rainbow Trout. There are deep plunge pools which allow for adult holding and appropriate substrates for spawning. This area has the highest frequency of LWD which remain from the poor logging practices. The LWD present offers rearing habitat. The substrates present are an appropriate size for spawning.

Possible Limiting Factors:
Channel instability and LWD movement during flood stages as well as unstable slopes can bury salmon redds downstream or trout redds and increase suspended sediments (affecting downstream water quality).

Completed Restoration Activities:
There have been no completed restoration activities to date.

Ursus Creek Mainstem

Reach 1 (0-3.1km)

Overview:
This low gradient reach is the most important in the watershed (Brown et al, 1989). It is close to pristine condition and offers the most important and stable habit in the watershed. It begins at the confluence with the Bedwell River and progresses upstream for ~3km, on an average gradient of 0.5%. The majority of this watershed has been not been logged. The lower reach has only been partially logged with large cedars were left standing (Brown et al 1979). Mineral extraction occurred on the right bank

and was held by the Prosper Group (Sargent, 1940). The remaining cedars and juvenile deciduous trees have protected the high habitat values of large deep pools and stable gravel riffles. The channel is well confined and protected due to a bedrock outcropping along the southern bank; it has an average channel width of 41.0m and a wetted width of 27.8m. The substrates consist primarily of spawning gravels with a compliment of cobbles, and fines (Triton, 1993). Pool cover is provided by large boulders, LWD, and overhanging vegetation. M.C. Wright & Associates (1996) identified many different off channel habitats and sidechannels along this reach. These off channels offered fish a variety from winter refuge and spawning to summer rearing habitat. The most significant sidechannel is the Bedwell – Ursus Sidechannel which shares approximately 300m of the floodplain along the Ursus Creek to the confluence with the Bedwell River. Reach 1 supports Chinook, Coho, Chum, and River Type Sockeye Salmon, as well as Resident Cutthroat Trout and Steelhead. It ends at a boulder/bedrock cascade at the end of a narrow canyon.

Table 3.) Ursus Creek Reach 1 Habitat Data Summary of Results.

Habitat Parameter	Result
Percent Pool Area	Fair
Large Woody Debris/Bankfull Channel Width	Fair
Average Percent Cover in Pools	Fair
Average Percent Boulder Cover	Fair
Percent Crown Cover	Good
Substrate (Percent Fines)	Fair
Percent Erosion Sites	**Poor**
Obstructions	Good
Percent Altered Stream Sites	Fair
% Wetted Area (Wetted Area/Total Area)	Fair
% Off Channel Area	Good
Dissolved Oxygen	Good
PH	Good
Result	**Good**

Known High Value Habitats:
Reach 1 is considered the most important reach in the entire watershed (MC Wright, 1995). It offers excellent off channel rearing and spawning for Chinook, Coho, Chum, and River Type Sockeye Salmon (Figure 5). The mainstem is regarded as high in value as the sidechannels due to the protected riparian areas and high instream habitat complexity for rearing and spawning. The Bedwell – Ursus Sidechannel is noted in the publications as the highest value sidechannel in the Ursus. The headwater glacier offers a perennial water source to support summer rearing in the mainstem.

Possible Limiting Factors:
Small channel disturbances due to historic mining as well as left bank erosion at the confluence opposite the Bedwell/Ursus side channel observed by MC Wright (1996) are suggested limiting factors.

Completed Restoration Activities:
There have been no restoration activities to date in this reach.

Reach 2 (3.1-7.3km)

Overview:
Located above the boulder walled valley and cascade of reach 1, this reach is wider and less confined. The gradient and drop (approx. 4m[5]) results in a barrier to most species except Coho and Steelhead.

[5] D.R. Clough pers Comm

It is low gradient with an intact old growth riparian zone. The sidewalls are steep with short fish accessible tributaries. The mean channel width is 60.7m wide and freely meanders throughout the loose gravels with a 37.0m average summer wetted channel. This reach is braided and shallow. The off channels offer excellent rearing habitat. This stream segment is 4.2km long and has an average gradient of 1% (Triton, 1993). The substrates consist primarily of spawning gravels with a compliment of fines and boulders (Triton, 1993). Pool cover is provided by large boulders and LWD. This reach supports Coho, Cutthroat and Steelhead Trout. This reach ends at a small cascade where the gradient increases and the channel becomes confined.

Table 4.) Ursus Creek Reach 2 Habitat Data Summary of Results.

Habitat Parameter	Result
Percent Pool Area	**Poor**
Large Woody Debris/Bankfull Channel Width	Fair
Average Percent Cover in Pools	Fair
Average Percent Boulder Cover	Fair
Percent Crown Cover	Good
Substrate (Percent Fines)	Fair
Percent Erosion Sites	Fair
Obstructions	Fair
Percent Altered Stream Sites	Good
% Wetted Area (Wetted Area/Total Area)	Fair
% Off Channel Area	Good
Dissolved Oxygen	Good
PH	Good
Result	**Fair**

Known High Value Habitats:
This reach offers excellent off channel rearing and spawning for Coho and Steelhead (Figure 5). The mainstem has several LWD jams that hide adult salmon during migration and fry rearing during low flow periods with good instream cover and deep pools. Only four pools observed by MC Wright in 1995. The headwater glacier offers a perennial water source to support summer rearing in the mainstem. The substrates present are an appropriate size for spawning and are relatively stable (Palfrey, pers. comm.).

Possible Limiting Factors:
There are only four pools over a 4.2km length of river which is well below the standard for a healthy system.

Completed Restoration Activities:
There have been no completed restoration activities to date in this reach.

Reach 3 (7.3-11.1km)

Overview:
This reach is the upper-most extent of salmon access. It is 3.8km long and has a mean gradient of 2.0%. The stream drains through a steep mountainous reach in a confined channel with an average channel width of 36.3m and wetted width of 21.6m (MC Wright, 1995). This reach has an intact old growth riparian zone and features three high gradient tributaries (Triton, 1993). The substrates consist primarily of large boulders and cobbles but pockets of spawning gravels have been reported (MC Wright, 1995). Pool cover is provided primarily by large boulders and to a lesser extent LWD. This reach supports Coho, Cutthroat and Steelhead Trout. This reach ends at a 6m bedrock falls just above the confluence of Thunderbird Creek.

Table 5.) Ursus Creek Reach 3 Habitat Data Summary of Results.

Habitat Parameter	Result
Percent Pool Area	**Poor**
Large Woody Debris/Bankfull Channel Width	Fair
Average Percent Cover in Pools	Fair
Average Percent Boulder Cover	Fair
Percent Crown Cover	Good
Substrate (Percent Fines)	Fair
Percent Erosion Sites	Fair
Obstructions	Fair
Percent Altered Stream Sites	Good
% Wetted Area (Wetted Area/Total Area)	Fair
% Off Channel Area	Good
Dissolved Oxygen	Good
PH	Good
Result	**Fair**

Known High Value Habitats:
This reach offers excellent in channel rearing and spawning for Coho and Steelhead. The mainstem offers adequate adult migration and holding during low flow periods with good instream cover and deep pools formed by the large boulders found in this reach. This reach offers three stable pools for holding and summer rearing. The headwater glacier offers a perennial water source to support summer rearing in the mainstem. The substrates present are an appropriate size for spawning and are relatively stable (Palfrey, pers. comm.).

Possible Limiting Factors:
The gradient of this reach is steeper than the previous lower reaches. This has led to a fairly low abundance of LWD and off channel habitat. Three pools in a 3.8km length are below standard.

Completed Restoration Activities:
There have been no completed restoration activities to date in this reach.

Reach 4 (11.1-16.5km)

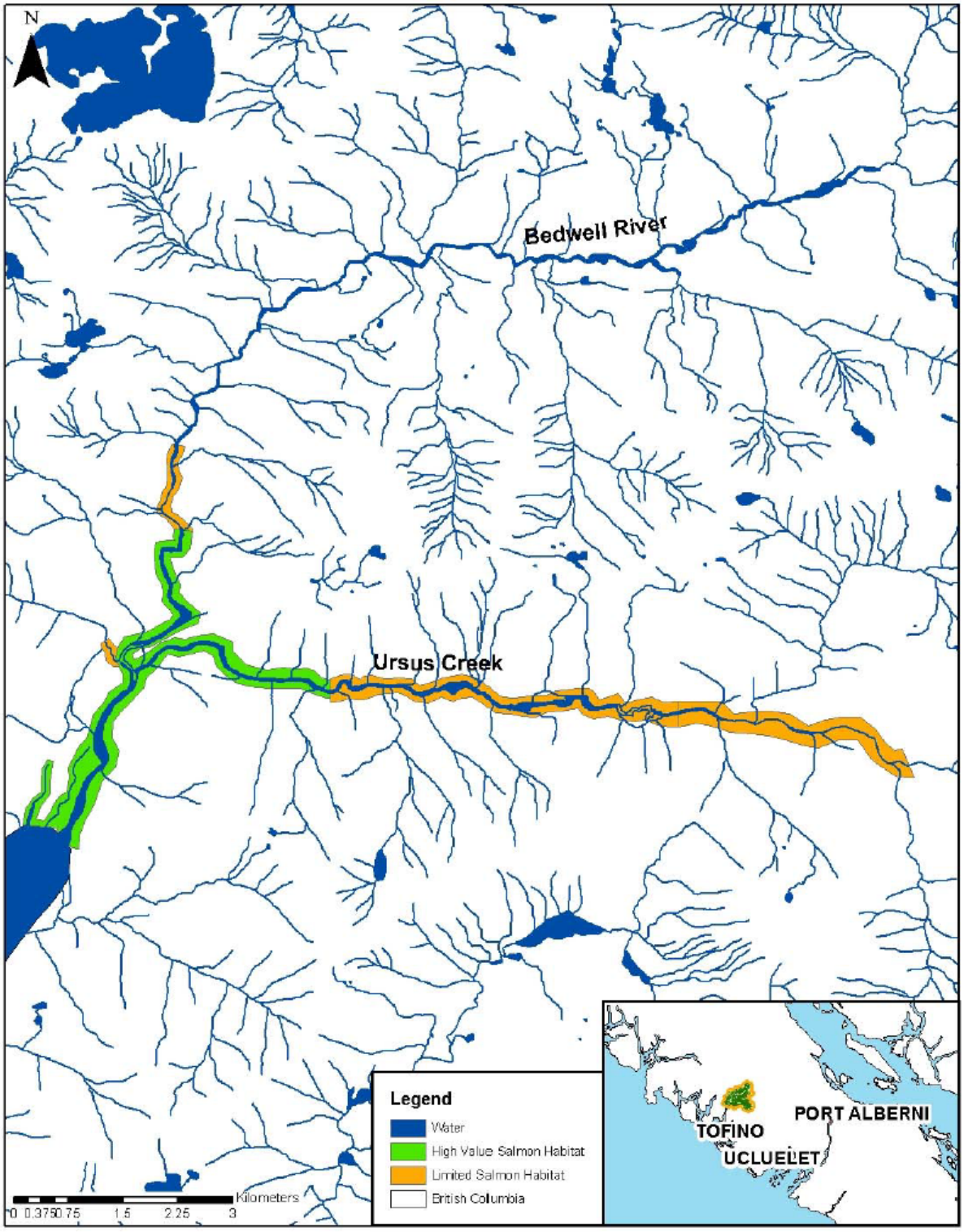
Overview:
This canyon reach is above the anadromous fish barrier and leads to the glacial headwaters. The steep stream banks are 6-8m high and consist primarily of bedrock. Resident trout presence is unknown at this time.

Known High Value Habitats:
There is no data available on this reach.

Possible Limiting Factors:
There is no data available on this reach.

Completed Restoration Activities:
There is no data available on this reach.

Figure 5: Known High Value Habitats



P Channel (Bedwell R1)

Reach 1 (0-2.1km)

Overview:
This off channel was designed by M.C. Wright in 2003 with Clayoquot Wilderness Resort staff. It was built in segments and is 2.1 km long offering approximately 10,000m^2 of wetted habitat. The habitat has been made complex with pools, spawning gravel and wood cover (M.C. Wright 2003 & D.R. Clough 2006, 2007, 2008). It is fed by groundwater from the Bedwell River and the adjacent sidehill. This channel accounts for nearly 50% of the Chum production in this reach (Palfrey, pers. comm.). This reach also supports Coho spawning and rearing, off channel rearing for Chinook and River Type Sockeye Salmon, as well as Resident Cutthroat Trout. This reach ends at a large cascade at the base of the mountain.

Known High Value Habitats:
The Chum and Coho production in the protected waters of the side channel are considerable. This off channel area provides year round protection from floods or droughts for eggs, fry, smolts and adults.

Possible Limiting Factors:
This channel was flooded in the winter of 2006/2007 and the LWD and gravel were displaced. Repairs to the channel were made (Clough 2007) and measures to protect from future floods.

Relic Channel (Bedwell R1)

Reach 1 (0-0.5km)

Overview:
This channel is the one of the most productive low gradient habitats within the Bedwell Watershed. It is tidally influenced and fed by ground water seepages from the valley sidewall. It offers approximately 500m of access from the confluence of the mainstem (Brown et al, 1989). Side channel P enters this water body mid reach. It has a well-developed sedge grass land across the tidally flooded benches. The riparian area of this reach has been logged and it has a bridge crossing used by the Clayoquot Wilderness Resort. The substrates consist primarily of cobbles and spawning gravels (Brown, et al. 1989). This reach supports Chum spawning, Coho rearing, off channel rearing for Chinook and River Type Sockeye Salmon, as well as Resident Cutthroat Trout.

Known High Value Habitats:
There is limited information available on this tributary. It was identified by Brown *et al.* (1989) but was not surveyed by either MC Wright or Triton during the 1990's. This relic channel offers excellent habitat as observed from recent surveys of side channel development (D. R. Clough pers. comm.).

Possible Limiting Factors:
Limited water supplies from shifting subsurface water sources and the instability of the H-Channel headwaters have caused damage in the past (D.R. Clough 2007).

H Channel (Bedwell R1)

Reach 1 (0-0.5km)

Overview:
This is a dynamic tributary located along the north boundary of Clayoquot Wilderness Resort. It has approximately 500m of fish access from the Bedwell reach 1 before entering steep gradients just above the Resort buildings. The lower portions of this reach are well used by Coho but the reach dries during the summer. In 2006/2007 a slide from logged headwaters filled the channel with debris. Clayoquot

Wilderness Resort removed the debris and restored the channel (D.R. Clough 2007). It has been stable since 2007. The Resort has plans to create lower gradient habitat with its water supply by diverting flow into one of its vestigial channels to the north (J. Caton, pers. comm.).

Known High Value Habitats:
H- channel offers a perennial water supply to offchannel habitat.

Possible Limiting Factors:
The lower channel is disturbed and porous such that it dries. A large slide originating in the mountain headwaters above completely filled the channel. It has been repaired by the Resort but still dries at the lower reach.

Penny Creek (Bedwell R2)

Reach 1 (0-0.5km)

Overview:
This is the one of the few low gradient tributaries located off the mainstem of the Bedwell River; it enters Reach 2 on the right bank. This low gradient reach offers approximately 500m of access from the mainstem (Brown et al, 1989). This reach has been logged and has an old logging road crossing which is seasonally used by the Wilderness Resort. The substrates consist primarily of cobbles and spawning gravels (Brown et al, 1989). It supports Coho spawning and rearing, off channel rearing for Chinook and River Type Sockeye Salmon, as well as Resident Cutthroat Trout. This reach ends at a large cascade at the base of a mountain.

Known High Value Habitats:
There is limited information available on this tributary.

Possible Limiting Factors:
There is limited information available on this tributary. It is limited in LWD in the lower reach (Caton, pers. comm.).

Completed Restoration Activities:
There have been no completed restoration activities to date in this reach.

Noble Creek (Bedwell R3)

Overview:
This tributary enters the Bedwell River at Reach 3 on the right bank. In 1983 this channel was stocked with 2483 Cutthroat fry. There is no further information on the results of this stocking.

Known High Value Habitats:
There is limited information available on this tributary.

Possible Limiting Factors:
There is limited information available on this tributary. This reach had two mineral claims and likely suffered some channel and riparian disturbance during active mining operations (Sargent, 1940).

Completed Restoration Activities:
There have been no completed restoration activities to date in this reach.

Other Tributaries:

The tributaries have been identified by watershed code and either have large barriers at their confluences or are too steep and offer limited potential habitat. These drainages include:

- Ashwood Creek Watershed Code: 930-355300-57300
- Blaney Creek Watershed Code: 930-355300-51800
- Dry Creek Watershed Code: 930-355300-4200
- North Fork Watershed Code: 930-355300-11600-55000
- Sam Craig Creek Watershed Code: 930-355300-45300
- Thunderbird Creek Watershed Code: 930-355300-11600-67700
- You Creek Watershed Code: 930-355300-70900

Estuary

Overview:

There is currently no literature available for the estuary of the Bedwell River. Based on orthophoto interpretation and personal interviews the estuary is relatively undisturbed along its eastern side while the western edge may have been historically dredged to accommodate the logging and mining requirements for transportation (Caton, pers. comm.). The estuary itself is a large salt marsh offering approximately 24 hectares of tidally wetted habitat with at least 12 active tidal channels. It appears undisturbed from the historic developments. The steep mountain on the estuary side of the river (east) protected it from road access by the loggers or miners. The development of road access, log dumping and barge loading all occurred over deep water in the west side of Bedwell Inlet.

Known High Value Habitats:

There is approximately 24 hectares of rearing habitat for all juvenile species found in this watershed. This area is critical rearing habitat for Stream type Sockeye (Holtby & Ciruna, 2007) as well as River type Chinook and Pink, Chum and Coho. There are at least 12 active tidal channels and appears to be abundant eel grass and sedges to feed the lower trophic levels of the ecosystem. This area also sees a relatively low volume of marine traffic.

Possible Limiting Factors:

There is limited information available on the Estuary. The upland disturbance and erosion likely delivered a substantial amount of material onto the native substrates (Caton, pers. comm.), although this was not confirmed by any of the existing studies. The estuary has been relatively stable since the early 1990's (Palfrey, pers. comm.).

Completed Restoration Activities:

There have been no completed restoration activities to date in this reach.

Current Stock Status

Chinook populations in Clayoquot Sound have been depressed for nearly as long as DFO has been enumerating streams. Beginning in 1947, when escapement numbers were first recorded on the Bedwell River, 750 adult Chinook were observed and by the mid 1960's there were only 25 returning adults (Brown *et. al*, 1979). In 1995, DFO began using the Area-Under-the-Curve (AUC) methodology and the Bedwell River was chosen as an "Indicator Stream". Indicator Status allowed for set parameters of snorkel surveys to be initiated which will allow for comparison across a given timeframe (Dobson, pers. comm.). Table 6 shows the 10 year average escapement and the 2010 adjusted returns.

Table 6: Bedwell River Salmon Escapement

Species	1995-2005 Average Esc.	2010
Sockeye	479	1015
Coho	1,629	1,300
Chinook	222	50
Pink	22	42
Chum	3,652	3,370

Since 1995 the salmon returns to the Bedwell River have been highly variable but a few general trends are present. The Chum and Coho returns remain close to their average run size which is understandable given the relative stability of the habitat features in the CU's. The ocean survival of Sockeye is highly variable, similar to the Somass and Kennedy Sockeye stocks along the west coast of Vancouver Island. The Chinook has plummeted to less than 50 individuals from 2007-2010 from a high of 528 in 1996. In 2008, the Tofino Salmon Enhancement Society was given permission to enhance the Chinook populations, given their low abundance.

Habitat Status Tables

DFO provided a template for the Habitat Status Tables (Appendix 1). This template was completed for each of the five species found in this watershed. Information was extracted from existing literature and any information gaps were filled, where possible, by personal interviews. The tables assist this report in identifying existing high value habitats, limiting factors, performance indicators, information gaps, possible indicator thresholds, potential measures to maintain productivity and habitat restoration which has been undertaken.

Pressure State Indicators

Similar to other large watersheds on Vancouver Island the problems within the Bedwell River are a direct result from resource extraction practices. The historic poor logging and mining practices within the watershed have resulted in a degraded and over widened channel. The selected indicators/thresholds were chosen based on:

1. Loss of bank stability, reduced water quality, and reduction in potential LWD;
2. Reduction of instream channel complexity caused from logging the riparian vegetation, cross stream yarding, and dredge mining which is responsible for bank erosion, channel aggradation, and channel stability.
3. Increased sedimentation leading to a possible reduction of spawning success and reduction in wetted areas during low flow periods.

These factors lead to the following habitat indicators (Table 7) which were most appropriate for the Bedwell River. Habitat indicators, metrics and benchmarks were selected from Appendixes 12 and 14 in the Stalberg *et al* 2009 report.

Table 7: Application of Recommended Habitat Indicators

Habitat Type	Action	Indicator
Stream	Pressure	Disturbance of Riparian Areas
Stream	Pressure	Total land cover alteration (Forestry and Mining)
Stream	State	Stream Discharge
Stream	State	Water Temperatures
Stream	State	Suspended Sediment

Potential Restoration Projects

The Clayoquot Wilderness Resort has undertaken the only restoration projects within this watershed. They have done so on their private lands and funded the project themselves with the exception of a small grant from the Pacific Salmon Foundation in 2007. M.C. Wright, 2003 designed the series of side channels on Resort property and D.R. Clough Consulting assisted the Resort from 2006 with further work on the original plan. To date there has been no restoration in the mainstem. Based on the existing data and personal interviews the following actions should be considered to improve or maintain the fish habitat values within the Bedwell River.

Bedwell River Restoration:

Reaches 1 and 2:

The lower reaches of the Bedwell River and sidechannels should be considered the highest priority for fish habitat restoration opportunities. They have the highest fish use, the most anthropogenic impact but appear to have the best cost /benefit ratio (best access). The literature and interviews identified the following habitat impacts;

1. Increased slide activity post logging
2. Increased sedimentation from upland sources
3. Increased bank erosion
4. Reduction in wetted habitat
5. Lack of large pools
6. Reduction of channel complexity
7. Destabilization of spawning gravels

Up to date assessments are needed. The most important is to complete a watershed assessment prioritizing the slopes, roads, riparian and instream habitat conditions similar to the Kennedy Watershed Plan[6]. The previous habitat inventories (Triton 1993, Wright 1995) were limited in scope and did not include the entire watershed. A new assessment should include the headwaters as new landslides were observed on orthophotos from 2007.

Restoration activities should address the causes of instability as well as the means to accommodate the best outcomes for fish habitat, based on existing condition. It may involve slope stabilization, road deactivation and riparian restoration. Instream and off channel fish habitat improvement may make use of LWD spurs, parallel logs, stump revetments, single log deflectors as well as rock groins and boulder complexes to improve the spawning, rearing, and migration for salmon in this reach. The off channel improvements by Clayoquot Resort have shown the example of success. Fish utilization in these channels is very high. The Resort is a willing partner and has several ideas on further work that can be done. They are currently pursuing a partnership to build an extension of H-Channel (called L-Channel

[6] Warttig et al, 2001

Wright 2003) that offers approximately 1.0 km of potential off channel pool and riffle habitat. There is an additional off channel restoration option identified by Wright (1995), but being across the river at the mouth of the Ursus, there may be an issue with access. The existing riparian area along the mainstem may respond to treatments to improve biodiversity, growth and habitat. The air photos indicate a high proportion of deciduous trees that may respond to thinning and underplanting of conifers. Channel assessments may indicate riffle crests are degraded or aggraded and need treatments such as rock weirs, gravel removal or stabilized with vegetative staking.

Reaches 3-6:

The stability of these reaches should be assessed according to a watershed recovery plan described above. These reaches are a source of debris and sediments which are a concern to downstream high value fish habitat. There may be some opportunities to improve the resident fish habitat as well. The most cost effective methods to deal with issues in these hard to access reaches is likely bioengineering techniques where heavy equipment is not required. Previously logged riparian areas may need treatments. A brushing and planting program for biodiversity and stability may be an option.

Ursus Creek:

Reaches 1-3:

Given the relatively unlogged, undisturbed condition of the watershed, the habitat should remain undisturbed and monitored. We recommend a watershed assessment to collect data on the habitat condition as well as use for templates for other reaches in the Bedwell or Clayoquot Sound. The Bedwell River offers more opportunity and easier access than these reaches. The cascades between Reach 1 and 2 should be monitored for debris that could impede fish access, but in this location it may not be a concern. It is a very important area to salmon production and mistakes cannot be afforded.

Reach 4 and Tributaries:

At this point in an undisturbed watershed, there is no potential or benefit to restoration in this reach.

Off Channels (Relic, H, P, L Channels):

The Relic and P channels are in good shape and should be monitored to ensure stability. H channel has been repaired from the recent landslides. It may need future excavation of sediments as they migrate downstream. L channel should be investigated as discussed in reach 1 above.

Estuary

The estuary is in good shape with abundant vegetation and habitat diversity. It appears to not have been affected by humans other than added sedimentation rates that have likely increased the intertidal areas. Monitoring polygons should be established and inspected with changes over time.

Possible Measures to Maintain Productivity

With respect to protection of the existing habitat values, the Bedwell River is relatively unique to the West Coast of Vancouver Island for the following reasons:

1. The majority of the watershed (68%) is held within Strathcona Provincial Park. The remainder is held by Iisaak Forest Products who currently have no access or plans to log the remaining watershed. A minimal amount of land is privately held or Indian reserve.
2. The private property owners (Clayoquot Wilderness Resort) are stewards of the watershed. They have already spent hundreds of thousands of their own money in creating and restoring off channel habitat in the vicinity of their property. They also have an educational component for resort quests and they run a fry salvage program during the summer for children.
3. The forest tenure holders likely will not log this watershed during this rotation of logging. There is currently no access to the available timber and it would create a public relations nightmare (Brad Taylor, pers. comm.).
4. The riparian is recovering throughout most of reaches and benefits from protection provided by the Provincial Park designation and the 30-50m riparian setback standard under the Clayoquot Sound Scientific Panel Logging Recommendations on Crown Land.

Reasonable Information Gaps

The previous habitat assessments on the Bedwell River provided a fair picture of the salmon bearing reaches. However, neither of these reports occurred on the reaches within the Strathcona Park or the estuary. The existing reports are also over 15 years old which was prior to the large storm events from 2006-2010 (Palfrey, pers. comm.). For the purposes of this report the watershed should be assessed from top to bottom. Potential information gaps include:

1. Current extent of the health of the estuary and establishment of elevations and monitoring polygons. The estuary is critical rearing habitat for out migrating smolts and must be protected.
2. There is limited information available on the upper reaches within Strathcona Park; including Bedwell Lake, resident fish presence and bank stability, and channel morphology. Information is also limited on the smaller tributaries which did not have names or watershed codes.
3. Little to no hydrology or water quality information exists. A water quality testing regiment should be established since Brown *et al* (1979) identified this water quality as potentially hazardous, and referred to the gravels as exceptionally clean with no bottom life.

Discussion:

The Bedwell River has been negatively affected by historic forestry and mining practices. Luckily in the case of the Bedwell most resource extraction has ceased for 30 years given the area is now located with the Strathcona Provincial Park or held by Iisaak Forest Products who currently have no plans to develop the area. The only remaining private lands are held by Clayoquot Wilderness Resort who are good stewards of the watershed. However, the historic practices removed nearly the entire riparian zone of the river which contributes to the unstable terrain and large sediment volumes in the lower reaches.

There is limited data available on this watershed but the existing literature and personal interviews have identified potential opportunities to improve and protect fish salmon habitat. All species of Pacific salmon have the same requirements. The need cool clean water, non-impacted stable gravels for

spawning, deep pools for adult migration and holding, a healthy riparian for shade and bank stability, and a healthy estuary to ensure abundant feeding opportunities during the transition period from fresh to salt water. The Bedwell River is currently in a healing state with recovering riparian area of approximately 20-40 years old. A complete watershed level assessment is recommended including the estuary and headwaters which are absent from the existing literature.

The result of the literature review and interviews is that Reach 1 of Ursus Creek, Reach 2 of the Bedwell and the estuary are the most important areas in comparison to the remainder of the watershed. But the remainder of the watershed was severely damaged during logging operations. Other important salmonid habitats are located in the Relic and P Channels which are important Chum and Coho producers. Reach 1 of the Bedwell River is primarily used for adult migration for Sockeye and Chinook but offers spawning for Pink and Chum.

The Bedwell River is an important system in the Southwest Vancouver Island Chinook CU (Margaret Wright, pers. comm.). They require stable mainstem gravel bars for spawning and flowing boulder runs for rearing. This will require assessment and restoration within the Reach 1 and 2 of the Bedwell. The Ursus is fairly pristine and offers adequate Chinook habitat.

The upper reaches of the Bedwell and Ursus do not support anadromous salmon populations, however they should be surveyed for channel stability and sediment sources. This would be included within the watershed level assessment.

The Ahoushat First Nations have had very little involvement with the enumeration or enhancement of this watershed. Perhaps it is the distance from their village or the relatively low levels of returning salmon of which more abundant runs were found closer to home. If any large scale restoration activities are to occur it could be a possible source of emplyoment for the local residents.

Stock rebuilding through enhancement such as an onsite hatchery or transplant is not an option as there is no facility. Off site enhancement strategies are currently being applied through the Tofino Salmon Enhancement Society. The Society, after several years of interest, was permitted in 2010 to collect Chinook broodstock. Currently 18,000 eggs are being incubated at the Tofino Hatchery to then pond the smolts in sea pens. The Society has made a significant impact on the Chinook rebuilding in the nearby Tranquil River through a similar strategy. Restoring the Pink stocks through enhancement has always suffered from a lack of broodstock. If started, there exists the option of outplanting eyed eggs in the stable waters of P-Channel at Clayoquot Wilderness Resort. Re-establishment of the Pink run would enhance Chinook fry survival in the estuary.

In closing; the Bedwell River Habitat Status could be described as hopeful. It is one of the least developed watersheds on Vancouver Island. The significant but historic impacts of logging and mining are now over. The river has had 40 years of recovery from most impacts. Unfortunately, 40 year old Red Alder do not protect habitat like old growth Red Cedar, Sitka Spruce and Western Hemlock. Fortunately the land is under good stewardship; it is protected in Park areas, Forestry Areas (under CSSP) and by a dedicated private land owner (Clayoquot Wilderness Resort and Spa).

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John Winpenny, Logging Contractor, Barkley Forest Ltd.

Brad Taylor, Forestry Engineer, Iisaak Forest Resources Ltd.

Appendix 1: Habitat Status Tables Chinook, Chum, Coho, Pink, Sockeye. (5pps)

Chinook Conservation Unit - Bedwell River Watershed Habitat Status Report

Life Stage	Known limiting factors	Known high value habitats	Performance Indicator(s) for habitat limiting factors	Performance Indicator(s) Status	Performance Indicators Thresholds	Information Gaps	Possible measures to address limiting factors	Possible measures to maintain productivity	Habitat Protection & Restoration Measures Undertaken
Spawner/Egg/ Alevin	Invasive logging and mining practices from mid 1800's to mid 1970's[1,3,4,5,6] Significant channel aggradation resulting with infilling of pools, damage to redds (mobilization,suffocation), and reduction of available wetted habitat reducing upstream migration[1] Removal of riparian vegetation has led to extreme fluctuations in water levels with floods during winter and drought in summer. It also contributes to increased water temperature and reduces Large Woody Debris[3,4,5]. Unstable upslope materials are migrating with storms into fish habitat[2].	Chinook utilize the lower 7km of Bedwell mainstem and lower 11km of the Ursus. Abundant spawning gravel in tail outs but appears unstable[3,4,5].	Riparian disturbance & land cover alteration (mining & forestry). Suspended sediment. Low and High Flows Water temperature Migration & Spawning	Discharge data available in Triton 1993, MC Wright 1995 and Water Survey Canada 1992. Water chemistry parameters available in Triton 1993. Land use alterations, area logged, age of forest) available in Bedwell Ursus Bulson Watershed Plan (2006)	Proportion of stream length with disturbed riparian zone: Functioning condition (NOAA 1996) Proper: < 20 disturbed and > 50% of riparian vegetation similar to natural community composition. Equivalent clearcut area (ECA): area harvested,cleared, or burned: proper: < 15 % ECA with no concentration of disturbance in unstable or potentially unstable areas. Total suspended sediments as identified by EIFAC 1964 and DFO 2000: < 25 parts per million (ppm) of suspended solids - no evidence of harmful effects on fish and fisheries; Magnitude of flow events (Richter et al. 1997): 10% MAD minimum instantaneous flow for survival of most aquatic life (though 20% of MAD has been recommended as a minimum instream flow for some streams) 7-day average of mean daily temperature(Richter and Kolmes 2005): Spawning and incubation 10ºC	Hydrology, Water Quality, including hydraulic sampling	Address upslope instability, Develop fish habitat structures in mainstem and continue off channel creation.	Protect existing riparian areas during future logging. Clayoquot Sound Scientific Panel logging restrictions are in effect. Increase nutrient load	Clayoquot Wilderness Resort has undertaken off channel creation as per MC Wright prescriptions 2004
Fry/Juvenile Summer	Fry spend limited time in the river, migrate to estuary within 3 months, River type Chinook have not been observed in this watershed[2].	na	na	na	na	na	na	na	na
Fry/Juvenile Winter	Fry spend limited time in the river, previous to winter	na	na	na	na	na	na	na	na
Smolt	Limited data available, Estuary habitat appears least changed and productive.	Numerous estuarine channels with associated vegetation offer feeding opportunities[1,2]	na	na	7-day average of mean daily temperature(Richter and Kolmes 2005): Spawning and incubation 15ºC	na	Monitor changes over time Create boulder riffle habitat	Stabilize headwaters and limit sediment deposition	
Marine Coastal	na	na	na	na	na		6-8 open net fish farms now operate year round in Bedwell Sound		
Marine Offshore	Ocean survival is highly dependant on ocean conditions. Which are highly variable year to year.	na	na	na	na	na	na	na	na
Returning Adult Migration	Limited upstream migration upstream during periods of extreme drought. Limited pool rearing cover[1,3,4,5].	Best adulting holding is between Marker 10-12 near Ursus Confluence[2]	Riparian disturbance land cover alteration (mining & forestry) Suspended sediment Stream discharge Water temperature migration & spawning		Proportion of stream length with disturbed riparian zone: Functioning condition (NOAA 1996) Proper: < 20 disturbed and > 50% of riparian vegetation similar to natural community composition. Equivalent clearcut area (ECA): area harvested, cleared, or burned: proper: < 15 % ECA with no concentration of disturbance in unstable or potentially unstable areas. Total suspended sediments as identified by EIFAC 1964 and DFO 2000: < 25 parts per million (ppm) of suspended solids - no evidence of harmful effects on fish and fisheries; Magnitude of flow events (Richter et al. 1997): 10% MAD minimum instantaneous flow for survival of most aquatic life (though 20% of MAD has been recommended as a minimum instream flow for some streams) 7-day average of mean daily temperature(Richter and Kolmes 2005):Migration 16ºC	Restoration opportunities focusing on creating scour and pool cover. Hydrology requirements with respect to future logging. Marine survival including sport and commercial fishing.	Address upslope instability, Develop fish structures in mainstem and continue off channel creation.	Increase tagging to provide fish management migration data	none

References:

1.) Doug Palfrey, 2.) John Caton, pers com 3.) Triton 1993 4.) MC Wright 1995 5.) Brown 1979 6.) Sargent 1940

Chum Conservation Unit - Bedwell River Watershed Habitat Status Report

Life Stage	Known limiting factors	Known high value habitats	Performance Indicator(s) for habitat limiting factors	Performance Indicator(s) Status	Performance Indicators Thresholds	Information Gaps	Possible measures to address limiting factors	Possible measures to maintain productivity	Habitat Protection & Restoration Measures Undertaken
Spawner/Egg/ Alevin	Extremely poor logging and mining practices from mid 1800's to mid 1970's[1,3,4,5,6] Severe channel aggradation resulting in the infilling of pools, destruction of redds, and reduction of available wetted habitat reducing upstream migration[1] Removal of riparian vegetation has led to extreme fluctuations in water levels over the course of year with extreme floods during winter and drought in summer. Contributes to increase water temperature and reduction of Large Woody Debris[3,4,5]. Unstable upslope materials are still mobile and getting worst with recent storm events[2].	Chum utilize the lower Bedwell mainstem and lower reach of the Ursus (up to M6). Abundant spawning gravel in tail outs but appears unstable. CWR and Relic offchannels produce high proportion of fry[1,6].	Riparian disturbance land cover alteration (mining & forestry). Suspended sediment. Peak and Min discharge. Water temperature. Migration & Spawning.	Discharge data available in Triton 1993, M.C. Wright 1998 and Water Survey Canada 1992 Water chemistry parameters available in Triton 1993. Land use alterations, total area logged, age of forest) available in Bedwell Ursus Bulson Watershed Plan (2006)	Proportion of stream length with disturbed riparian zone: Functioning condition (NOAA 1996) Proper: < 20 disturbed and > 50% of riparian vegetation similar to natural community composition. Equivalent clearcut area (ECA): area harvested,cleared, or burned: proper: < 15 % ECA with no concentration of disturbance in unstable or potentially unstable areas. Total suspended sediments as identified by EIFAC 1964 and DFO 2000: < 25 parts per million (ppm) of suspended solids - no evidence of harmful effects on fish and fisheries; Magnitude of flow events (Richter et al. 1997): 10% MAD minimum instantaneous flow for survival of most aquatic life (though 20% of MAD has been recommended as a minimum instream flow for some streams) 7-day average of mean daily temperature(Richter and Kolmes 2005): Spawning and incubation 10ºC	Hydrology, Water Quality, including hydraulic sampling.	Address upslope instability. Develop fish habitat structures in mainstem and continue off channel creation Increase nutrient load	Protect existing riparian during future logging . Clayoquot Sound Scientific Panel logging restrictions are in effect.	Clayoquot Wilderness Resort has undertaken off channel creation as per MC Wright prescriptions 2004
Fry/Juvenile Summer	Fry spend limited time in the river, migrate to estuary by June	na	na	Discharge data available in Triton 1993, MC Wright 1998 and Water Survey Canada 1992. Water chemistry parameters available in Triton 1993. Land use alterations,area logged, age of forest) available in Bedwell Ursus Bulson Watershed Plan (2006)		na	na	na	Clayoquot Wilderness Resort has undertaken off channel creation as per MC Wright prescriptions 2004
Fry/Juvenile Winter	na	na	na	na		na	na	na	na
Smolt	Limited data available, Estuary appears in relativity good shape	Numerous tidal channels with associated vegetation offer feeding opportunities	na	na	na	na	monitor changes over time. Beach seining for juveniles	Stabilize headwaters and limit sediment deposition	Clayoquot Wilderness Resort has undertaken off channel creation as per MC Wright prescriptions 2004
Marine Coastal	na	na	na	na	na		6-8 open net fish farms now operate year round in Bedwell Sound		
Marine Offshore	na	na	na	na	na	na	na	na	na
Returning Adult Migration	Limited upstream migration upstream during periods of extreme drought. Limited pool rearing cover[1,3,4,5].	Known best adulting holding is between Marker 3-4 (Bedwell), Marker 6 in the Ursus and CWR and RB sidechannel 1	Riparian disturbance land cover alteration (mining & forestry) Suspended sediment Stream discharge Water temperature migration & spawning		Proportion of stream length with disturbed riparian zone: Functioning condition (NOAA 1996) Proper: < 20 disturbed and > 50% of riparian vegetation similar to natural community composition Equivalent clearcut area (ECA): area harvested, cleared, or burned: proper: < 15 % ECA with no concentration of disturbance in unstable or potentially unstable areas Total suspended sediments as identified by EIFAC 1964 and DFO 2000: < 25 parts per million (ppm) of suspended solids - no evidence of harmful effects on fish and fisheries; Magnitude of flow events (Richter et al. 1997): 10% MAD minimum instantaneous flow for survival of most aquatic life (though 20% of MAD has been recommended as a minimum instream flow for some streams) 7-day average of mean daily temperature(Richter and Kolmes 2005):Migration 16ºC	Restoration opportunities focusing on creating scour and pool cover. Hydrology requirements with respect to future logging. Marine survival including sport and commericial fishing.	Address upslope instability. Develop fish structures in mainstem and continue off channel creation.	Protect existing riparian during future logging . Clayoquot Sound Scientific Panel logging restrictions are in effect	Clayoquot Wilderness Resort has undertaken off channel creation as per MC Wright prescriptions 2004

REFERENCES:

1.) Doug Palfrey, pers com
2.) John Caton, pers com
3.) Triton 1993
4.) MC Wright 1995
5.) Brown 1979
6.) Sargent 1940

Coho Conservation Unit - Bedwell River Watershed Habitat Status Report

Life Stage	Known limiting factors	Known high value habitats	Performance Indicator(s) for habitat limiting factors	Performance Indicator(s) Status	Performance Indicators Thresholds	Information Gaps	Possible measures to address limiting factors	Possible measures to maintain productivity	Habitat Protection & Restoration Measures Undertaken
Spawner/Egg/ Alevin	Extremely poor logging and minning practices from mid 1800's to mid 1970's[1,3,4,5,6] Severe channel aggradation resulting in the infilling of pools, destruction of redds, and reduction of available wetted habitat reducing upstream migration[1] Removal of riparian vegetation has led to extreme fluctuations in water levels over the course of year with extreme floods during winter and drought in summer. Contributes to increase water temperature and reduction of Large Woody Debris[3,4,5]. Unstable upslope materials are still mobile and getting worst with recent storm events[2].	Coho utilize the lower 7km of Bedwell mainstem and lower 13.5km of the Ursus[1]. Abundant spawning gravel in tail outs but appears unstable. CWR, Ursus Confluence and Right Bank Side Channels offer good Coho spawning habitat.	Riparian disturbance land cover alteration (mining & forestry) Suspended sediment Stream discharge Water temperature migration & spawning	Discharge data available in Triton 1993, MC Wright 1998 and Water Survey Canada 1992 Water chemistry parameters available in Triton 1993, Land use alterations, area logged, age of forest) available in Bedwell Ursus Bulson Watershed Plan (2006)	Proportion of stream length with disturbed riparian zone: Functioning condition (NOAA 1996) Proper: < 20 disturbed and > 50% of riparian vegetation similar to natural community composition. Equivalent clearcut area (ECA): area harvested,cleared, or burned: proper: < 15 % ECA with no concentration of disturbance in unstable or potentially unstable areas. Total suspended sediments as identified by EIFAC 1964 and DFO 2000: < 25 parts per million (ppm) of suspended solids - no evidence of harmful effects on fish and fisheries; Magnitude of flow events (Richter et al. 1997): 10% MAD minimum instantaneous flow for survival of most aquatic life (though 20% of MAD has been recommended as a minimum instream flow for some streams) 7-day average of mean daily temperature(Ricther and Kolmes 2005): Spawning and incubation 10ºC	Hydrology, Water Quality, including hydraulic sampling Increase nutrient load	Address upslope instability, Develop fish structures in mainstem and continue off channel creation	Protect existing riparian during future logging . Clayoquot Sound Scientific Panel logging restrictions are in effect	Clayoquot Wilderness Resort has undertaken off channel creation as per MC Wright prescriptions 2004
Fry/Juvenile Summer (N/A for immediate ocean migrants, ie. pink, chum, some chinook & sockeye poplns)	Low base flow in summer especially in the tributaries and flood channels resulting in disconnected pools and stranded fry[1,2,4,5] Migration through habitat types during low flow conditions is limited. Reduced large woody debris input. Decreased water quality (increased water temperature) due to riparian alterations	CWR, Ursus Confluence and Right Bank Side Channels offer high value summer rearing habitat.	Riparian disturbance land cover alteration (minning & forestry) Suspended sediment Stream discharge Water temperature rearing	Discharge data available in Triton 1993, MC Wright 1998 and Water Survey Canada 1992 Water chemistry parameters available in Triton 1993, Land use alterations, area logged, age of forest) available in Bedwell Ursus Bulson Watershed Plan (2006)	Same as above Performance Indicator Threshholds for other life histories	Hydrology, Water Quality, including hydraulic sampling Increase nutrient load	Develop fish habitat structures in mainstem and continue off channel creation throughout watershed	Protect existing riparian during future logging . Clayoquot Sound Scientific Panel logging restrictions are in effect	Clayoquot Wilderness Resort has undertaken off channel creation as per MC Wright perscriptions 2004
Fry/Juvenile Winter (N/A for immediate ocean migrants as above)	High instantaneous flows with limited instream cover. Limited off channel habitat[1,3,4,5] Lack of functional LWD instream	CWR, Ursus Confluence and Relic Side Channels offer high value winter rearing habitat.	Riparian disturbance land cover alteration (minning & forestry) Suspended sediment Stream discharge Water temperature rearing	Discharge data available in Triton 1993, MC Wright 1998 and Water Survey Canada 1992 Water chemistry parameters available in Triton 1993, Land use alterations, area logged, age of forest) available in Bedwell Ursus Bulson Watershed Plan (2006)		Hydrology,	Address upslope instability, Develop fish structures in mainstem and continue off channel creation	Protect existing riparian during future logging . Clayoquot Sound Scientific Panel logging restrictions are in effect	Clayoquot Wilderness Resort has undertaken off channel creation as per MC Wright prescriptions 2004
Smolt	Limited data available, Estuary appears in relativity good shape	Numerous tidal channels with associated vegetation offer feeding opportunities	na	na	na	Water Quality, including hydraulic sampling	monitor changes over time	Protect existing riparian during future logging . Clayoquot Sound Scientific Panel logging restrictions are in effect	
Marine Coastal	na	na	na	na	na		6-8 open net fish farms now operate year round in Bedwell Sound		
Marine Offshore	na	na	na	na	na	na	na	na	na
Returning Adult Migration	Limited upstream migration upstream during periods of extreme drought. Limited pool rearing cover[1,3,4,5].	Known best adulting holding is between Marker 10-12 near Ursus Confluence[1]	Riparian disturbance land cover alteration (mining & forestry) Suspended sediment Stream discharge Water temperature migration & spawning		Same as above Performance Indicator Threshholds for other life histories	Restoration opportunities focusing on creating scour and pool cover. Hydrology requirements with respect to future logging. Marine survival including sport and commercial fishing.	Address upslope instability, Develop fish structures in mainstem and continue off channel creation.		none

REFERENCES:
1.) Doug Palfrey, pers com
2.) John Caton, pers com
3.) Triton 1993
4.) MC Wright 1995
5.) Brown 1979
6.) Sargent 1940

Pink Conservation Unit - Bedwell River Watershed Habitat Status Report

Life Stage	Known limiting factors	Known high value habitats	Performance Indicator(s) for habitat limiting factors	Performance Indicator(s) Status	Performance Indicators Thresholds	Information Gaps	Possible measures to address limiting factors	Possible measures to maintain productivity	Habitat Protection & Restoration Measures Undertaken
Spawner/Egg/ Alevin	Extremely poor logging and mining practices from mid 1800's to mid 1970's[1,3,4,5,6] Severe channel aggradation resulting in the infilling of pools, destruction of redds, and reduction of available wetted habitat reducing upstream migration[1] Removal of riparian vegetation has led to extreme fluctuations in water levels over the course of year with extreme floods during winter and drought in summer. Contributes to increase water temperature and reduction of Large Woody Debris[3,4,5]. Unstable upslope materials are still mobile and getting worst with recent storm events[2].	Pinks utilize the lower Bedwell mainstem and numerous tidal channels of estuary[1]. Abundant spawning gravel in tail outs but appears unstable.	Riparian disturbance land cover alteration (minning & forestry) Suspended sediment Stream discharge Water temperature migration & spawning	Discharge data available in Triton 1993, MC Wright 1998 and Water Survey Canada 1992 Water chemistry parameters available in Triton 1993, Land use alterations, area logged, age of forest) available in Bedwell Ursus Bulson Watershed Plan (2006)	Proportion of stream length with disturbed riparian zone: Functioning condition (NOAA 1996) Proper: < 20 disturbed and > 50% of riparian vegetation similar to natural community composition. Equivalent clearcut area (ECA): area harvested,cleared, or burned: proper: < 15 % ECA with no concentration of disturbance in unstable or potentially unstable areas. Total suspended sediments as identified by EIFAC 1964 and DFO 2000: < 25 parts per million (ppm) of suspended solids - no evidence of harmful effects on fish and fisheries; Magnitude of flow events (Richter et al. 1997): 10% MAD minimum instantaneous flow for survival of most aquatic life (though 20% of MAD has been recommended as a minimum instream flow for some streams) 7-day average of mean daily temperature(Richter and Kolmes 2005): Spawning and incubation 10ºC	Hydrology, Water Quality, including hydraulic sampling Increase nutrient load	Address upslope instability, Develop fish structures in mainstem and continue off channel creation	Protect existing riparian during future logging . Clayoquot Sound Scientific Panel logging restrictions are in effect	Clayoquot Wilderness Resort has undertaken off channel creation as per MC Wright prescriptions 2004
Fry/Juvenile Summer (N/A for immediate ocean migrants, ie. pink, chum, some chinook & sockeye popIns)	Fry spend limited time in the river, migrate to estuary by May	na	na	na	na	na	na	na	na
Fry/Juvenile Winter (N/A for immediate ocean migrants as above)	Fry spend limited time in the river, previous to winter	na	na	na	na	na	na	na	na
Smolt	Limited data available, Estuary appears in relativity good shape	Numerous tidal channels with associated vegetation offer feeding opportunities	na	na	na	na	monitor changes over time	Stabilize headwaters and limit sediment deposition	
Marine Coastal	na	na	na	na	na		6-8 open net fish farms now operate year round in Bedwell Sound		
Marine Offshore	na	na	na	na	na	na	na	na	na
Returning Adult Migration	Limited upstream migration upstream during periods of extreme drought. Limited pool rearing cover[1,3,4,5].	Known best adulting holding is between Marker 10-12 near Ursus Confluence	Riparian disturbance land cover alteration (mining & forestry) Suspended sediment Stream discharge Water temperature migration & spawning		Proportion of stream length with disturbed riparian zone: Functioning condition (NOAA 1996) Proper: < 20 disturbed and > 50% of riparian vegetation similar to natural community composition Equivalent clearcut area (ECA): area harvested, cleared, or burned: proper: < 15 % ECA with no concentration of disturbance in unstable or potentially unstable areas Total suspended sediments as identified by EIFAC 1964 and DFO 2000: < 25 parts per million (ppm) of suspended solids - no evidence of harmful effects on fish and fisheries; Magnitude of flow events (Richter et al. 1997): 10% MAD minimum instantaneous flow for survival of most aquatic life (though 20% of MAD has been recommended as a minimum instream flow for some streams) 7-day average of mean daily temperature(Richter and Kolmes 2005):Migration 16ºC	Restoration opportunities focusing on creating scour and pool cover. Hydrology requirements with respect to future logging. Marine survival including sport and commericial fishing.	Address upslope instability, Develop fish structures in mainstem and continue off channel creation.		none

REFERENCES:

1.) Doug Palfrey, pers com
2.) John Caton, pers com
3.) Triton 1993
4.) MC Wright 1995
5.) Brown 1979
6.) Sargent 1940

Sockeye Conservation Unit - Bedwell Watershed Habitat Status Report

Life Stage	Known limiting factors	Known high value habitats	Performance Indicator(s) for habitat limiting factors	Performance Indicator(s) Status	Performance Indicators Thresholds	Information Gaps	Possible measures to address limiting factors	Possible measures to maintain productivity	Habitat Protection & Restoration Measures Undertaken
Spawner/Egg/ Alevin	Extremely poor logging and mining practices from mid 1800's to mid 1970's[1,3,4,5,6] Severe channel aggradation resulting in the infilling of pools, destruction of redds, and reduction of available wetted habitat reducing upstream migration[1] Removal of riparian vegetation has led to extreme fluctuations in water levels over the course of year with floods during winter and drought in summer. Contributes to increase water temperature and reduction of Large Woody Debris[3,4,5]. Unstable upslope materials are still mobile as observed with recent storm events[2].	Sockeye utilize the lower 7km of Bedwell mainstem (marker 10-12) and lower Ursus (marker 3-6).[1,4] Abundant spawning gravel in tail outs but appears unstable.	Riparian disturbance land cover alteration (mining & forestry) Suspended sediment Stream discharge Water temperature migration & spawning	Discharge data available in Triton 1993, MC Wright 1998 and Water Survey Canada 1992. Water chemistry parameters available in Triton 1993. Land use alterations,area logged, age of forest) available in Bedwell Ursus Bulson Watershed Plan (2006)	Proportion of stream length with disturbed riparian zone: Functioning condition (NOAA 1996) Proper: < 20 disturbed and > 50% of riparian vegetation similar to natural community composition Equivalent clearcut area (ECA): area harvested, cleared, or burned: proper: < 15 % ECA with no concentration of disturbance in unstable or potentially unstable areas Total suspended sediments as identified by EIFAC 1964 and DFO 2000: < 25 parts per million (ppm) of suspended solids - no evidence of harmful effects on fish and fisheries; Magnitude of flow events (Richter et al. 1997): 10% MAD minimum instantaneous flow for survival of most aquatic life (though 20% of MAD has been recommended as a minimum instream flow for some streams) 7-day average of mean daily temperature(Richter and Kolmes 2005): Spawning and incubation 10ºC	Hydrology, Water Quality, including hydraulic sampling Increase nutrient load	Address upslope instability, Develop fish structures in mainstem and continue off channel creation	Protect existing riparian during future logging . Clayoquot Sound Scientific Panel logging restrictions are in effect	none
Fry/Juvenile Summer	Fry spend limited time in the river, migrate to estuary within 3 months,	na	na	na	na	na	na	na	na
Fry/Juvenile Winter	Fry spend limited time in the river, previous to winter	na	na	na	na	na	na	na	na
Smolt	Limited data available, Estuary appears in relativity good shape	Numerous tidal channels with associated vegetation offer feeding opportunities	na	na	na	na	Monitor changes over time	Stabilize headwaters and limit sediment deposition	
Marine Coastal	na	na	na	na	na		6-8 open net fish farms now operate year round in Bedwell Sound		
Marine Offshore	na	na	na	na	na	na	na	na	na
Returning Adult Migration	Limited upstream migration upstream during periods of extreme drought. Limited pool rearing cover[1,3,4,5].	Known best adult holding is between Marker 9-12 in Bedwell and 3-6 in Ursus[2]	Riparian disturbance land cover alteration (mining & forestry) Suspended sediment Stream discharge Water temperature migration & spawning		Performance indicator threshold - same as Spawner/Egg/Alevin above.	Restoration opportunities focusing on creating scour and pool cover. Hydrology requirements with respect to future logging. Marine survival including sport and commercial fishing.	Address upslope instability, Develop fish structures in mainstem and continue off channel creation.		none

REFERENCES:

1.) Doug Palfrey, pers com

2.) John Caton, pers com

3.) Triton 1993

4.) MC Wright 1995

5.) Brown 1979

6.) Sargent 1940

Appendix 2: Transcripts of Personal Interviews

Doug Palfrey – Tofino Salmon Enhancement Society January 24, 2011
Bedwell River Habitat Questionnaire

1.) **How familiar are you with this system?**

Very I have worked on the system doing snorkel surveys since 93.

2.) **For each reach and tributary do you know of any limiting habitats (i.e. spawning, rearing, migration) for each life stage (egg, alevin, fry, smolt, adult) for each species**

Since I have been working on the stream (93) the habitat has been pretty stable. There has been an increase in bank erosion over the past few years. Sadly on this system it is under seeded.

3.) **What is the most limited habitat in this system? (summer water quality, migration, lack of spawning gravel)**

There are only a few pools early in the year, Ursus produces 80% of Sockeye and Chinook. There is lots of spawning gravel but limited instream cover. There is over 18km of habitat and less than 100 adult Chinook, I am glad we started to enhance it. There is bank erosion and a wide floodplain along the lower reaches. Ocean survival the inside waters have been open for years. The sardine fishery has historically netted 500m from the mouth.

4.) **Do you know of any seasonal problems in habitats (flooding, erosion, base flow, water temperature) in the stream?**

The channels have held up pretty well but recently I have noticed some pool infilling and bank erosion. The system is cold and offers good summer flow for fry. When it floods we can't swim it because of high turbidity levels. Most tribs are pretty steep and don't offer much off channel. The pools have in filled recently.

5.) **Are there any high value habitats in the watershed? Where? For what species? Can you locate them on this watershed map?**

Yes please see high value habitat map. Bedwell: up to marker 12, Ursus between markers 2-6. Most fish production comes from Reach 1 of the Ursus. I have only seen 1 Chinook in the Bedwell above the Ursus but there are always lots of Coho up there. The high value areas haven't changed since I have been around especially the spawning areas. CWR and Relic side channels produce lots of Coho and Chum.

6.) **How has land development affected fish habitat? Can you compare to an adjacent watercourse that has had less development (Tranquil).**

There is currently very little human activity currently. There is the trial on the left bank from Highway 4 and the old logging road along the right bank. The old logging and mining is still evident and the sort was down the inlet to the southwest of the estuary. The CWR is located on the right bank but they are great neighbors. Bedwell has cleaner substrates than other systems and is slightly wider and has fewer pools.

7.) **Would you recommend any enhancement/restoration to increase fish populations in this watershed? It is typical to start in the headwaters and work downstream but might not be applicable in this case.**

We tried to get a pink transplant in the mid 90's but were refused. The watershed is suffering from old logging with large gravel bars and a wide shallow channel. The bottom end could use some work. CWR have completed some sidechannels which make up 50% of chum return.

8.) **What shape is the estuary in? Have you noticed any changes over time with respect to plant communities and general morphology?**

Estuary is great lots of grasses and other vegetation, not disturbed via logging or mining days.

9.) **Are there any high value habitats present in the estuary? Do you know anything about the water quality in the estuary?**

It should be fine. It looks natural and pinks spawn down there every year.

10.) **Do you know the percentage of the watershed has been developed?**

Most of the river banks were logged throughout; lots of old mine equipment and large stumps.

11.)**Other observations? Wilderness Resort?**

They are great they really help with our enumeration and enhancement activities. Their restoration produces lots of fish and educates their clients on awareness. They also take kids on fry salvage throughout the summer in the small tribs.

12.)**How much has the river changed since you have been involved with it?**

Not a lot the gravel bars have gotten a little bigger and there is more bank erosion and debris movement during storms. The pools are filling in after large floods. The old logging bridge washed out in 2003 leaving behind a soft spot which is eroding.

John Caton Clayoquot Wilderness Resort, Manager January 24, 2011
Bedwell River Habitat Questionnaire –

1.) **How familiar are you with this system?**

I live here most of the year so very. The resort was built in 1997.

2.) **For each reach and tributary do you know of any limiting habitats (i.e. spawning, rearing, migration) for each life stage (egg, alevin, fry, smolt, adult) for each species**

We try to help the salmon enhancement guys as much as possible. We have a fry salvage program in the summer for kids. We built 2 side channels and would like to do a 3rd. The lower reaches have had very mobile gravels lately. The pools are getting smaller and the flooding is worse than it used to be.

3.) **What is the most limited habitat in this system? (summer water quality, migration, lack of spawning gravel)**

The smaller tributaries dry completely in the summer, and the pools in the Bedwell are smaller. There is more bank erosion every year and some of the logs along the bank have washed away.

4.) **Do you know of any seasonal limitations in habitats (flooding, erosion, base flow, water temperature) in the stream**?

The mainstem is cold and flows pretty good all year because of the glacier. But there are big floods and the water becomes full of sediment like the Fraser. Base flow in the off channels and small creeks.

5.) **Are there any high value habitats in the watershed? Where? For what species? Can you locate them on this map**?

Yes, the Ursus and our channels. Chum spawn in the lower Bedwell as well.

6.) **How has land development affected fish habitat? Can you compare to an adjacent watercourse that has had less development (tranquil).**

Well they logged the entire river bank which didn't help. There are also the mines but all of that activity ended years ago. I don't know about the other streams.

7.) **Would you recommend any enhancement/restoration to increase fish populations in this watershed? It is typical to start in the headwaters and work downstream but might not be applicable in this case.**

I would like to see more side channels in the lower reach. It would be nice to do some work on the lower Bedwell to increase Chinook and protect us from flooding.

8.) **What shape is the estuary in? Have you noticed any changes over time with respect to plant communities and general morphology?**

The estuary is fine it hasn't changed at all since 1997.

9.) **Are there any high value habitats present in the estuary? Do you know anything about the water quality in the estuary**?

I'm not sure but would assume it is good, we see lots of chum and a few pinks down there.

10.) **Do you know the percentage of the watershed has been developed**?

Most of the river banks.

11.) **Any invasive species present**?

No

12.) **Other observations?**

The fish farms in Bedwell Sound might not be a good thing. There are 5 of them now.

13.) **How much has the river changed since you have been involved with it**?

There are bigger floods, more erosion, a few more landslides like in 2006 and more importantly less fish.

Appendix 3: 1940 Mining Locations

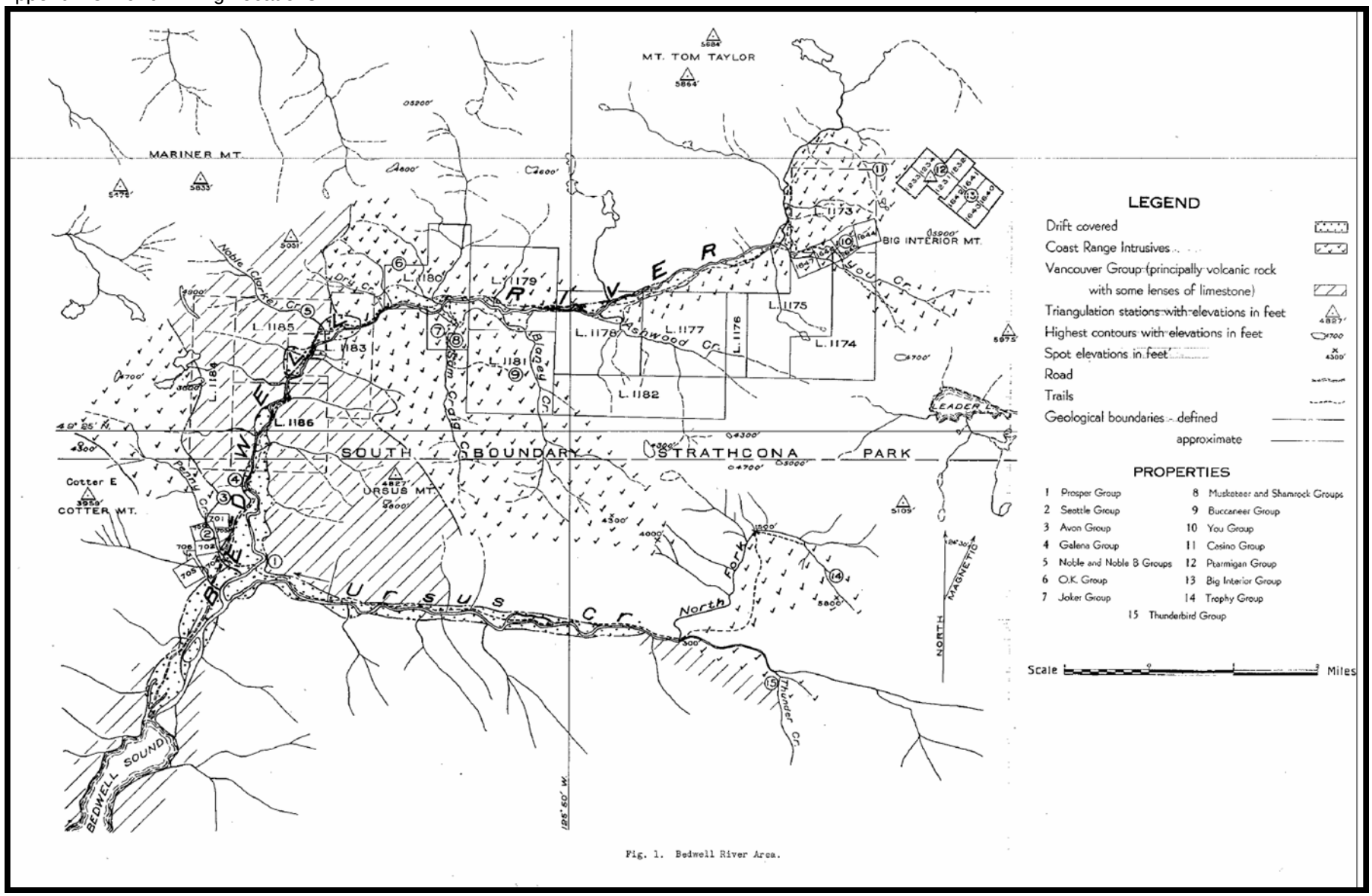

Fig. 1. Bedwell River Area.