FISH PASSAGE PLANNING: CLOWHOM RIVER WATERSHED
COA-F18-F-2504

Prepared for:

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Prepared with financial support of the Fish and Wildlife Compensation Program on behalf of its program partners BC Hydro, the Province of BC, Fisheries and Oceans Canada, First Nations and public stakeholders.

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March 29, 2018

EXECUTIVE SUMMARY

Fish passage impediments created by road crossing structures in British Columbia are a significant challenge that can have a substantial cumulative impact on local fish populations by reducing access to critical habitat and fragmenting populations. Closed bottom road crossing structures (culverts) can present barriers to fish migration due to a number of factors including increased water velocity, turbulence, a vertical drop at the culvert outlet and/or maintenance issues. The rehabilitation of fish passage at road crossing structure barriers presents tangible opportunities to reconnect habitat values within currently fragmented ecosystems.

For this project, fish passage planning maps and data tables/files have been prepared for the Clowhom River watershed, which flows into the Salmon inlet near Squamish, BC. This work is intended to provide a product that will serve as a catalyst for the implementation of fish passage remediation projects in the watershed with the goal of restoration of fish passage into critical habitat areas for priority species.

The Clowhom River watershed was chosen for assessment planning due to a synergy between the objectives of the British Columbia Ministry of Environment and Climate Change Strategy- Ecosystem Branch and the Fish and Wildlife Compensation Program (FWCP) – Coast Region objectives. An organized approach to fish passage remediation in the watershed takes action towards implementation of some of the high level objectives of both organizations which are included in the Clowhom River Watershed Action Plan:

- Conserving and restoring habitat capacity and diversity for fish and other aquatic organisms.
- Sustaining and increasing the population viability of Pacific herring as well as resident kokanee, rainbow trout and cutthroat trout.
- Maintain or improve opportunities to sustainably use ecosystem values for sustenance, social, ceremonial, recreational and commercial purposes.

A strategic approach to the planning and data collection at road crossing structures and the sharing of information provided by the Fish Passage Technical Working Group (FPTWG) provides a platform for an efficient allocation of effort towards the restoration of fish passage opportunities in the Clowhom River watershed with the highest ecosystem benefits. The FPTWG tools such as the data collection protocol documents and the Provincial Stream Crossing Inventory System database tools should be used so that data collection is consistent and can be shared.

In the Clowhom River watershed, 357 crossings were identified as likely closed bottom structures using the fish habitat model. Of these, 29 crossings are predicted to occur on modelled fish habitat, while the remaining 328 are predicted to be located on modelled non-fish habitat (above sections of stream >100m long with gradient >20%).

Assessment of crossing locations on modelled fish bearing habitat in the watershed is recommended and should be conducted according to FPTWG protocols. The FPTWG has prepared on-line training resources, field work guidance, field assessment protocols and data forms to help guide the collection of data and submission of assessment deliverables.

The maps and spreadsheets developed through this project are a step towards implementation of an inventory of closed bottom structures in the Clowhom River watershed (Phase 1). Following the assessment of fish passage at crossing structures, subsequent phases of the FPTWG's Fish Passage Strategic Approach can follow (Phase 2 – Habitat Confirmation, Phase 3 – Design, Phase 4 – Remediation), hopefully resulting in the restoration of fish passage into areas of critical habitat in the watershed for species of interest.

This project was funded in part by the Fish and Wildlife Compensation Program (FWCP) on behalf of its program partners BC Hydro, the Province of BC, Fisheries and Oceans Canada, First Nations and the public, who work together to conserve and enhance fish and wildlife impacted by the construction of BC Hydro dams. The project was also funded by the Ministry of Environment & Climate Change Strategy-Ecosystem Branch.

This project would not have been possible without the highly skilled GIS, data analysis, modelling and mapping support of Simon Norris from Hillcrest Geographics.

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1 INTRODUCTION

The health and viability of freshwater fish populations depends on access to suitable spawning, high water refuge, rearing and overwintering habitat. Watershed connectivity is important to accommodate population abundance fluctuations and the flow of genes that provides resilience to environmental stressors such as floods, landslides and extreme climate events.

Fish passage impediments created by road crossing structures in British Columbia are a significant challenge that can have a substantial cumulative impact on local fish populations by reducing access to critical habitat and fragmenting populations. Estimates based on fish passage data collected to date indicate that there are over 170,000 closed bottom culverts in the province that impede fish passage (FPTWG 2014). Closed bottom road crossing structures (culverts) can present barriers to fish migration due to increased water velocity, turbulence, a vertical drop at the culvert outlet and/or maintenance issues. Rehabilitation and replacement of crossing structure barriers can provide access to currently isolated high value habitats.

For this project, fish passage planning maps and data files have been prepared for the Clowhom River watershed, near Squamish, British Columbia. This work is intended to provide a product that will serve as a catalyst to the future implementation of fish passage remediation projects in the watershed with the goal of restoration of fish passage into critical habitat areas for priority species.

2 BACKGROUND

As a result of high-level direction from the provincial government, a Fish Passage Strategic Approach protocol has been developed for British Columbia to ensure that the greatest opportunities for restoration of fish passage are pursued. A Fish Passage Technical Working Group (FPTWG) has been formed to coordinate the protocol, and the data is continuously amalgamated within the Provincial Stream Crossing Inventory Database (PSCIS). The strategic approach protocol involves a four phase process as described in FPTWG (2014):

- Phase 1: Fish Passage Assessment – Fish stream crossings within watersheds with high fish values are assessed to determine barrier status of structures and document a general assessment of adjacent habitat quality and quantity.
- Phase 2: Habitat Confirmation – Assessments of crossings prioritized for follow up in Phase 1 studies are conducted to confirm quality and quantity of habitat upstream and down as well as to scope for other potential nearby barriers that could affect the practicality of remediation.
- Phase 3: Design – Site plans and designs are drawn for priority crossings where high value fish habitat has been confirmed.
- Phase 4: Remediation – Implementation of reconnection of isolated habitats through replacement, rehabilitation or removal of prioritized crossing structure barriers.

The scope of this project includes portions of the planning for the first phase of fish passage assessment in the Clowhom River watershed. The Clowhom River watershed was chosen for assessment planning due to a synergy between the objectives of the British Columbia Ministry of Environment and Climate Change Strategy- Ecosystem Branch and the Fish and Wildlife Compensation Program (FWCP) – Coast Region objectives. An organized approach to fish passage remediation in the watershed takes action towards implementation of some of the high level objectives of both organizations which are included in the Clowhom River Watershed Action Plan:

- Conserving and restoring habitat capacity and diversity for fish and other aquatic organisms.
- Sustaining and increasing the population viability of Pacific herring as well as resident kokanee, rainbow trout and cutthroat trout.
- Maintain or improve opportunities to sustainably use ecosystem values for sustenance, social, ceremonial, recreational and commercial purposes.

To date, within the Clowhom River watershed, no fish passage assessments (Phase 1) are documented within the PSCIS database. PSCIS data is accessed through Imap BC or with information downloaded directly from the British Columbia Data Catalogue. Data uploaded includes assessment data and links to project reports and photos.

3 OBJECTIVES

The objective of this project is to provide some of the background and field work tools necessary to facilitate an inventory of stream crossing structures on fish bearing and potentially fish bearing streams in the Clowhom River watershed according to the FPTWG standards (MoE 2011).

This work is intended to provide a product that will serve as a catalyst to the future implementation of fish passage remediation projects in the watershed with the goal of restoration of fish passage into critical habitat areas for priority species.

Deliverables of this project are intended to encourage the collection of future fish passage data according to FPTWG standards including upload into the PSCIS database. This is so that the work will not be unnecessarily repeated and so that further phases of the Fish Passage Strategic Approach protocol can be prioritized on a watershed and province wide basis towards road structure barriers providing the best opportunities for rehabilitation.

4 STUDY AREA

The Clowhom River watershed is located approximately 25 km to the west of Squamish and approximately 32 km north-east of Sechelt (Figure 1). The watershed flows into the Salish Sea at the Salmon Inlet. The watershed is of interest to the Sechelt First Nation (FWCP 2017). The watershed is

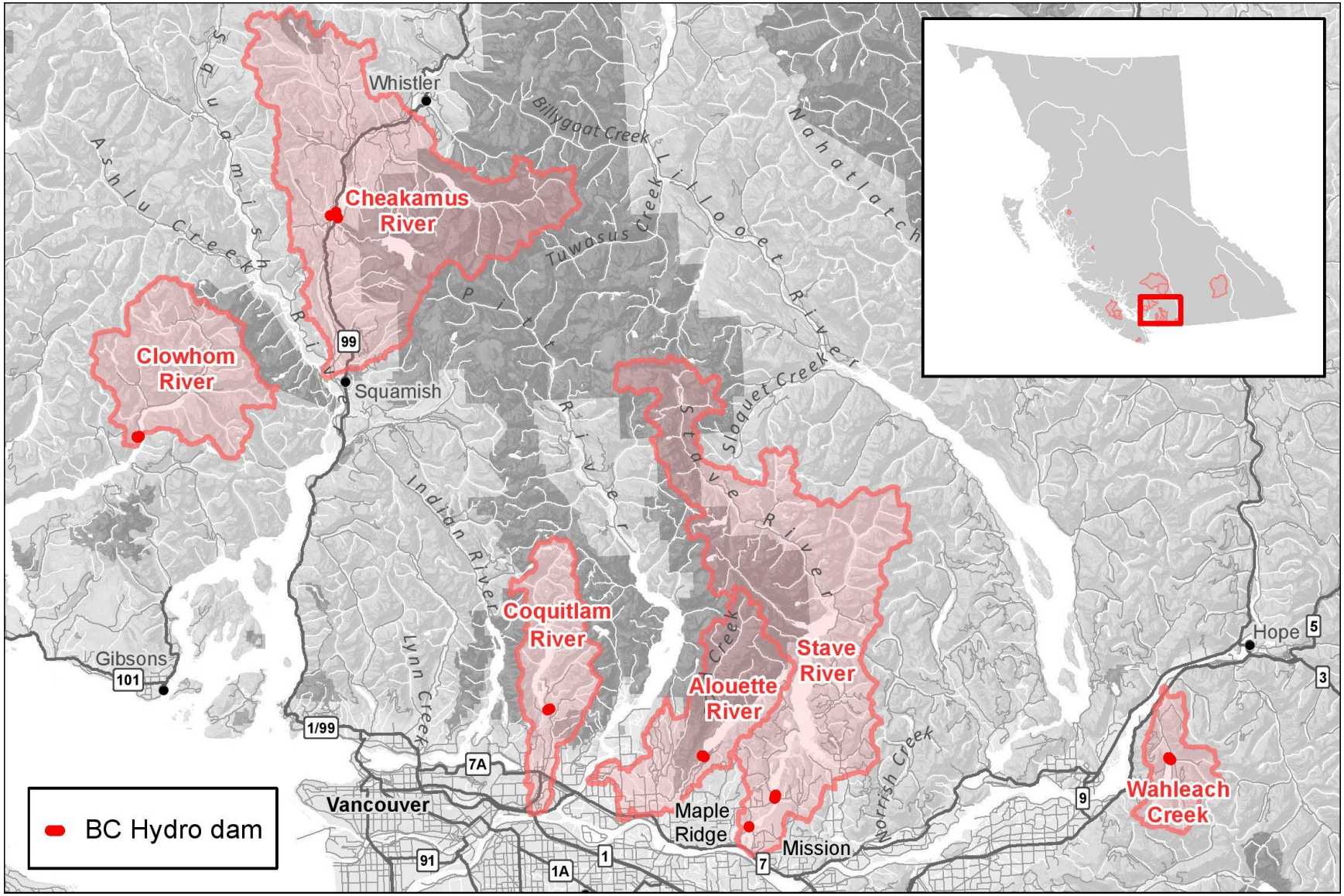

Figure 1. Map of study area.

located primarily on crown land with Tantalus Provincial Park bordering the north-west edge of the watershed. It is located within the Sunshine Coast Natural Resource District.

The Clowhom River is a 6th order stream that drains an area of 385 km^2. The river originates in the Tantalus Range of the Coast Mountains with peaks at the north-east side of the watershed reaching elevations to 2603 m (Mount Tantalus). The stream flows in a generally south western direction to the Clowhom Reservoir before emptying to the Salmon Inlet. Small portions of the watershed are glaciated. The watershed receives Pacific Ocean air masses and significant storms that result in large amounts of precipitation as both rain and snow. Flows in the watershed are heavily influenced by snow melt in the summer and heavy rainfalls in the fall (Figure 2).

The Clowhom Dam is a concrete gravity dam that diverts flows through a penstock directly into the Salmon Inlet of the Salish Sea. The dam operates continuously during periods high runoff that occur in the summer and during fall rains (FWCP 2017). Two run-of-river hydroelectric projects are also located in the upper watershed.

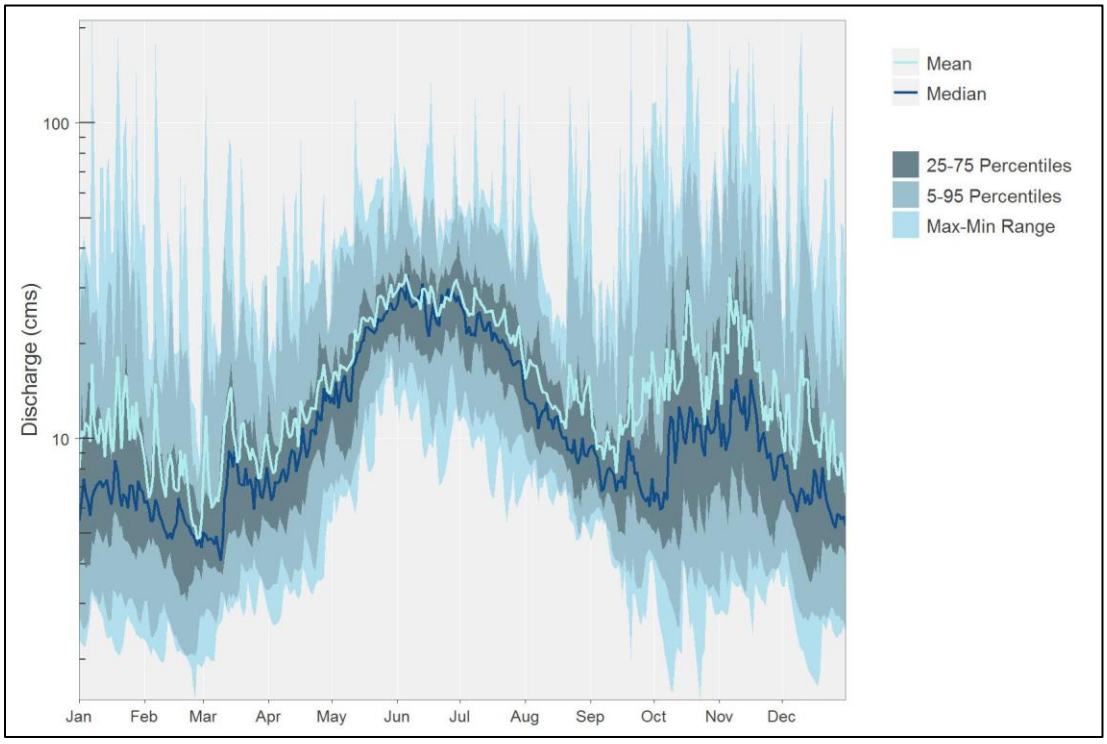

Figure 2. Clowhom River near Clowhom Lake (Station #08GB013 - Lat 49.787189 Lon -123.420418). Available daily discharge data from 1993 to 2016 plotted in R with fasstr (Goetz and Schwarz NA).

4.1 Fisheries

Anadromous species recorded in the watershed within the Fisheries Information Summary System include chum (*Oncorhynchus keta)* and coho salmon (*O. kisutch*) (Table 1, FISS 2018). Upstream of the

Clowhom Dam there are resident populations of rainbow trout (*O. mykiss*), dolly varden (*Salvelinus malma*) and coastal cutthroat trout (*O. clarki clarki*). Threespine stickeback (*Gasterosteus aculeatus*) have been recorded below the dam and prickly sculpin (*Cottus asper*) have been recorded both upstream and downstream (FISS 2018).

Sigma (2005) report that no critical spawning or rearing habitats are located downstream of the dam as it is high gradient bedrock. Reconnaissance surveys were conducted in the historic Upper and Lower Clowhom Lakes by T.G.N. (1950a, 1950b). A reconnaissance survey was also conducted in the Upper Clowhom River basin in 2010. Rainbow trout were the only species that have been observed in Phantom Lake in the upper watershed (ECL 2011).

Table 1. Fish species present in the Clowhom River watershed (FISS 2018).

Scientific name	**Species name**	**Species code**
Cottidae	Sculpin (General)	CC
Cottus asper	Prickly Sculpin	CAS
Gasterosteus aculeatus	Threespine Stickleback	TSB
Micropterus dolomieui	Smallmouth Bass	SMB
Oncorhynchus clarki clarki	Coastal Cutthroat Trout	CCT
Oncorhynchus keta	Chum Salmon	CM
Oncorhynchus kisutch	Coho Salmon	CO
Oncorhynchus mykiss	Rainbow Trout	RB
Salmonidae	Cutthroat Trout	CT
Salvelinus malma	Dolly Varden	DV

5 METHODS

To amalgamate maps and datasheets for crossing structure inventory, potential stream crossing locations were derived and analyzed within the Fish Habitat Model (MoE 2016). The Fish Habitat Model identifies potential stream crossing locations and models known and potential fish habitat based on gradient.

Gradient is a key factor in fish distribution and channel type. High value rearing, overwintering and spawning habitat is often located within channel types with lower gradients, while high gradient sections typically present upstream migration barriers and/or lower quality e habitat. Gradient categories are used in the Fish Passage Model to identify potential gradient barriers as well as to help characterize habitat associated with rehabilitation opportunities by estimating the slope and quantity of potential fish habitat upstream of a crossing.

The Fish Habitat Model utilized stream segments from the GIS stream layer (1:20,000) of the Freshwater Atlas for its gradient analysis (MoE 2016). For this project, the gradient categories detailed in Table 2 were utilized to delineate and classify habitat. The model starts at the mouth of a stream and iterates

through each vertex of the stream flow line, calculating the gradient between the given vertex and the next vertex at least 100m upstream. It delineates additional stream segments at locations where the gradient exceeded the defined thresholds. Following delineation, the average gradient of each stream layer segment located within potential fish habitat was calculated with results classified according to the channel type categories. Finally, for potential habitat upstream of each crossing, stream lengths were summed within the average gradient categories with total areas of wetland and lake habitat also calculated.

Table 2. Stream gradient threshold and average gradient categories generated from the Fish Habitat Model and associated channel type.

***Gradient Range**	**Channel Type**
0 – 5%	Riffle and cascade pool
6 – 13%	Step pool
14 – 20%	Step pool - very steep
>20%	Non fish habitat

*Rounded to the nearest percent

Gradient threshold and average gradient categories were rounded to the nearest percent. Segments downstream of sections up to 13% grade were delineated and classified according to channel type groupings adapted from the British Columbia Channel Assessment Procedure Guidebook which include riffle and cascade pool and step-pool (FPC 1996, Table 2). Stream segments with sections containing gradients from 14 – 20% were classified as step pool - very steep. Stream segments upstream of 100 m sections with an average gradient >20% were considered non fish habitat. Although fish have been reported to utilize habitat with gradients up to 30% (Baxter 1999), a cutoff of 20% was used as the goal was to identify and prioritize crossing rehabilitation opportunities. Stream segments with gradients between 20-30% are extremely steep and do not typically provide high value spawning or rearing habitat.

6 RESULTS

In the Clowhom River watershed, 357 crossings were modelled using the fish habitat model (Table 3). Of these, 29 crossings are predicted to occur on modelled potential fish habitat, while the remaining 328 are predicted to be located on modelled non-fish habitat (above sections of stream >100m long with gradient >20%).

Table 3. Summary of modelled crossings within the Clowhom River watershed.

Crossings	**Number**
On observed or modelled potential fish habitat	29
On modelled non-fish habitat	328
Total	**357**

Maps of the watershed are provided as Attachment 1 and a summary of modelled crossing characteristics (stream name, road name, modelled habitat characteristics upstream, area of wetlands/lakes/reservoir upstream, etc.) are provided as Appendix 1 with a more detailed digital summary provided as Attachment 2. A key to the data included in Attachment 2 is detailed in Appendix 2.

7 NEXT STEPS

7.1 Phase 1 - Fish Passage Assessment

7.1.1 Preparing for the Field

Maps and datasheets provided as deliverables for this project can be used to prioritize stream crossing structure inventories based on sub-watersheds of interest, species of interest as well as quantities and types of habitat upstream and downstream of modelled crossings. To compliment these materials, field work guidance has been provided by the FPTWG. Fisheries literature for the watershed should be reviewed to gather information on fish bearing stream reaches as well as non-fish bearing reaches in preparation for field assessment. Stream reconnaissance reports showing non-fish bearing status can provide the information necessary to greatly reduce the number of crossings requiring inventory. FISS sample sites and obstacles to fish passage have been included on maps to aid in background review of watershed information. Details related to each of these points can be accessed through Imap BC or with information downloaded directly form the British Columbia Data Catalogue. Additionally local knowledge from government, First Nations and industry fisheries/habitat staff should be used to augment the modeled fish habitat data and background fisheries information when possible.

7.1.2 Data Collection

The FPTWG has prepared on-line training resources as well as the procedural document titled "Field Assessment for Determining Fish Passage Status of Closed Bottom Structures" and details assessment deliverables to help guide data collection and submission. A brief summary of data collection, data submission protocols and reporting is included below.

Each watershed should be systematically approached to assess crossings identified as fish bearing or potentially fish bearing. Additional closed bottom crossings encountered incidentally in the field can also be assessed if they occur on unmapped streams and appear to have potential for fish presence. Drainage culverts should not be assessed unless mapped and identified as potentially or known fish bearing.

For all crossings assessed, including open bottom structures and fords, photos should be taken that include images of the crossing inlet, crossing outlet, crossing barrel, channel downstream and channel upstream and any relevant features (ex. natural barriers, road signs adjacent to crossing to aid in location, significant habitat features, etc.). Additionally, the following information should be recorded for all surveyed crossings on standardized filed forms found in MoE 2011: date of inspection, crossing

reference, crew member initials, Universal Transverse Mercator (UTM) coordinates, stream name, road name and kilometer, road tenure information, crossing type, crossing subtype, culvert diameter or span for OBS, culvert length or width for OBS. A more detailed "full assessment" was completed for all closed bottom structures.

In addition to the above information full assessments should include the following parameters: presence/absence of continuous culvert embedment (yes/no), average depth of embedment, whether or not the culvert bed resembled the native stream bed, presence of and percentage backwatering, fill depth, outlet drop, outlet pool depth, inlet drop, culvert slope, average downstream channel width, stream slope, presence/absence of beaver activity, presence/absence of fish at time of survey, type of valley fill, and a habitat value rating. Some of this information is utilized to determine the barrier status of the crossing based on data obtained from various studies (Clarkin et al. 2003; Robison and Walsh 2003) and scored according to the values provided in the MoE protocol (MoE 2011, Tables 4 – 5).

Table 4. Fish barrier scoring.

Risk	Embedded	Value	Outlet Drop	Value	Slope	Value	SWR	Value	Length	Value
LOW	>30cm or >20% of diameter and continuous	0	<15	0	<1	0	<1.0	0	<15	0
MOD	<30cm or 20% of diameter but continuous	5	15-30	5	1-3	5	1.0-1.3	3	15-30	3
HIGH	No embedment or discontinuous	10	>30	10	>3	10	>1.3	6	>30	6

Table 5. Fish barrier result.

Cumulative Score	Result
0-14	Passable
15-19	Potential Barrier
≥20	Barrier

Habitat value ratings should be given for each stream where a crossing is assessed and should be based on channel morphology, flow characteristics (perennial, intermittent, ephemeral), fish migration patterns, the presence/absence of deep pools, un-embedded boulders, substrate, woody debris, undercut banks, aquatic vegetation and overhanging riparian vegetation (Table 6, MoE 2011). For crossings determined to be potential barriers or barriers based on the data, a culvert fix should be recommended based on options provided in MoE 2011 which include:

1. Removal
2. Open Bottom Structure

3. Streambed Simulation
4. Additional Substrate Material
5. Backwater

Table 6. Habitat Value Criteria.

Habitat Value	Fish Habitat Criteria
High	• The presence of high value spawning or rearing habitat (e.g., locations with abundance of suitably sized gravels, deep pools, undercut banks, or stable debris), which are critical to the fish population.
Medium	• Important migration corridor. • Presence of suitable spawning habitat. • Habitat with moderate rearing potential for the fish species present.
Low	• The absence of suitable spawning habitat, and habitat with low rearing potential (e.g., locations without deep pools, undercut banks, or stable debris, and with little or no suitably sized spawning gravels for the fish species present).

All field data collected including photos must be uploaded to the Provincial Stream Crossing Inventory System (PSCIS) by using the excel PSCIS Assessment Form via the Electronic Submission Framework (ESF). A users guide for the PSCIS system is provided on the Fish Passage Activity website.

Reporting for fish passage assessments should include the following as summarized in the FPTWG assessment deliverables:

- Executive Summary.
- Study Area – description and map.
- Scope of works completed.
- Methods.
- Results including a data summary table with structures number and fish passage score and description of fish presence determination.
- Analysis of data collected including Habitat Gained Index (amount of suitable habitat potentially available upstream of the crossing).
- Recommendations - Priorities for fish passage restoration and any limitations and linkages. (ex. structure is a priority but road that crosses downstream was not assessed and other crossings on the same system should be fixed in conjunction to realize highest habitat gains).
- Map showing priority restoration sites.
- Conclusions.

7.2 Phase 2 – Fish Habitat Confirmation

Following the assessment of closed bottom structures in an area of interest, highest priority crossings can progress to the second phase of the FPTWG strategic protocol (Fish Habitat Confirmation). Preparation before going out to the field as well as field sampling and data collection should follow the steps outlined

in FPTWG 2011 – "A Checklist for Fish Habitat Confirmation Prior to the Rehabilitation of a Stream Crossing". The main objectives of these fish habitat assessments are to confirm the presence of high value fish habitat, a large amount of habitat gain through remediation and the absence of fish migration barriers immediately downstream of crossings.

7.2.1 Step 1: Preparation Before Going Out to the Field

Step 1 of the habitat confirmation protocol involves a background review of all relevant access and fisheries information. All provincial fish habitat modeling should be reviewed and government information databases should be searched for relevant background information. Local regulatory biologists should be consulted regarding local fisheries information and insights into fish species utilizing study area watersheds.

Maps and/or web mapping services should be reviewed to determine distance to any potential barriers downstream and upstream of the crossings. PSCIS information on any downstream or upstream crossings located within the watershed should also be reviewed to determine if they have been assessed for fish passage. Fish sampling permits should be obtained for electrofishing to facilitate assessment of fish bearing status and fish species present in subject streams.

7.2.2 Step 2: Field Sampling and Data Collection

Step 2 consists of surveying all the culvert crossings identified as high priority as well as the fish habitat upstream and downstream of the crossing. Each culvert should be flagged and labeled in the field including the crossing ID, date and crew initials. The crossings should be assessed again for fish passage following the procedures outlined in "Field Assessment for Determining Fish Passage Status of Closed Bottomed Structures" (MoE 2011) to confirm the accuracy of the original assessment and determination that the crossing was a barrier to fish passage.

The stream should be surveyed upstream and downstream of the crossing to assess habitat quality. Any upstream crossings should be assessed for fish passage and habitat at access points on the stream should be assessed to determine quality of habitat upstream and downstream of access points. The crew should survey the stream downstream of the crossing to the point where fish passage has been previously confirmed. When necessary, electrofishing should be conducted to aid in the determination of fish bearing status and species identification. Any potential barriers to fish passage should be inventoried with photos, physical descriptions and locations recorded. Surveyed routes should be recorded using GPS units. Each habitat type within the surveyed area should be described, photographed and rated.

7.2.3 Step 3: Submit Survey Summary and Conclusions

A brief documents should be drafted for each habitat confirmation conducted and should include maps and photos and use the headings below as detailed in FPTWG (2011):

- Site Location

- Findings from Background Information Search
- Stream Characteristics at Crossing
- Stream Characteristics Downstream
- Stream Characteristics Upstream
- Conclusions

8 CONCLUSION

In the Clowhom River watershed, 357 crossings were identified using the fish habitat model. Of these, 29 crossings are predicted to occur on modelled fish habitat, while the remaining 328 are predicted to be located on modelled non-fish habitat (above sections of stream >100m long with gradient >20%).

Assessment modelled crossing locations on modelled fish habitat in the watershed is recommended and should be conducted according to FPTWG protocols. The FPTWG has prepared on-line training resources, field work guidance, field assessment protocols and data forms to help guide the collection of data and submission of assessment deliverables.

The rehabilitation of fish passage at road crossing structure barriers presents tangible opportunities to reconnect habitat values within currently fragmented ecosystems. A strategic approach to the planning and data collection at road crossing structures and the sharing of information provided by the FPTWG tools such as the data collection protocol documents and the PSCIS database provides a platform for an efficient allocation of effort towards the restoration of fish passage opportunities with the highest ecosystem benefits. Following implementation of an inventory of closed bottom structures in the Clowhom River watershed (Phase 1) subsequent phases of the FPTWG's Fish Passage Strategic Approach can follow (Phase 2 – Habitat Confirmation, Phase 3 – Design, Phase 4 – Remediation) hopefully resulting in the restoration of fish passage into areas of critical habitat for species of interest in the watershed.

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Appendix 1

Modelled Crossings on Known and Potential Fish Habitat

Crossing ID	Map ID	Stream Name	Road Name	UTM (10U)	Habitat Gain (km)	Lake/ Wetland (ha)	Species Upstream	*Road Tenure
7302005	092G122			469474 5522563	1			Unclassified
7302008	092G122			468242 5522609	0.1			Unclassified
7302011	092G122			468585 5522763	0.1			Unclassified
7302014	092G122			469854 5521668	0.1			Unclassified
7302015	092G122			470520 5520463	0.1			Unclassified
7302017	092G122			469338 5522255	0.1			Unclassified
7302699	092G122			468829 5522851	0.2			Unclassified
7303192	092G122		42	470391 5521735	0			Interfor
7303193	092G122		42	469256 5522787	0.6			Interfor
7303194	092G117		42	471166 5515922	0.1			Interfor
7303195	092G117		42	471346 5516020	0			Interfor
7303196	092G122		42	471626 5517840	0.1			Interfor
7303197	092G122		42	471617 5517965	0.2			Interfor
7303198	092G122		42	470302 5521807	0.2			Interfor
7303202	092G122		42	470618 5520765	0			Interfor
7303203	092G122		42	470998 5520277	0			Interfor
7303204	092G122		42	469454 5522575	0.9			Interfor
7303205	092G122		42	470548 5520969	0			Interfor
7303206	092G122		42	471670 5517032	0			Interfor
7303208	092G122		42	471331 5519854	0.2			Interfor
7303209	092G122		42	471623 5517386	0.2			Interfor
7303210	092G122		42	470522 5521342	0			Interfor
7303211	092G117		42	470245 5514842	0.2			Interfor
7303214	092G117		42	471535 5516449	0			Interfor
7303218	092G122		42	469687 5522334	1.8			Interfor
7303424	092G117		01	468907 5514102	0.1			FLNRORD
7303431	092G117		01	468822 5513905	0.1		BNH,CO,CT,RB,SMB	FLNRORD

Crossing ID	Map ID	Stream Name	Road Name	UTM (10U)	Habitat Gain (km)	Lake/ Wetland (ha)	Species Upstream	*Road Tenure
7303434	092G117		01	469325 5514719	0.2			FLNRORD
7303435	092G117		01	461767 5509998	0			FLNRORD

*FLNRORD = District Manager Sunshine Coast

Appendix 2

Key to Attachment 2 - Digital Summary of Modelled Crossing Characteristics on Known and Potential Fish Habitat

Table heading	**Column Name (BC data distribution)**	**Details/attribute**	**Source/URL**
crossing_id		Unique crossing ID	Fish Habitat Model
map_tile	map_tile	1:50,00 mapsheet	nts-50k-grid-digital-baseline-mapping-at-1-50-000-nts
stream_name	gnis_name	The BCGNIS (BC Geographical Names Information System) name associated with the GNIS feature id	freshwater-atlas-stream-network
stream_order	stream_order	The calculated modified Strahler order.	freshwater-atlas-stream-network
road_name	road_name_full or rfi_highway_description or road_section_id	Dependent on logic incorporating distance of modelled crossing to associated road layers and presence absence of forest tenure information	digital-road-atlas-dra-master-partially-attributed-roads ministry-of-transportation-mot-road-features-inventory-rfi forest-tenure-road-segment-lines
fish_habitat_threshold_type_atcrossing		Stream threshold category of stream at crossing (ex. FISH HABITAT - INFERRED - 055-135PCT = no fish habitat downstream of crossing with gradient > 13.5% for more than 100m)	Fish Habitat Model freshwater-atlas-stream-network
habitat_gain_threshold_sub035		Total linear length (m) of inferred or observed fish habitat upstream of the crossing before 3.5% gradient is exceeded for more than 100 m.	Fish Habitat Model freshwater-atlas-stream-network
habitat_gain_threshold_sub05		Linear length (m) of inferred or observed fish habitat upstream of the crossing before 5.5% gradient is exceeded for more than 100 m.	Fish Habitat Model
habitat_gain_threshold_sub13		Linear length (m) of inferred or observed fish habitat upstream of the crossing before 13.5% gradient is exceeded for more than 100 m.	Fish Habitat Model
habitat_gain_threshold_sub20		Linear length(m) of inferred or observed fish habitat upstream of the crossing before 20.5% gradient is exceeded for more than 100 m.	Fish Habitat Model freshwater-atlas-stream-network
upstr_len_slope_0_035		Linear length (m) of inferred or observed fish habitat upstream of the crossing with average gradient ≤3.5% (riffle).	Fish Habitat Model
upstr_len_slope_035_055		Linear length (m) of inferred or observed fish habitat upstream of the crossing with average gradient from 3.5 - 5.5% (cascade).	Fish Habitat Model
upstr_len_slope_055_135		Linear length (m) of inferred or observed fish habitat upstream of the crossing with average gradient 5.5 - 13.5% (step-pool).	Fish Habitat Model
upstr_len_slope_135_205		Linear length(m) of inferred or observed fish habitat upstream of the crossing with average gradient 13.5 - 20.5% (step pool – very steep).	Fish Habitat Model
upstr_len_slope_sub_205		Total linear length(m) of inferred or observed fish habitat upstream of the crossing with average gradient <- 20.5%.	Fish Habitat Model
lake_area_ha	area_ha	Total area of lake habitat upstream of crossing and stream segments modelled with	Fish Habitat Model

Table heading	Column Name (BC data distribution)	Details/attribute	Source/URL
		habitat threshold <20.5%.	freshwater-atlas-stream-network freshwater-atlas-lakes
wetland_area_ha	area_ha	Total area of wetland habitat upstream of crossing and stream segments modelled with habitat threshold <20.5%.	Fish Habitat Model freshwater-atlas-stream-network freshwater-atlas-wetlands
spp_upstream	species_code	Codes for fish species located on stream segments upstream of the subject crossing.	known-bc-fish-observations-and-bc-fish-distributions
road_tenure	road_class client_name	Dependent on logic incorporating distance of modelled crossing to associated road layers and presence absence of forest tenure information as well as presence of key words in attribute names (ex. FSR is output when "FSR" contained within DRA layer attribute "road_name_full" when DRA layer attributre "road_class" = "resource".	digital-road-atlas-dra-master-partially-attributed-roads ministry-of-transportation-mot-road-features-inventory-rfi forest-tenure-road-segment-lines
upstr_crossing_ids		Unique identifiers for all modelled crossings located upstream of the subject modelled crossing on stream segments modelled as <20.5% threshold.	Fish Habitat Model
dnstr_crossing_ids		Unique identifiers for all modelled crossings located downstream of the subject modelled crossing.	Fish Habitat Model