Proposed Wildlife Habitat Areas for the Coastal Tailed Frog (*Ascaphus truei*) on the Central Coast of British Columbia

Draft

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Summary

The coastal tailed frog (*Ascaphus truei*) is considered at risk (Blue listed, Conservation Data Centre 2001) in British Columbia requiring forest managers to protect the habitat of this frog. However, substantial knowledge gaps exist related to distribution patterns and habitat availability for tailed frogs.

To evenly distribute a sufficient number of Wildlife Habitat Areas (WHAs) across the Central Coast Forest District, we assessed occurrence patterns and habitat suitability for coastal tailed frogs. Sampling was in part based on the spatial predictive model for tailed frog presented by the Coastal Information Team.

During the 2007-2008 field seasons, we sampled a total of 356 sites in and outside of protected areas on the Central Coast. We identified a total of 87 potential WHAs in 28 landscape units. Fifteen of the potential areas are situated in existing or proposed protected areas. Due to lack of detectibility of tailed frogs in targeted sites and insufficient sampling resources, we were still unable to establish potential WHAs in all relevant landscape units.

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Introduction

The coastal tailed frog[4] (*Ascaphus truei*) is designated as species of special concern in Canada (COSEWIC, 2002) and is provincially blue listed (Conservation Data Centre, 2001). The tailed frog is very vulnerable to disturbances such as timber harvesting because it has very specialized habitat requirements, a low reproductive rate, and a reduced survival rate in second-growth forests (e.g., Dupuis, 2004; Dupuis and Steventon 1999; Steventon et al 1996; Dupuis and Friele 2004; Frid et al 2003). Historically, the mountainous stream habitat required by the tailed frog has not received any legislative protection resulting in a substantial reduction of such habitat (Dupuis 2004).

To ensure long-term survival of viable tailed frog populations, it is necessary to identify and protect critical habitat components for this species (BC Ministry of Environment and BC Ministry of Forests 1999, Dupuis 2004). Recent legislation and government policy, such as the Identified Wildlife Management Strategy (IWMS) (Environment 1999) and various legal orders (Ministry of Agriculture and Lands 2007a, 2007b), call for special management for this species. The IWMS supports the establishment of spatially explicit Wildlife Habitat Areas (WHAs) and associated legislative directions (e.g. General Wildlife Measures) for forest management related to tailed frogs.

Unfortunately, substantial knowledge gaps exist to identify critical habitat for the tailed frog in the Central Coast portion of the Central Coast – North Island Forest District[5]. Occurrence patterns and critical habitat areas for the tailed frog have not been confirmed in the Central Coast.

Our main objective for this project is to confirm the presence of tailed frogs and habitat suitability in enough sites to distribute potential WHAs evenly across the project area (i.e. two or three WHAs per landscape unit). As a secondary objective, we evaluated the performance[6] of a spatial predictive model for suitable tailed frog habitat presented by the Coast Information Team (Rumsey 2004).

The objective ensures representation of tailed frog habitat by capturing the full diversity of habitat throughout the distribution limits of tailed frogs in the Central Coast. This approach was applied both in and outside of protected areas.

Information from this project should provide essential input into the forest management practices of various First Nations groups and forestry companies.

Study Area

The study area (see Figure 1) consists of a land base of roughly 4.8 million hectares encompassing the Central Coast. It includes a range of biogeoclimatic zones and variants of which the Coastal Western Hemlock and the Mountain Hemlock zones are the most common in forested areas (Meidinger and Pojar 1991).

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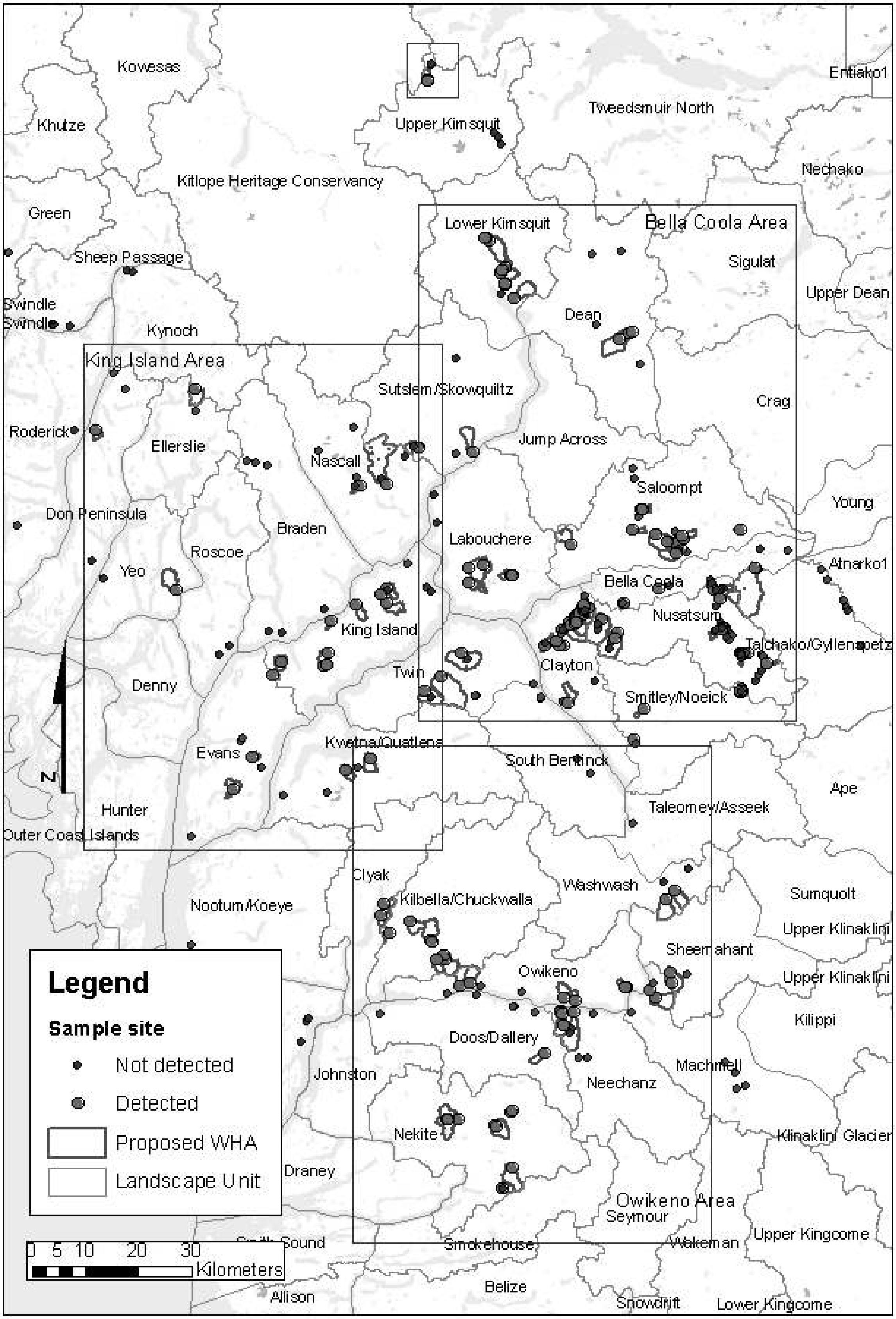
[4] Hereafter referred to as the tailed frog.
[5] Hereafter referred to as the Central Coast.
[6] Here defined as the ability to identify suitable habitat and predict the presence of tailed frogs.

Figure 1: Study Area



The Central Coast also includes a substantial proportion of proposed and existing protected areas. Recent major anthropogenic disturbance within the study areas includes logging and subsequent silvicultural efforts and erosion. Historic natural disturbances encompass windthrow, snow and debris avalanches, and infrequent fires. The relatively steep basins that create suitable tailed frog habitat exhibit frequent debris and snow avalanche activity relative to valley bottoms. Landscape units on the outer coast with very low relief profiles were excluded from the study area. For a closer overview of outlined areas see Appendix 1.

Methods

Data collection and sampling design

We collected habitat and presence data based on an extensive (reconnaissance; landscape-level) and intensive (non-random; watershed-level) sampling to achieve the main project objective. Data was collected following a standard field form (see Appendix I).

Extensive, or reconnaissance sampling, was designed to approximate an even distribution of WHAs throughout the study area. In each landscape unit in the study area, we aimed to survey enough sites to establish a minimum of two WHAs. We established this lower limit of WHAs per landscape units based on the limited resources available for sampling. Future work may reveal that additional WHAs are needed to adequately protect tailed frog habitat on the Central Coast.

A preliminary list of sites targeted for extensive sampling was derived using the habitat suitability model from the Coast Information Team (Rumsey et al. 2004). In landscape units where pre-stratified stream sections (i.e., sections identified by the model) did not occur or were not accessible by foot, truck, boat or helicopter, we sampled other accessible stream sections deemed suitable during *in situ* observations or based on previous surveys (e.g., Dupuis and Bunnell 1997). During such *in situ* observations, we deemed stream sections suitable if visual estimations (usually from the helicopter) confirmed that basin slope, size, and channel unit characteristics were approximately optimal (see Table 1).

Access to sample sites relied on boat, helicopter, truck and foot traverse. Boat access resulted in samples being distributed along shorelines; while helicopter allowed access to higher elevations limited by landing sites; sampling from vehicle was restricted to valleys with road access, with sites located near stream crossings. Foot traverse was used where more intensive sampling was required to distribute samples across elevational (basin area) gradients.

In the Bella Coola area[7] and other easier-to-access areas, we were able to intensify our sampling effort in tributaries where tailed frog presence was confirmed during extensive sampling. Intensive sampling was directed across all major reach types to elicit elevational distribution patterns (Dupuis and Friele 2003). Reach types are defined here

[7] Bella Coola, Clayton, Nusatsum, Saloompt and Talchako/Gyllenspetz Landscape Units.

as stream reaches that differ substantially in slope (i.e., within major slope classes – 0-30%, 31-60%, 61-120%) and elevation.

Between May 12 and August 31, 2007, and July 1 and October 22, 2008 we visited 195 and 161 sites respectively during extensive and intensive sampling. We used time constraint searches (TCS) following standards established by the Resource Inventory Standards Committee (2000). At all sites, we measured habitat parameters identified by Dupuis and Friele (2003) and classified the structural stage of the surrounding forest (BC Ministry of Environment Lands and Parks and BC Ministry of Forests 1998).

WHA Design

Reference frame

Based on expert consensus and the existing literature (Dupuis and Friele 2006), we used the "basin scale" as the reference frame for WHA design and management of tailed frog habitat (e.g., Dupuis 2003, Dupuis and Friele personal communication 2007). Various hydrological and environmental dynamics (such as debris avalanches) that affect the habitat of the tailed frog operate at the basin scale (e.g., DeScally et al 2001; Millard et al 2005). Accordingly, we delineated potential tailed frog WHAs along basin boundaries above appropriate sites with confirmed tailed frog presence. As a result, tailed frog habitat can be managed at the appropriate scale (i.e. the basin scale). Such management does not necessarily exclude timber harvesting (Dupuis and Friele 2003), but rather is concerned with management of stream temperature, sediment supply and hydrologic regimes.

Ranking Criteria

We based the suitability ranking of potential WHAs on the confirmed presence of tailed frogs and also habitat characteristics at the stand and watershed scale (Dupuis and Friele 2003). Based on presence or abundance alone, suitability ranking would not account for potential population sinks. In addition to presence information, therefore, we base our ranking on a range of habitat characteristics from the relevant literature, with a particular emphasis on the Identified Wildlife Management Strategy (Ministry of Environment 1999).

Ranking parameters are related to forest structure, stream morphology, terrain characteristics, and age group presence of tailed frogs (Table 1). All variables stem from the relevant literature based on quantitative (e.g. statistical analysis) and qualitative assessments (e.g., Dupuis et al. 1995, Dupuis and Bunnell 1997, Dupuis and Steventon 1999, Friele and Dupuis 2001, Sutherland et al. 2001, Wahbe et al. 2001, 2003, Frid et al. 2003, Dupuis 2004, Dupuis and Friele 2004, Friele and Dupuis 2007).

We used the ranking criteria to assign to each proposed WHA a relative rank of one to three (high-low suitability respectively). This rank is based on a relative comparison of habitat suitability of WHAs within a given landscape unit. Also, individual ranking criteria are compared to an absolute optimal range (see Table 1 for optimal ranges). Shaded criteria are weighted more as crucial biophysical variables within their optimal ranges.

Table 1: Summary of habitat suitability criteria for potential WHAs

Ranking Criteria:	Classes	Optimal range	Related IWMS criteria	Supporting literature
Species presence	N/A	Various age groups (cohorts) present	Presence of tadpoles	(Dupuis and Steventon 1999, Dupuis and Friele 2003, Dupuis 2006)
*Elevation	N/A	< 900 meters		(Dupuis and Friele 2003)
*Basin area	N/A	0.3 – 10 km^2		(Dupuis and Friele 2003)
*Watershed ruggedness	N/A	31-70%		(Ens 2007)
Reach gradient	N/A	Intermittent (3-40%)	Intermediate gradient to allow formation of step-pool morphology	(Dupuis and Friele 2003, Sutherland, Hayes et al. 2001)
Channel unit characteristic	Step pool, pool/riffle, plane bed, cascade, colluvial	Stable step pool or cascade	Intermediate gradient to allow formation of step-pool morphology	(Dupuis and Friele 2003, Friele and Dupuis 2007)
Substrate embeddedness	High, medium, low, none	low to medium (<50%)		Dupuis and Friele 2003
Substrate texture	Boulder, cobble, pebble, sand	% boulder and cobble > % pebble, sand	Coarse substrates (cobble-boulder substrate)	(Sutherland *et al*. 2001, Dupuis and Friele 2003
Temperature	N/A	8-15 ^{o}C (measured late summer during daytime)		Dupuis and Friele 2003
Water source	N/A	groundwater, lake, glacier		
Seasonality of water flow	Perennial, ephemeral	Perennial	Year-round flow	Dupuis 2004
Channel Disturbance Intensity	Low-very high	Low to moderate disturbance systems	Stable channel beds	Dupuis and Friele 2003 (Based on disturbance evaluation)
Seasonal activity channel width (bankfull width)	N/A	1-6.5		(Dupuis and Friele 2003, Ens 2007
Riparian Canopy Cover	N/A	55-70% taken from highest canopy	Forest cover (and indirectly stable channel beds)	Dupuis and Friele 2003
Bedrock geology - broad class as determined at plot	granitic, volcanic	Stable bedrock	Stable channel beds	(Sutherland et al. 2001, Dupuis 2006)

Ranking Criteria:	Classes	Optimal range	Related IWMS criteria	Supporting literature
*Position in watershed (backend versus valley mouth)	0-100%	Valley mouth better than back end (only applied if lowest elevation > 600 meters,		(Friele, personal comm., Dupuis and Friele 2003, Rumsey et al. 2004, Ens 2007)
**Forest cover age/structural stage	0-7	Old Growth/ structural stage 7	Forest cover	(Dupuis and Friele 2003)
**Past logging	yes, no	No		(Dupuis and Friele 2003)
Dendritic stream network present (yes/no)	yes, no	yes		(Dupuis and Friele 2003)
Potential connectivity[6]	yes, no	Yes; connects to other WHAs or protected areas		
*Basin aspect	N/A	North, east, and west on outer coast; south, east, and west leeward of coast mountains (submaritime in between)		(Dupuis and Friele 2003 Frid et al 2003)
Ranking criteria related to forest management:				
Contributing % of timber harvesting landbase (TSR2) in WHA[7]	N/A	smallest amount of contributing possible within WHA		
Other important ranking criteria which we were not able to include in this evaluation				
Long profile shape	Convex, concave	Irregular (series of concave/convex breaks)		Dupuis and Friele 2003
Dispersal probability	N/A	presence of dispersal nodes		(Dupuis 2006)

*Values are derived from the GIS (inputs are provincial DEM derivatives and 1:20000 TRIM base), Aspect is based on field evaluation and DEM derivates.

**Based on field evaluation, 1:250000 GIS Vegetation Resource Inventory (VRI), and 2004/05 Spot 5 satellite imagery.

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[6] For the purpose of this report, connectivity is defined as contiguous protected habitat which may be relevant from a management perspective.
[7] This is a secondary consideration for comparative purposes.

Construction of the data set

For subsequent suitability ranking of WHAs, we constructed a matrix of categorical and quantitative environmental variables per WHA. The matrix includes field and GIS derived variables (for details on these variables see section on ranking criteria above). We used ArcInfo 9.2 for all spatial processing and to construct the final matrix we used MS Access and Excel. Following is a list of formulas used for spatial processing of selected variables:

Backend rule (Dupuis and Friele 2003) = (H- T)/(H-L),

where H= highest elevation in basin (meters),

T= tree line elevation (1500 meters)

L= lowest basin elevation (elevation of point at which basin was defined, in meters)

Watershed ruggedness (Dupuis and Friele 2003, Ens 2007) = $R/B^{1/2}$

Where

R=relief (meters)

B=basin area (meters^2)

(see Table 1 for additional information on these variables)

Model performance

We used the inventory data to evaluate the performance of the Coast information Team (CIT) model. The CIT model is based on spatially explicit algorithms and incorporates five biophysical conditions important to tailed frog habitat: basin area; basins with limited 'back-end' valleys; watershed ruggedness; favourable aspect; and forest cover class (Rumsey et al. 2004).

To evaluate the performance of the model, all inventory sample points for 2007 and 2008 were identified as being either in or out of the stream sections identified by the model (i.e., predicted tailed frog habitat) and then broken down into biogeoclimatic variant sub-zones: hyper-maritime, maritime, sub-maritime. Habitat suitability was evaluated as suitable or marginal. The latter are both value judgments based on the same criteria as for WHAs (Table 1) with the shaded criteria again weighted more as crucial variables within their optimal ranges. In general terms suitable habitat can be characterized by the absence of many slight or gross deviations from the optimal values while marginal habitat may have one or two gross deviations (these typically occur in ruggedness or bankful width). This can still be distinguished from unsuitable habitat in which it can be categorically said not to host tailed frogs.

The sampling approach used during 2007-08 was not conducive for vigorous model validation due to the absence of a systematic random approach to sampling (see potential biases and limitations). For the purpose of model evaluation, our sampling approach approximates random selection of sampling points reasonably well within stream sections identified by the model. However, we used a non-random approach for stream sections not identified by the model (see section on sampling design). Hence, we are not able to quantify potential false negatives (i.e., suitable tailed frog habitat not identified by the model).

Potential Biases and Limitations

Although our sampling approach was appropriate for the main objective, the sampling effort is only marginally suitable to make detailed ecological inferences related to tailed frog distribution patterns and associated habitat characteristics. Due to budgetary limitations, sampling outside the Bella Coola valley was not based on a rigorous statistical approach. Only limited statistical inferences can be made from data generated or from the accuracy of models used.

Extensive and intensive sampling was biased by site accessibility. The Central Coast contains steep, remote, and otherwise difficult to access tailed frog habitat. Limited access to such areas reduces the ability to assess the full variation of response variables. Limited access is attributed to the costs of helicopter and boat charter resulting in limited drop points and long foot traverse between sample points.

Water levels during the 2007 field season were not ideal for tailed frog assessments. Deeper than average and prevailing snow packs during the previous winter resulted in high water levels throughout the field season. Such water conditions likely reduced detectability, thus potentially underestimating presence (and relative abundance) of tailed frogs.

Results and Discussion

Sampling effort

For WHA identification, we established a total of 356 sample sites during the 2007-2008 field seasons. Figure 1 depicts the location of all plots in the study area. Tailed frogs were detected in 46% of all sample sites. Multiple cohorts of tailed frogs were detected in 50% of all sites with tailed frog presence. The relatively high percentage of sample sites with detected frogs reflects our sampling approach of preferentially selecting sites which likely have suitable habitat (see section on sampling design). Thus, this result does *not* indicate that tailed frogs are present in 46% of all streams.

We were able to establish sample sites in 32 out of 42 considered landscape units with an average of 9 sites per landscape unit (not considered were landscape units on the outer coast with very low relief). In the remaining landscape units, insufficient suitable habitat was found (see below).

The sampling effort was highest in areas that are easily accessible (Figure 1). In some WHAs we only were able to locate one sample. However, in several cases more than one sample per WHA was possible. More than one sample provides a better picture of tailed frog distribution within the WHA. Moreover, where tailed frogs are not detected, more than one sample is required to establish lack of presence.

WHA evaluation

Using the criteria identified in Table 1, we evaluated each biophysical variable in the selection of potential WHAs. As mentioned above, fields that are shaded were used qualitatively to optimize habitat suitability and representation within each landscape unit.

We identified a total of 87 potential WHAs in 28 landscape units (see Appendix 2). Our objective of establishing a minimum of 2 potential WHAs fell short in 10 landscape units and there are no proposed WHAs for Braden, Ellerslie, Fish Egg, Green, Johnston, Jump Across, Nootem/Koeye, Roderick, Roscoe, Sheep Passage, South Bentinck, or Taleomy Landscape Units where we were not able to identify enough suitable habitat. This shortcoming is in part due to insufficient sampling effort but is also due to the scarcity of suitable habitat in some of those landscape units (such as the Fish Egg). For landscape units such as Clayton, Nusatsum, Owikeno and Saloompt, the relatively large number of WHAs is due to ease of access resulting in a large sampling effort.

All proposed WHAs are based on a host of habitat criteria including those listed in the IWMS (see Table 1, for detailed assessments see Appendix 3). We paid particular attention to the number of cohorts. This variable figures prominently in the selection process as a possible indicator of survival over successive breeding seasons.

Potential connectivity indicates, in our context, contiguous habitat protection beyond the boundary of each WHA. To assess potential connectivity across the landscape we did a GIS overlay of parks and protected areas in the Central Coast as well as examining adjacency to other WHAs. It should be noted, however, that this assessment makes no assumptions regarding dispersal ability of tailed frogs as we did not map dispersal nodes (see Table 1). We found 15 WHAs (17%) to lie within existing protected areas and 63 WHAs (72%) to have some degree of connectivity. Where potential WHAs are situated adjacent to each other they should, wherever possible, be amalgamated into one protection unit to protect meta-populations ranging over more than one basin. Certain landscape units (e.g. King Island, Saloompt) have no existing protected areas which highlights the need for WHAs in these areas with protective measures for tailed frogs.

All potential WHAs, were assigned a relative habitat suitability rank between one and three (i.e. high to low suitability respectively). The suitability rank is based on a relative comparison of WHAs within a given landscape unit (the same ranking criteria for the relative comparison are listed in Table 1).

For example, in the Evans Landscape Unit there are three proposed WHAs. We first looked at the number of cohorts found at the optimal sample location. WHA 12 was found to have two cohorts, no logging within the basin and it connects to the King Biodiversity Area. All other variables fall within the suitable optimal range and therefore we ranked WHA 12 highest. No connectivity existed for either of the other two proposed WHAs except that WHA 9 had a higher cohort presence than 10. WHA 10 also more deviations from the optimal range for channel unit class, substrate embeddedness and texture, not to mention that it may exist ephemerally. Ten was therefore rated lower than 9. Where more than three WHAs have been proposed in a landscape unit and not all of those WHAs can be formally established, those with the highest rank should be chosen first for formal WHA establishment.

Although the habitat information generated during past inventories allowed us to rank all potential WHAs in a biophysically meaningful manner, the ranking scheme would benefit from additional inventory information. In particular, potential WHAs with only one inventory plot require more intensive sampling to elicit vertical distribution patterns of tailed frogs. Furthermore, those landscape units with less than two potential WHAs require additional inventory work to establish further potential WHAs.

Table 2: Summary of Proposed WHAs

Landscape Unit	# of WHAS	in protected areas	with connectivity	with multiple cohorts
Bella Coola	1	1	1	0
Clayton	10	1	9	6
Clyak	2	0	1	0
Dean	1	0	1	1
Don Peninsula	1	0	0	1
Doos/Dallery	1	0	1	0
Evans	3	2	3	2
Kilbella/Chuckwalla	5	0	5	4
King Island	7	0	3	5
Kwatna/Quatlena	2	0	0	0
Kynoch	1	1	1	1
Labouchere	3	0	3	2
Lower Kimsquit	4	0	3	4
Machmell	1	0	0	1
Nascall	2	2	2	1
Neechanz	2	0	2	2
Nekite	5	1	3	4
Nusatsum	8	1	6	4
Owikeno	5	2	4	3
Saloompt	8	0	3	5
Sheemahant	1	0	1	1
Smitley/Noeick	4	2	2	2
Sutslem/Skowquiltz	2	1	1	2
Talchako	1	0	1	0
Twin	3	0	3	0
Upper Kimsquit	1	0	1	1
Washwash	2	0	2	1
Yeo	1	1	1	0
TOTAL	87	15	63	53
Percent total	100	17	72	61

Model performance

The sampling approach used during 2007-08 was not conducive for vigorous model validation due to the absence of a systematic random approach (see potential biases and limitations). Nonetheless, our findings about the models may be helpful to future research and we have included a short analysis.

Table 3 shows the breakdown of sample locations within each biogeoclimatic variant sub-zone and in and out of stream sections identified by the model. The CIT model seeks to identify suitable habitat described by Dupuis and Friele 2003; “stable headwater mountain systems with step pool channel morphology and low levels of bedload movement.”

Of the total sites sampled, a total of 230, 106 and 20 were done in the sub-maritime, maritime, and hyper-maritime variants respectively. Only a small portion of these were actually done in areas identified by the model; 19, 39 and 14 in those zones respectively. Within the CIT model, 46% of the sample sites had presence detected. Of the sites that were within the CIT model, 60 were deemed to be suitable and 12 were deemed to be marginal (see model performance in methods). Suitable habitat means small deviations from optimal conditions as described in Table 1 while marginal means greater deviations that a visual assessment would generally discard as sub-optimal.

The CIT model is able to select sites with suitable habitat and frog presence reasonably well. In the absence of systematic population inventories on the Mid Coast, we contrasted our results on model performance with the expert opinion on the overall abundance of tailed frogs. Accordingly, roughly 30-40% of fourth or lower order tributaries on the mid coast have suitable habitat and of those tributaries, roughly 50-70% contain tailed frogs (Friele personal communication 2008). Thus approximately 15-28% of all fourth or lower order tributaries on the Mid Coast may contain tailed frogs. These percentages are averages over the entire mid coast and do not consider the clumpy distribution of tailed frogs at finer spatial scales. A comparison of these percentages with our inventory results in stream sections identified by the CIT model indicates that the CIT model identifies substantially more suitable tailed frog streams than if streams where picked randomly (see Table 3). We must caution that the approximations of tailed frog abundance are associated with much uncertainty and should be interpreted carefully. As well, although the model may be able to identify suitable tailed frog streams reasonably well, it is likely too exclusive in identifying such streams (see methods).

Model performance appears to be lowest in the hypermaritime zone. Habitat suitability, presence detected, and presence of multiple cohorts of sites in the CIT model were lowest in this zone. This indicates that some of the existing model parameters need to be refined for the hypermaritime zone. As well, this zone has unique ecological conditions/parameters not considered in the model. For example, this zone contains many otherwise suitable streams with tannic water which appears to be detrimental to tailed frogs.

Table 3: CIT site detection

Biogeoclimatic zone	Total sites samp led	Sampled sites in CIT	Habitat suitability			Presence of tailed frogs		
			Suitable Sites in CIT*	Marginal Sites in CIT	Estimated suitable streams**	Sampled sites in CIT with presence*	Sampled sites in CIT with multiple cohorts*	Estimated presence in streams**
Sub-Maritime	230	19	16 (84%)	3	30-40%	8 (42%)	5 (26%)	15-28%
Maritime	106	39	34 (87%)	5		20 (51%)	11 (28%)	
Hyper-Maritime	20	14	10 (71%)	4		5 (36%)	1 (7%)	
TOTAL	356	72	60 (83 %)	12		33 (46%)	17 (24%)	

*Percentage of sampled sites in CIT model

**Rough estimates for entire Central Coast based on expert opinion

Future Work

Future inventory work and research should focus on eliminating existing information gaps. First, wherever the objective of establishing 2-3 potential WHAs per landscape unit was not met, additional sampling is necessary to identify additional tributaries with tailed frogs and optimal habitat characteristics. Second, intensive sampling should be continued to further elicit vertical distribution patterns on the Central Coast. To complement this knowledge, models should be developed to determine dispersal nodes and establish where *biological* connectivity is conducive to tailed frog colonization and meta-populations. This would help better manage for other disturbance regimes, such as climate change, whereby migration may be just as important as *in situ* persistence.

In short, the more we can understand about the coastal tailed frog, the better we can manage for its persistence in mountain streams and coexistence with human communities. Protecting tailed frog habitat and its associated features brings us one step closer to achieving our mandate for Ecosystem-based Management and ensuring healthy, functioning ecosystems for future generations.

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Appendix 1: Maps of Proposed WHA Locations

Figure 2: Bella Coola area and Upper Kimsquit

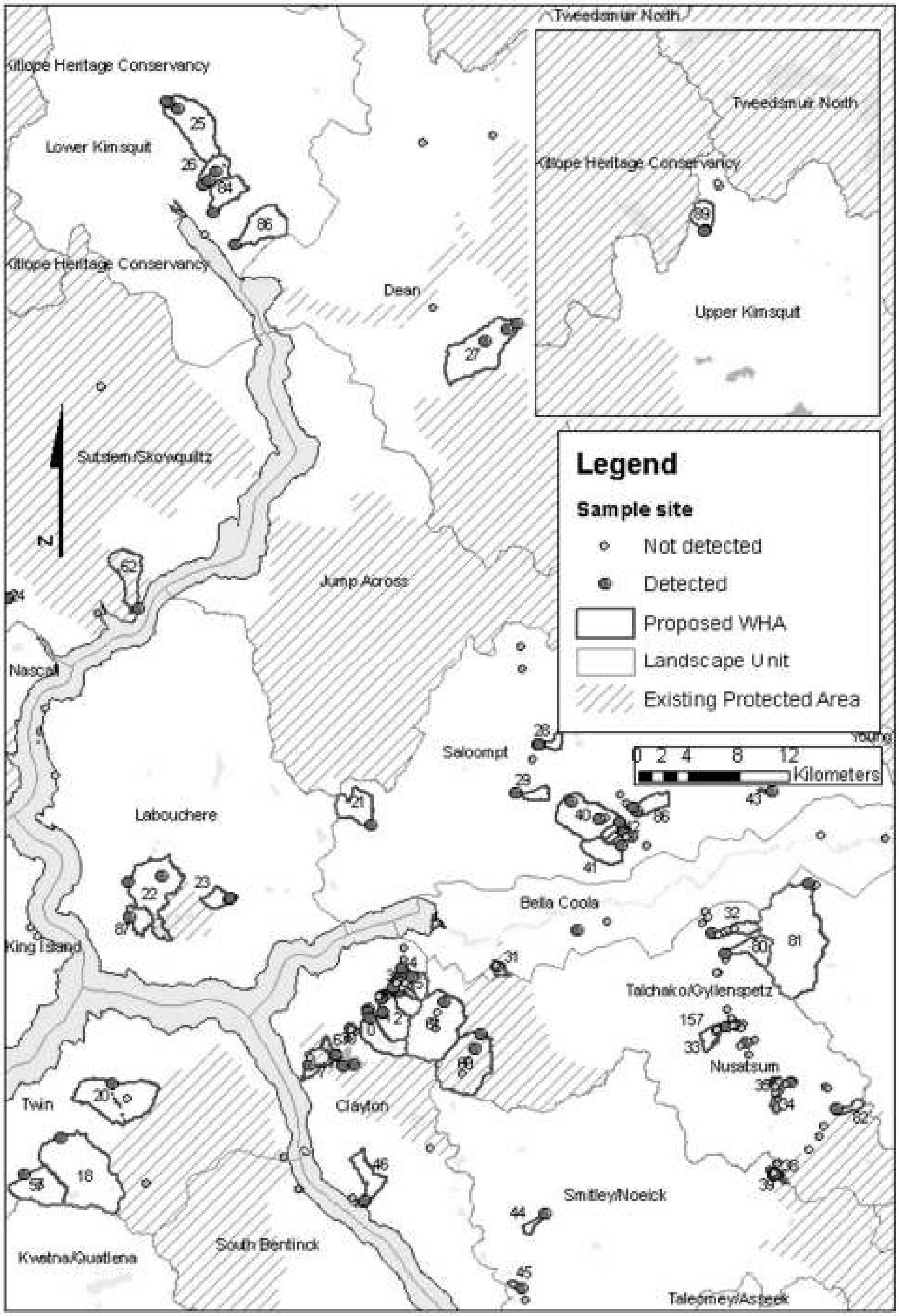


Figure 3: King Island area

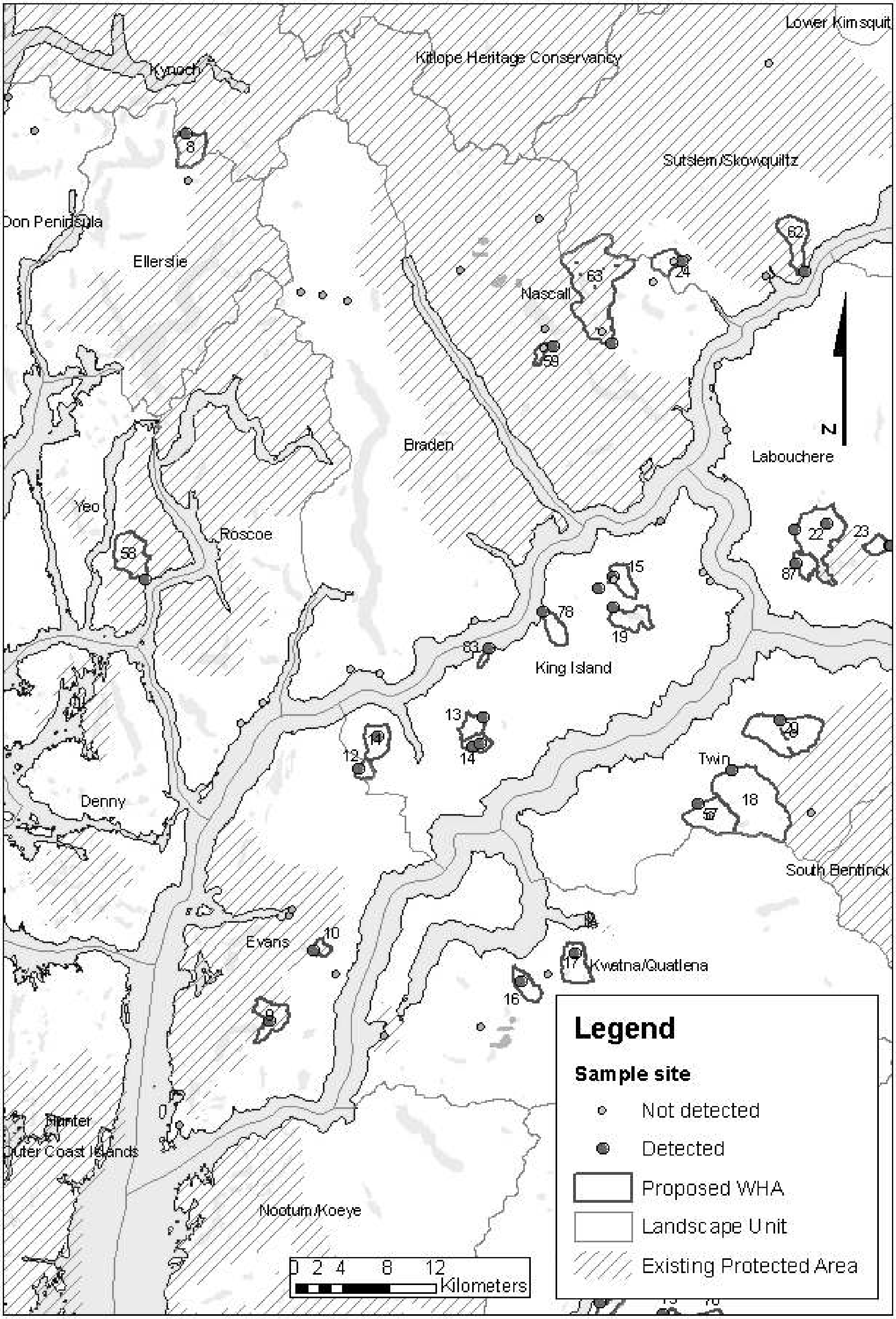
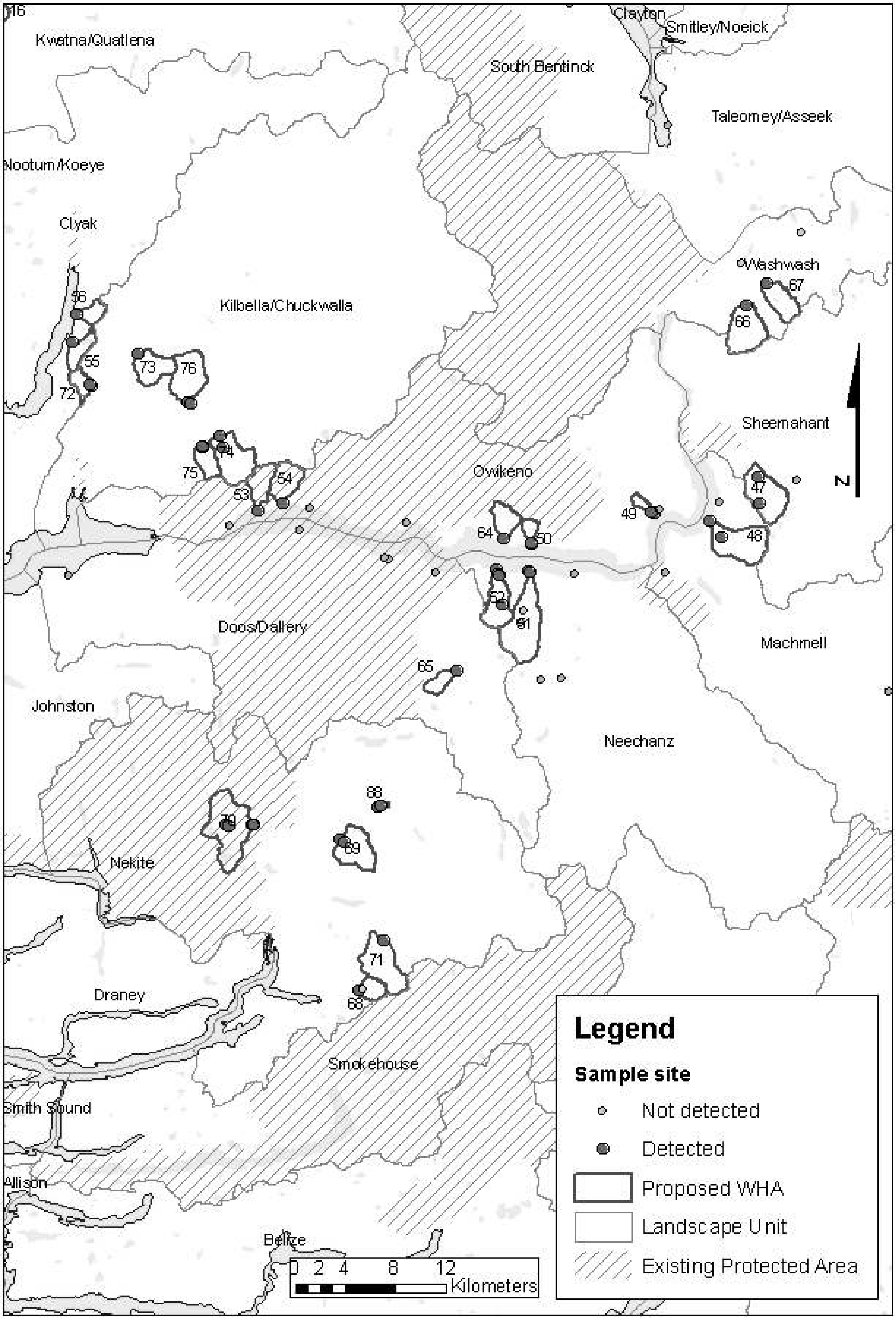


Figure 4: Owikeno area



Appendix 2: Data Form for 2007-2008 Field Seasons

Tailed Frog Inventory Site Form

Search type: 30 minute time constrained 15 metre area constrained

Recorder: Date: Time: Weather:

Area & creek ID: Directions:

Sample UTM Datum: Zone: E: N: Error:

Site description: Aspect: Elevation (m): Water temp. (C): Reach gradient:

Headwater comments: lake, glacier, groundwater fed, etc.,

Bedrock Geology Field description:

Note: presence of local faults or shear zones; dimensions of representative fracture or joint spacing (m); nominal size class of bedrock derived debris (e.g., talus/rubble).

Reach type: Gully (>3 m sidewall) Hillslope channel (<3 m sidewall) Fan Confined mainstem Floodplain

If gully: Sidewall length (m): Sidewall material: Sidewall instability: Y N

Channel processes: Floods Sediment floods Debris flows Snow avalanches Avulsions Braiding

Evidence:

Note: presence/absence of moss on substrate; bed armouring (imbricate/loose); presence of sediment wedges (thickness, age, abundance, nominal clast size); recent debris flow/sediment floods (levees, age estimate from regen.); etc.

Channel units (features 1-7 channel widths in length): well formed moderately formed not formed

Pool/Riffle Plane bed Step pool Cascade Colluvial (after Montgomery and Buffington 1997)

Step forming materials (rapids & cascades): Log Boulder Rock

Bankful width (cm): Bankful depth (cm): Wet width (cm): Wet depth (cm):

Substrate Embededness: high medium low none

Texture: %Boulder (0.25-4.0 m): %Cobble (64-256 mm): %Pebble (2-64 mm): %Sand (<2 mm):

Ten largest clasts B-axis (cm): Average (D90):

CWD: scattered/jams logging slash: light/medium/heavy Fine organic matter: high/moderate/low

Vegetation Logged: Y N Buffer length (m): Right bank: Left bank: Fire regen.: Y N

Stand age: <1 yr 1-20 yrs 21-60 yrs 61-100 yrs 100+ yrs Sub-alpine Alpine

Percent canopy (5 m in) Right bank: Left bank: Percent understorey Right bank: Left bank:

TAFR: late summer cohorts after Brown (1990)

# Adults		Hatchling	1	2: Larger head+hind buds	3: Developed hind legs	4: Losing disk and tail	Meta	Juvenile male
♂	♀							

Time 1st detection: Note: record SVL (frogs), TL (tad) in field book. Velocity (m/s)=0.18*(D90*10)^0.487

Appendix 3: Detailed WHA Assessments

Bella Coola Landscape Unit

WHA number	31
Relative rank	N/A
Basin area (km2)	1.02
Overall basin ruggedness (%)	95
Average basin elevation	342
Number of cohorts	1
Basin aspect	E
Basin forest age	>141
Logging (comments)	1/3 logged <60 yrs
Connectivity	yes
THLB contributing (% basin area)	Clayton/Thorsen
THLB partially contributing (% basin area)	Protected Area
Sample site	Optimal
Number of cohorts	1
Catchment Area (km2)	1.02
Watershed ruggedness (%)	95
Position in watershed (% backend)	N/A
Elevation (m)	130
Aspect (degrees)	270
Reach gradient (%)	10
Bedrock type	granitic
Water source	groundwater
Water temperature	8
Dentritic stream network	no
Perennial water flow	yes
Channel disturbance intensity	moderate
Channel unit class	step pool
Bankful width (m)	2.6
Substrate embeddedness	low
Substrate texture (% boulders & cobbles)	85
Stand age	21-60
Structural stage	5
Canopy cover (%)	80

Clayton Landscape Unit

WHA number	0		1		2	
Relative rank	2		1		1	
Basin area (km2)	6.1		7.1		2.8	
Overall basin ruggedness (%)	66		64		95	
Average basin elevation	1341		1168		1276	
Number of cohorts	3		3		2	
Basin aspect	NW		NW		NW	
Basin forest age	>141		>141		>250	
Logging (comments)	minor logging		lower 1/4 logged <20 yrs		lower 1/4 logged <20 yrs	
Connectivity	yes		yes		yes	
THLB contributing (% basin area)	3		14		7	
THLB partially contributing (% basin area)	0		0		0	
Sample site	Optimal	Supporting	Optimal	Supporting	Optimal	Supporting
Number of cohorts	3	2	2	2	2	1
Catchment Area (km2)	6.1	5.87	5.88	5.04	2.78	2.67
Watershed ruggedness (%)	66	55	65	59	91	86
Position in watershed (% backend)	N/A	36	N/A	36	N/A	N/A
Elevation (m)	450	737	359	670	319	494
Aspect (degrees)	15	350	3	38	310	310
Reach gradient (%)	22	10	5	22	14	50
Bedrock type	granitic	granitic	granitic	granitic	granitic	granitic
Water source	lake	lake	groundwater	groundwater	groundwater	groundwater
Water temperature	9	9	8	4	9	9
Dentritic stream network	yes	yes	yes	yes	yes	yes
Perennial water flow	yes	yes	yes	yes	yes	yes
Channel disturbance intensity	high	low	moderate	low	low	moderate
Channel unit class	cascade	cascade	pool/riffle	cascade	pool/riffle	cascade
Bankful width (m)	12.6	12.6	7.9	11.3	5.3	4.5
Substrate embeddedness	low	?	medium	medium	low	low
Substrate texture (% boulders & cobbles)	80	80	45	75	60	85
Stand age	1-20.	>140	21-60	>141	21-60	21-60
Structural stage	7	7	5	7	5	5
Canopy cover (%)	55	35	60	75	90	10

Clayton Landscape Unit

WHA number	3		4		5	
Relative rank	3		3		1	
Basin area (km2)	0.8		0.6		2.7	
Overall basin ruggedness (%)	>100		>100		97	
Average basin elevation	860		673		1141	
Number of cohorts	2		2		4	
Basin aspect	NW		NW		NW	
Basin forest age	>250		>250		>250	
Logging (comments)	1/3 logged <20 yrs		1/2 logged <20 yrs		minor logging	
Connectivity	yes		yes		yes	
THLB contributing (% basin area)	48		60		8	
THLB partially contributing (% basin area)	8		7		0	
Sample site	Optimal	Supporting	Optimal	Supporting	Optimal	Supporting
Number of cohorts	1	1	2	1	3	3
Catchment Area (km2)	0.8	0.69	0.54	0.6	2.7	2.7
Watershed ruggedness (%)	>100	>100	>100	>100	97	97
Position in watershed (% backend)	N/A	N/A	N/A	N/A	N/A	N/A
Elevation (m)	251	317	294	236	241	213
Aspect (degrees)	285	307	340	285	290	335
Reach gradient (%)	29	20	29	29	12	27
Bedrock type	granitic	granitic	granitic	granitic	granitic	granitic
Water source	groundwater	groundwater	groundwater	groundwater	groundwater	groundwater
Water temperature	7	5	4	7	12	10
Dentritic stream network	yes	yes	yes	yes	yes	yes
Perennial water flow	yes	yes	yes	yes	yes	yes
Channel disturbance intensity	low	low	low	moderate	low	low
Channel unit class	cascade	pool/riffle	pool/riffle	cascade	step pool	step pool
Bankful width (m)	3.7	1.8	1.5	3.7	4.8	2.3
Substrate embeddedness	low	medium	medium	low	low	medium
Substrate texture (% boulders & cobbles)	50	65	65	50	65	60
Stand age	>100	21-60	1-20.	>150	1-20.	1-20.
Structural stage	7	5	4	7	6	4
Canopy cover (%)	62	80	80	45	30	10

Clayton Landscape Unit

WHA number	6		7	30	46	
Relative rank	1		2	3	2	
Basin area (km2)	1.34		3.17	0.22	4.46	
Overall basin ruggedness (%)	68		76	>100	69	
Average basin elevation	1181		886	1029	854	
Number of cohorts	2		2	1	3	
Basin aspect	SE		SW	W	S	
Basin forest age	>250		>250	>100	>140	
Logging (comments)	protected		1/3 logged <20 yrs	no logging	logging throughout	
Connectivity	yes		yes	yes	no	
THLB contributing (% basin area)	Clayton/Thorsen		66	5	46	
THLB partially contributing (% basin area)	Protected Area		0	0	0	
Sample site	Optimal	Supporting	Optimal	Optimal	Optimal	Supporting
Number of cohorts	2	2	2	1	3	2
Catchment Area (km2)	0.8	1	2.32	0.22	4.4	4.46
Watershed ruggedness (%)	35	46	47	>100	63	69
Position in watershed (% backend)	0	0	0	0	N/A	N/A
Elevation (m)	1186	1048	661	630	133	20
Aspect (degrees)	146	162	220	0	223	200
Reach gradient (%)	22	10	21	20	55	26
Bedrock type	granitic	granitic	granitic	granitic	granitic	granitic
Water source	lake	lake	lake	groundwater	groundwater	groundwater
Water temperature	9	9	14	4	14	12
Dentritic stream network	no	no	no	no	yes	yes
Perennial water flow	yes	yes	yes	yes	yes	yes
Channel disturbance intensity	moderate	low	moderate	moderate	low	moderate
Channel unit class	step pool	cascade	cascade	step pool	step pool	step pool
Bankful width (m)	1.9	2	3.9	1.8	9.4	3.5
Substrate embeddedness	medium	low	low	medium	low	low
Substrate texture (% boulders & cobbles)	80	70	95	40	70	75
Stand age	>250	>250	>250	>100	>100	61-100
Structural stage	7	7	3	7	6	5
Canopy cover (%)	60	60	55	55	70	40

Clyak Landscape Unit

WHA number	55	56
Relative rank	1	3
Basin area (km2)	3.51	2.56
Overall basin ruggedness (%)	53	59
Average basin elevation	596	573
Number of cohorts	1	1
Basin aspect	NW	W
Basin forest age	>140	>140
Logging (comments)	1/3 logged <60 yrs	logging througout <60 yrs
Connectivity	yes	no
THLB contributing (% basin area)	27	41
THLB partially contributing (% basin area)	11	0
Sample site	Optimal	Optimal
Number of cohorts	1	1
Catchment Area (km2)	3.51	2.56
Watershed ruggedness (%)	53	59
Position in watershed (% backend)	N/A	N/A
Elevation (m)	115	25
Aspect (degrees)	350	25
Reach gradient (%)	20	15
Bedrock type	granitic	granitic
Water source	lake	groundwater
Water temperature	13	13
Dentritic stream network	yes	yes
Perennial water flow	yes	yes
Channel disturbance intensity	moderate	moderate
Channel unit class	step pool	step pool
Bankful width (m)	7.5	6
Substrate embeddedness	medium	low
Substrate texture (% boulders & cobbles)	68	65
Stand age	21-60	61-100
Structural stage	7	7
Canopy cover (%)	25	35

Dean Landscape Unit

WHA number	27	
Relative rank	N/A	
Basin area (km2)	15.98	
Overall basin ruggedness (%)	36	
Average basin elevation	1023	
Number of cohorts	2	
Basin aspect	E	
Basin forest age	>140	
Logging (comments)	no logging	
Connectivity	yes (adj. Jump Across Conservancy)	
THLB contributing (% basin area)	0	
THLB partially contributing (% basin area)	0	
Sample site	Optimal	Supporting
Number of cohorts	2	1
Catchment Area (km2)	14.72	15.98
Watershed ruggedness (%)	42	36
Position in watershed (% backend)	N/A	N/A
Elevation (m)	511	387
Aspect (degrees)	70	20
Reach gradient (%)	21	25
Bedrock type	granitic	granitic
Water source	glacier	glacier
Water temperature	8	9
Dentritic stream network	yes	yes
Perennial water flow	yes	yes
Channel disturbance intensity	moderate	low
Channel unit class	step pool	step pool
Bankful width (m)	12	11.7
Substrate embeddedness	medium	low
Substrate texture (% boulders & cobbles)	65	90
Stand age	>140	>140
Structural stage	7	7
Canopy cover (%)	45	55

Don Peninsula Landscape Unit

WHA number	77	
Relative rank	N/A	
Basin area (km2)	2.24	
Overall basin ruggedness (%)	55	
Average basin elevation	330	
Number of cohorts	2	
Basin aspect	NW	
Basin forest age	>250	
Logging (comments)	1/3 logged <60 yrs	
Connectivity	no	
THLB contributing (% basin area)	56	
THLB partially contributing (% basin area)	0	
Sample site	Optimal	Supporting
Number of cohorts	2	1
Catchment Area (km2)	2.24	2.18
Watershed ruggedness (%)	55	54
Position in watershed (% backend)	N/A	N/A
Elevation (m)	8	61
Aspect (degrees)	0	5
Reach gradient (%)	10	30
Bedrock type	granitic	granitic
Water source	groundwater	groundwater
Water temperature	11	11
Dentritic stream network	yes	yes
Perennial water flow	yes	yes
Channel disturbance intensity	low	low
Channel unit class	plane bed	step pool
Bankful width (m)	4.5	5
Substrate embeddedness	low	low
Substrate texture (% boulders & cobbles)	75	75
Stand age	>61	>61
Structural stage	6	6
Canopy cover (%)	75	70

Doos/Dallery Landscape Unit

WHA number	65
Relative rank	N/A
Basin area (km2)	2.68
Overall basin ruggedness (%)	80
Average basin elevation	1093
Number of cohorts	1
Basin aspect	NE
Basin forest age	>250
Logging (comments)	no logging
Connectivity	yes (adj. Owikeno Protected Area)
THLB contributing (% basin area)	13
THLB partially contributing (% basin area)	0
Sample site	Optimal
Number of cohorts	1
Catchment Area (km2)	2.68
Watershed ruggedness (%)	80
Position in watershed (% backend)	N/A
Elevation (m)	370
Aspect (degrees)	60
Reach gradient (%)	25
Bedrock type	granitic
Water source	lake/glacier
Water temperature	10
Dentritic stream network	yes
Perennial water flow	yes
Channel disturbance intensity	low
Channel unit class	step pool
Bankful width (m)	4.3
Substrate embeddedness	low
Substrate texture (% boulders & cobbles)	83
Stand age	>250
Structural stage	7
Canopy cover (%)	75

Evans Landscape Unit

WHA number	9	10	12
Relative rank	2	3	1
Basin area (km2)	6.15	1.44	1.81
Overall basin ruggedness (%)	33	42	48
Average basin elevation	377	579	723
Number of cohorts	2	1	2
Basin aspect	NE	W	NW
Basin forest age	>250	>140	>250
Logging (comments)	protected	protected	no logging
Connectivity	yes	yes	yes
THLB contributing (% basin area)	King Biodiversity	King Biodiversity	0
THLB partially contributing (% basin area)	Area	Area	1
Sample site	Optimal	Optimal	Optimal
Number of cohorts	2	1	2
Catchment Area (km2)	6.15	1.44	1.81
Watershed ruggedness (%)	33	42	48
Position in watershed (% backend)	N/A	N/A	N/A
Elevation (m)	146	425	452
Aspect (degrees)	80	270	250
Reach gradient (%)	8	4	8
Bedrock type	granitic	sedimentary	granitic
Water source	groundwater	groundwater	groundwater
Water temperature	17	12	9
Dentritic stream network	yes	yes	yes
Perennial water flow	yes	?	yes
Channel disturbance intensity	high	low	low
Channel unit class	cascade	plane bed	step pool
Bankful width (m)	8.6	2.8	4.2
Substrate embeddedness	high	high	none
Substrate texture (% boulders & cobbles)	55	30	70
Stand age	>250	>140	>150
Structural stage	7	7	7
Canopy cover (%)	30	62	55

Kilbella/Chuckwalla Landscape Unit

WHA number	73	76		72		75		74	
Relative rank	1	2		1		1		2	
Basin area (km2)	6.23	8.76		2.6		3.88		9.66	
Overall basin ruggedness (%)	42	49		47		37		35	
Average basin elevation	986	896		662		1026		1048	
Number of cohorts	3	2		3		2		2	
Basin aspect	NW	SE		E		N		N	
Basin forest age	>250	>250		>250		>250		>250	
Logging (comments)	no logging	no logging		no logging		no logging		no logging	
Connectivity	yes	yes		yes		yes (adj. Owikeno Protected Area)			
THLB contributing (% basin area)	0	21		14		5		7	
THLB partially contributing (% basin area)	16	2		12		3		13	
Sample site	Optimal	Optimal	Supporting	Optimal	Supporting	Optimal	Supporting	Optimal	Supporting
Number of cohorts	3	2	2	3	1	2	2	2	2
Catchment Area (km2)	6.23	8.76	8.7	2.48	2.6	3.88	3.58	7.83	9.66
Watershed ruggedness (%)	42	49	47	46	47	37	39	37	35
Position in watershed (% backend)	N/A	N/A	N/A	N/A	N/A	13	13	14	N/A
Elevation (m)	510	90	242	299	252	655	658	636	574
Aspect (degrees)	330	100	135	140	100	310	356	345	0
Reach gradient (%)	7	15	20	30	20	10	10	8	8
Bedrock type	granitic	granitic	granitic	granitic	granitic	granitic	granitic	granitic	granitic
Water source	groundwater	groundwater	groundwater	groundwater	groundwater	groundwater	groundwater	glacier	glacier
Water temperature	6	12	14	14	10	6	7	7	7
Dentritic stream network	yes	yes	yes	yes	yes	yes	yes	yes	yes
Perennial water flow	yes	yes	yes	yes	yes	yes	yes	yes	yes
Channel disturbance intensity	low	low	low	high	low	low	low	moderate	low
Channel unit class	step pool	step pool	step pool	step pool	step pool	step pool	step pool	cascade	step pool
Bankful width (m)	10.6	13.6	19.9	6.8	6	9.2	8	10.8	16.9
Substrate embeddedness	low	medium	medium	low	medium	medium	low	low	low
Substrate texture (% boulders & cobbles)	50	85	83	75	50	75	60	65	75
Stand age	>100	>100	>100	>250	>250	>250	>250	>100	>250
Structural stage	6	6	7	7	7	7	7	4	7
Canopy cover (%)	75	95	65	40	45	15	30	2	60

King Island Landscape Unit

WHA number	11	13	14		78	15	19	83
Relative rank	1	1	1		1	2	2	2
Basin area (km2)	5.14	5.14	2.66		3.8	4.01	5.32	0.75
Overall basin ruggedness (%)	36	36	43		63	59	52	77
Average basin elevation	625	649	742		692	922	1081	417
Number of cohorts	3	2	2		3	2	1	1
Basin aspect	N	NE	SE		NW	W	NW	N
Basin forest age	>250	>250	>250		>140	>250	>140	>250
Logging (comments)	no logging	logging road	no logging		no logging	minor logging	no logging	no logging
Connectivity	yes	yes	yes		no	no	no	no
THLB contributing (% basin area)	0	2	0		1	15	0	29
THLB partially contributing (% area)	8	0	0		39	13	0	0
Sample site	Optimal	Optimal	Optimal	Supporting	Optimal	Optimal	Optimal	Optimal
Number of cohorts	3	2	2	1	3	2	1	1
Catchment Area (km2)	5.14	5.14	1.68	0.12	3.8	4.01	5.32	0.75
Watershed ruggedness (%)	36	36	45	76	63	59	52	77
Position in watershed (% backend)	N/A	N/A	N/A	0	N/A	N/A	N/A	N/A
Elevation (m)	352	352	495	812	49	359	431	20
Aspect (degrees)	0	40	124	0	338	256	10	36
Reach gradient (%)	11	10	5	12	18	19	17	25
Bedrock type	granitic	granitic	granitic	granitic	granitic	granitic	granitic	granitic
Water source	groundwater	groundwater	groundwater	groundwater	lake	groundwater	glacier	lake
Water temperature	10	9	9	10	10	9	5	10
Dentritic stream network	yes	yes	yes	yes	yes	yes	yes	yes
Perennial water flow	yes	yes	yes	yes	yes	yes	yes	yes
Channel disturbance intensity	moderate	low	moderate	moderate	moderate	low	moderate	moderate
Channel unit class	step pool	pool/riffle	step pool	cascade	step pool	step pool	step pool	step pool
Bankful width (m)	9.4	5.8	4.3	1.4	9.1	4.7	14	6
Substrate embeddedness	low	low	low	medium	low	low	low	low
Substrate texture (% coarse)	75	93	85	45	70	74	91	70
Stand age	>150	>150	>250	>250	>61	>250	>120	>100
Structural stage	7	7	7	7	6	7	7	6
Canopy cover (%)	40	60	70	40	35	55	65	80

Kwatna/Quatlena Landscape Unit

WHA number	16	17
Relative rank	1	2
Basin area (km2)	3.79	6.66
Overall basin ruggedness (%)	58	43
Average basin elevation	843	919
Number of cohorts	2	1
Basin aspect	NW	N
Basin forest age	>250	>140
Logging (comments)	no logging	no logging
Connectivity	no	no
THLB contributing (% basin area)	7	0
THLB partially contributing (% basin area)	0	12
Sample site	Optimal	Optimal
Number of cohorts	2	1
Catchment Area (km2)	2.79	5.5
Watershed ruggedness (%)	36	43
Position in watershed (% backend)	0	0
Elevation (m)	682	981
Aspect (degrees)	336	2
Reach gradient (%)	19	11
Bedrock type	granitic	granitic
Water source	groundwater	lake
Water temperature	13	12
Dentritic stream network	yes	yes
Perennial water flow	yes	yes
Channel disturbance intensity	low	moderate
Channel unit class	step pool	step pool
Bankful width (m)	4.5	410
Substrate embeddedness	medium	low
Substrate texture (% boulders & cobbles)	75	77
Stand age	>250	>140
Structural stage	7	7
Canopy cover (%)	60	70

Kynoch Landscape Unit

WHA number	8
Relative rank	N/A
Basin area (km2)	6.37
Overall basin ruggedness (%)	39
Average basin elevation	682
Number of cohorts	2
Basin aspect	NW
Basin forest age	>250
Logging (comments)	protected
Connectivity	yes
THLB contributing (% basin area)	Fjordland Recreation
THLB partially contributing (% basin area)	Area
Sample site	Optimal
Number of cohorts	2
Catchment Area (km2)	6.37
Watershed ruggedness (%)	39
Position in watershed (% backend)	N/A
Elevation (m)	360
Aspect (degrees)	350
Reach gradient (%)	5
Bedrock type	granitic
Water source	lake
Water temperature	11
Dentritic stream network	yes
Perennial water flow	yes
Channel disturbance intensity	low
Channel unit class	step pool
Bankful width (m)	9.5
Substrate embeddedness	medium
Substrate texture (% boulders & cobbles)	65
Stand age	>250
Structural stage	7
Canopy cover (%)	55

Labouchere Landscape Unit

WHA number	37 (formerly 87)	23		22	
Relative rank	2	1		1	
Basin area (km2)	2.95	2.47		14.77	
Overall basin ruggedness (%)	26	90		32	
Average basin elevation	1082	865		1036	
Number of cohorts	1	4		2	
Basin aspect	W	E		W	
Basin forest age	>140	>250		>250	
Logging (comments)	no logging	no logging		no logging	
Connectivity	yes	yes		yes	
THLB contributing (% basin area)	0	4		0	
THLB partially contributing (% basin area)	0	7		4	
Sample site	Optimal	Optimal	Supporting	Optimal	Supporting
Number of cohorts	1	4	3	2	1
Catchment Area (km2)	2.95	1.8	2.47	14.77	3.27
Watershed ruggedness (%)	26	94	90	32	46
Position in watershed (% backend)	46	N/A	N/A	N/A	16
Elevation (m)	854	217	250	430	800
Aspect (degrees)	100	70	88	278	72
Reach gradient (%)	20	17	22	?	27
Bedrock type	granitic	granitic	granitic	granitic	granitic
Water source	lake	groundwater	groundwater	groundwater	lake
Water temperature	6	9	9	8	10
Dentritic stream network	yes	yes	yes	yes	yes
Perennial water flow	yes	yes	yes	yes	yes
Channel disturbance intensity	low	moderate	high	low	low
Channel unit class	pool/riffle	step pool	step pool	step pool	step pool
Bankful width (m)	8	7.4	8.2	6.5	9.4
Substrate embeddedness	low	low	low	medium	medium
Substrate texture (% boulders & cobbles)	85	85	70	70	80
Stand age	>100	>250	>250	>250	>100
Structural stage	7	7	3	7	7
Canopy cover (%)	35	85	55	65	35

Lower Kimsquit Landscape Unit

WHA number	25		26		84		36 (formerly 86)
Relative rank	2		1		1		1
Basin area (km2)	12.3		4.35		4.94		7.9
Overall basin ruggedness (%)	41		45		58		67
Average basin elevation	1348		1303		1202		1364
Number of cohorts	3		3		4		2
Basin aspect	NW		SW		SW		SW
Basin forest age	>250		>250		>250		>140
Logging (comments)	no logging		no logging		no logging		no logging
Connectivity	yes		yes		yes		no
THLB contributing (% basin area)	1		0		0		20
THLB partially contributing (% basin area)	0		0		0		5
Sample site	Optimal	Supporting	Optimal	Supporting	Optimal	Supporting	Optimal
Number of cohorts	2	2	3	1	4	2	2
Catchment Area (km2)	12.3	0.41	4.35	3.43	4.94	4.94	7.9
Watershed ruggedness (%)	41	>100	45	45	58	58	67
Position in watershed (% backend)	36	26	31	36	N/A	N/A	N/A
Elevation (m)	630	718	814	873	535	572	341
Aspect (degrees)	285	324	230	219	147	179	200
Reach gradient (%)	25	18	20	9	23	23	13
Bedrock type	granitic	granitic	granitic	granitic	granitic	granitic	granitic
Water source	groundwater	groundwater	lake	groundwater	lake	lake	glacier
Water temperature	8	6	8	8	11	11	10
Dentritic stream network	yes	yes	yes	yes	yes	yes	yes
Perennial water flow	yes	yes	yes	yes	yes	yes	yes
Channel disturbance intensity	low	low	low	moderate	low	low	low
Channel unit class	step pool	cascade	step pool	step pool	step pool	cascade	step pool
Bankful width (m)	16.3	4.5	4.8	6.6	9	8.6	6.7
Substrate embeddedness	low	low	low	medium	low	low	medium
Substrate texture (% boulders & cobbles)	75	70	68	52	80	80	60
Stand age	>100	>100	>100	>100	>100	>100	>140
Structural stage	7	7	7	7	6	6	6
Canopy cover (%)	70	5	60	55	60	45	60

Machmell Landscape Unit

WHA number	48	
Relative rank	N/A	
Basin area (km2)	10.76	
Overall basin ruggedness (%)	59	
Average basin elevation	1286	
Number of cohorts	4	
Basin aspect	N	
Basin forest age	>250	
Logging (comments)	minor logging	
Connectivity	no	
THLB contributing (% basin area)	14	
THLB partially contributing (% basin area)	0	
Sample site	Optimal	Supporting
Number of cohorts	4	2
Catchment Area (km2)	10.76	9.02
Watershed ruggedness (%)	59	48
Position in watershed (% backend)	N/A	N/A
Elevation (m)	26	512
Aspect (degrees)	358	315
Reach gradient (%)	9	23
Bedrock type	granitic	granitic
Water source	glacier	glacier
Water temperature	9	6
Dentritic stream network	yes	yes
Perennial water flow	yes	yes
Channel disturbance intensity	moderate	high
Channel unit class	step pool	cascade
Bankful width (m)	6.5	6
Substrate embeddedness	medium	low
Substrate texture (% boulders & cobbles)	55	70
Stand age	1-20.	1-20.
Structural stage	3	3
Canopy cover (%)	20	78

Nascall Landscape Unit

WHA number	63	59
Relative rank	2	1
Basin area (km2)	29.5	1.32
Overall basin ruggedness (%)	24	93
Average basin elevation	1054	949
Number of cohorts	1	2
Basin aspect	S	E
Basin forest age	>250	>140
Logging (comments)	protected	protected
Connectivity	yes	yes
THLB contributing (% basin area)	Cascade/Sutslem	Cascade/Sutslem
THLB partially contributing (% basin area)	Conservancy	Conservancy
Sample site	Optimal	Optimal
Number of cohorts	1	2
Catchment Area (km2)	29.5	1.32
Watershed ruggedness (%)	24	93
Position in watershed (% backend)	6	N/A
Elevation (m)	893	332
Aspect (degrees)	148	102
Reach gradient (%)	12	18
Bedrock type	granitic	grantitic
Water source	glacier	groundwater
Water temperature	9	8
Dentritic stream network	yes	yes
Perennial water flow	yes	yes
Channel disturbance intensity	low	moderate
Channel unit class	pool/riffle	step pool
Bankful width (m)	11	10.4
Substrate embeddedness	low	medium
Substrate texture (% boulders & cobbles)	70	75
Stand age	>100	>100
Structural stage	7	7
Canopy cover (%)	55	0

Neechanz Landscape Unit

WHA number	51		52	
Relative rank	1		1	
Basin area (km2)	13.89		6.99	
Overall basin ruggedness (%)	53		63	
Average basin elevation	1172		968	
Number of cohorts	3		3	
Basin aspect	N		N	
Basin forest age	>250		>250	
Logging (comments)	no logging		1/4 logged <60 yrs	
Connectivity	yes		yes	
THLB contributing (% basin area)	4		9	
THLB partially contributing (% basin area)	7		2	
Sample site	Optimal	Supporting	Optimal	Supporting
Number of cohorts	2	2	3	1
Catchment Area (km2)	13.89	13.8	6.8	6.99
Watershed ruggedness (%)	53	51	60	63
Position in watershed (% backend)	N/A	N/A	N/A	N/A
Elevation (m)	30	65	131	12
Aspect (degrees)	20	322	355	325
Reach gradient (%)	7	10	22	11
Bedrock type	granitic	granitic	granitic	granitic
Water source	glacier	glacier	groundwater	groundwater
Water temperature	10	8	9	9
Dentritic stream network	yes	yes	yes	yes
Perennial water flow	yes	yes	yes	yes
Channel disturbance intensity	moderate	moderate	moderate	low
Channel unit class	step pool	step pool	step pool	step pool
Bankful width (m)	12	12.1	10.2	6
Substrate embeddedness	low	medium	low	low
Substrate texture (% boulders & cobbles)	75	85	75	59
Stand age	>250	>250	21-60	61-100
Structural stage	7	7	6	5
Canopy cover (%)	35	45	60	45

Nekite Landscape Unit

WHA number	68	69		70		71	85 (formerly 88)	
Relative rank	1	1		2		1	2	
Basin area (km2)	3.11	7.88		14.7		10.2	0.25	
Overall basin ruggedness (%)	45	42		36		39	>100	
Average basin elevation	1096	1092		978		1123	897	
Number of cohorts	3	2		2		1	3	
Basin aspect	W	NW		E		N	W	
Basin forest age	>250	>250		>250		>250	>250	
Logging (comments)	no logging	no logging		protected		no logging	minor logging	
Connectivity	yes	no		yes		yes	no	
THLB contributing (% basin area)	2	8		Barer Creek		1	1	
THLB partially contributing (% basin area)	3	0		Biodiversity Area		0	11	
Sample site	Optimal	Optimal	Supporting	Optimal	Supporting	Optimal	Optimal	Optimal
Number of cohorts	3	2	2	1	1	1	3	2
Catchment Area (km2)	3.11	7.88	6.4	14.7	5.4	10.2	0.21	0.25
Watershed ruggedness (%)	45	42	44	36	47	39	>100	>100
Position in watershed (% backend)	5	N/A	N/A	N/A	20	N/A	48	40
Elevation (m)	772	510	525	323	628	539	780	730
Aspect (degrees)	240	320	315	100	102	25	356	0
Reach gradient (%)	17	20	32	32	10	5	6	5
Bedrock type	granitic	granitic	granitic	granitic	granitic	granitic	granitic	granitic
Water source	lake	lake	lake	lake	lake	groundwater	lake/glacier	lake/glacier
Water temperature	8	9	9	11	8	8	8	9
Dentritic stream network	yes	yes	yes	yes	yes	yes	no	no
Perennial water flow	yes	yes	yes	yes	yes	yes	yes	yes
Channel disturbance intensity	low	moderate	low	low	low	low	moderate	high
Channel unit class	pool/riffle	step pool	step pool	step pool	pool/riffle	step pool	step pool	step pool
Bankful width (m)	8	11.9	8.1	17	7.2	12.2	9.1	13.8
Substrate embeddedness	low	low	low	low	low	low	low	low
Substrate texture (% boulders & cobbles)	65	85	70	85	65	85	80	80
Stand age	>250	>250	>250	>250	>250	>250	1-20.	>100
Structural stage	7	7	7	7	7	7	7	?
Canopy cover (%)	50	65	55	75	15	35	20	30

Nusatsum Landscape Unit

WHA number	32	33	34	35
Relative rank	2	3	2	2
Basin area (km2)	2.39	2.34	0.66	0.54
Overall basin ruggedness (%)	>100	>100	>100	>100
Average basin elevation	1244	1439	1288	1098
Number of cohorts	2	1	2	1
Basin aspect	W	E	N	N
Basin forest age	>140	>140	>140	>140
Logging (comments)	1/4 logged <60 yrs	1/4 logged <60 yrs	no logging	no logging
Connectivity	yes	no	yes	yes
THLB contributing (% basin area)	11	2	2	8
THLB partially contributing (% basin area)	5	1	2	0

Sample site	Optimal	Optimal	Supporting	Optimal	Supporting	Optimal
Number of cohorts	2	1	1	2	2	1
Catchment Area (km2)	2.39	2.34	2.24	0.66	0.6	0.54
Watershed ruggedness (%)	>100	>100	82	>100	>100	>100
Position in watershed (% backend)	N/A	N/A	40	29	33	N/A
Elevation (m)	200	325	740	520	719	501
Aspect (degrees)	55	75	105	10	8	0
Reach gradient (%)	15	25	55	18	75	10
Bedrock type	granitic	granitic	granitic	granitic	granitic	granitic
Water source	groundwater	groundwater	groundwater	groundwater	groundwater	groundwater
Water temperature	10	12	13	7	9	7
Dentritic stream network	yes	yes	yes	no	no	no
Perennial water flow	yes	yes	yes	yes	yes	yes
Channel disturbance intensity	low	moderate	low	low	high	high
Channel unit class	step pool	step pool	step pool	step pool	step pool	step pool
Bankful width (m)	8.8	2.1	4.7	2	1	2.6
Substrate embeddedness	low	low	low	high	medium	low
Substrate texture (% boulders & cobbles)	85	45	65	60	70	20
Stand age	>140	21-60	>140	>140	>140	>140
Structural stage	5	5	7	7	7	6
Canopy cover (%)	40	45	85	40	45	35

Nusatsum Landscape Unit

WHA number	60 (Tatsquan)	61 (Thorsen)		80	82
Relative rank	3	2		1	2
Basin area (km2)	16.05	18.61		4.57	1.22
Overall basin ruggedness (%)	41	35		86	>100
Average basin elevation	1348	1308		1408	1436
Number of cohorts	1	1		2	2
Basin aspect	NE	NE		W	W
Basin forest age	>250	sub-alpine		>140	>140
Logging (comments)	no logging	protected		1/4 logged <60 yrs	1/3 logged <60 yrs
Connectivity	yes	yes		yes	no
THLB contributing (% basin area)	0	Clayton/Thorsen		4	2
THLB partially contributing (% basin area)	0	Protected Area		7	5
Sample site	Optimal	Optimal	Supporting	Optimal	Optimal
Number of cohorts	1	1	1	2	2
Catchment Area (km2)	16	18.61	13.2	4.57	1.22
Watershed ruggedness (%)	36	35	41	86	>100
Position in watershed (% backend)	N/A	40	45	N/A	52
Elevation (m)	596	596	684	310	739
Aspect (degrees)	20	20	23	234	285
Reach gradient (%)	15	15	11	30	5
Bedrock type	granitic	granitic	granitic	granitic	granitic
Water source	groundwater	glacier	glacier	glacier	groundwater
Water temperature	6	6	7	9	9
Dentritic stream network	yes	yes	yes	yes	no
Perennial water flow	yes	yes	yes	yes	yes
Channel disturbance intensity	moderate	moderate	very high	low	low
Channel unit class	cascade	cascade	step pool	step pool	plane bed
Bankful width (m)	6.5	6.5	25	5.8	2.2
Substrate embeddedness	medium	medium	low	low	low
Substrate texture (% boulders & cobbles)	65	65	75	90	40
Stand age	>250	>100	21-60	61-100	61-100
Structural stage	?	?	4	6	
Canopy cover (%)	65	70	30	75	20

Owikeno Landscape Unit

WHA number	49		50		53	54	64
Relative rank	1		1		2	2	1
Basin area (km2)	1.28		1.6		4.99	5.8	4.29
Overall basin ruggedness (%)	>100		>100		72	67	83
Average basin elevation	708		972		927	962	1035
Number of cohorts	3		3		2	1	2
Basin aspect	SE		S		S	S	S
Basin forest age	>250		>100		>250	>250	>100
Logging (comments)	no logging		no logging		1/3 logged <60 yrs	protected	no logging
Connectivity	no		yes (adj. Owikeno)		yes	yes	yes (adj. Owikeno)
THLB contributing (% basin area)	23		0		Owikeno		13
THLB partially contributing (% basin area)	0		6		Protected Area		2
Sample site	Optimal	Supporting	Optimal	Supporting	Optimal	Optimal	Optimal
Number of cohorts	3	2	2	1	2	1	2
Catchment Area (km2)	1.2	1.23	1.6	1.6	4.99	5.8	4.29
Watershed ruggedness (%)	>100	>100	>100	>100	72	67	83
Position in watershed (% backend)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Elevation (m)	174	120	24	79	14	66	68
Aspect (degrees)	137	92	209	117	160	165	144
Reach gradient (%)	53	50	40	35	9	15	32
Bedrock type	granitic	granitic	granitic	granitic	granitic	granitic	granitic
Water source	groundwater	groundwater	groundwater	groundwater	groundwater	groundwater	groundwater
Water temperature	11	11	11	14	10	10	11
Dentritic stream network	yes	yes	yes	yes	yes	yes	yes
Perennial water flow	yes	yes	yes	yes	yes	yes	yes
Channel disturbance intensity	moderate	moderate	low	moderate	moderate	moderate	high
Channel unit class	step pool	step pool	step pool	step pool	step pool	step pool	step pool
Bankful width (m)	4.8	5.8	3.5	3.9	7.9	6.4	8.7
Substrate embeddedness	low	low	low	?	medium	low	low
Substrate texture (% boulders & cobbles)	50	70	65	50	50	70	83
Stand age	>250	>100	>100	>100	>250	>250	21-100
Structural stage	7	7	7	5	5	5	6
Canopy cover (%)	75	55	55	25	42	40	55

Saloompt Landscape Unit

WHA number	21	28		29	40	
Relative rank	2	1		1	1	
Basin area (km2)	8.38	1.43		1.81	11.62	
Overall basin ruggedness (%)	61	>100		>100	58	
Average basin elevation	1313	1059		1243	1168	
Number of cohorts	1	4		2	2	
Basin aspect	SE	W		W	E	
Basin forest age	>250	>250		>250	>250	
Logging (comments)	no logging	1/3 logged <60 yrs		minor logging	1/3 logged <60 yrs	
Connectivity	no	no		no	yes	
THLB contributing (% basin area)	0	13		3	12	
THLB partially contributing (% basin area)	0	0		0	0	
Sample site	Optimal	Optimal	Supporting	Optimal	Optimal	Supporting
Number of cohorts	1	2	2	2	2	1
Catchment Area (km2)	8.38	1.43	1.38	1.81	11.62	8.3
Watershed ruggedness (%)	61	>100	>100	>100	58	56
Position in watershed (% backend)	N/A	N/A	N/A	N/A	N/A	N/A
Elevation (m)	383	232	278	165	244	480
Aspect (degrees)	120	295	338	245	100	120
Reach gradient (%)	?	20	16	15	9	17
Bedrock type	granitic	granitic	granitic	granitic	granitic	granitic
Water source	groundwater	glacier	glacier	groundwater	groundwater	groundwater
Water temperature	7	11	7	14	8	10
Dentritic stream network	yes	no	no	no	yes	yes
Perennial water flow	yes	yes	yes	yes	yes	yes
Channel disturbance intensity	moderate	moderate	moderate	low	high	high
Channel unit class	step pool	step pool	step pool	step pool	step pool	pool/riffle
Bankful width (m)	9	4.7	5.9	6	12	12.3
Substrate embeddedness	medium	medium	medium	low	?	low
Substrate texture (% boulders & cobbles)	80	65	50	55	40	75
Stand age	1-20.	21-60	21-60	21-60	>250	<20
Structural stage	?	5	5	5	4	3
Canopy cover (%)	70	38	70	38	50	5

Saloompt Landscape Unit

WHA number	41		42		43	86	
Relative rank	1		3		3	1	
Basin area (km2)	5.02		0.71		0.2	3.21	
Overall basin ruggedness (%)	88		>100		>100	92	
Average basin elevation	1246		1246		659	1249	
Number of cohorts	2		1		1	3	
Basin aspect	NE		NE		E	SW	
Basin forest age	>250		>250		>250	>250	
Logging (comments)	1/3 logged <60 yrs		1/2 logged <60 yrs		1/2 logged <60 yrs	no logging	
Connectivity	yes		yes		no	no	
THLB contributing (% basin area)	3		42		39	20	
THLB partially contributing (% basin area)	0		0		0	5	
Sample site	Optimal	Supporting	Optimal	Supporting	Optimal	Optimal	Supporting
Number of cohorts	2	1	1	1	1	2	2
Catchment Area (km2)	4.68	5.02	0.71	0.71	0.2	3.21	1.2
Watershed ruggedness (%)	67	88	>100	>100	>100	92	>100
Position in watershed (% backend)	43	N/A	N/A	N/A	N/A	N/A	42
Elevation (m)	680	171	214	283	314	590	681
Aspect (degrees)	20	80	70	140	35	322	305
Reach gradient (%)	15	9	15	15	15	25	15
Bedrock type	granitic	granitic	granitic	granitic	granitic	granitic	granitic
Water source	groundwater	groundwater	groundwater	groundwater	groundwater	groundwater	groundwater
Water temperature	8	10	10	8	8	9	8
Dentritic stream network	yes	yes	yes	yes	no	yes	no
Perennial water flow	yes	yes	no	no	?	yes	yes
Channel disturbance intensity	low	moderate	moderate	low	moderate	moderate	low
Channel unit class	step pool	step pool	step pool	step pool	step pool	step pool	step pool
Bankful width (m)	5.3	7.2	1.6	1.9	2.3	3.9	0.9
Substrate embeddedness	low	low	medium	low	medium	medium	low
Substrate texture (% boulders & cobbles)	80	55	40	40	50	70	55
Stand age	>250	21-60	>250	21-60	21-60	>100	>100
Structural stage	6	4	5	4	4	7	7
Canopy cover (%)	35	32	60	25	45	85	85

Sheemahant Landscape Unit

WHA number	47	
Relative rank	N/A	
Basin area (km2)	9.89	
Overall basin ruggedness (%)	51	
Average basin elevation	1141	
Number of cohorts	2	
Basin aspect	N	
Basin forest age	>250	
Logging (comments)	no logging	
Connectivity	no	
THLB contributing (% basin area)	17	
THLB partially contributing (% basin area)	3	
Sample site	Optimal	Supporting
Number of cohorts	2	1
Catchment Area (km2)	8.84	0.54
Watershed ruggedness (%)	45	48
Position in watershed (% backend)	N/A	19
Elevation (m)	421	1283
Aspect (degrees)	340	340
Reach gradient (%)	22	25
Bedrock type	granitic/metamorphic	granitic
Water source	groundwater	groundwater
Water temperature	9	8
Dentritic stream network	yes	no
Perennial water flow	yes	yes
Channel disturbance intensity	moderate	moderate
Channel unit class	step pool	step pool
Bankful width (m)	5.6	1.25
Substrate embeddedness	low	low
Substrate texture (% boulders & cobbles)	88	65
Stand age	>250	>250
Structural stage	7	7
Canopy cover (%)	35	10

Smitley/Noeick Landscape Unit

WHA number	38	39		44	45
Relative rank	1	2		3	3
Basin area (km2)	0.28	1.4		0.96	0.37
Overall basin ruggedness (%)	>100	>100		>100	>100
Average basin elevation	1563	1435		1203	1385
Number of cohorts	3	2		1	1
Basin aspect	NW	NW		NE	SE
Basin forest age	sub-alpine	sub-alpine		>250	>140
Logging (comments)	protected	protected		no logging	no logging
Connectivity	yes	yes		no	no
THLB contributing (% basin area)	Ape Lake			0	0
THLB partially contributing (% basin area)	Biodiversity Area			0	0
Sample site	Optimal	Optimal	Supporting	Optimal	Optimal
Number of cohorts	3	2	1	1	1
Catchment Area (km2)	0.28	0.12	1.4	0.96	0.37
Watershed ruggedness (%)	>100	>100	>100	>100	>100
Position in watershed (% backend)	55	64	59	N/A	38
Elevation (m)	1030	1137	1047	474	981
Aspect (degrees)	250	295	290	60	80
Reach gradient (%)	55	30	65	18	20
Bedrock type	granitic	granitic	granitic	granitic	granitic
Water source	groundwater	glacier	glacier	groundwater	groundwater
Water temperature	9	10	6	7	7
Dentritic stream network	no	no	no	no	no
Perennial water flow	yes	yes	yes	yes	yes
Channel disturbance intensity	high	high	high	moderate	moderate
Channel unit class	cascade	cascade	cascade	step pool	pool/riffle
Bankful width (m)	5	5	1.5	3.7	1.6
Substrate embeddedness	low	medium	medium	medium	medium
Substrate texture (% boulders & cobbles)	75	45	40	65	45
Stand age	1-20.	1-20.	1-20.	>250	61-100
Structural stage	3	3	3	6	7
Canopy cover (%)	60	0	0	65	65

Sutslem/Skowquiltz Landscape Unit

WHA number	24	62
Relative rank	1	1
Basin area (km2)	3.59	7.02
Overall basin ruggedness (%)	57	59
Average basin elevation	948	827
Number of cohorts	2	2
Basin aspect	E	E
Basin forest age	>250	>100
Logging (comments)	no logging	protected
Connectivity	no	yes
THLB contributing (% basin area)	0	Cascade/Sutslem
THLB partially contributing (% basin area)	0	Conservancy
Sample site	Optimal	Optimal
Number of cohorts	2	2
Catchment Area (km2)	3.59	7.02
Watershed ruggedness (%)	57	59
Position in watershed (% backend)	1212	227
Elevation (m)	135	60
Aspect (degrees)	0	N/A
Reach gradient (%)	14	9
Bedrock type	granitic	granitic
Water source	lake	groundwater
Water temperature	7	8
Dentritic stream network	yes	yes
Perennial water flow	yes	yes
Channel disturbance intensity	moderate	moderate
Channel unit class	step pool	pool/riffle
Bankful width (m)	5.2	6.6
Substrate embeddedness	low	low
Substrate texture (% boulders & cobbles)	87	75
Stand age	>250	61-100
Structural stage	7	6
Canopy cover (%)	65	65

Talchako Landscape Unit

WHA number	81
Relative rank	N/A
Basin area (km2)	33.6
Overall basin ruggedness (%)	35
Average basin elevation	1627
Number of cohorts	1
Basin aspect	N
Basin forest age	>140
Logging (comments)	minor logging
Connectivity	yes
THLB contributing (% basin area)	0
THLB partially contributing (% basin area)	0
Sample site	Optimal
Number of cohorts	1
Catchment Area (km2)	33.6
Watershed ruggedness (%)	35
Position in watershed (% backend)	N/A
Elevation (m)	542
Aspect (degrees)	10
Reach gradient (%)	12
Bedrock type	granitic
Water source	glacier
Water temperature	6
Dentritic stream network	yes
Perennial water flow	yes
Channel disturbance intensity	moderate
Channel unit class	cascade
Bankful width (m)	16
Substrate embeddedness	low
Substrate texture (% boulders & cobbles)	80
Stand age	61-100
Structural stage	6
Canopy cover (%)	80

Twin Landscape Unit

WHA number	18	20	57
Relative rank	3	2	2
Basin area (km2)	26.3	16.37	9.35
Overall basin ruggedness (%)	31	38	39
Average basin elevation	714	1160	1021
Number of cohorts	1	1	1
Basin aspect	E	N	NW
Basin forest age	>250	>140	>250
Logging (comments)	no logging	no logging	no logging
Connectivity	yes (adj. Hot Springs/No Name Creek)		yes
THLB contributing (% basin area)	2	0	0
THLB partially contributing (% basin area)	1	5	3
Sample site	Optimal	Optimal	Optimal
Number of cohorts	1	1	1
Catchment Area (km2)	26.3	16.37	9.35
Watershed ruggedness (%)	31	38	39
Position in watershed (% backend)	248	475	482
Elevation (m)	180	19	180
Aspect (degrees)	N/A	N/A	N/A
Reach gradient (%)	2	5	8
Bedrock type	granitic	granitic	granitic
Water source	groundwater	glacier	groundwater
Water temperature	8	8	8
Dentritic stream network	no	yes	yes
Perennial water flow	yes	yes	yes
Channel disturbance intensity	very high	moderate	moderate
Channel unit class	plane bed	pool/riffle	cascade
Bankful width (m)	11	7.7	9
Substrate embeddedness	high	medium	?
Substrate texture (% boulders & cobbles)	45	52	80
Stand age	>250	>140	>250
Structural stage	7	7	7
Canopy cover (%)	50	60	55

Upper Kimsquit Landscape Unit

WHA number	79 (formerly 89)	
Relative rank	N/A	
Basin area (km2)	2.4	
Overall basin ruggedness (%)	61	
Average basin elevation	1175	
Number of cohorts	3	
Basin aspect	S	
Basin forest age	>250	
Logging (comments)	no logging	
Connectivity	yes (adj. Kitlope Heritage Conservancy)	
THLB contributing (% basin area)	0	
THLB partially contributing (% basin area)	0	
Sample site	Optimal	Supporting
Number of cohorts	3	2
Catchment Area (km2)	2.3	2.4
Watershed ruggedness (%)	61	61
Position in watershed (% backend)	18	18
Elevation (m)	736	730
Aspect (degrees)	220	160
Reach gradient (%)	14	7
Bedrock type	granitic	granitic
Water source	lake	lake
Water temperature	10	10
Dentritic stream network	yes	yes
Perennial water flow	yes	yes
Channel disturbance intensity	low	low
Channel unit class	pool/riffle	pool/riffle
Bankful width (m)	5.4	5.6
Substrate embeddedness	low	low
Substrate texture (% boulders & cobbles)	50	60
Stand age	>250	>250
Structural stage	6	7
Canopy cover (%)	40	65

Washwash Landscape Unit

WHA number	66	67
Relative rank	2	1
Basin area (km2)	9.097	5.44
Overall basin ruggedness (%)	43.2	32
Average basin elevation	1306	1339
Number of cohorts	1	2
Basin aspect	N	NW
Basin forest age	>250	>140
Logging (comments)	no logging	no logging
Connectivity	yes	yes
THLB contributing (% basin area)	5	0
THLB partially contributing (% basin area)	6	0
Sample site	Optimal	Optimal
Number of cohorts	1	2
Catchment Area (km2)	9.097	5.44
Watershed ruggedness (%)	43	32
Position in watershed (% backend)	34	21
Elevation (m)	754	904
Aspect (degrees)	8	300
Reach gradient (%)	15	35
Bedrock type	granitic	granitic
Water source	groundwater	lake
Water temperature	7	11
Dentritic stream network	yes	yes
Perennial water flow	yes	yes
Channel disturbance intensity	moderate	low
Channel unit class	cascade	cascade
Bankful width (m)	12	5.2
Substrate embeddedness	medium	medium
Substrate texture (% boulders & cobbles)	65	92
Stand age	>100	>100
Structural stage	7	7
Canopy cover (%)	45	30

Yeo Landscape Unit

WHA number	58
Relative rank	N/A
Basin area (km2)	8.55
Overall basin ruggedness (%)	33
Average basin elevation	375
Number of cohorts	1
Basin aspect	S
Basin forest age	>250
THLB contributing (% basin area)	Ellerslie/Roscoe
THLB partially contributing (% basin area)	Conservancy
Logging (comments)	protected
Connectivity	yes
Sample site	Optimal
Number of cohorts	1
Catchment Area (km2)	8.55
Watershed ruggedness (%)	33
Position in watershed (% backend)	N/A
Elevation (m)	180
Aspect (degrees)	N/A
Reach gradient (%)	5
Bedrock type	granitic
Water source	groundwater
Water temperature	14
Dentritic stream network	yes
Perennial water flow	yes
Channel disturbance intensity	moderate
Channel unit class	pool/riffle
Bankful width (m)	10.3
Substrate embeddedness	low
Substrate texture (% boulders & cobbles)	85
Stand age	>250
Structural stage	7
Canopy cover (%)	45