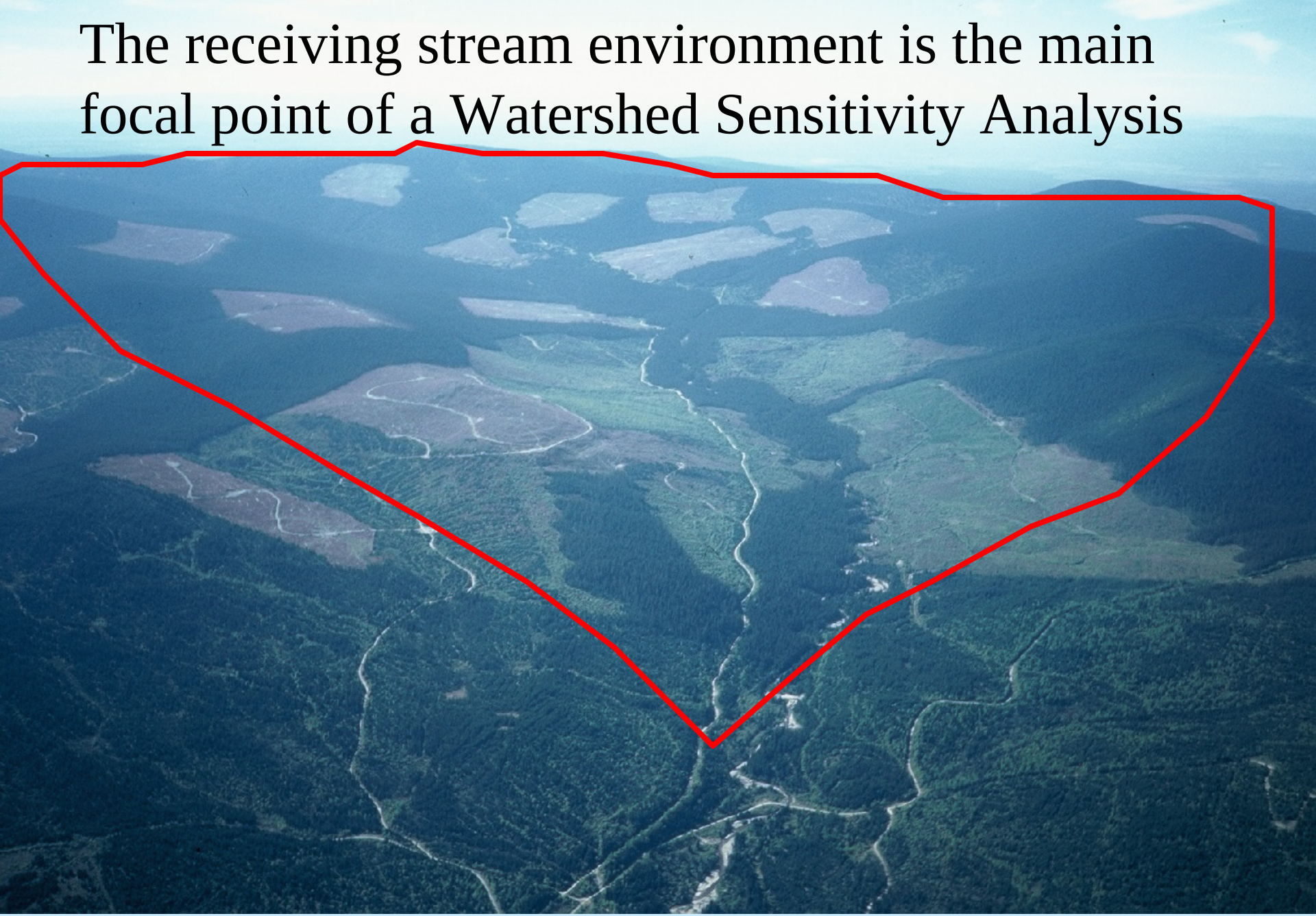
Watershed Sensitivity Assessment for Protection of Fish and Fish Habitat

BRITISH COLUMBIA

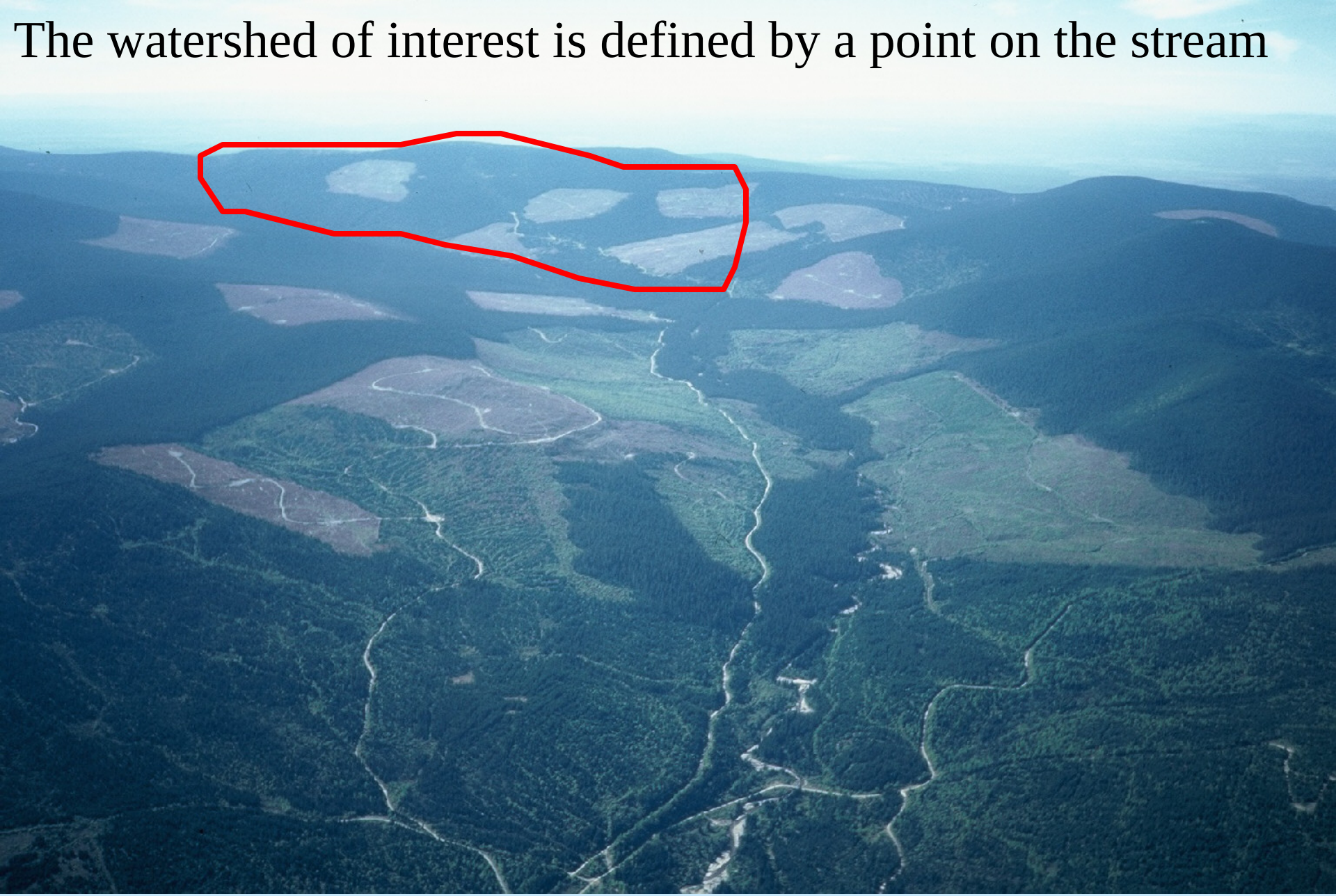
P. Beaudry and Associates Ltd.

Different watershed types have different sensitivities to watershed disturbances and thus should theoretically be able to sustain different management regimes

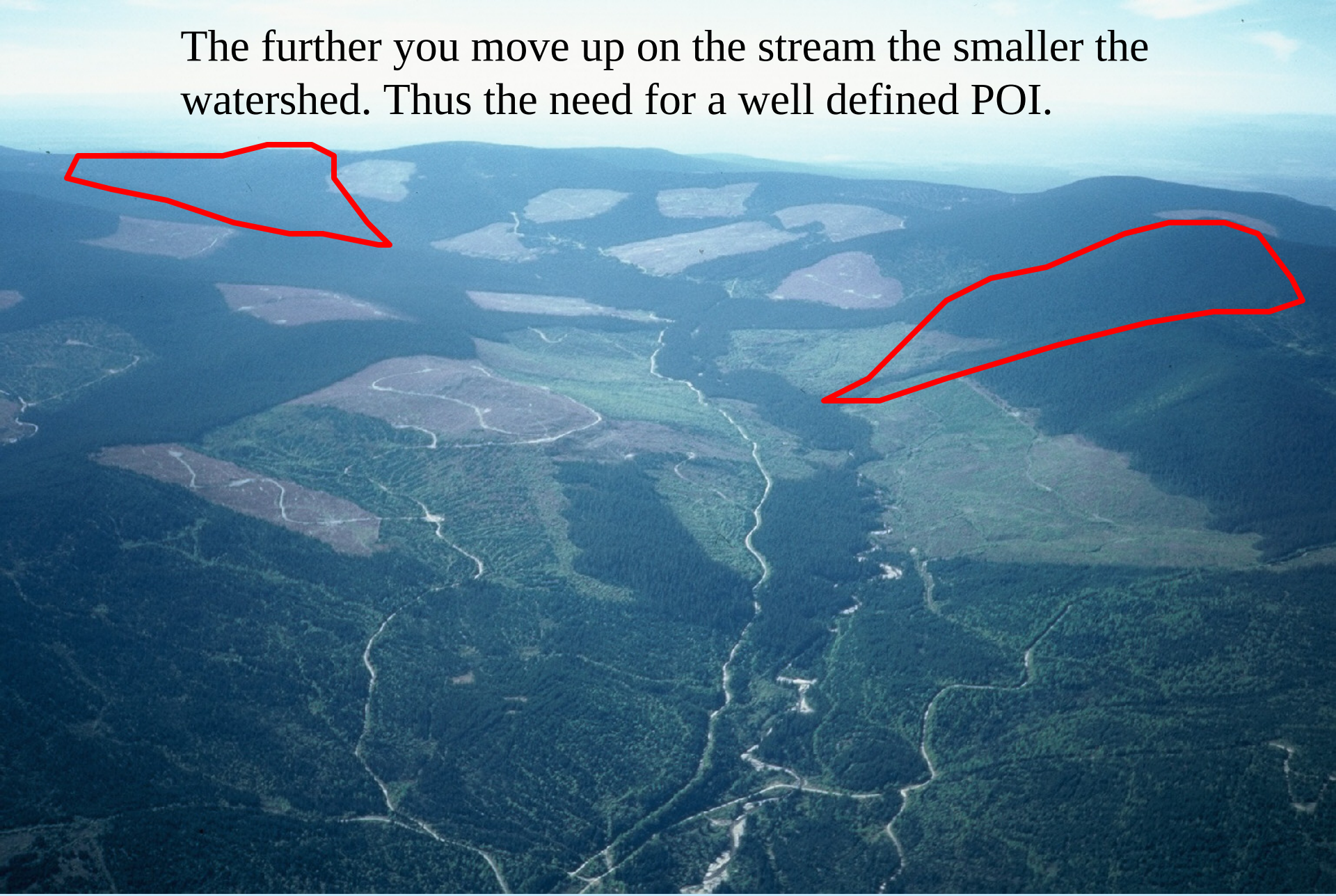
The receiving stream environment is the main focal point of a Watershed Sensitivity Analysis



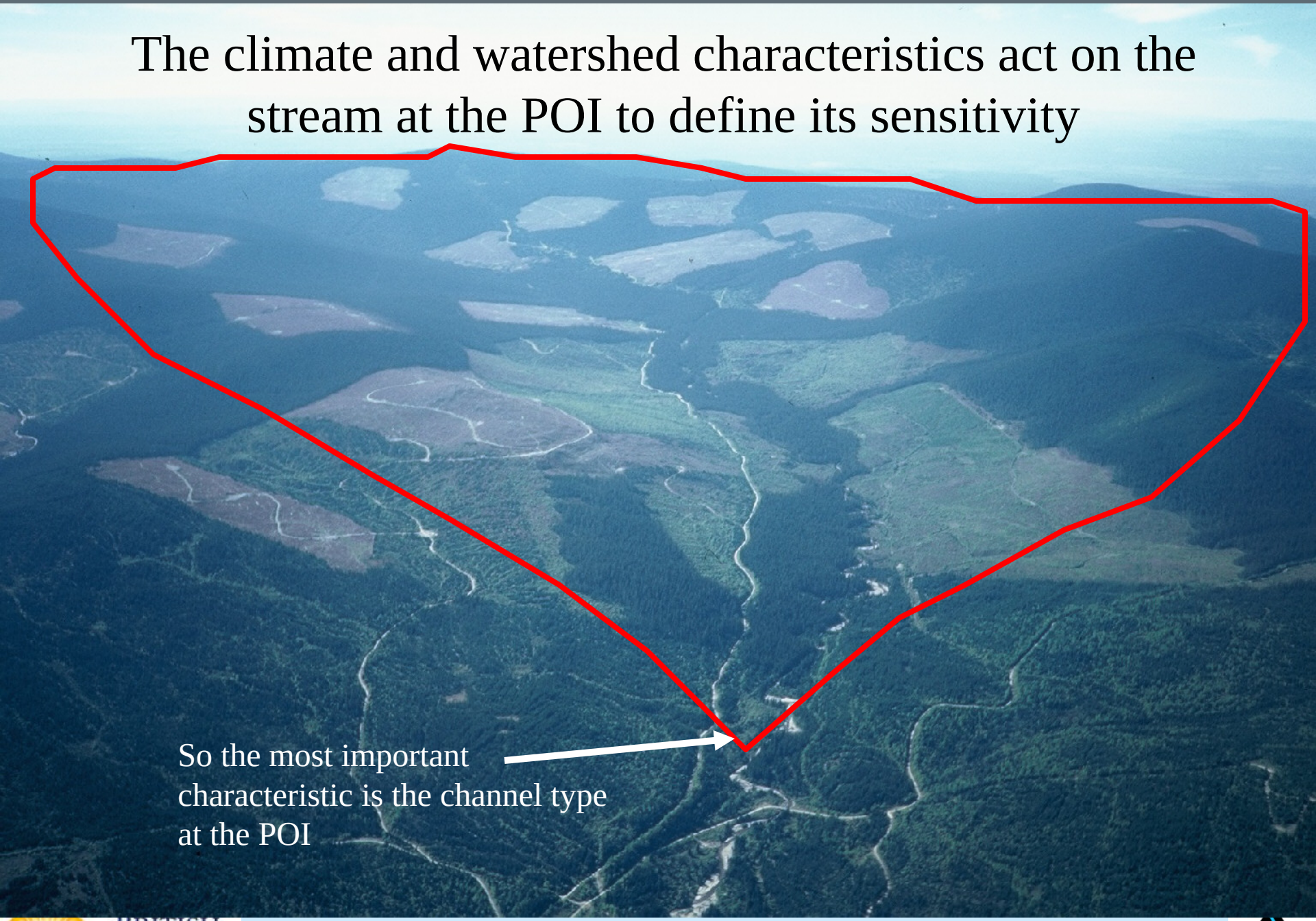
The watershed of interest is defined by a point on the stream



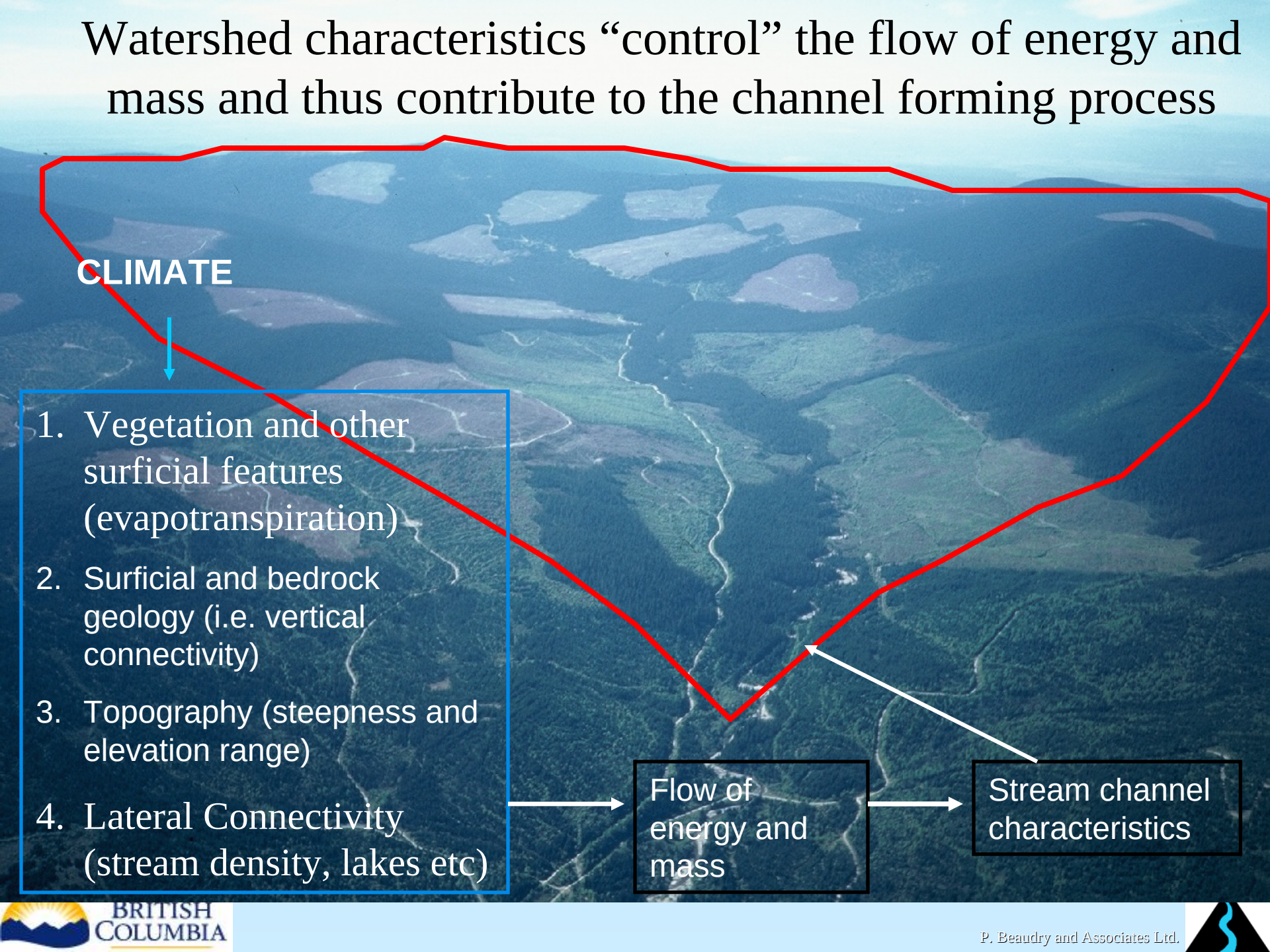
The further you move up on the stream the smaller the watershed. Thus the need for a well defined POI.



The climate and watershed characteristics act on the stream at the POI to define its sensitivity



Watershed characteristics "control" the flow of energy and mass and thus contribute to the channel forming process



Typical Steep Mountainous Watershed

Watershed characteristics:

1. Wet (CWH, ICH)
2. Steep
3. High lateral connectivity
4. Low vertical connectivity
5. Stream sensitivity? This depends on where you set you POI

Watershed Sensitivity?

Typical Rolling Central Interior Watershed

Watershed characteristics:

1. Moist (SBS)
2. Flat
3. Low lateral connectivity
4. High vertical connectivity
5. Stream sensitivity? This depends on where you set you POI

Watershed Sensitivity?

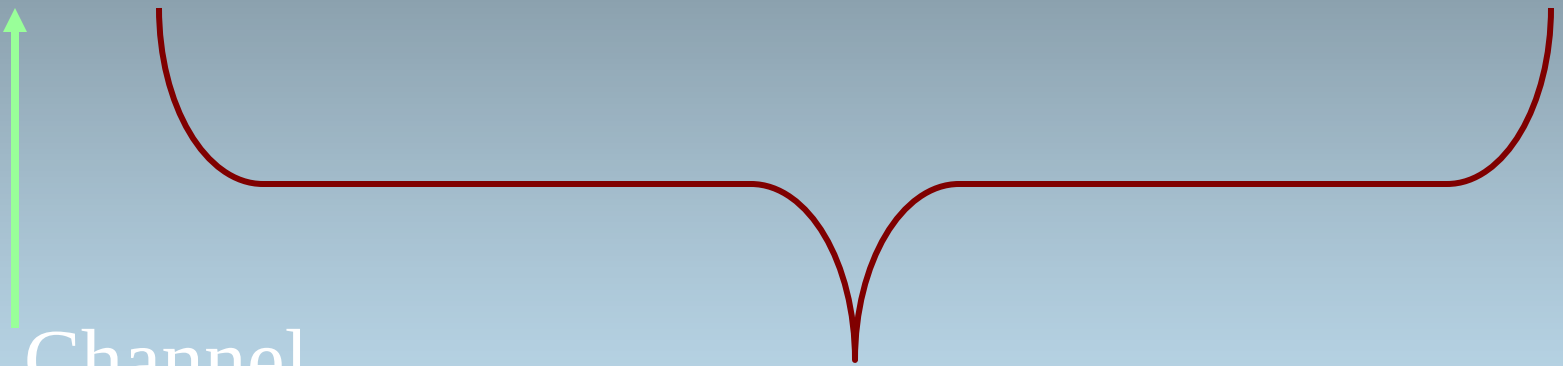
Steps in completing the first pass sensitivity assessment

1. Identify important fisheries watersheds with the assistance of the WET Tool and Regional Information – (MoE, FN, DFO).

2. Look at the Stream Type and then the watershed characteristics and assess the inherent sensitivity to broad landscape level disturbance.

Fisheries Sensitive Watershed Classification Model (Physical Watersheds Sensitivity Only)

PFs= Rs * TOP * DEf *VERT*CLIM*SYNC*NDT



Rosgen Channel Sensitivity: Main Variable

Modifiers of the Channel Sensitivity

Fisheries Sensitive Watershed Classification Model

PFs= Rs * TOP * DEf *VERT*CLIM*SYNC*NDT

PFs= Watershed Sensitivity To Increased Peak Flows

Rs= Rosgen Stream Channel Type Score (1 to 5)

TOP= General Watershed Topography Score (.9 to 1.1)

DEf= Surface Drainage Efficiency Score (.8 to 1.1)

VERT= Vertical Drainage Efficiency Score (.8 to 1.1)

Fisheries Sensitive Watershed Classification Model

PFs= Rs * TOP * DEf *VERT*CLIM*SYNC*NDT

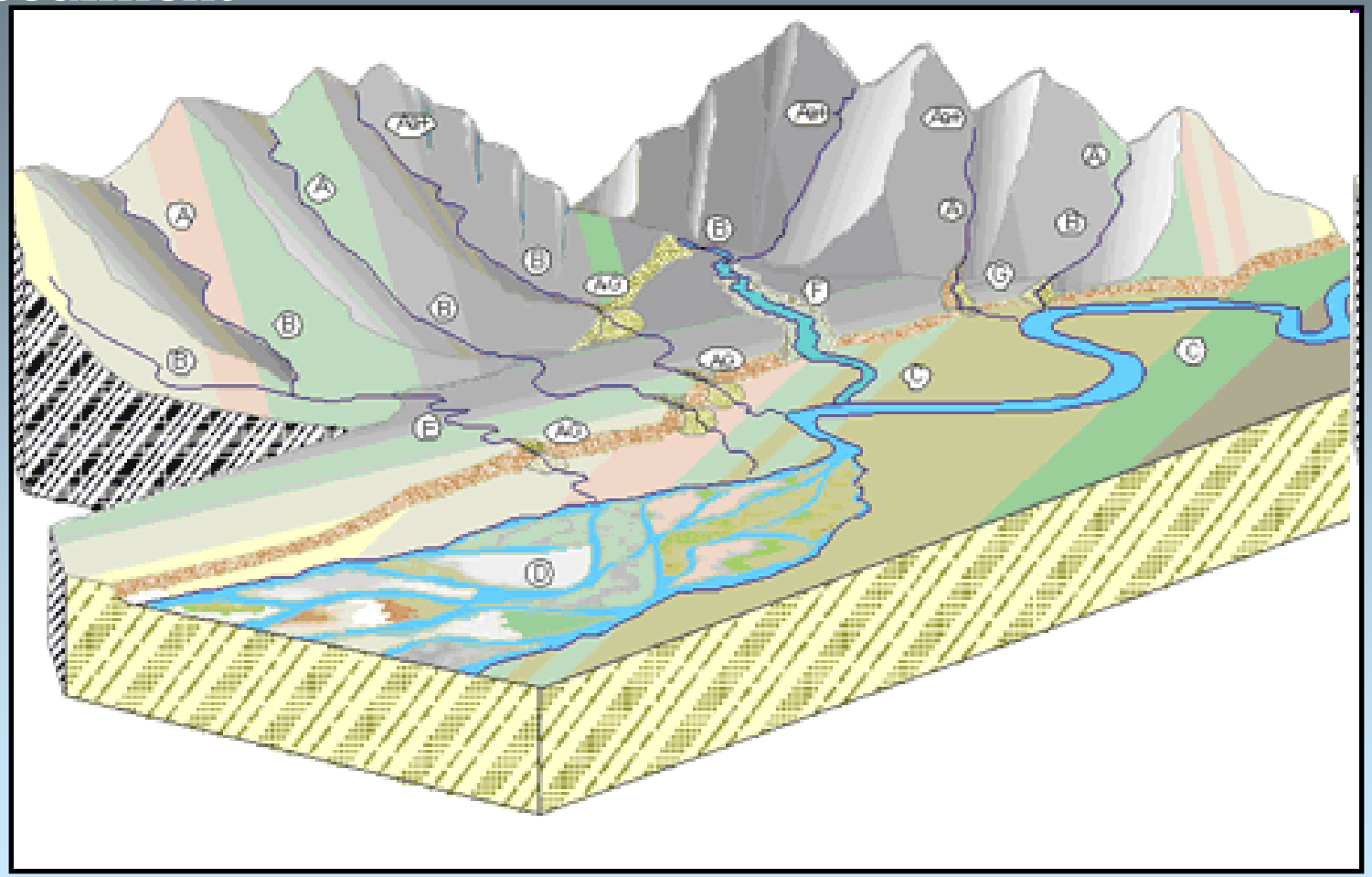
PFs= Watershed Sensitivity To Increased Peak Flows

CLIM = Dominant Watershed Climate Score (0.5 to 1.2)

SYNC= Flow Synchronization Score (.9 to 1.1)

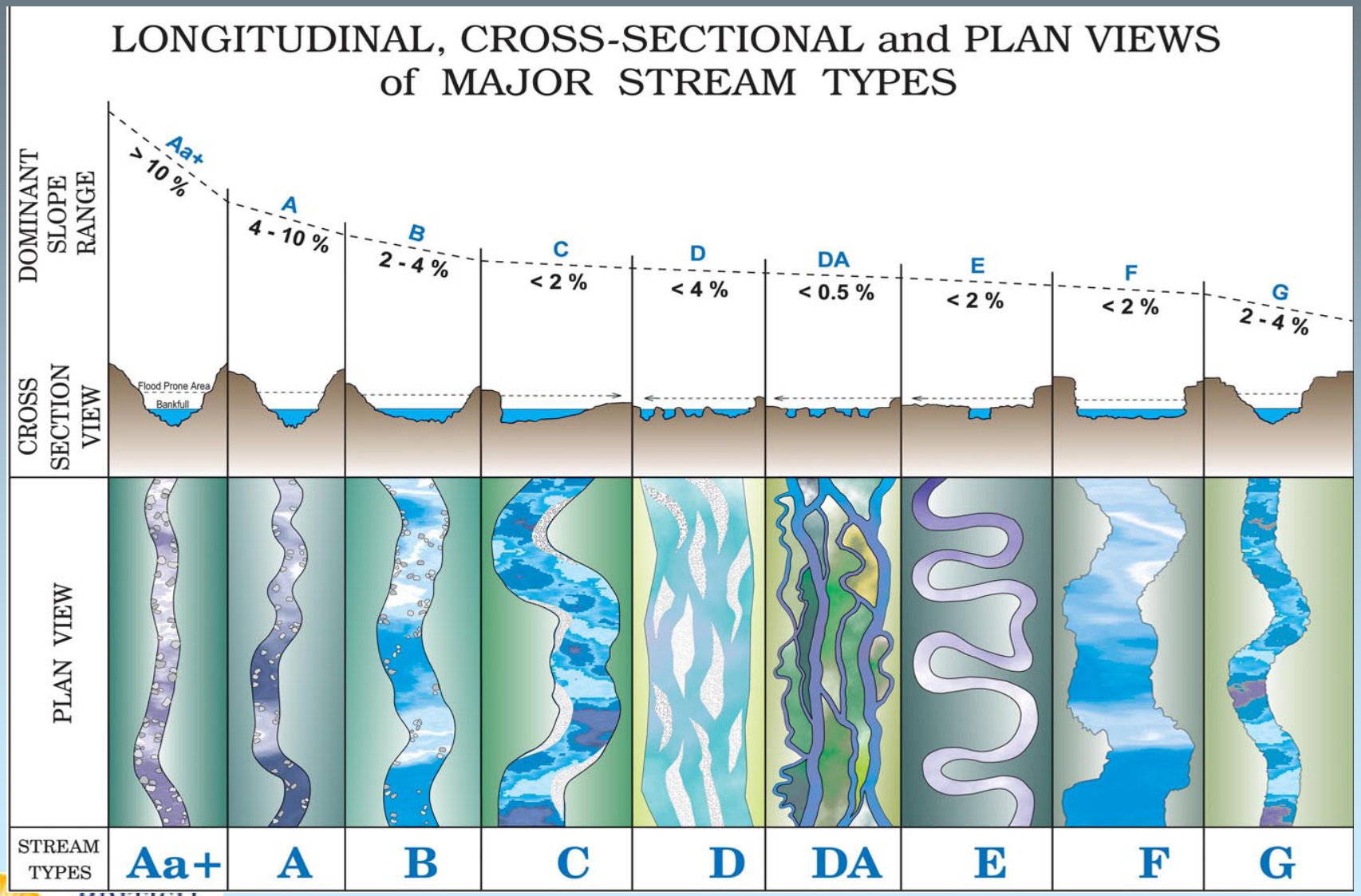
NDT= Natural Disturbance Type Score (.93 to 1.08)

First step= define channel type at POI and its sensitivity to increased peak flows and increased loads of sediment



Rosgen stream classification based on channel morphology

Rosgen Classification Overview



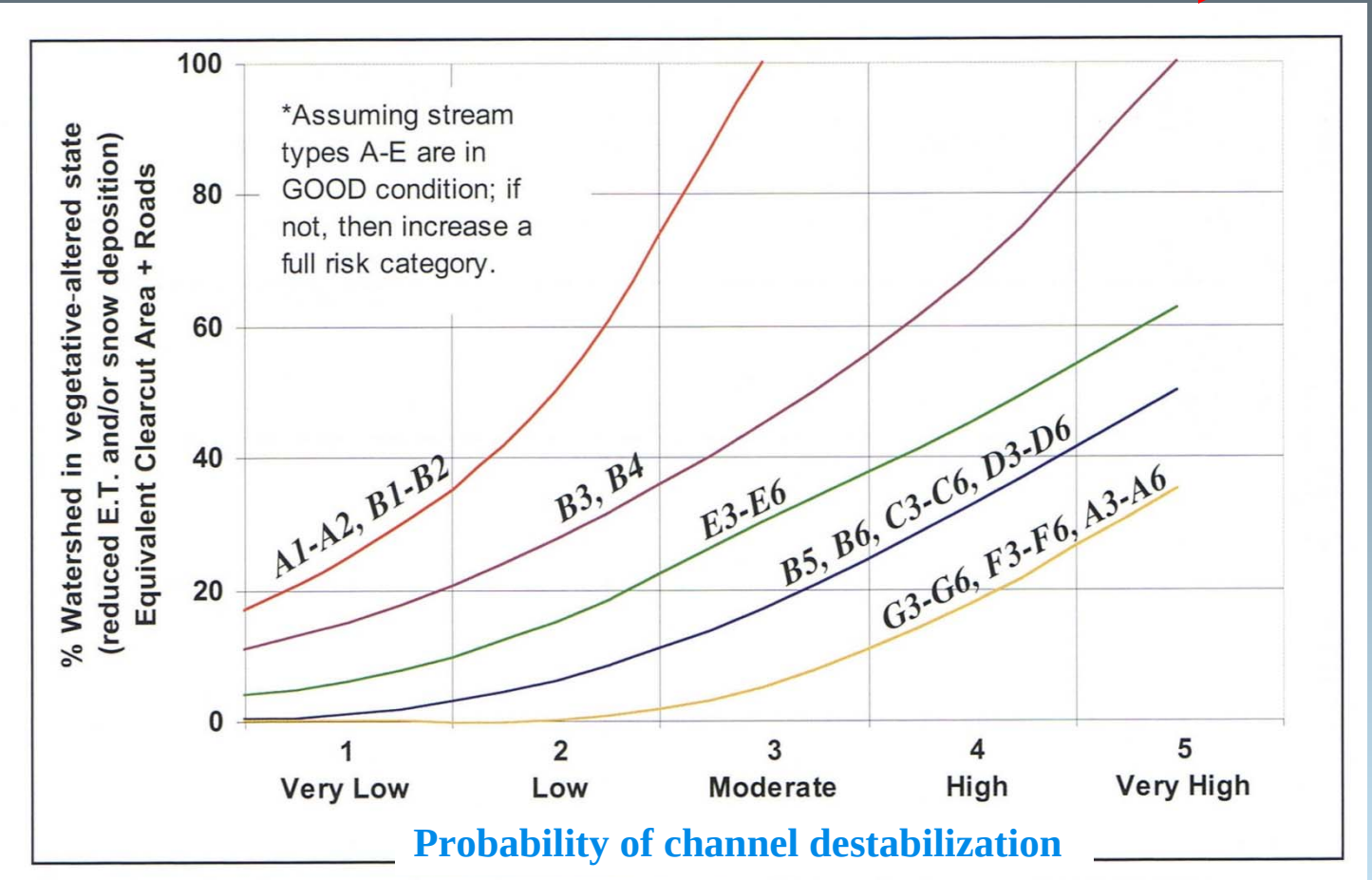
Example on an E4 type

Example on an C4 type

F4 Type

Example of a G5 Gully

Increased sensitivity of channel types



Probability of channel enlargement and accelerated bank erosion associated with increases in ECA for different Rosgen Stream types (Rosgen 2006) (based on "weak-link" stream type). If the channel is unstable, go up a class.

Sensitivity rating of stream channel types to increased flows (i.e. increased energy)

Table 1. Rosgen channel sensitivity rating table (Rs).

Rosgen Stream Type	Stream Sensitivity Class	Channel Sensitivity Score (Rs)
A3 to A6 F3 to F6, G3 to G6	Very High	5
C3 to C6 and D3 to D6	High	4
E3 to E6	Moderate	3
C1 and C2 and B3 to B6	Low	2
A1, A2, B1, B2, F1, F2, G1, G2	Very Low	1

**** This is the fundamental building block of the procedure

Table 1. Watershed topography rating table (TOP).

Description of the watershed	Topography Factor (TOP)
Gently rolling with very wide uncoupled floodplains	0.9
Hilly, gentle mountains, generally uncoupled with wide valley flats	0.95
Mountainous with localized steepness	1.0
Generally steep and coupled	1.05
Very steep and tightly coupled	1.10

Table 1. Watershed drainage efficiency rating table (DEf).

Description of Watershed Characteristics relative to abundance of lakes and wetlands	Drainage efficiency and lateral connectivity (Topology) (DEf)
Numerous lakes, or one big lake, near outlet (big reduction in sensitivity) low drainage density	0.8
Numerous lakes that are scattered throughout watershed, low to moderate drainage density	0.9
Moderate amount of lakes scattered throughout watershed with moderate to high drainage density.	1.0
Few lakes/swamps that are scattered throughout watershed with high drainage density	1.05
No lakes, very high drainage density	1.1

Table 1. Watershed typology rating table (VERT).

Description of the watershed	Typology Factor Soils and bedrock relative to vertical vs horizontal drainage (VERT)
Very deep porous soils with fractured bedrock	0.9
Deep porous soils with fractured bedrock	0.95
Shallow soils with fractured bedrock or deep soils with solid bedrock	1.0
Moderately shallow soils with solid bedrock	1.05
Very shallow soils and solid bedrock	1.10

Table 1. Watershed flow synchronization rating table (SYNC).

% of watershed in "Low Elevation (i.e. less than 300 m above outlet)	Flow Synchronization Factor (SYNC)
<10	0.9
10-30	0.95
30-60	1.0
60-90	1.05
90-100	1.10

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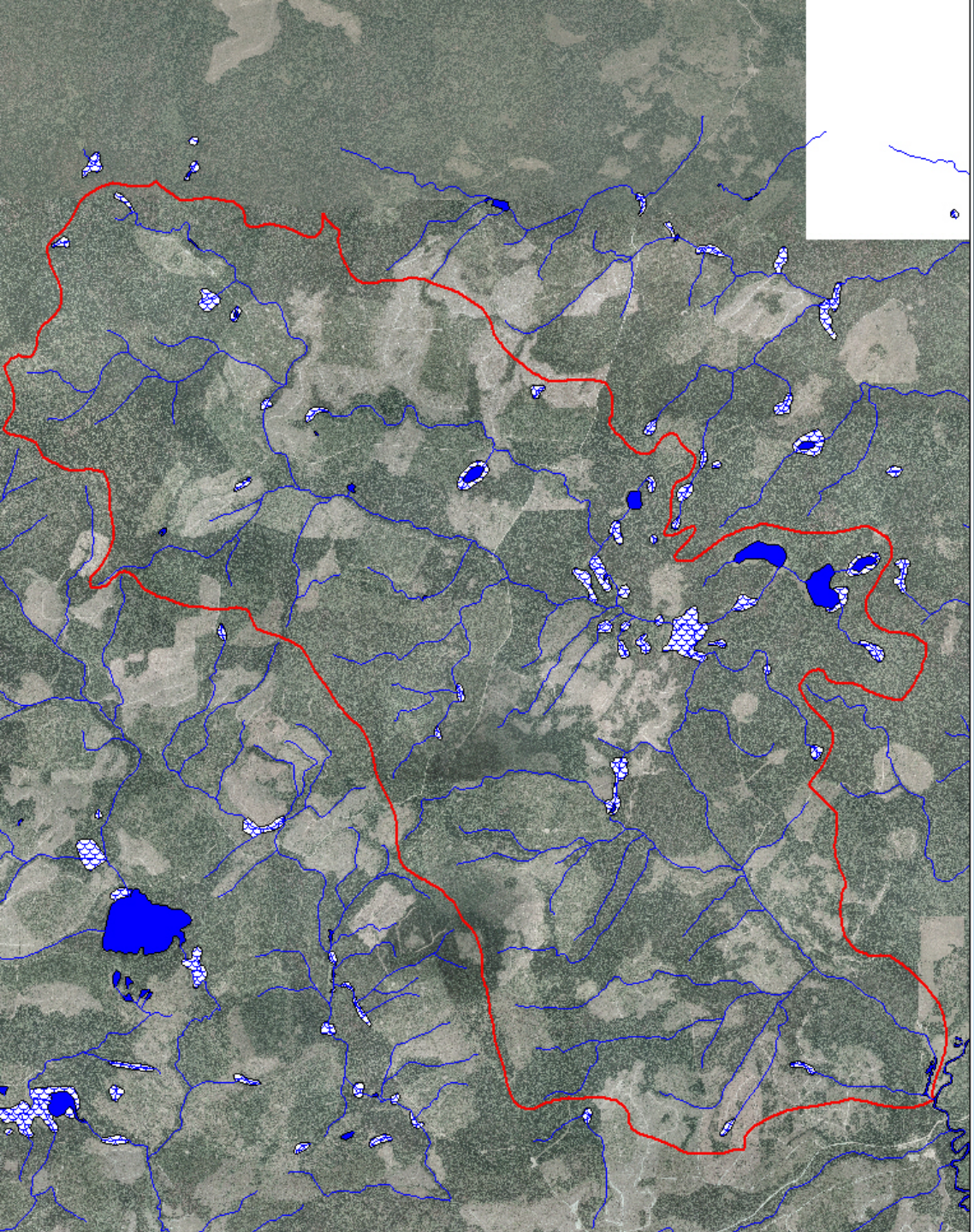
BEC Zone	Weight for BEC Peak Flow Generation Index	
	Rank	Score (CLIM)
MH	Very High	1.2
ICH	Very High	1.2
ESSF	Very High	1.2
MS	Very High	1.2
SBS	Very High	1.2
CWH	High	1.1
CDF	High	1.1
SWB	Moderate	1.0
BWBS	Moderate	1.0
SBPS	Low	0.90
IDF	Low	0.90
PP	Very Low	0.50
BG	Very Low	0.50
AT	Very Low	0.50

Dominant NDT Type in watershed	Natural Disturbance factor (NDTf)
NDT 5 - Alpine tundra and subalpine park land (less sensitive because better adapted to being disturbed)	0.93
NDT 4 - Frequent stand maintaining fires, (less sensitive because better adapted to frequent disturbance)	0.96
NDT 3 - Frequent stand initiating fires, (a bit less sensitive)	1.0
NDT 2 - Infrequent stand-initiating events (minor increase in sensitivity)	1.05
NDT 1 - Rare stand initiating events (increase in sensitivity)	1.08



Sensitivity Relative to Increased Peak flows

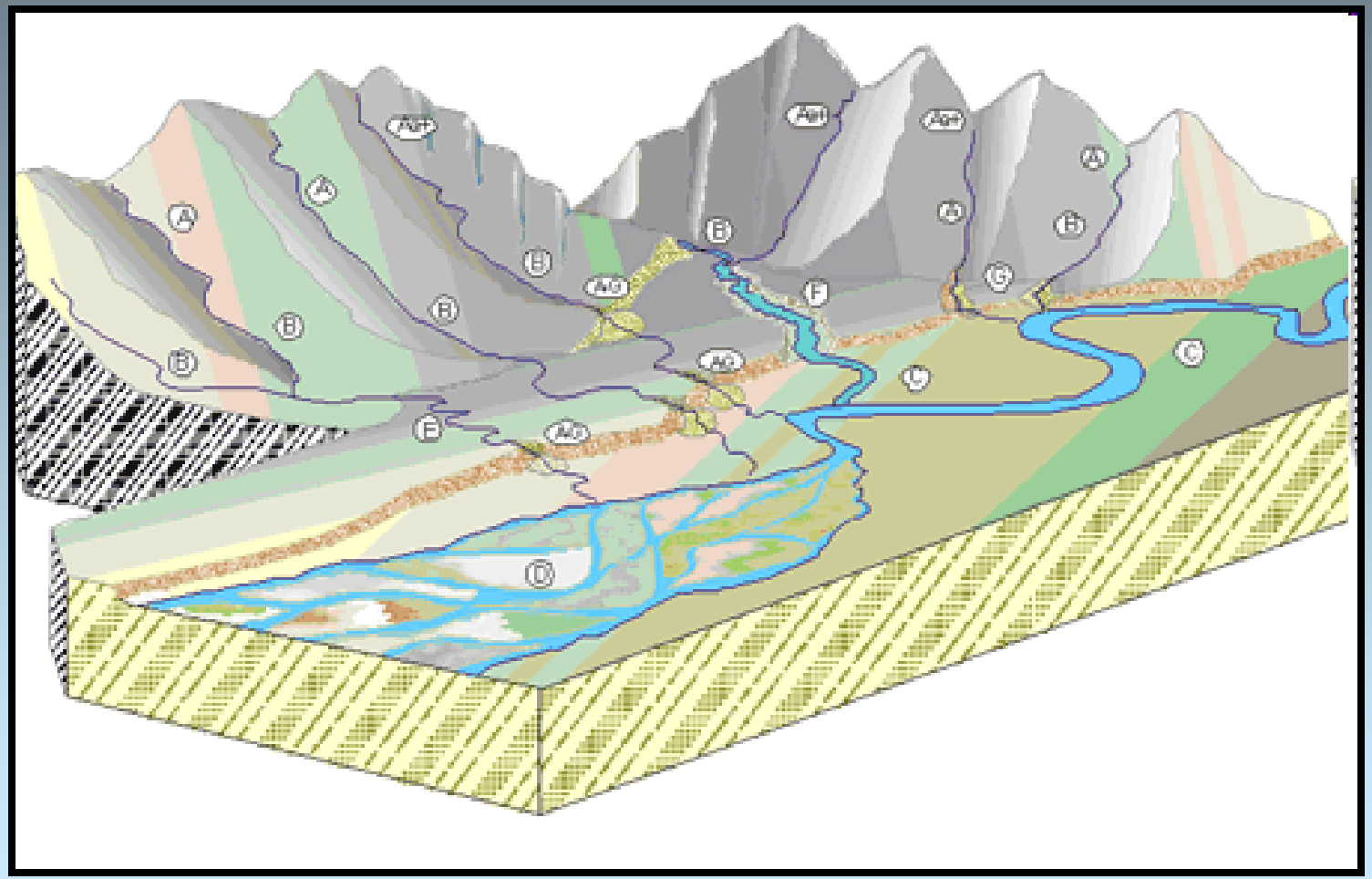
1. Channel (E4) = 3
2. Topog = 0.9
3. Lat Eff= 1.0
4. Vert Eff = 0.95
5. Clim = 1.1
6. Sync = 1.1
7. NDT = 1.0

Overall Watershed Sensitivity Score = 3.1

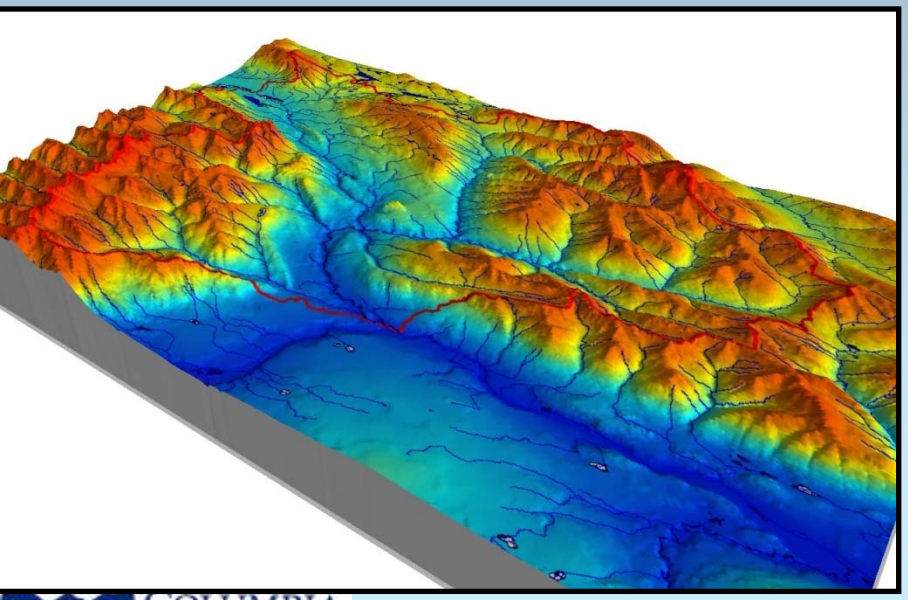
Determination of the sensitivity rating class based on the sensitivity scores.

Flow Sensitivity Rating	Sensitivity Score
Extreme	greater than or equal to 5.5
Very High	4.5 to 5.49
High	3.5 to 4.49
Moderate	2.5 to 3.49
Low	1.5 to 2.49
Very Low	less than 1.49

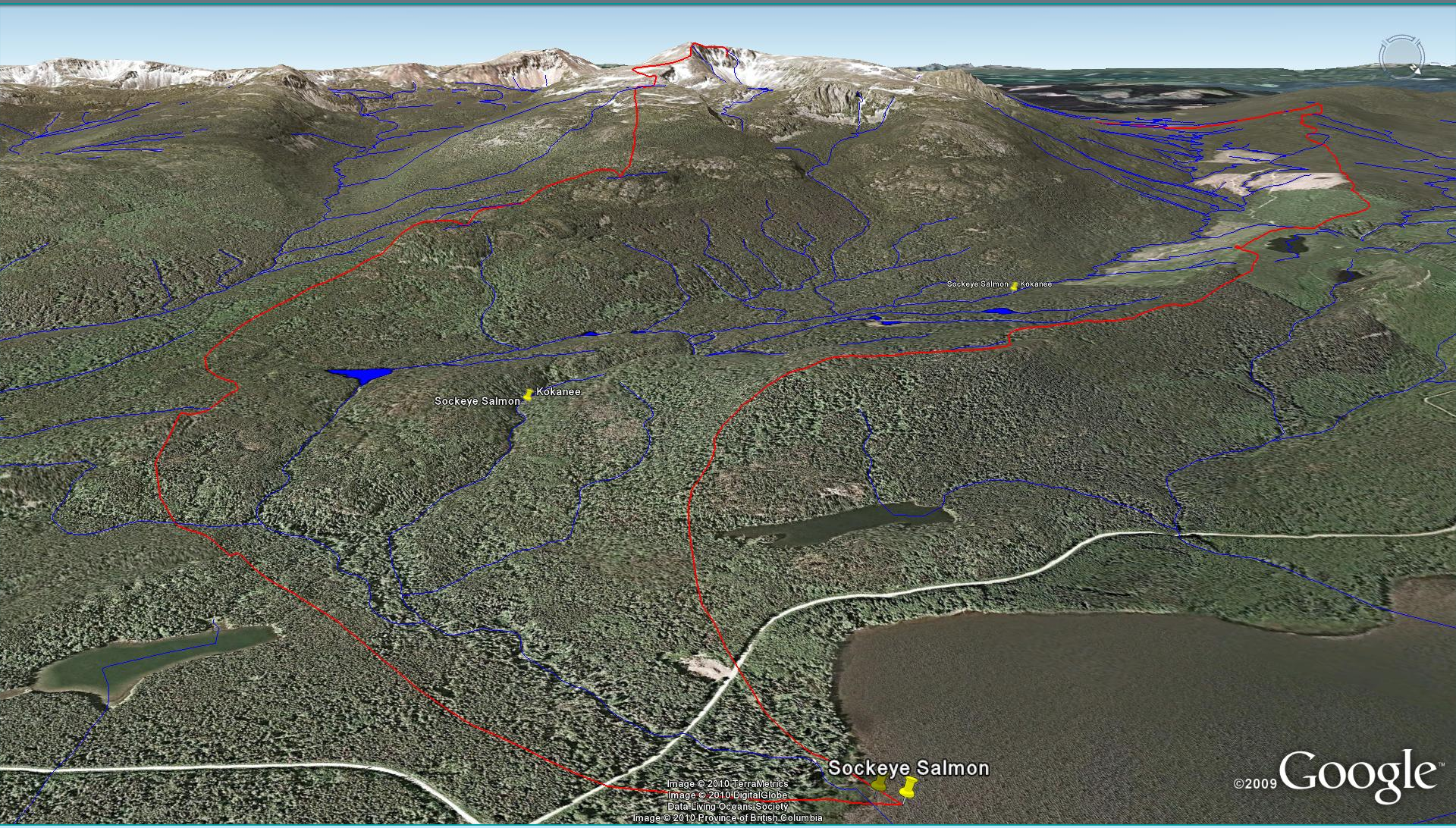
How do you determine the Rosgen Stream Channel Type?



Orthophotos, DEMs and Satellite Imagery



Gluskie Creek Watershed – one of the watersheds being considered for FSW designation.

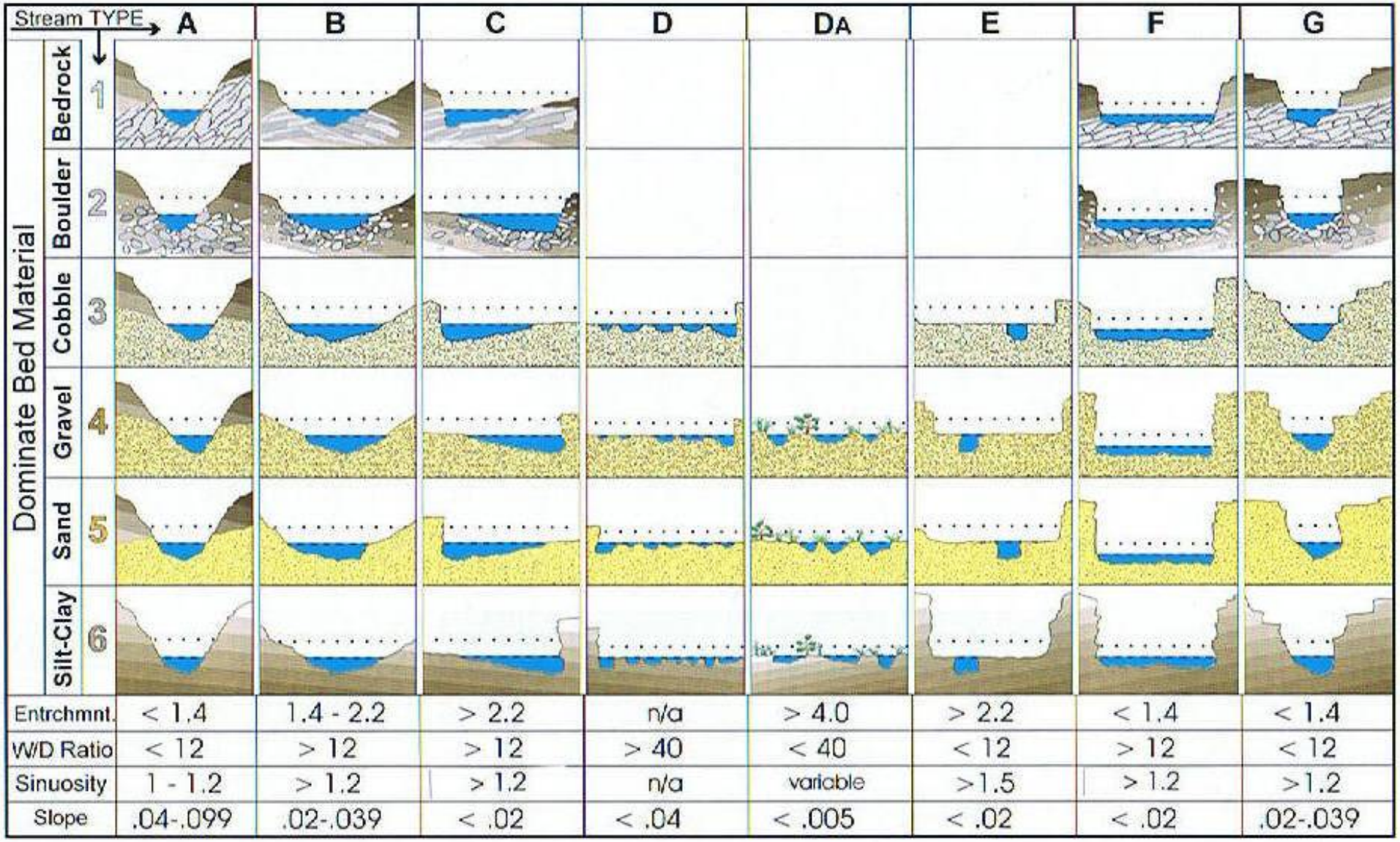


Lower reaches of Gluskie Creek

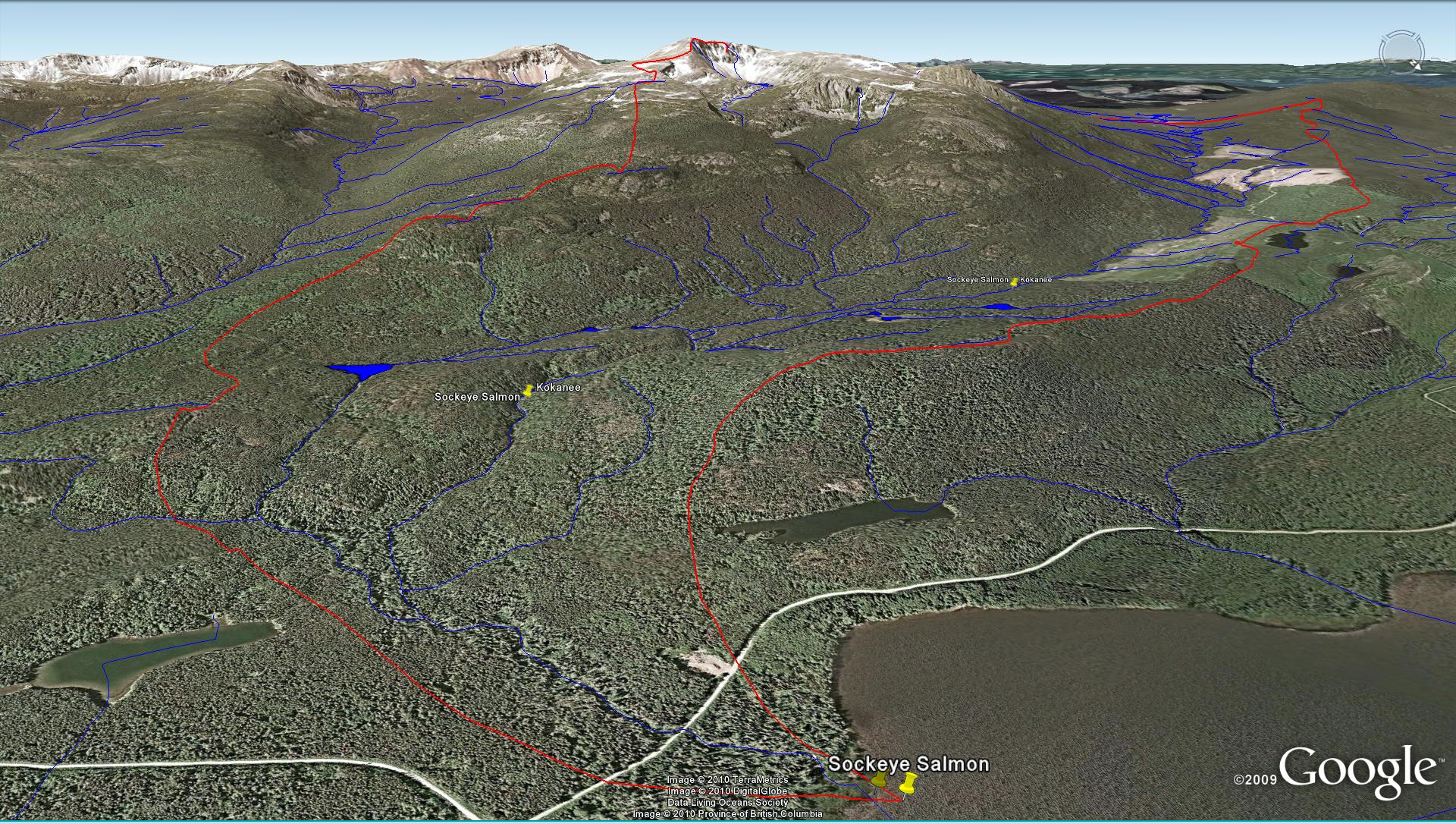
Rosgen Type “C” Stream Channel

- Low Gradient
- Meanders
- Point Bars
- Riffle/Pool Sequence
- Alluvial Channels
- Broad Floodplain

Rosgen stream type for designating stream channel sensitivity at POI

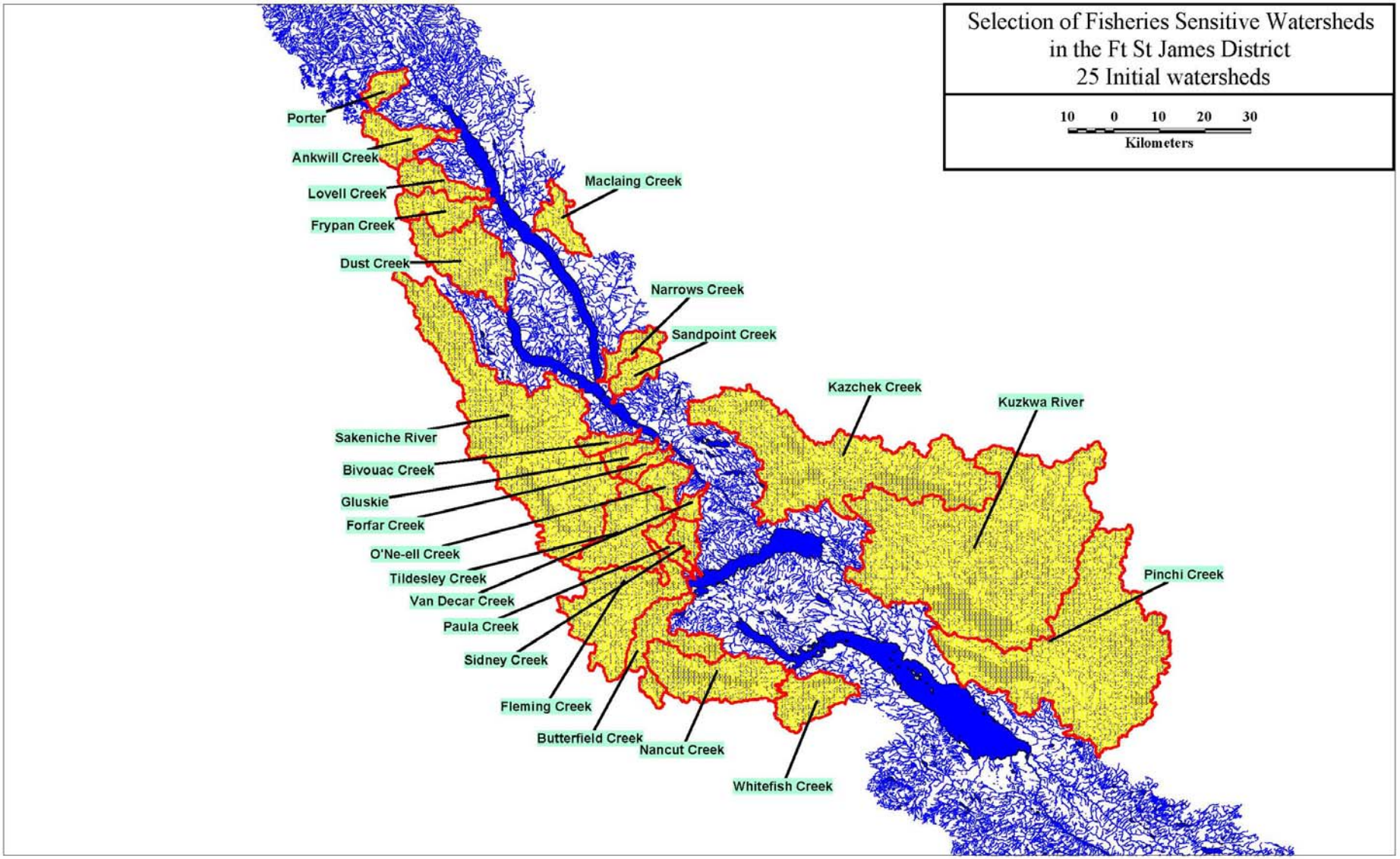


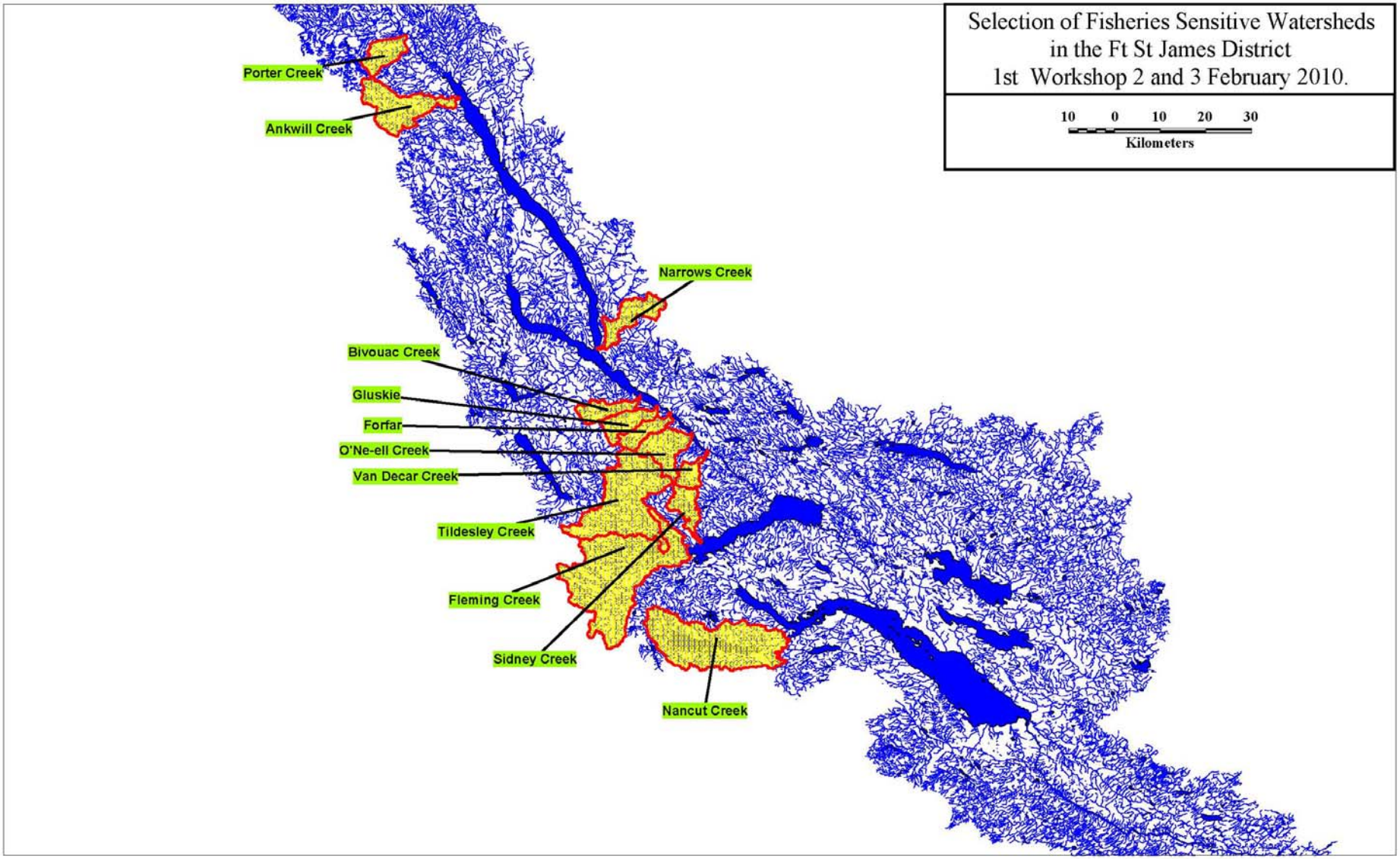
Stream TYPE	A	B	C	D	DA	E	F	G
Entrchmnt.	< 1.4	1.4 - 2.2	> 2.2	n/a	> 4.0	> 2.2	< 1.4	< 1.4
W/D Ratio	< 12	> 12	> 12	> 40	< 40	< 12	> 12	< 12
Sinuosity	1 - 1.2	> 1.2	> 1.2	n/a	variable	>1.5	> 1.2	>1.2
Slope	.04-.099	.02-.039	< .02	< .04	< .005	< .02	< .02	.02-.039



TOP=1, DEf= 1.05, VERT= 0.95, Syn = 0.95, Climate = 1.1. NDT= 1

Sensitivity Score = 4*1*1.05*0.95*0.95*1.1*1 = 4.2 = **HIGH**


Selection of Fisheries Sensitive Watersheds
in the Ft St James District
25 Initial watersheds
10 0 10 20 30
Kilometers
Porter
Ankwill Creek
Lovell Creek
Frypan Creek
Dust Creek
Maclaing Creek
Narrows Creek
Sandpoint Creek
Kazchek Creek
Kuzkwa River
Sakeniche River
Bivouac Creek
Gluskie
Forfar Creek
O'Ne-ell Creek
Tildesley Creek
Van Decar Creek
Paula Creek
Sidney Creek
Fleming Creek
Butterfield Creek
Nancut Creek
Whitefish Creek
Pinchi Creek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1st Workshop 2 and 3 February 2010.
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Fleming Creek
Sidney Creek
Nancut Creek

The Assessment of a Watershed is not only determined by Watershed Sensitivity.

One must also consider the **Hazards** in the watershed (type and amount) in order to determine the overall **Risk** to Fish and their Habitat.

What is Risk?

The probability of harmful consequences resulting from interactions between natural or human-induced hazards and the sensitivity of that particular environment.

What is Risk?

Conventionally risk is expressed by the relation
Risk = Sensitivity * Hazards.

Physical Sensitivity = The responsiveness of a system to a particular input

Hazard = a source of potential danger (i.e. more water, more sediment, less LWD)

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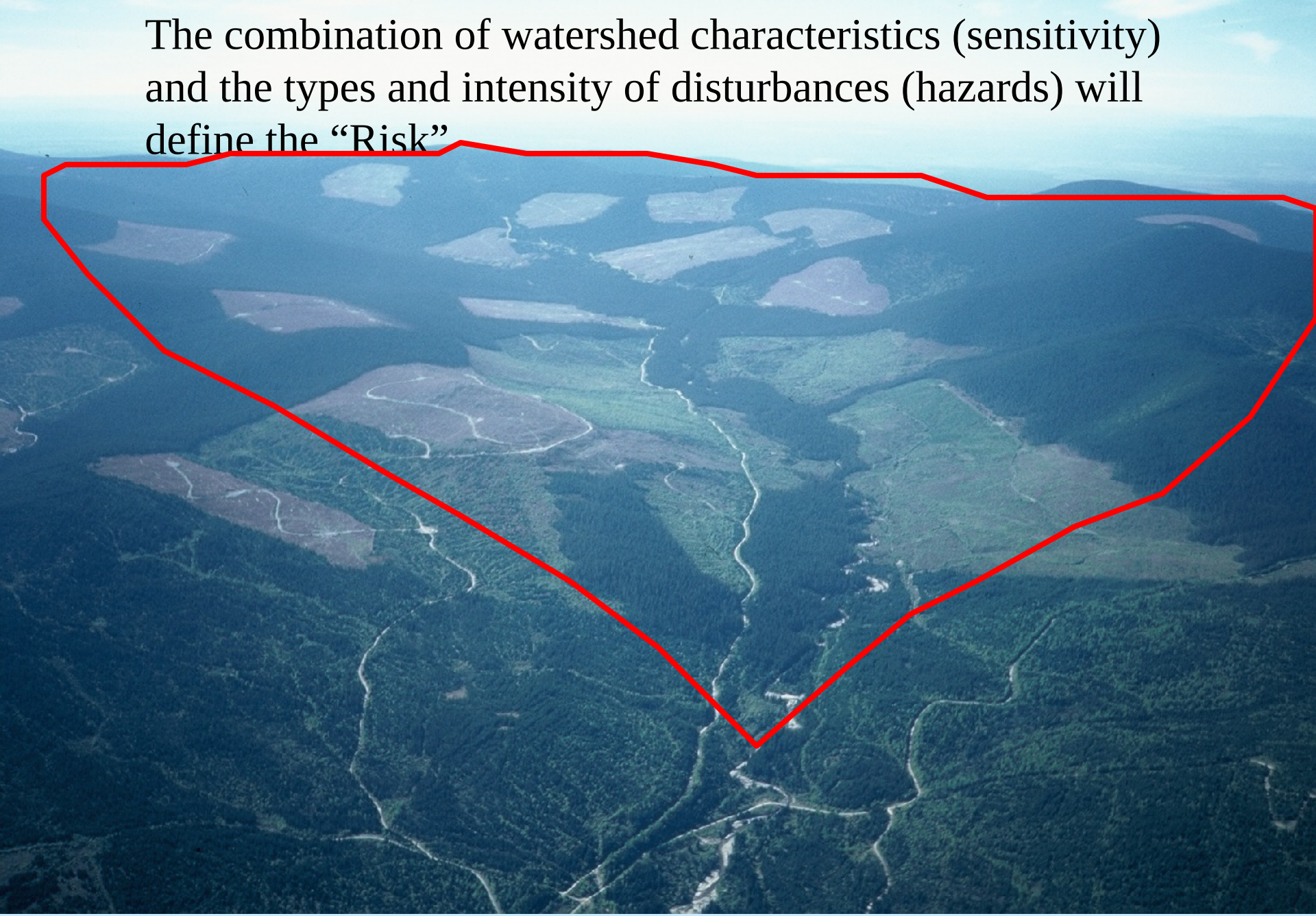
What are Watershed Hazards?

- Extent of Forest Harvesting (impacts water flow i.e. quantity and timing)
- Extent of Natural disturbances, such as MPB, fires, and other pests (impacts water quantity)
- Extent of riparian removal (impacts channel stability and water quality)
- Extent of road network (can impact water quantity)
- Quality ESC at stream crossings (impacts water quality)
- Installation of stream xing (can impact fish access)
- Mass wasting events (impacts channel stability and water quality)

The combination of watershed characteristics (sensitivity) and the types and intensity of disturbances (hazards) will define the “Risk”

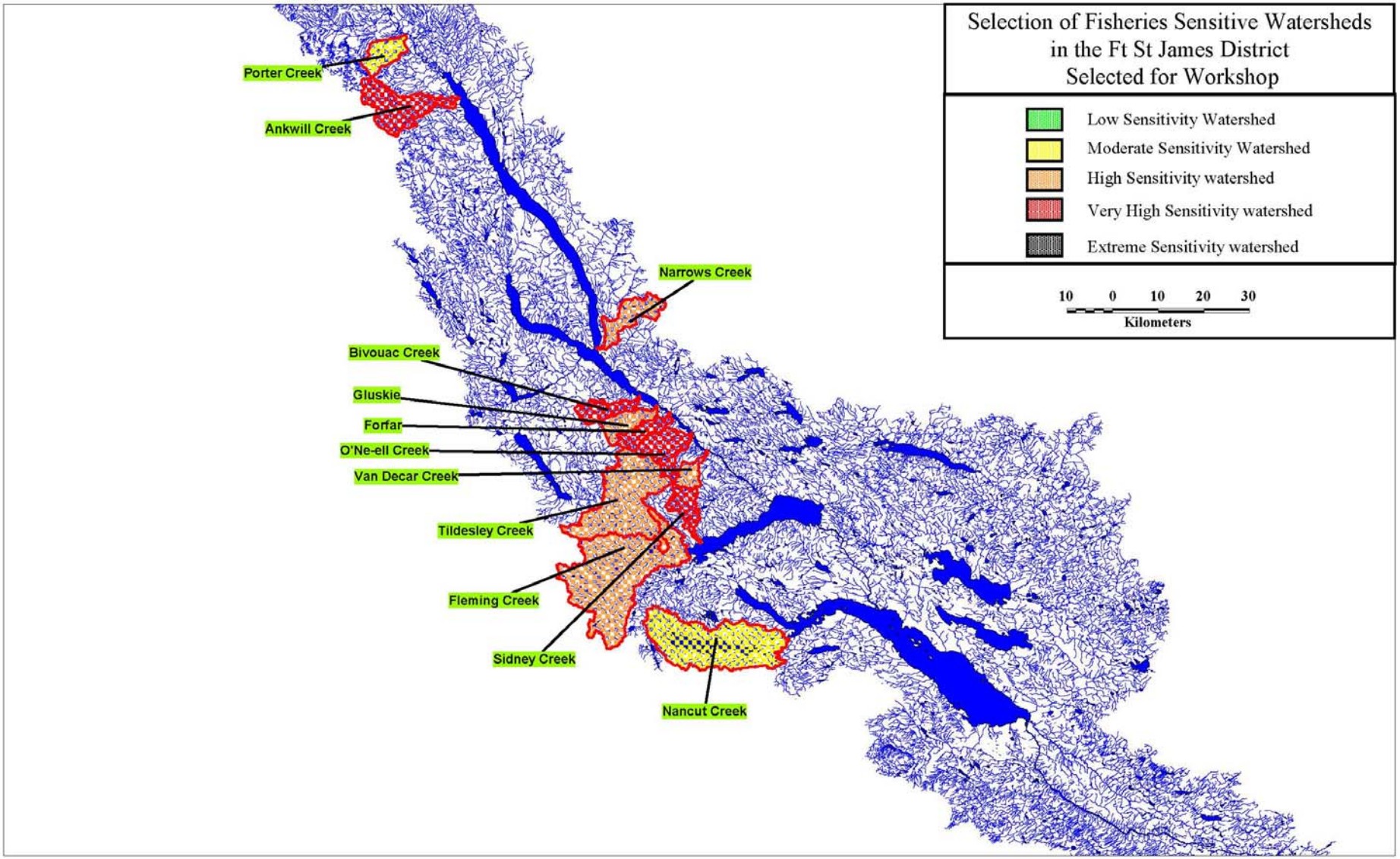


Risk Rating Matrix

Watershed Risk Ratings		Watershed Hazard Rating						
		None	Very Low	Low	Moderate	High	Very High	Extreme
Watershed Sensitivity Rating	None	**None**	**None**	**None**	**None**	**None**	**None**	**None**
	Very Low	**None**	**Very Low**	**Very Low**	**Low**	**Low**	**Low**	**Moderate**
	Low	**None**	**Very Low**	**Low**	**Low**	**Moderate**	**Moderate**	**High**
	Moderate	**None**	**Low**	**Low**	**Moderate**	**High**	**High**	**Very High**
	High	**None**	**Low**	**Moderate**	**High**	**Very High**	**Very High**	**Extreme**
	Very High	**None**	**Moderate**	**Moderate**	**High**	**Very High**	**Extreme**	**Extreme**
	Extreme	**None**	**Moderate**	**High**	**Very High**	**Extreme**	**Extreme**	**Extreme**

Is Risk Ranking a Good Tool for FSW Designation?

- FSW watersheds are meant to be high sensitivity, not necessarily high risk
- Is it more important to protect a watershed that currently has low hazard, but may be disturbed in the future?
- Or is it more important to protect a watershed that has been high disturbed and give it an opportunity to recover?
- Or maybe it is somewhere in the middle (i.e. moderate risk).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Van Decar Creek
Tildesley Creek
Fleming Creek
Sidney Creek
Nancut Creek

Name	Size (km2)	Potential Disturbance Class	Potential Disturbance Score	Hazard Class description	Hazard Score (Focuses on ECA and Road density)	Overall physical sensitivity Score	Physical sensitivity rating class	Current hazard Score	Current hazard Rating	**Current Risk Score**	**Current Risk Ranking**
ANKWILL CREEK	114.7	G- Not known	0	D- Mod: 30 to 40% ECA	3	**4.8**	**Very High**	**3**	**Mod**	**3.4**	**Mod**
BIVOUAC CREEK	41.6	G- Not known	0	A-None: - < 20% ECA	0.5	**4.8**	**Very High**	**0.5**	**Very Low**	**1.73**	**Low**
SIDNEY CREEK	43.8	G- Not known	0	D- Mod: 30 to 40% ECA	3	**4.5**	**Very High**	**3**	**Mod**	**3.33**	**Mod**
FORFAR CREEK	37.6	G- Not known	0	A-None: - < 20% ECA	0.5	**4.5**	**Very High**	**0.5**	**Very Low**	**1.73**	**Low**
O'NE-ELL CREEK (Kynoch Creek)	70.7	G- Not known	0	A-None: - < 20% ECA	0.5	**4.5**	**Very High**	**0.5**	**Very Low**	**1.73**	**Low**
GLUSKIE CREEK	48.5	G- Not known	0	A-None: - < 20% ECA	0.5	**4.3**	**High**	**0.5**	**Very Low**	**1.73**	**Low**
VAN DECAR CREEK	26.9	G- Not known	0	A-None: - < 20% ECA	0.5	**4.3**	**High**	**0.5**	**Very Low**	**1.73**	**Low**
NARROWS CREEK	64.9	G- Not known	0	A-None: - < 20% ECA	0.5	**4.0**	**High**	**0.5**	**Very Low**	**1.73**	**Low**
TILDESLEY CREEK	244.8	G- Not known	0	C- Low: 25 to 30% ECA	2	**4.0**	**High**	**2**	**Low**	**2.67**	**Mod**
FLEMING CREEK	604.1	G- Not known	0	D- Mod: 30 to 40% ECA	3	**3.8**	**High**	**3**	**Mod**	**3.14**	**Mod**
PORTER CREEK	40	G- Not known	0	B-VL: 20 to 25% ECA	1	**3.3**	**Mod**	**1**	**Very Low**	**1.93**	**Low**
NANCUT CREEK	273.2	G- Not known	0	B-VL: 20 to 25% ECA	1	**2.5**	**Mod**	**1**	**Very Low**	**1.6**	**Low**

We are now going to complete some Google Earth “over flights” of each of the 12 watersheds to review their characteristics and hazard levels and become collectively more familiar with the watershed.