Biostandards for Coastal Cutthroat Trout *(O. clarki clarki)*

Can EcoRegions be used as a place-based standard for abundance?

Presenter

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Introduction

This is a brief synopsis and meta-analysis of total removal surveys for Cutthroat (Ct) from 210 streams and 3060 electrofished sites in B.C. Involves all ecotypes in context of fish communities.

Persistent pattern of fish abundance according to place and population “self-thinning”.

Organization of Presentation

- Introduction.
- Premise and Applications.
- Methods.
- EcoRegion distribution.
- Results and fitting model.
- Model Validation and local examples.
- Conclusions.

Premise

- ➔ Streams have finite capacity to rear CCT (space+food).
- ➔ Maximum density is fish size dependent.
- ➔ Fish density-size or biomass varies according to meso-habitat or area, species-size habitat preferences, competition, food supply, etc.
- ➔ The biomass envelope or capacity (Allen Plot) = 95th Percentile per driver; usually parr in CCT streams.
- ➔ We can predict the biomass envelope.
- ➔ We can set density benchmarks from Biomass/size.

Population Health Goals and Assessment Methods

1. Quality and quantity of habitat.
2. Densities of juvenile Ct.
3. Egg-fry-parr stock-recruit functions.
4. Production of downstream migrants.
5. Distribution of juvenile fish (non-random; small streams).
6. Abundance of adult fish and age-size structure.
7. Life-history diversity and genetics.


1
2
22
23
24
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26
27
28

What density is OK?

- Defense of feeding territories is common among stream salmonids including cutthroat trout.
- Earlier density-size models were not explicit to Ct .
- Densities and habitats of Ct have been quantified for numerous streams to the reach and meso-habitat scale (30 yr).
- Province mapped to the EcoSection level (23 units for Coastal Ct) and opportunity to develop regional benchmarks for biomass and to compare to the Pacific Northwest.
- Oregon Plan for Salmon and Watersheds (2002) says mean trout fry density should be >50 FPU and Age 1+ parr should be >10 FPU; FPU = fish number per 100m^2 Unit.
- A “low” density may reflect capacity if the habitat was less suitable.

Methods

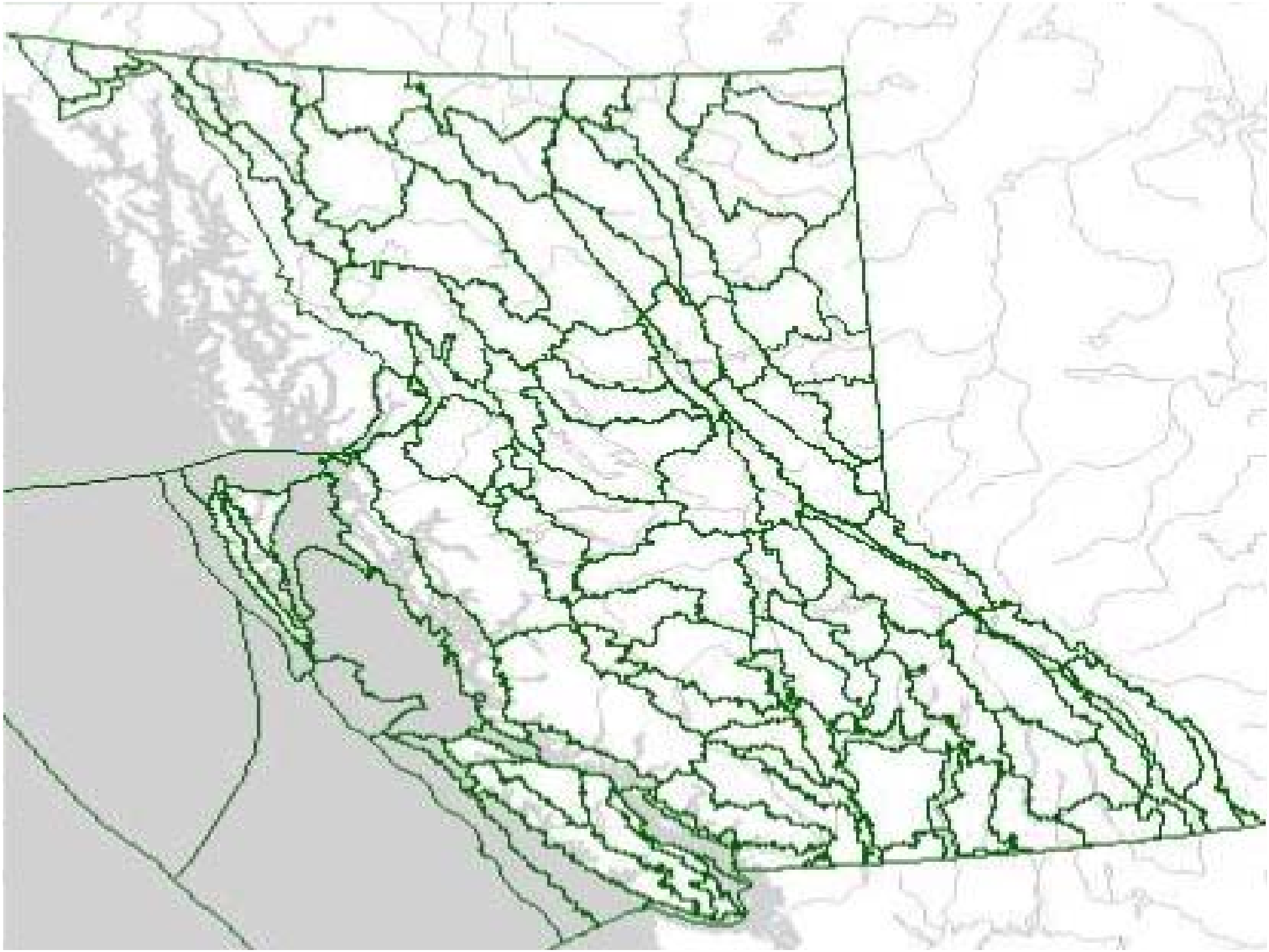
- Literature and database review of population density-size and habitat studies in BC and elsewhere; flag local vs reach data (scale). Include water chemistry and hydology.
- Develop a matrix (spreadsheet) of density by age, size and species for all sites.
- Drop cases that involved shallow habitats (reduce bias).
- Aggregate char and trout of the same size.
- Treat coho separately.
- Describe the 95th percentile of biomass per Species-Age and plot density on size (Allen Plot).
- Flag by stream the biomass “driver” (fry and/or parr).
- Stratify biomass per EcoProvince and EcoSection.
- Regress biomass on water quality parameters.
- Validate biomass model using an independent dataset.

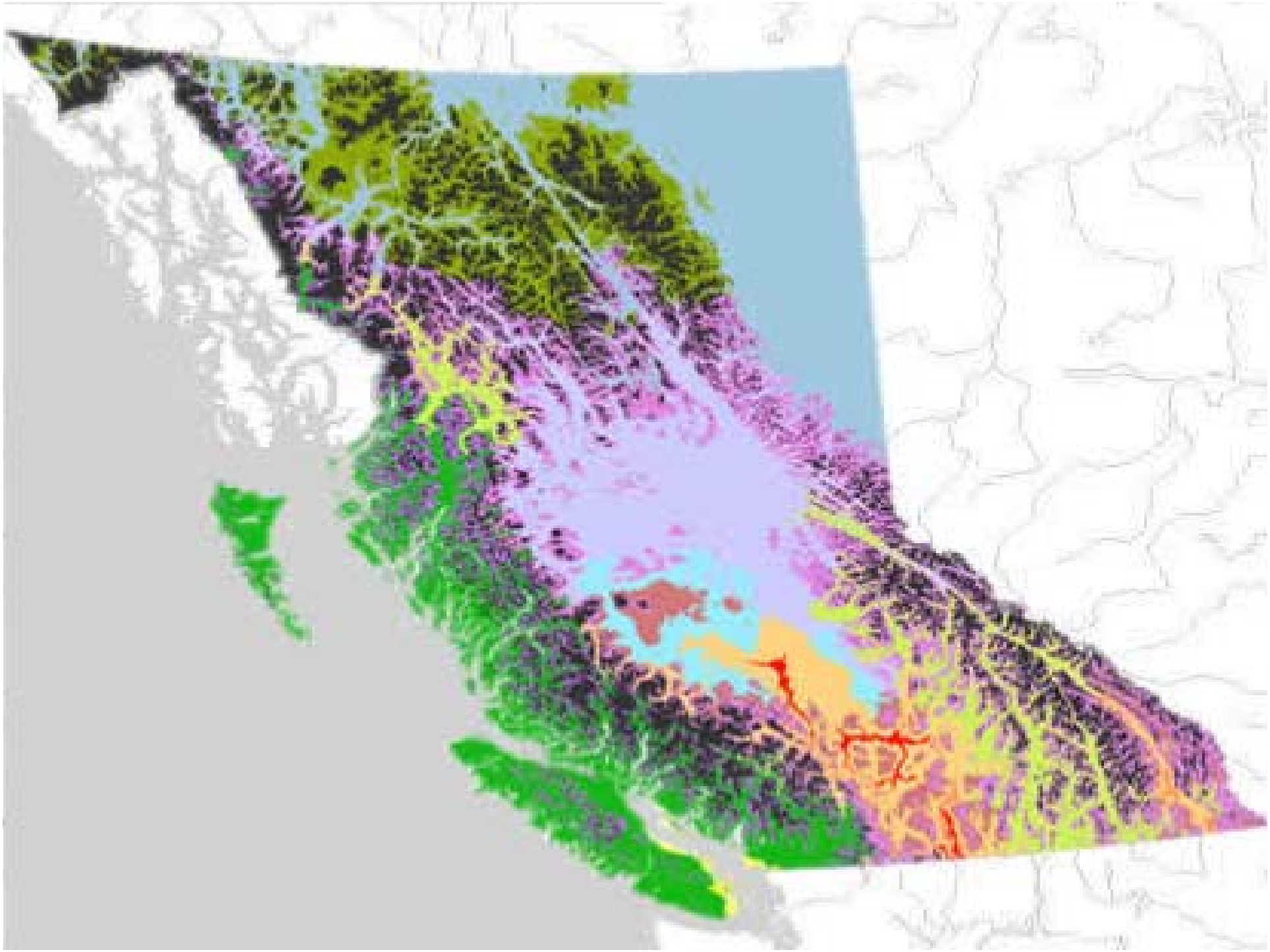
Ecosystems Fundamentals

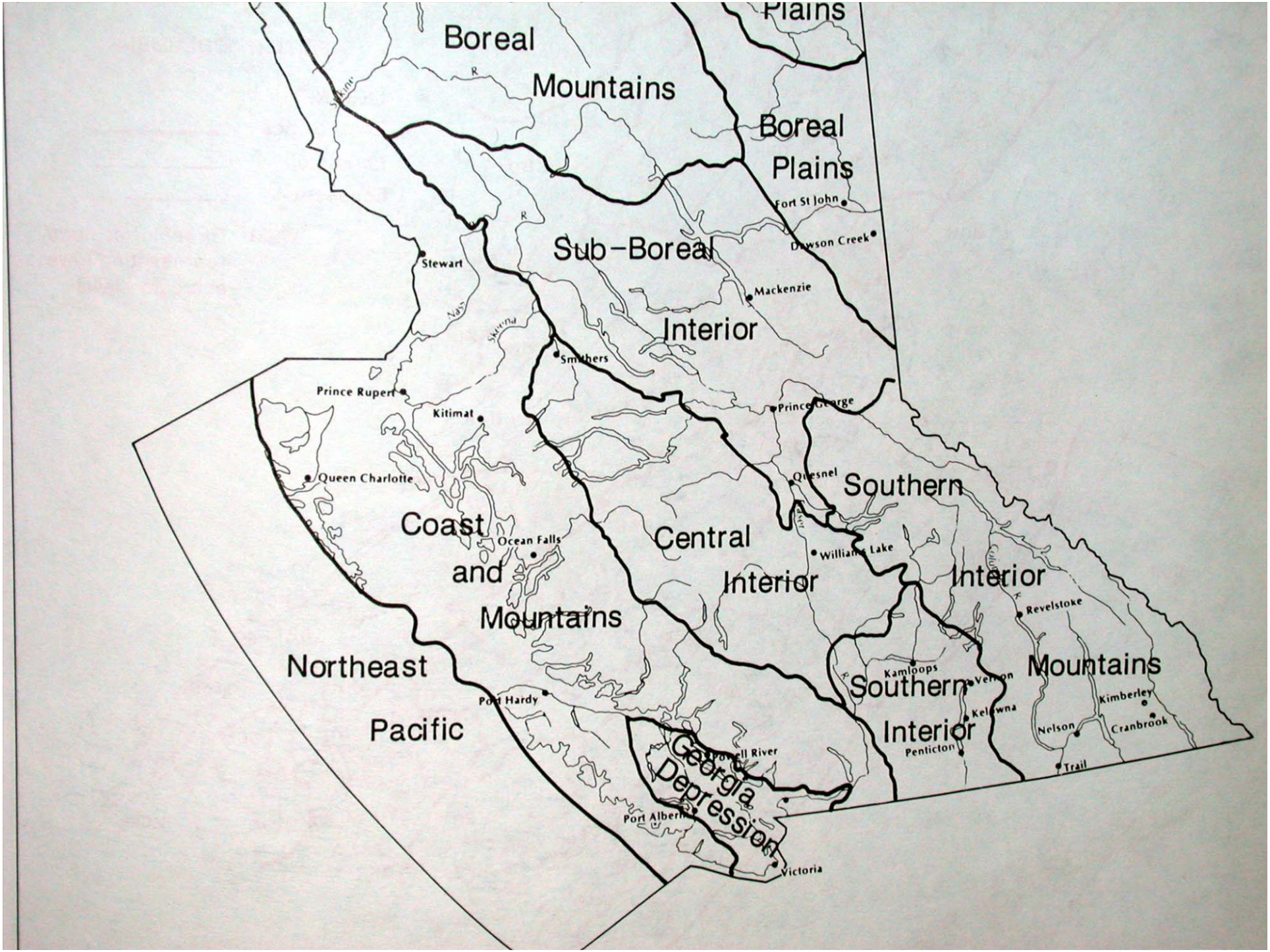
- The fundamental basis for delineation of ecological units is to capture the major ecological composition and the linkages between the various components (e.g., landforms, soils, water, fish/wildlife, humans and vegetation) rather than treating each component as a separate characteristic of the landscape.

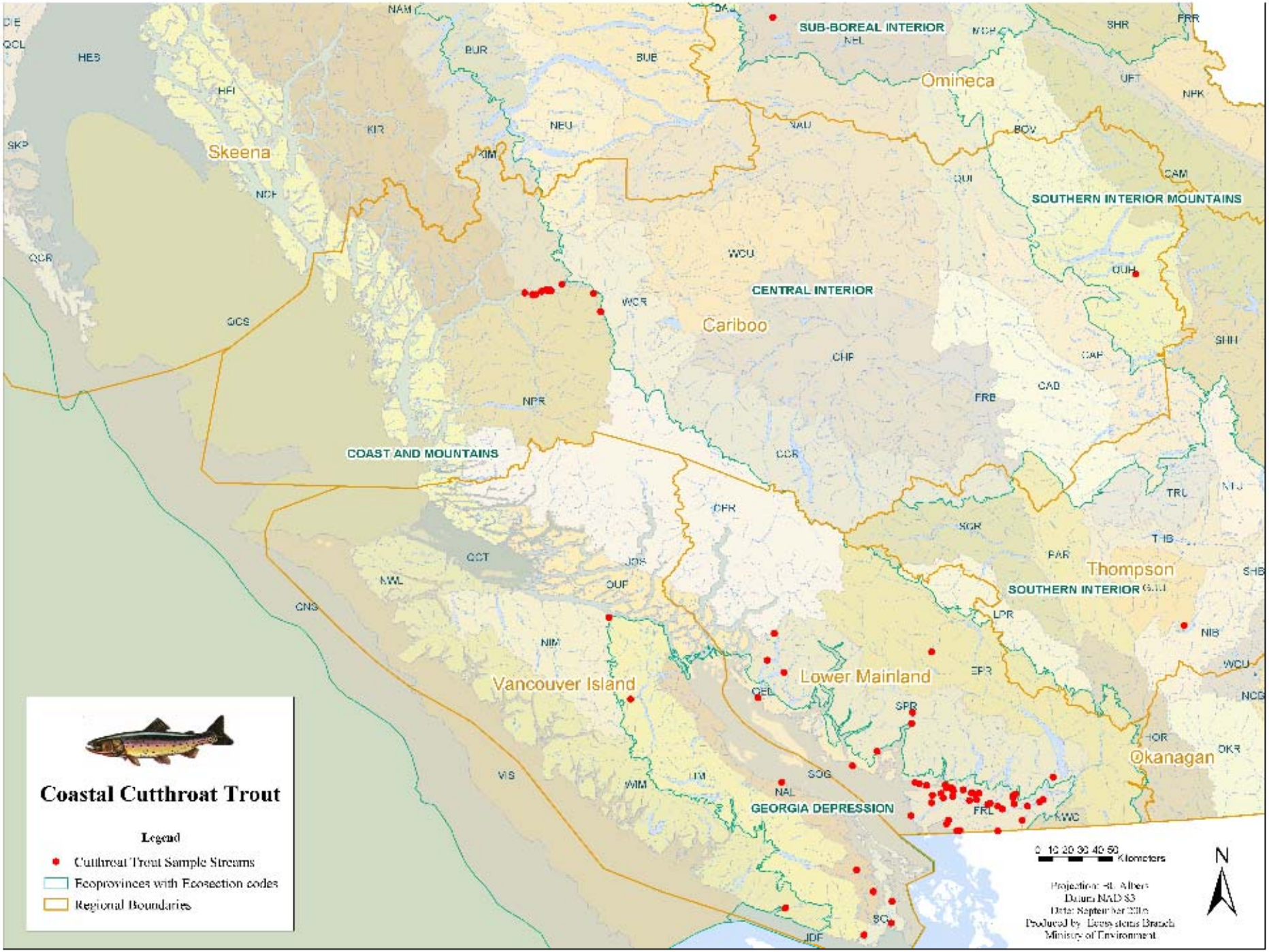
Nested Hierarchy and Strata

- **EcoProvince -** an area with consistent climate or oceanography, relief, and plate tectonics
- **EcoRegion -** an area with major physiographic and minor macroclimatic or oceanographic variation
- **EcoSection -** an area with minor physiographic and macroclimatic or oceanographic variation





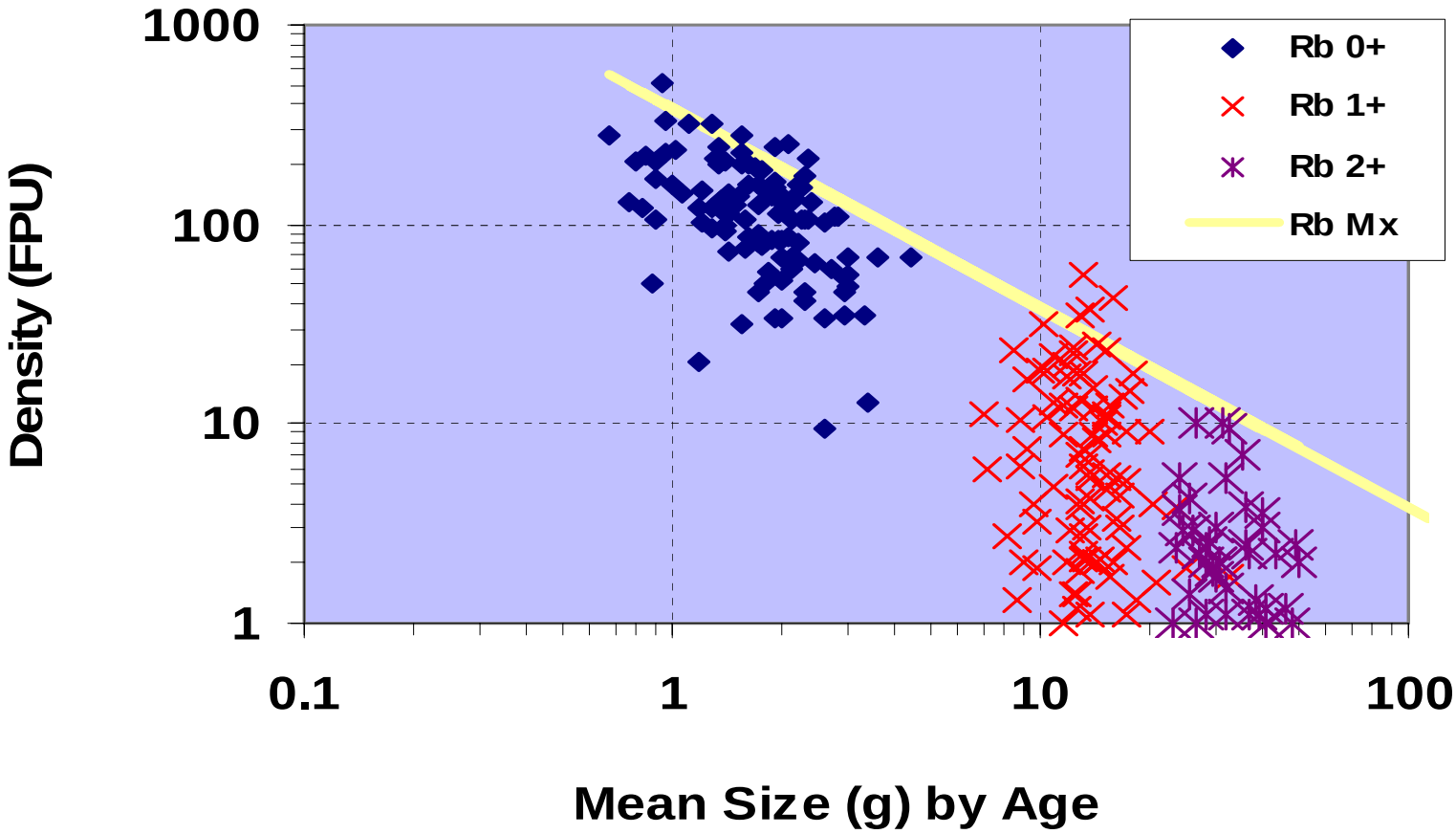

Plains
Boreal
Mountains
Boreal
Plains
Fort St John
Dawson Creek
Sub-Boreal
Interior
Stewart
Mackenzie
Smithers
Prince Rupert
Kitimat
Prince George
Queen Charlotte
Quesnel
Southern
Interior
Coast
and
Mountains
Ocean Falls
Central
Interior
Williams Lake
Revelstoke
Northeast
Pacific
Kamloops
Vernon
Mountains
Port Hardy
Southern
Interior
Kelowna
Kimberley
Nelson
Cranbrook
Penticton
Trail
Georgia
Depression
Port Alberni
Victoria


Coastal Cutthroat Trout
Legend
Cutthroat Trout Sample Streams
Ecoprovinces with Ecosection codes
Regional Boundaries
Skeena
Omineca
Cariboo
Thompson
Okanagan
Lower Mainland
Vancouver Island
SUB-BOREAL INTERIOR
SOUTHERN INTERIOR MOUNTAINS
CENTRAL INTERIOR
COAST AND MOUNTAINS
SOUTHERN INTERIOR
GEORGIA DEPRESSION
0 10 20 30 40 50 Kilometers
N
Projection: BC Albers
Datum: NAD 83
Date: September 2010
Produced by: Ecosystems Branch
Ministry of Environment

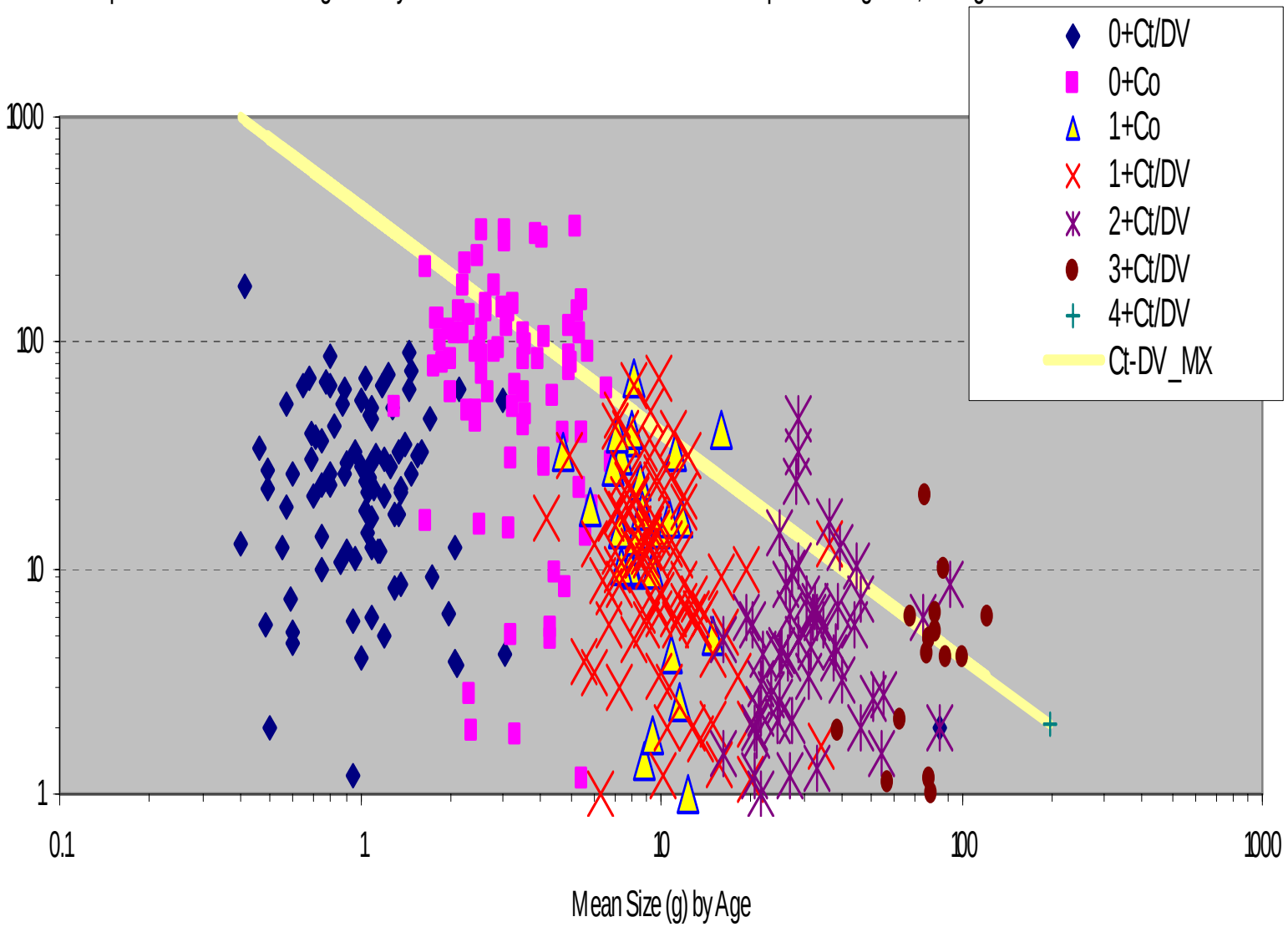
Administrative Region	Streams	EF	N
Vancouver Island	88	1266	3035
Lower Mainland (Vancouver)	85	962	2533
Cariboo-Skeena	37	832	2557
ALL	210	3060	8125

EF = #electrofished sites; N = #x,y co-ordinates in Allen Plots

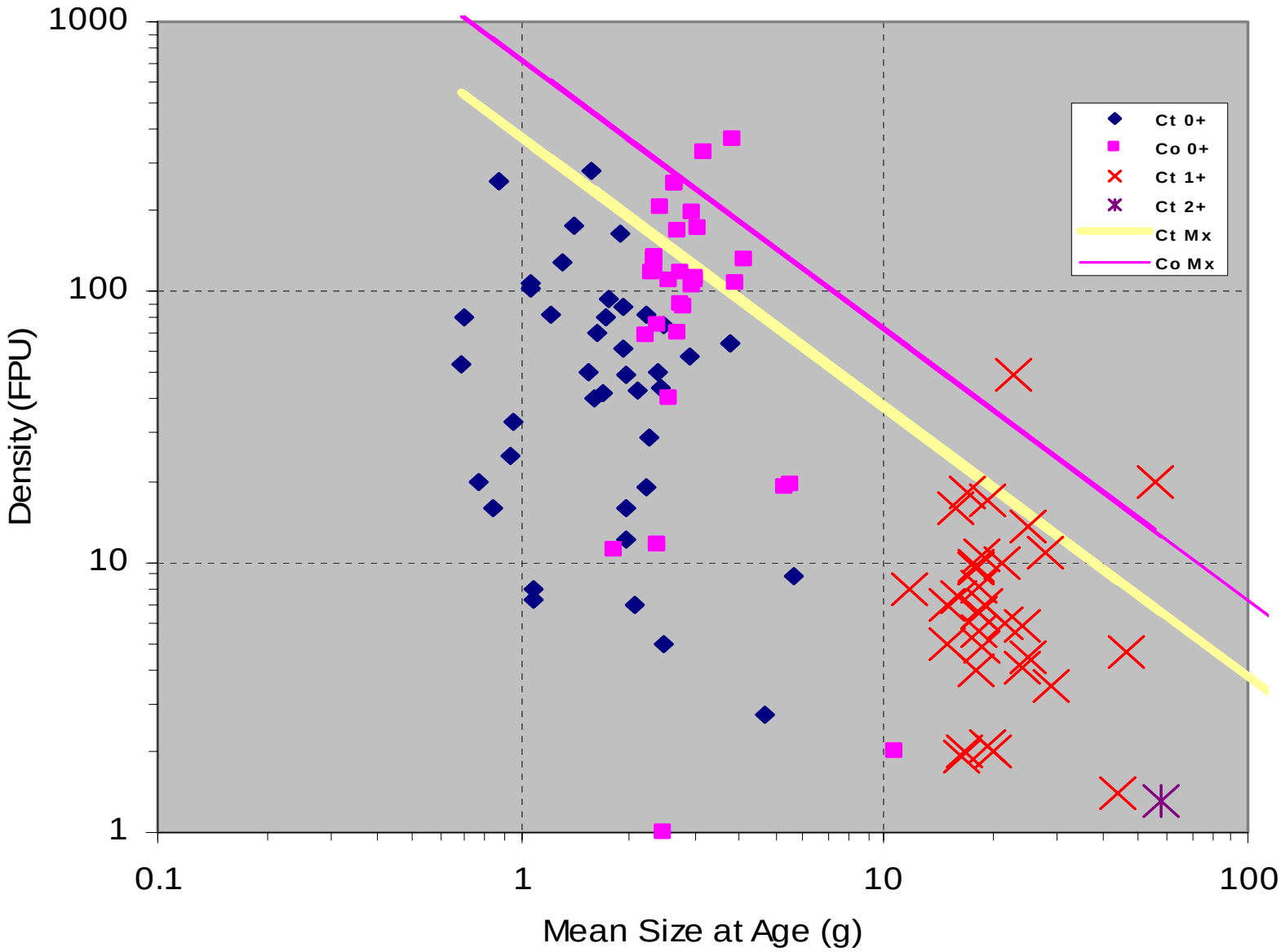
Scatterplot of fish density-size (biomass) (1983-95) observed in the lower Chilliwack River (below Slesse Creek; 113 sites). Rb biomass envelope = 380 g/Unit and is at the 95th Percentile



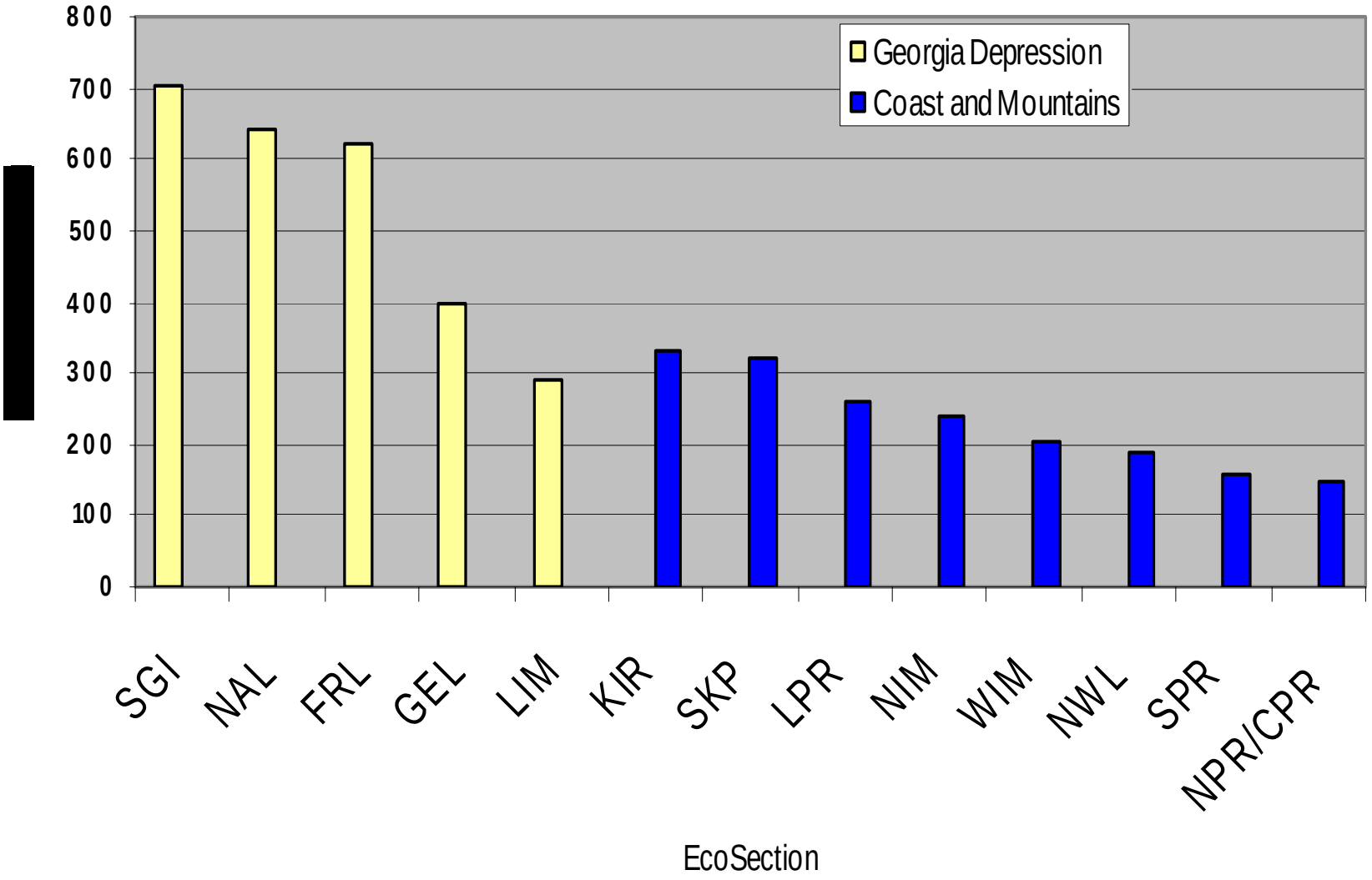
Scatterplot of observed fish density by Species-Size-Age in small tributaries to the Bella Coola River (1993-2004) during September electrofishing surveys. Reference Ct/DV biomass envelope = 400 g/Unit; 800 g/Unit for Coho



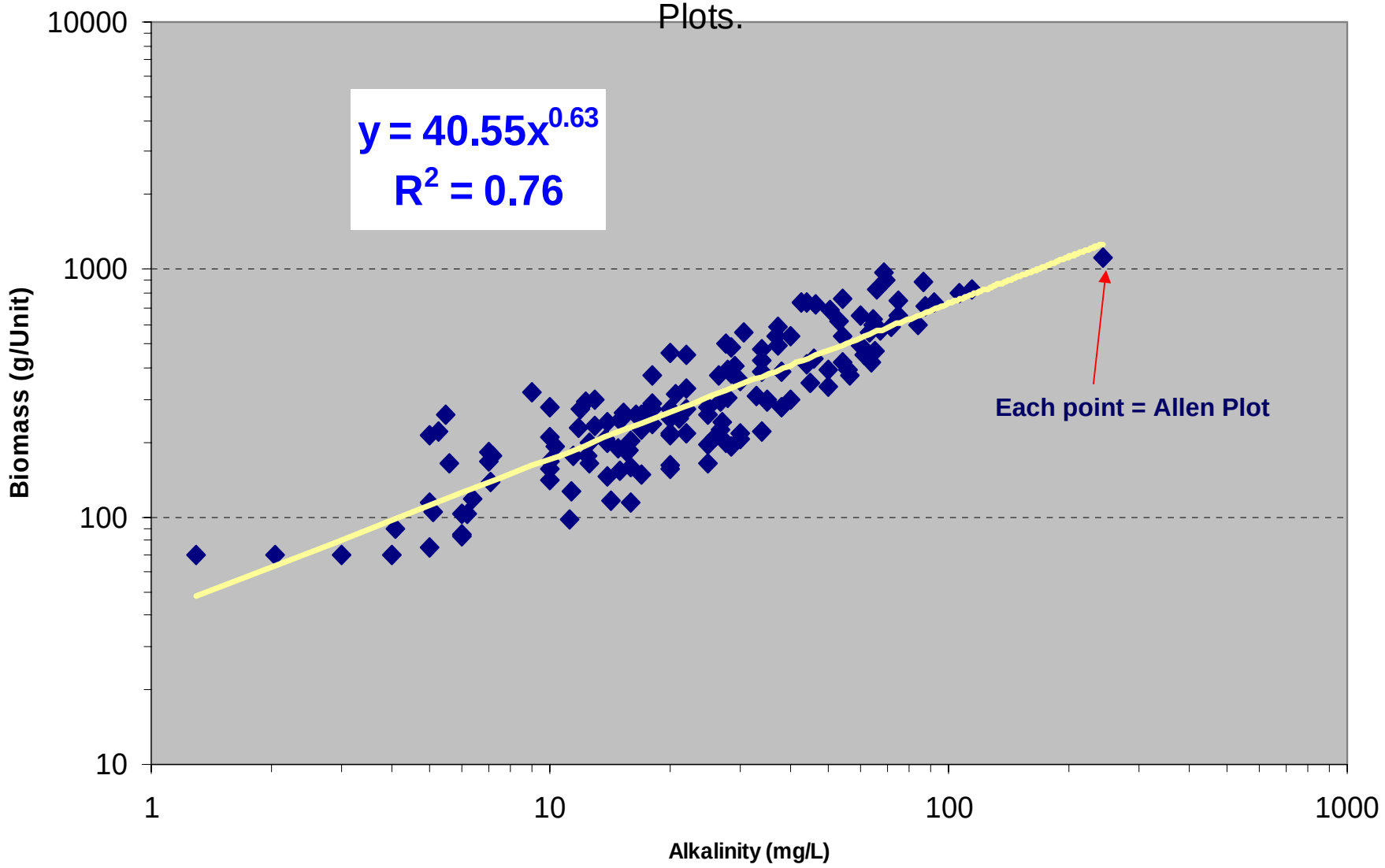
Scatterplot of local fish density-size (biomass) in Colquitz River in late summer. Ct biomass envelope = 376 g/Unit and coho biomass = 727 g/Unit.



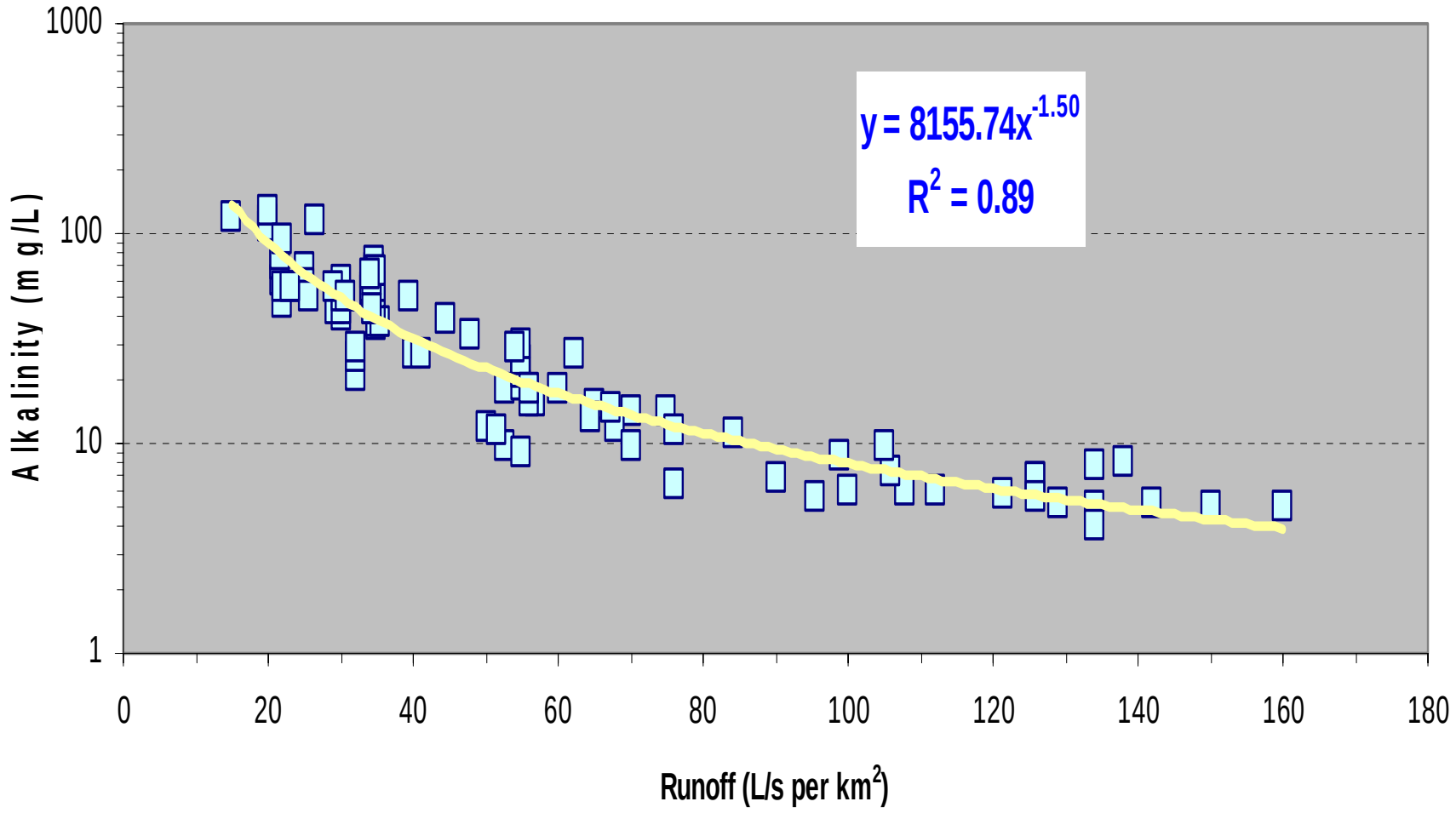
Average maximum CCT biomass per Age by EcoSection and EcoProvince



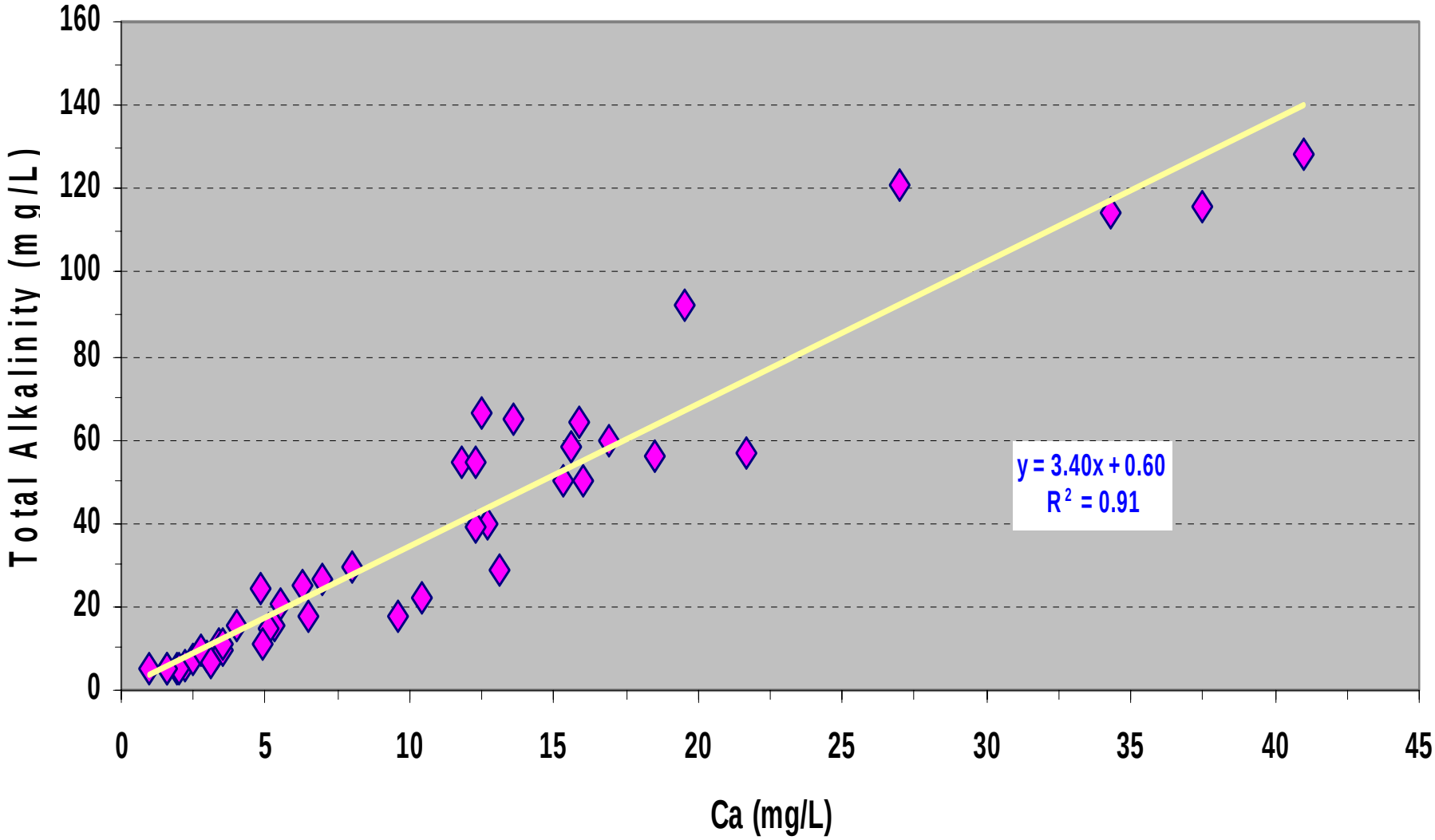
Scatterplot and trend of Trout-char Biomass with Alkalinity for BC streams. Biomass = 95th percentile value per Age or Size Class from various Allen Plots.



Scatterplot and trend of Annual Unit Runoff and summer baseflow Total Alkalinity in Region 2.



Scatterplot and trend for dissolved Calcium and Total Alkalinity for streams in Region 2.



Biomass Model (B.C.)

Power Fit: y=ax^b

Coefficient Data:

a = 42.2

b = 0.63

Model from Fitting Dataset

Power Fit: $y=ax^b$

Standard Error: 105.59

Correlation Coefficient: 0.872

Comments:

The fit converged to a tolerance of 1e-006 in 4 iterations. Regression weighted by x.

Results

- Maximum Ct density decreases with increased size or Age along a hyperbolic curve (slope = -1). Not -0.74
- Ct biomass is naturally high in the Georgia Depression and very high in some ecosections (Fraser Lowlands, South Gulf Islands, Nanaimo LL).
- Ct+DV biomass is also very high in lower Bella Coola tributaries in the presence of large pink salmon numbers and despite low alkalinity and conductivity.
- Ct biomass is generally low in most of the C&M EcoProvince dependent on hydrogeology, etc.
- Ct biomass as a rule is ½ that of coho per case.
- Biomass was lower in flow stressed streams.
- Max Density by Age (FPU) = Biomass/(Size)

Why alkalinity?

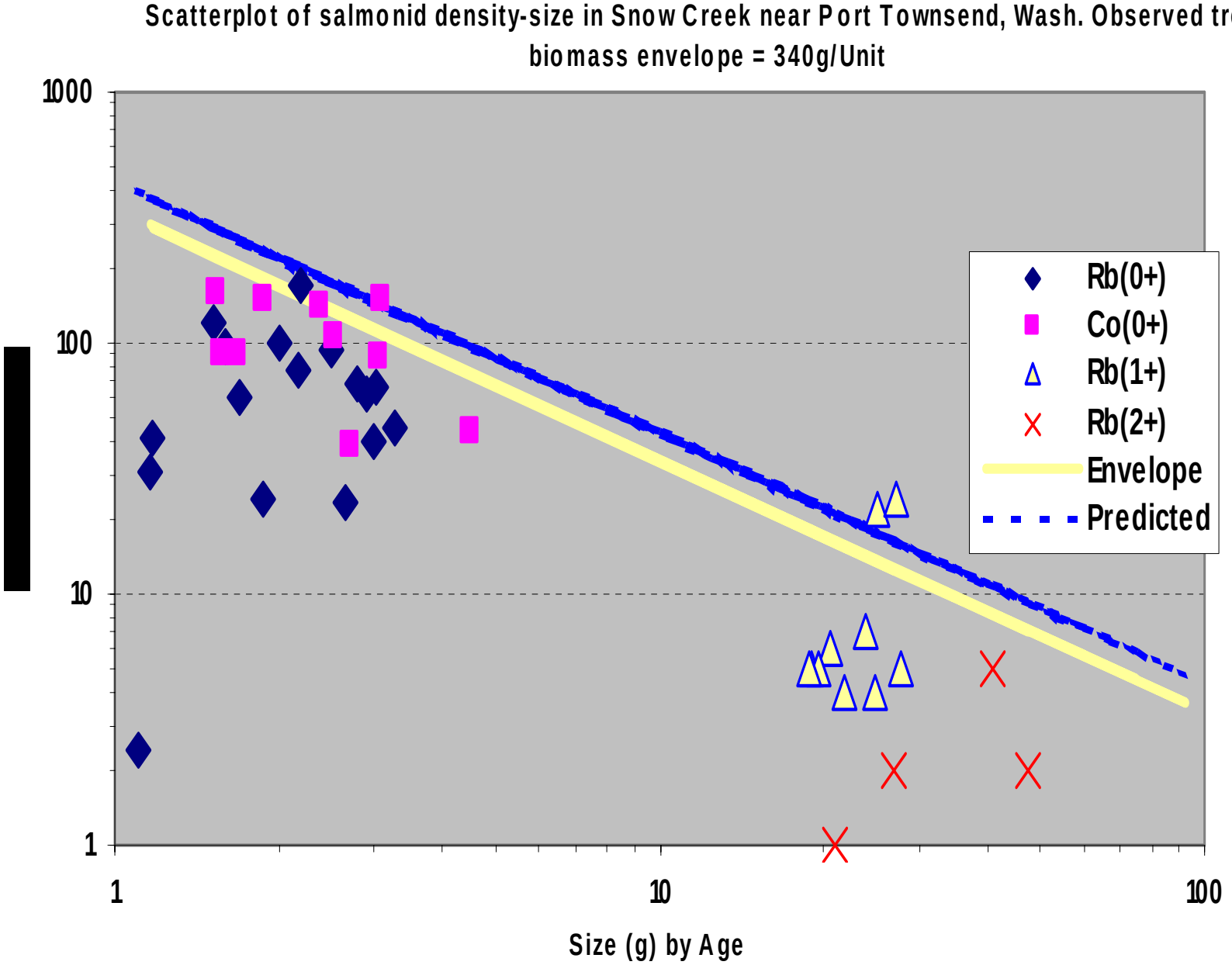
- Previous relationship with benthic invertebrate community density and biomass (food supply).
- Important in primary production in near absence of free CO_2.
- Algae can use bicarbonate ions as a CO_2 source in photosynthesis.

Model Validation

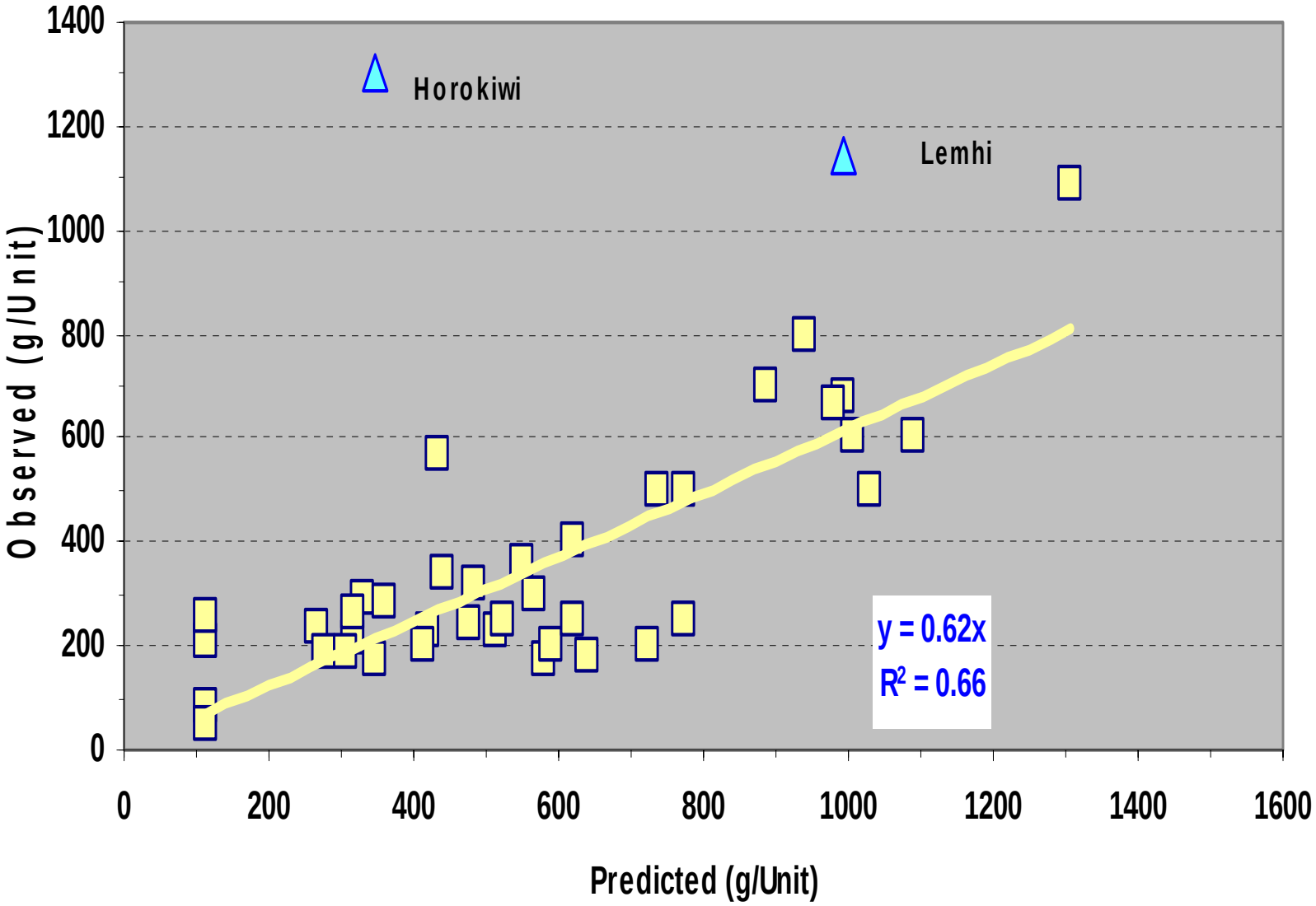
- Biomass envelopes determined from 48 cases or Allen Plots
- Few cases with meso-habitat scale.
- Density-size data did include segment or reach average values, so densities would be expected to be less than at the meso-habitat level; k = 0.62.
- A few cases of unusually high biomass.

Some local USA cases

- Snow Creek
- Andrews Creek
- Penny Creek
- Salmon Creek
- McDonald Cr.
- Siebert Cr.
- Jimmycomelately Cr.
- Gobar Creek
- Summers Creek
- Fish Creek
- South Casper
- S. Fork Yager
- Bummer L. Cr.
- Nooning Creek


Scatterplot of salmonid density-size in Snow Creek near Port Townsend, Wash. Observed trout biomass envelope = 340g/Unit
1000
100
10
1
1
10
100
Size (g) by Age
Rb(0+)
Co(0+)
Rb(1+)
Rb(2+)
Envelope
Predicted

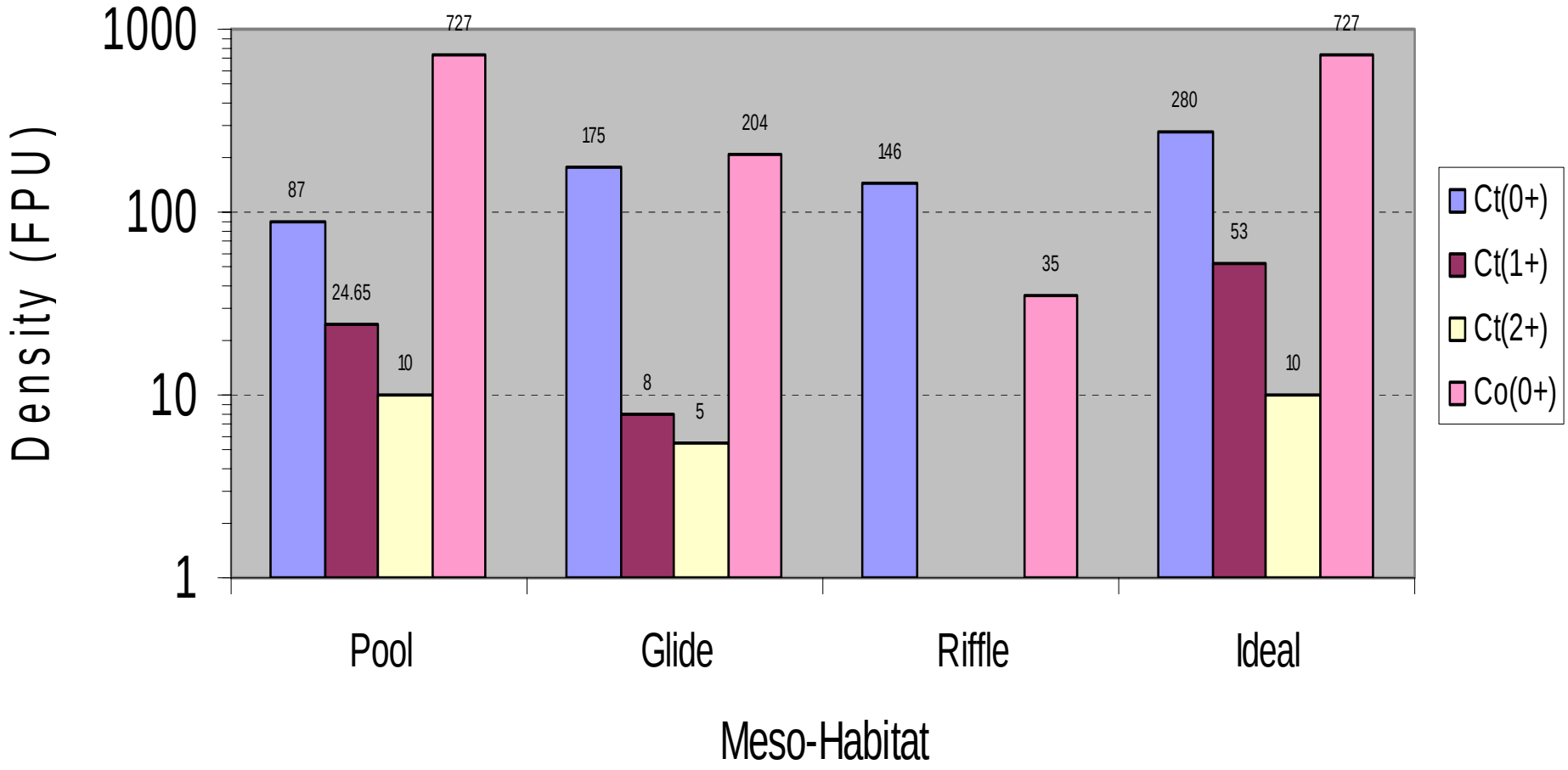
Scatterplot and trend of observed trout-char biomass versus predicted biomass using the density-size model on a "validation dataset" of 39 cases.



Conclusions

- Place or EcoRegion does matter. Ecosystems vary broadly in B.C. Unit runoff varies 0.3-160 L/s/km^2.
- Basic water chemistry and runoff can be used to predict biomass.
- Biomass models (power equations) per admin area were comparable. General validation applies.
- CCT parr density benchmarks will vary according to both place and meso-habitat (see following slide).
- CCT biomass can be inferred from coho biomass.
- CCT biomass will greatly exceed expectations in enriched streams (natural or otherwise).

Mean density of juvenile salmonids per species-age in Nathan Creek by Habitat Class. CCT biomass = 563 g/Unit per Age




sage
GRAPHITE III GFL 4100-3 RPLB


OR


WESTCOTT® Flexible Stainless Steel Ruler