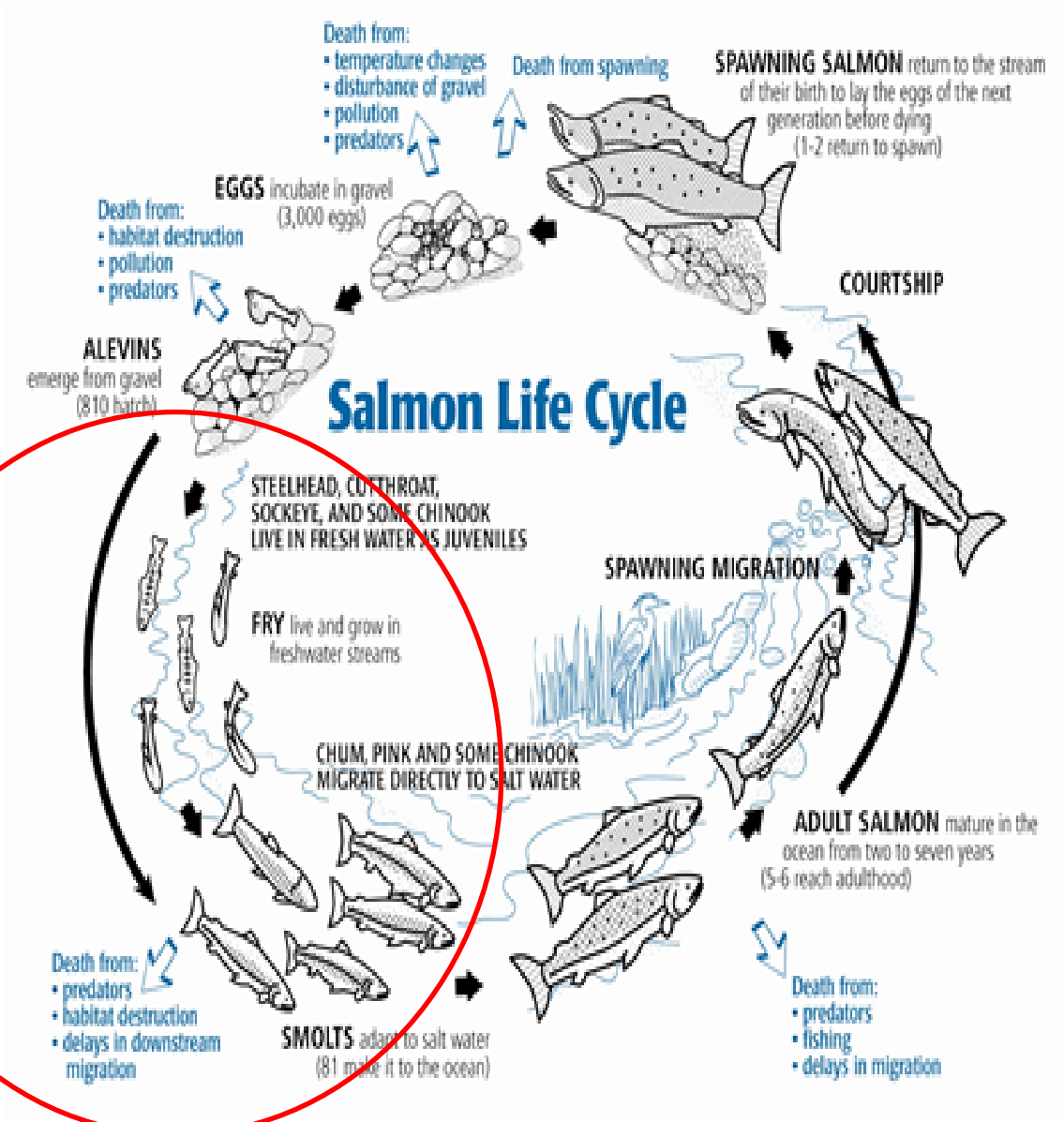
Colquitz River Habitat Improvement Experiment

Documenting the response of juvenile sea-run CCT to simple cover elements in an urbanized watershed---rocks and sticks

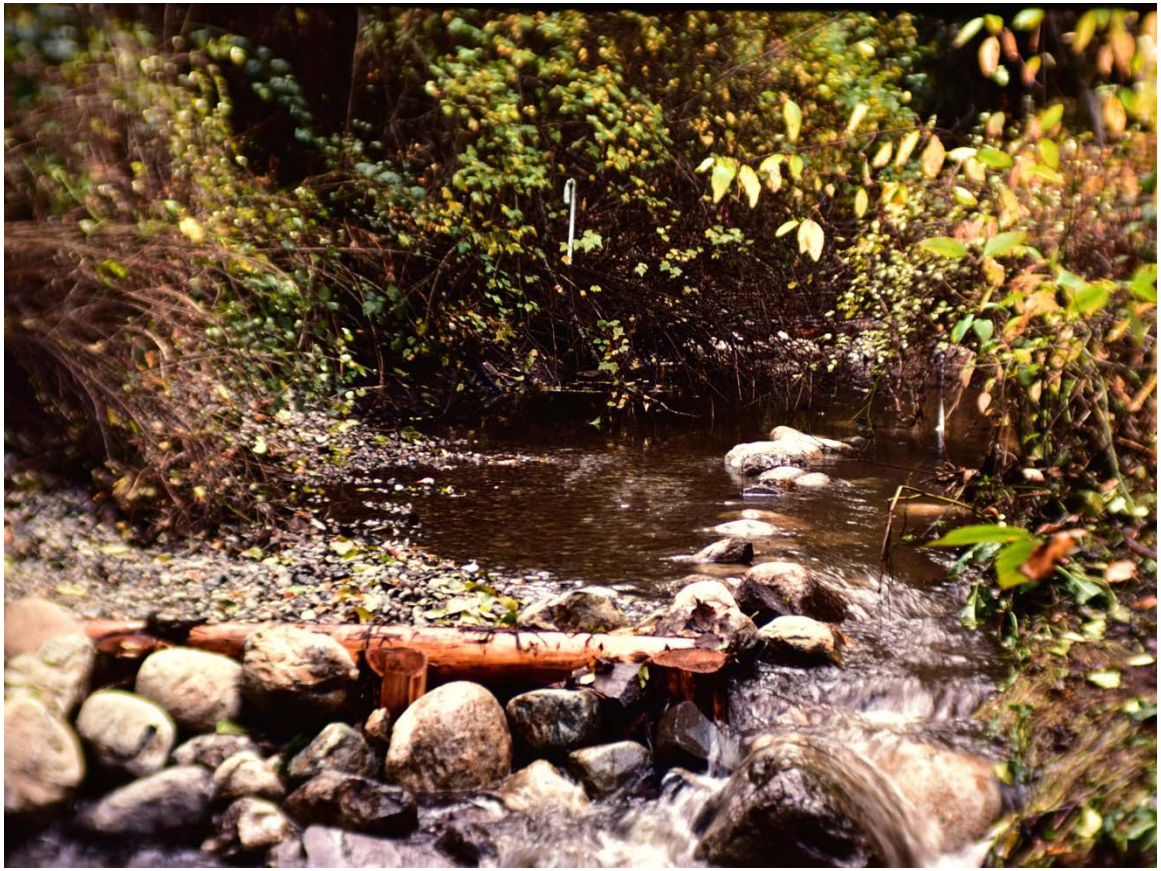
The Question

- Is juvenile (pre-smolt) CCT biomass or number independent of “cover” or habitat complexity and how is this manifest in anadromous smolt production?
- The research reach is located in the following slide within the red circle
- The experiment’s timely answers rely in part with controlled fry recruitment (stocking plus gravel platforms)


Death from:
• temperature changes
• disturbance of gravel
• pollution
• predators
Death from spawning
SPAWNING SALMON return to the stream of their birth to lay the eggs of the next generation before dying (1-2 return to spawn)
EGGS incubate in gravel (3,000 eggs)
Death from:
• habitat destruction
• pollution
• predators
COURTSHIP
ALEVINS
emerge from gravel (810 hatch)
Salmon Life Cycle
STEELHEAD, CUTTHROAT, SOCKEYE, AND SOME CHINOOK LIVE IN FRESH WATER AS JUVENILES
SPAWNING MIGRATION
FRY live and grow in freshwater streams
CHUM, PINK AND SOME CHINOOK MIGRATE DIRECTLY TO SALT WATER
ADULT SALMON mature in the ocean from two to seven years (5-6 reach adulthood)
Death from:
• predators
• habitat destruction
• delays in downstream migration
SMOLTS adapt to salt water (81 make it to the ocean)
Death from:
• predators
• fishing
• delays in migration

Experimental design

- Creation of 4 treatments (control, boulder, rootwad, and boulder-rootwad) in a ditch-like channel in 1977
- Treatments randomized in Research Reach
- 3 replicates per treatment each measured 50 m length with 20 m buffers between
- Reference to external controls with higher quality riparian, rooted banks and in-channel habitat diversity
- September 1978 and June 1979 total removal surveys (coho fry, juvenile CCT) and differential marking by treatment
- Recovery of marked members (fin removals) as smolts at a counting fence



Reverse Gravel Platform

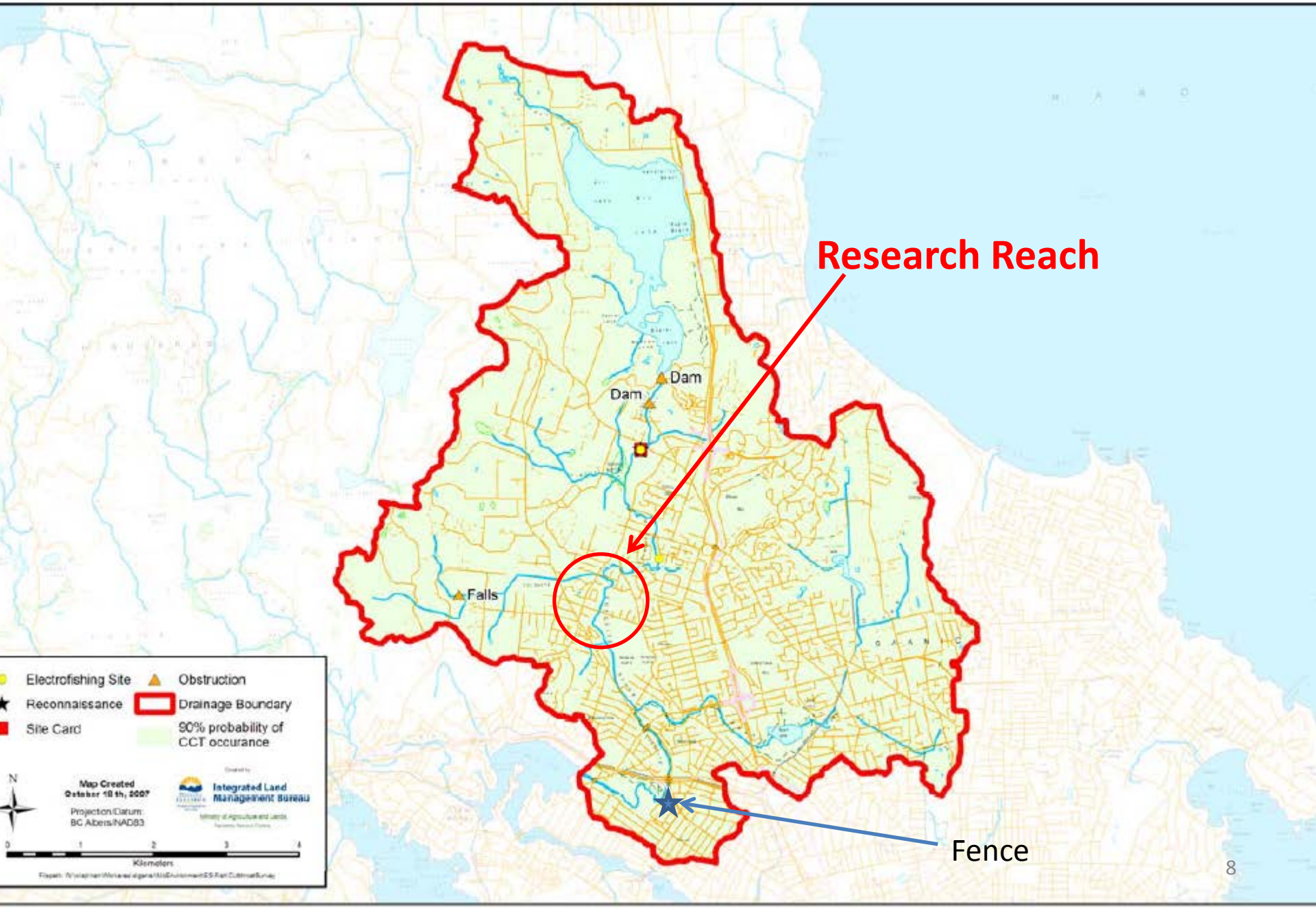
Simple device emulating the preferred habitat (pool tail-out) of cutthroat trout and coho salmon. This was a hedge bet to ensure natural fry recruitment within the research reach of Colquitz River. Managers and supervisors wanted quick answers without excuses.

Brood collection for upwelling gravel incubator

Statistical Tests

- Analysis of Covariance using thalweg depth or velocity to account for hydraulic differences among replicates and treatments ($p<0.05$) for fry and parr
- Comparing proportions- Chi-square (x^2) tests to evaluate fry-smolt survival and smolt yield differences among treatments ($p<0.05$)

Anadromous Coastal Cutthroat Trout Assessment
Colquitz Creek

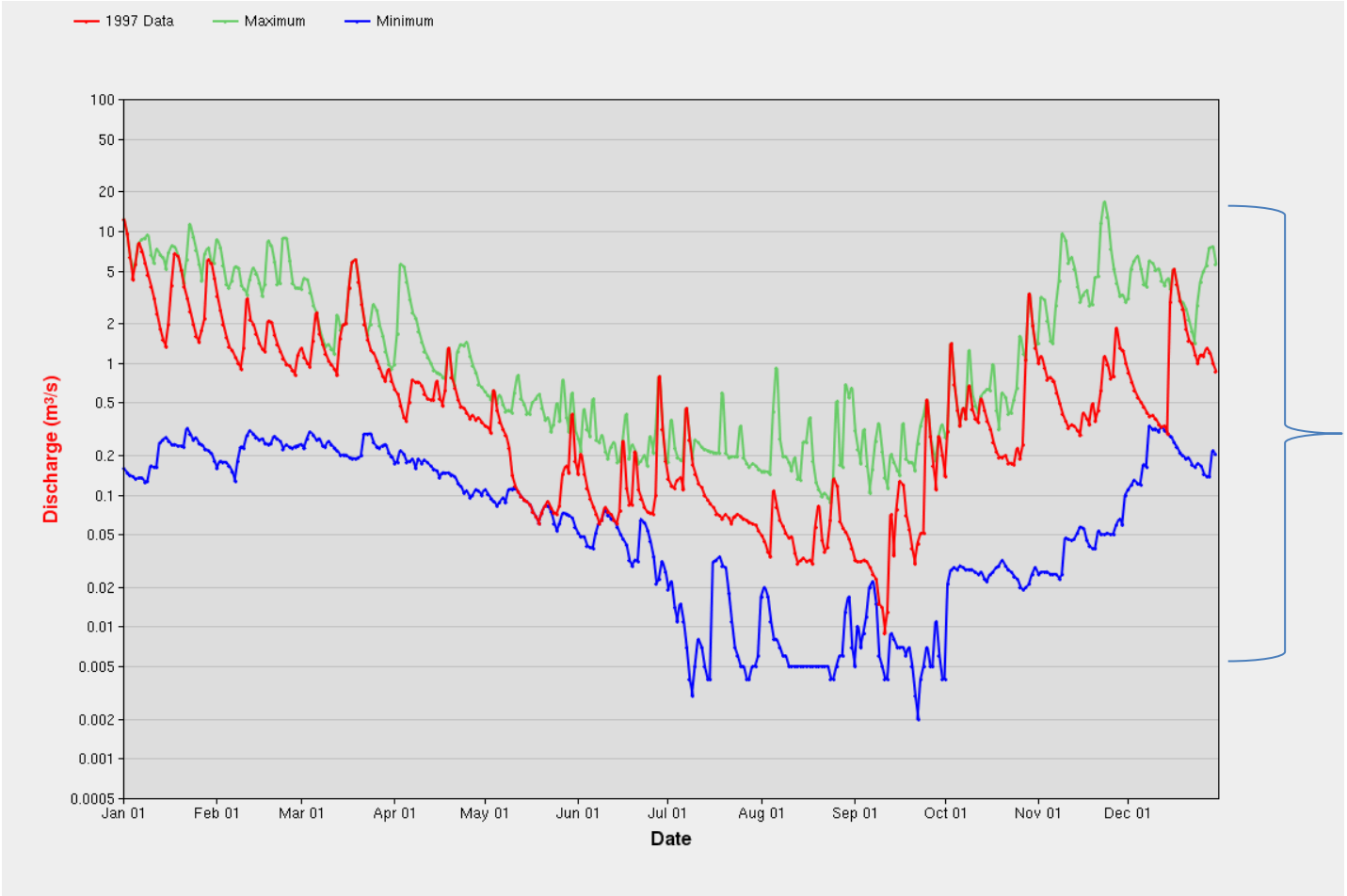


Headwaters of Colquitz River looking East

Hydrologic Character

- COLQUITZ RIVER AT VIOLET AVENUE (08HA047); 1 of 2 discontinued stations
- Drainage Area = 47 km^2 at Station 08HA047
- Summer baseflows regulated through controlled flow releases from Elk-Beaver Lakes in headwaters; limited groundwater influence
- Long-term mean annual discharge (LT mad) = 605 L/s or 21 cfs
- Annual unit runoff = 13 L/s per km^2 or 407 mm/yr which is fairly “dry”
- Period of record: 1981-1999
- 2 yr recurrence 30-day summer baseflow or CPSF = 44 L/s or 7%LT mad
- 30-day drought flow as low as 10 L/s or 2%LT mad; daily min = 2 L/s
- Summer CPSF in wet year as high as 84 L/s or 14%LT mad
- Peak winter flows as high as 17100 L/s or 28•LT mad; major source of fish mortality in simplified channels with limited off-channel habitats
- Flashy flow response typical of urbanized watersheds

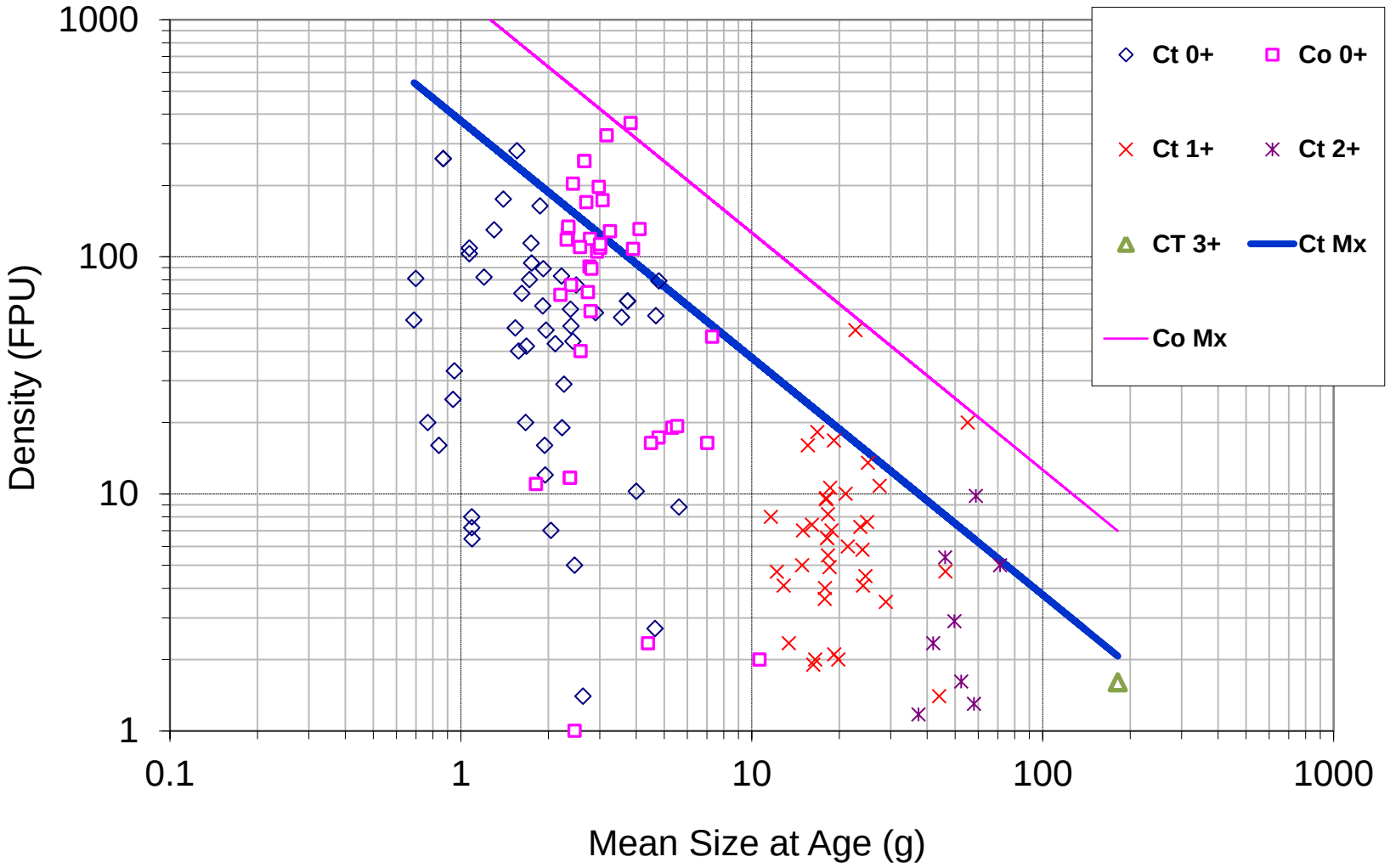
1997 Annual hydrograph; LT mad = 605 L/s; Log_{10} scale flows in cms



Productivity Profile

- Baseflow water chemistry infers moderate salmonid biomass potential; habitat, flow, and recruitment limited
- Specific Conductance = 164 µS/cm
- Total Alkalinity = 57 mg/L
- Nitrate Nitrogen = 30 µg/L
- Ortho Phosphorus = 14 µg/L
- Non-filterable Residue = 8 mg/L
- Upper limit for 2 g CCT (0+) of 188 FPU or ~2 fry/m^2
- Upper limit for 20 g CCT (1+) of 19 FPU
- Upper limit for 50 g CCT (2+) of 7.5 FPU

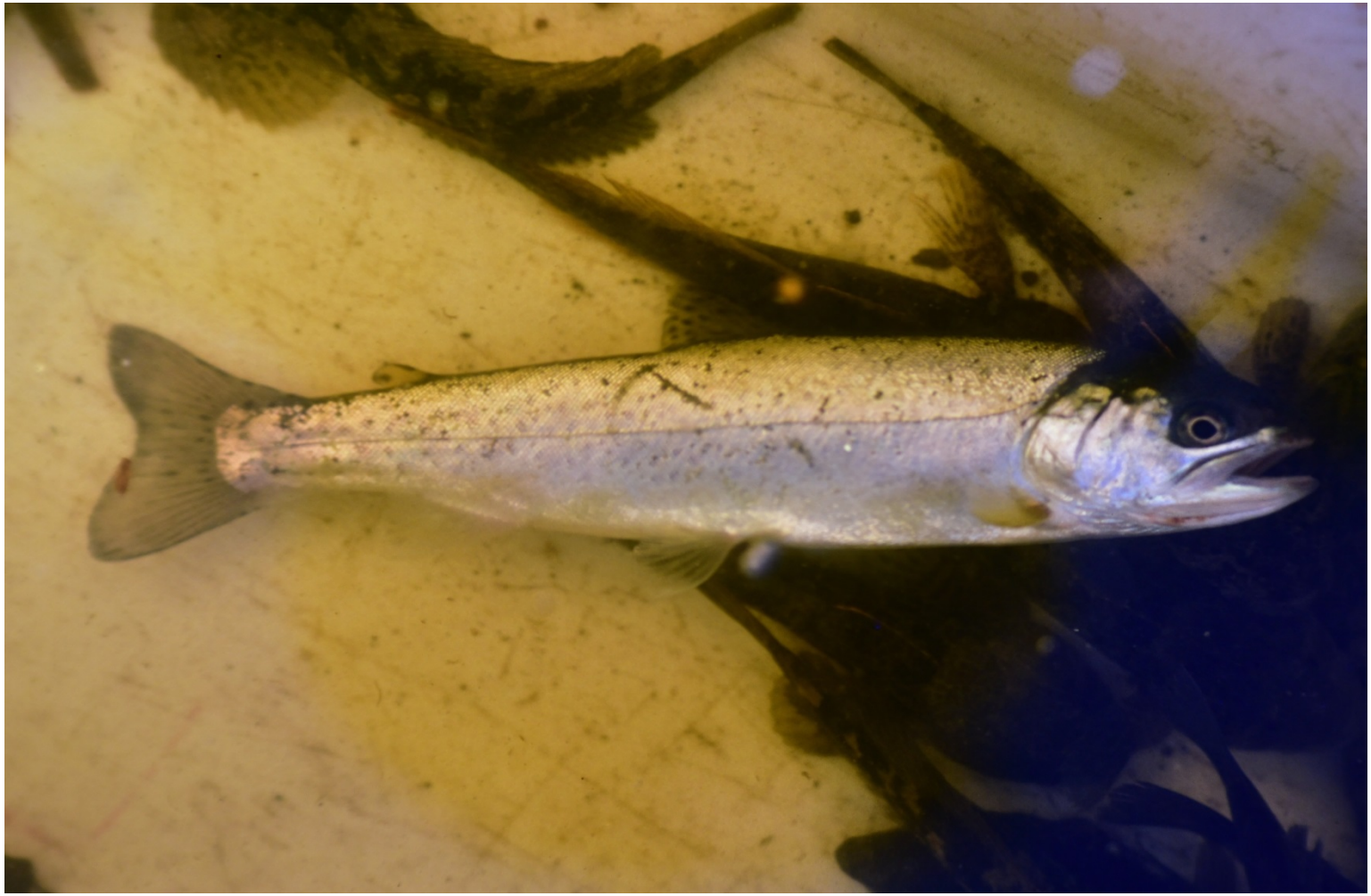
Scatterplot of local fish density-size (biomass) in Colquitz River in summer observed at meso-habitat scale. Ct biomass envelope = 375 g/Unit per Age and coho biomass = 1264 g/Unit. FPU is fish individuals per 100m² "Unit"



Invertebrate Drift Sampler

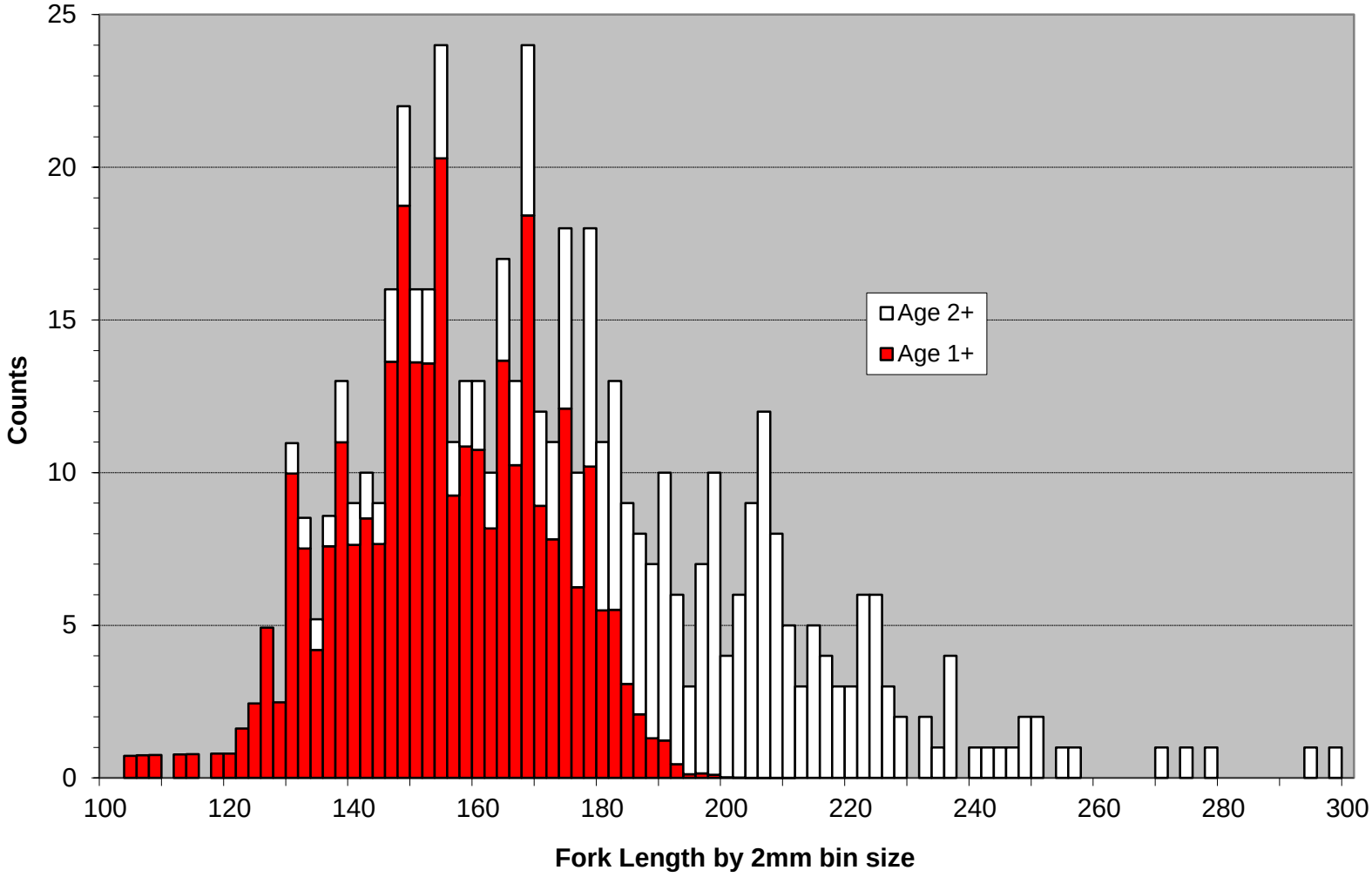
One of the study elements includes testing whether increased substrate surface improves food supply and affects fish abundance

Coastal cutthroat trout smolt from the Colquitz Fish Fence near Victoria; sculpins in background



Mixed catch during April-June at the counting fence near tidewater

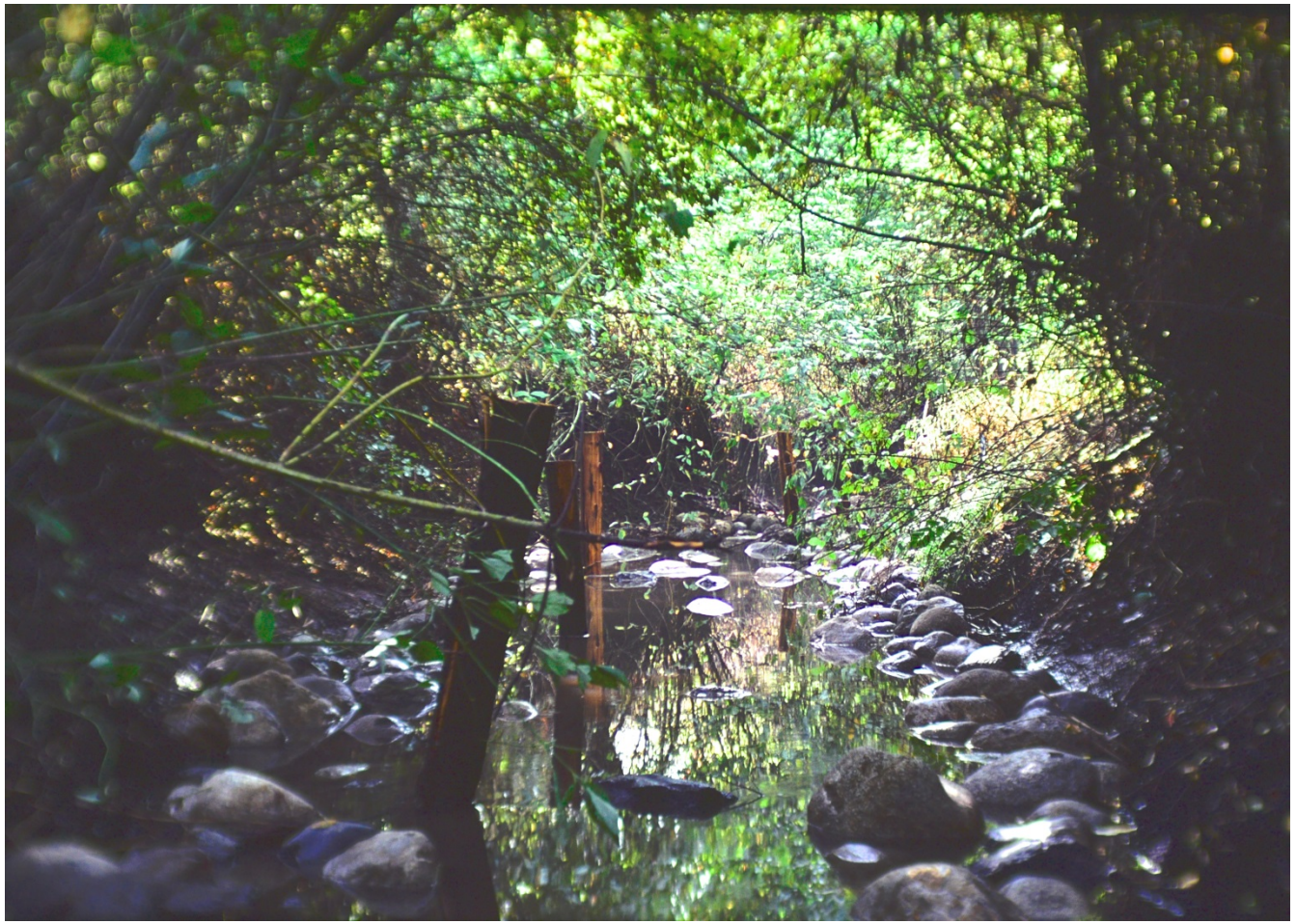
Bimodal Length frequency distribution and age of 546 CCT smolts captured in Spring 1976--Colquitz River counting fence.



General channel condition

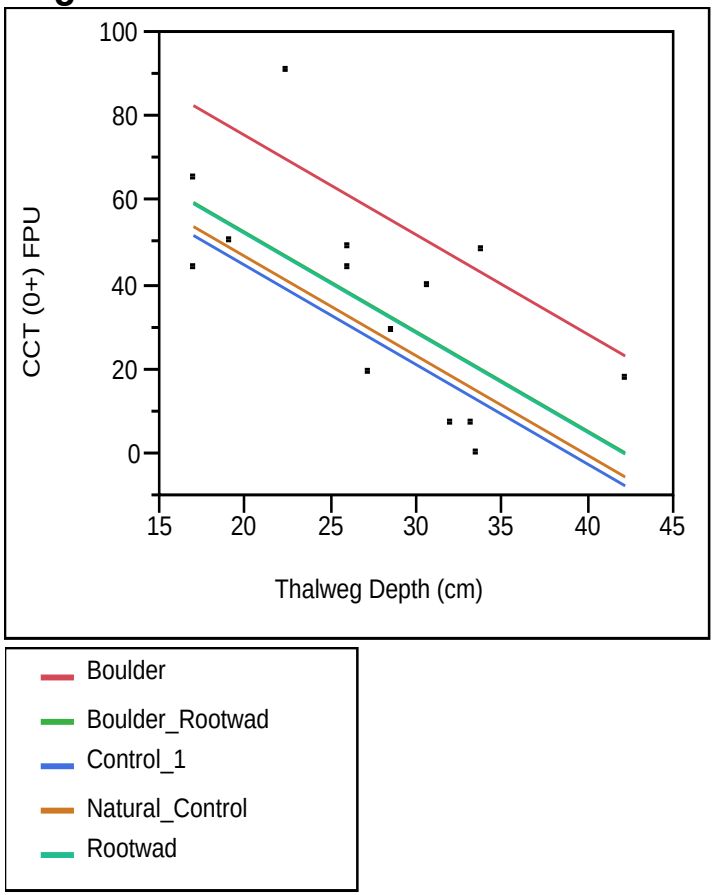
Pre-treatment “Simple” Channel

Nearly complete Boulder+Rootwad Treatment under extremely low flows



Manual cover additions

Response CCT (0+) FPU_1978
Whole Model
Regression Plot



No improvement in summer carrying capacity for CCT fry in 1978 after removing thalweg depth as a factor

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
Treatment	4	4	1747.7904	1.1529	0.3987
Thalweg Depth (cm)	1	1	3366.6831	8.8831	0.0176*

Level		Least Sq Mean
Boulder	A	57.128870
Boulder_Rootwad	A	34.137677
Rootwad	A	33.834389
Natural_Control	A	28.401189
Control_1	A	26.298271

Levels not connected by same letter are significantly different.

Thalweg Depth (cm)

Comparing proportions of CCT (0+) counts by treatment in Colquitz River in June 1979 under higher stream flows and velocities

Test Probabilities

Level	Estim Prob	Hypoth Prob
Boulder	0.32874	0.23000
Boulder/Rootwad	0.28391	0.26000
Control	0.15747	0.23000
Rootwad	0.22989	0.28000

Test	ChiSquare	DF	Prob>Chisq
Likelihood Ratio	65.0752	3	<.0001*
Pearson	66.4900	3	<.0001*

Indication that higher stream flows allowed a larger expression of CCT fry abundance in 1979 since the estimated probabilities >>hypothetical probabilities. This applies to all treatments except for the control. The mechanism is likely through higher food delivery.

Boulder Treatment produced more CCT smolts (>119 mmFL)

Treatment	Species	Area (m2)	Actual proportion	Dead	Alive	Total	Proportion Alive
Control	Cutthroat	353.3	0.246	72	3	75	0.04
Rootwad	Cutthroat	367.9	0.256	71	2	73	0.03
Boulder/Rootwad	Cutthroat	343.1	0.239	111	6	117	0.05
Boulder	Cutthroat	373.7	0.260	155	44	199	0.22
	Sum	1438					

Curious that Boulders alone did better than Boulders+Rootwads??

Chi-square test for CCT smolt differences

Test Probabilities

Level	Estim Prob	Hypoth Prob
Boulder	0.80000	0.25000
Boulder/Rootwad	0.10909	0.25000
Control	0.05455	0.25000
Rootwad	0.03636	0.25000

Test	ChiSquare	DF	Prob>Chisq
Likelihood Ratio	75.5598	3	<.0001*
Pearson	89.3636	3	<.0001*

Method:
Fix hypothesized values, rescale omitted

Relative Performance—smolts per km

- Colquitz boulder treatment: 293 fish/km
- Colquitz Creek control (ditch): 20 fish/km
- Coghlin Creek: 369 fish/km
- Stavis Creek (WA): 155 fish/km
- Salmon River (Ft.Langley): 150 fish/km
- EF Lobster Creek (Alsea): 187 fish/km
- Many streams model: 160 fish/km

Learnings and Advice

- Cover additions and impacts on CCT were muted under very low summer flows
- Boulder additions while beneficial may be out of context given boulders do not naturally occur in low stream gradients (<0.2%)
- The Colquitz experiment did not have control over regulated flows in 1978; flows of 3%LT mad occurred.
- Habitat improvement measures (pool frequency) that emulate nature may be more appropriate in small streams

Questions?


Colquitz Habitat Improvement – Coho, Cutthroat
This project is part of the Federal-Provincial Salmonid Enhancement Program (S.E.P.).
S.E.P.'s aim is to double west coast salmon and sea-run trout populations, restoring them to their historic levels, through a variety of techniques which improve habitat and enhance fish populations.
For further information on S.E.P., and how you can get involved write to —
Salmonid Enhancement Program
Fisheries & Marine Service, Canada
1090 West Pender Street
Vancouver, B.C. V6E 2P1
Fisheries and Marine Service
Ministry of Recreation and Conservation