

Local-Habitat, Landscape, and Biotic Factors Associated with the Distribution of Hybridization between Native Westslope Cutthroat Trout and Introduced Rainbow Trout in the Upper Flathead River System

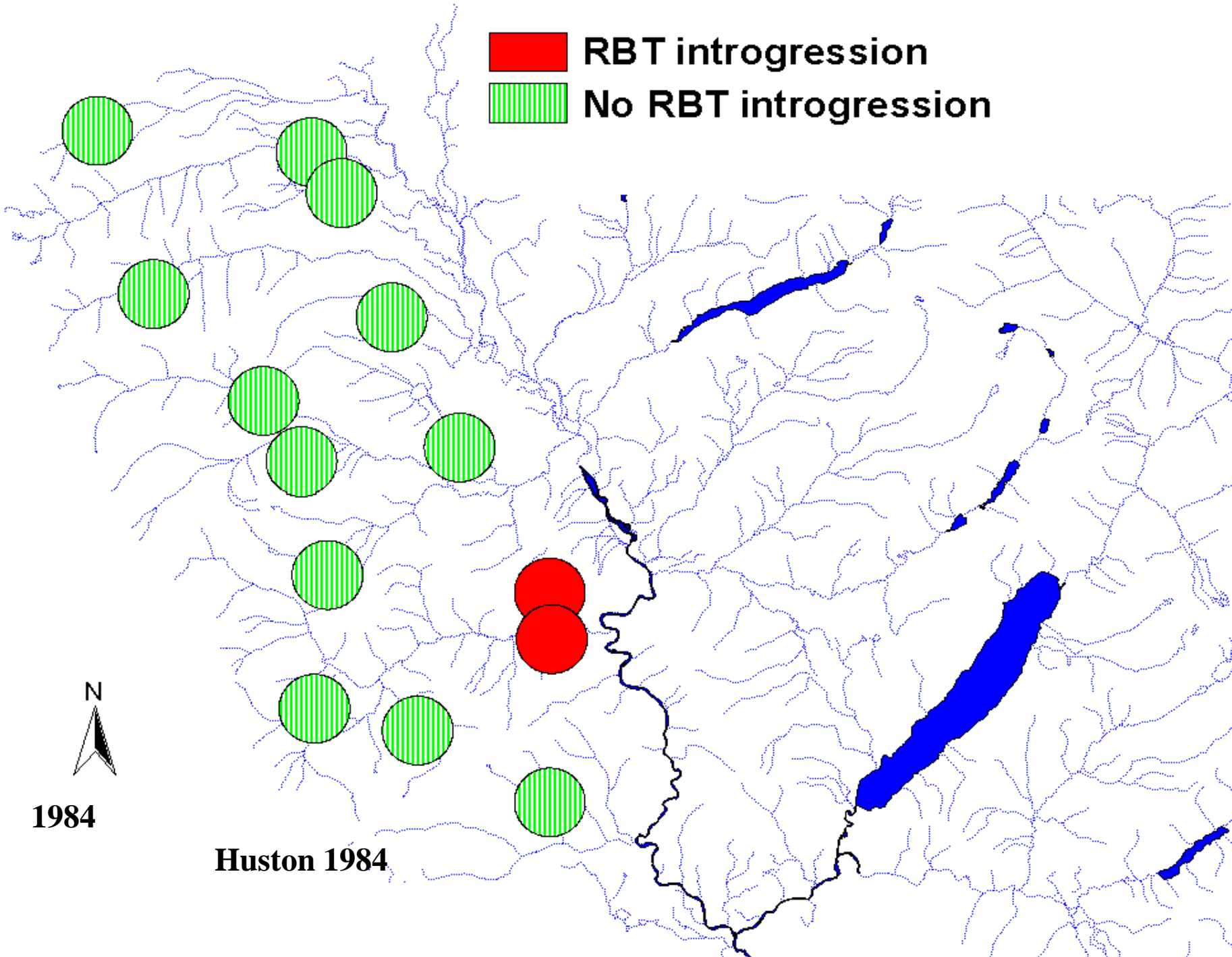
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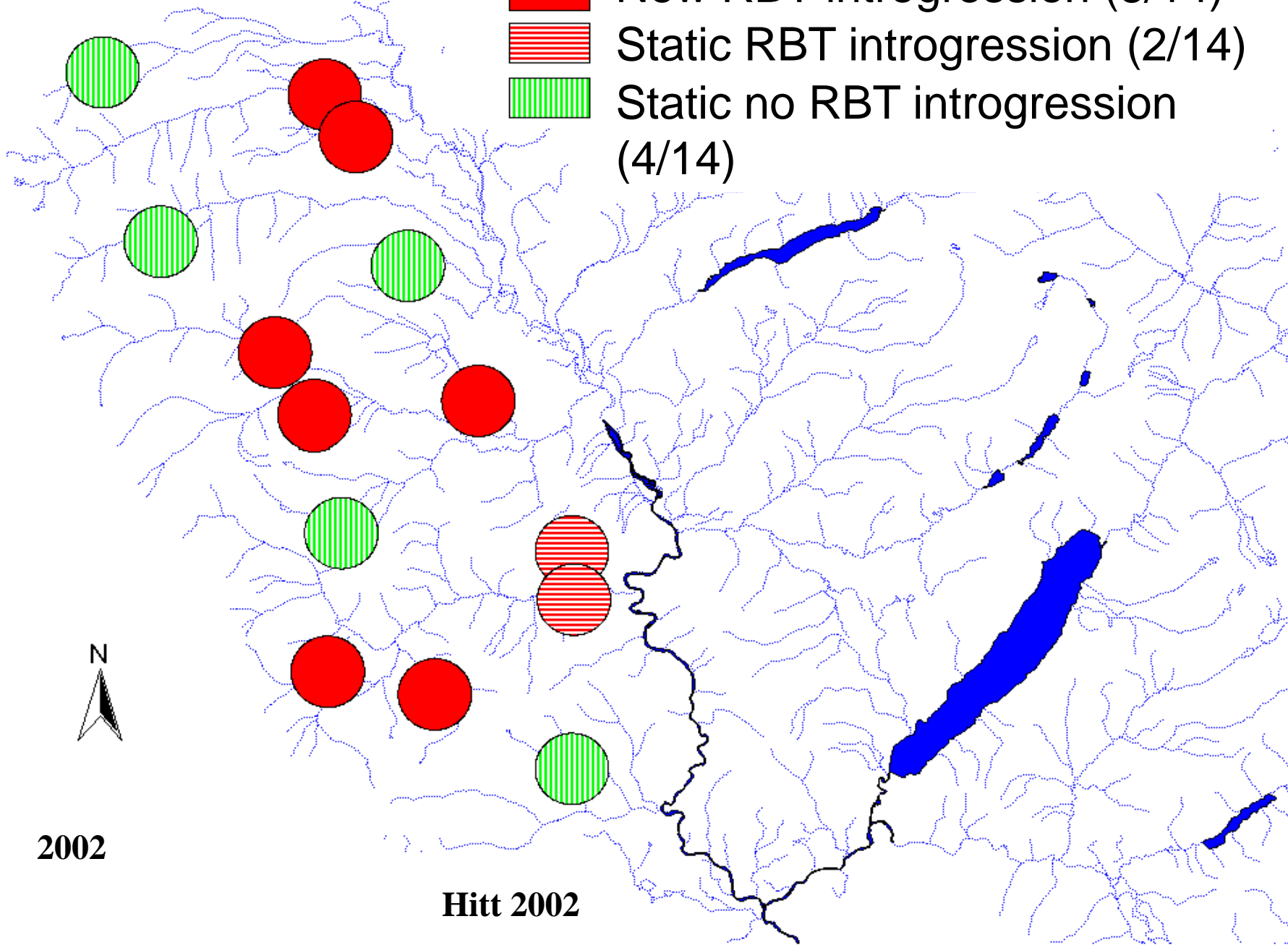
Red square RBT introgression
Green hatched square No RBT introgression



1984

Huston 1984

-  New RBT introgression (8/14)
-  Static RBT introgression (2/14)
-  Static no RBT introgression (4/14)



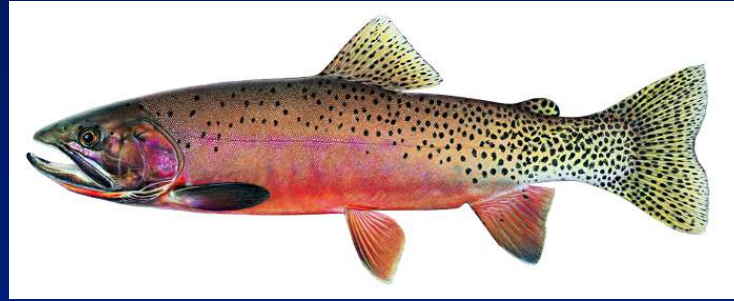
2002

Hitt 2002

Invasion and Hybridization

- ❑ Human-mediated introductions
- ❑ Habitat degradation
- ❑ Local-habitat features
- ❑ Landscape factors





- Hybridization can spread despite severe fitness penalties
- Hybridization between RBT and WCT is widespread despite outbreeding depression (Allendorf and Leary 1988; Leary et al. 1995; Ellstrand and Schierenbeck 2000)

Objectives

Objectives are to:

- (1) Examine the patterns of occurrence of hybridization in relation to local habitat, landscape and biotic characteristics using an information-theoretic approach;
- (2) Assess these factors as related to the degree of RBT introgression, and
- (3) Examine the role of fish abundance in the spread of hybridization.



Hypotheses

Ho: There is no relationship between environmental and demographic factors and

- presence/absence of hybridization
- degree of introgression
- density

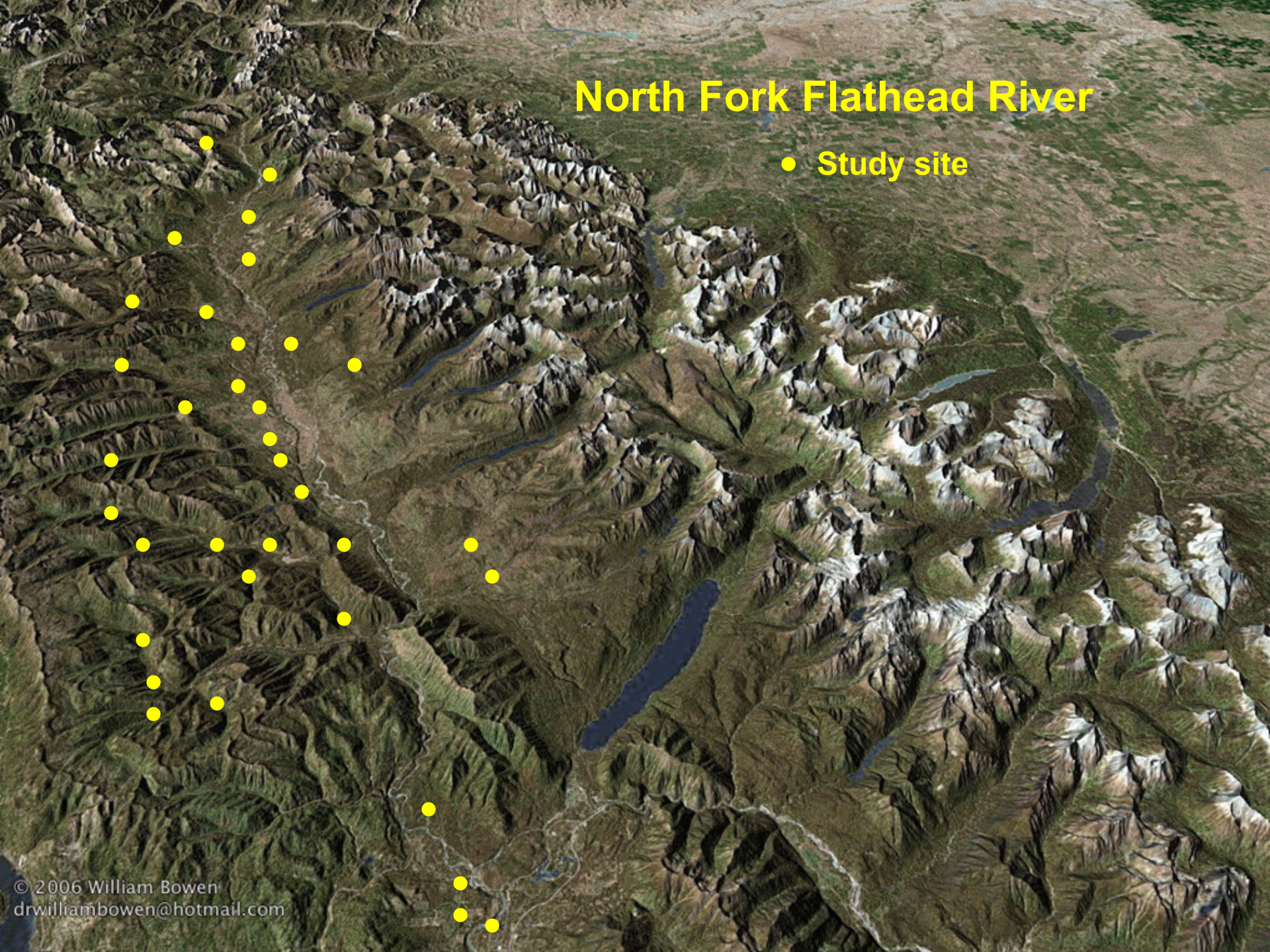


Predictions:

- Hybridization will occur in small low-elevation streams in close proximity to the ultimate source of hybridization, but that cold temperatures and intact habitats in headwater streams may constrain or slow the spread of hybridization.
- RBT admixture will be related to neighborhood effects

North Fork Flathead River

● Study site



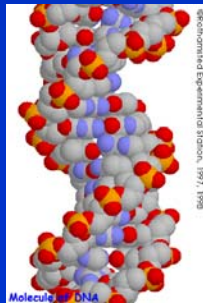
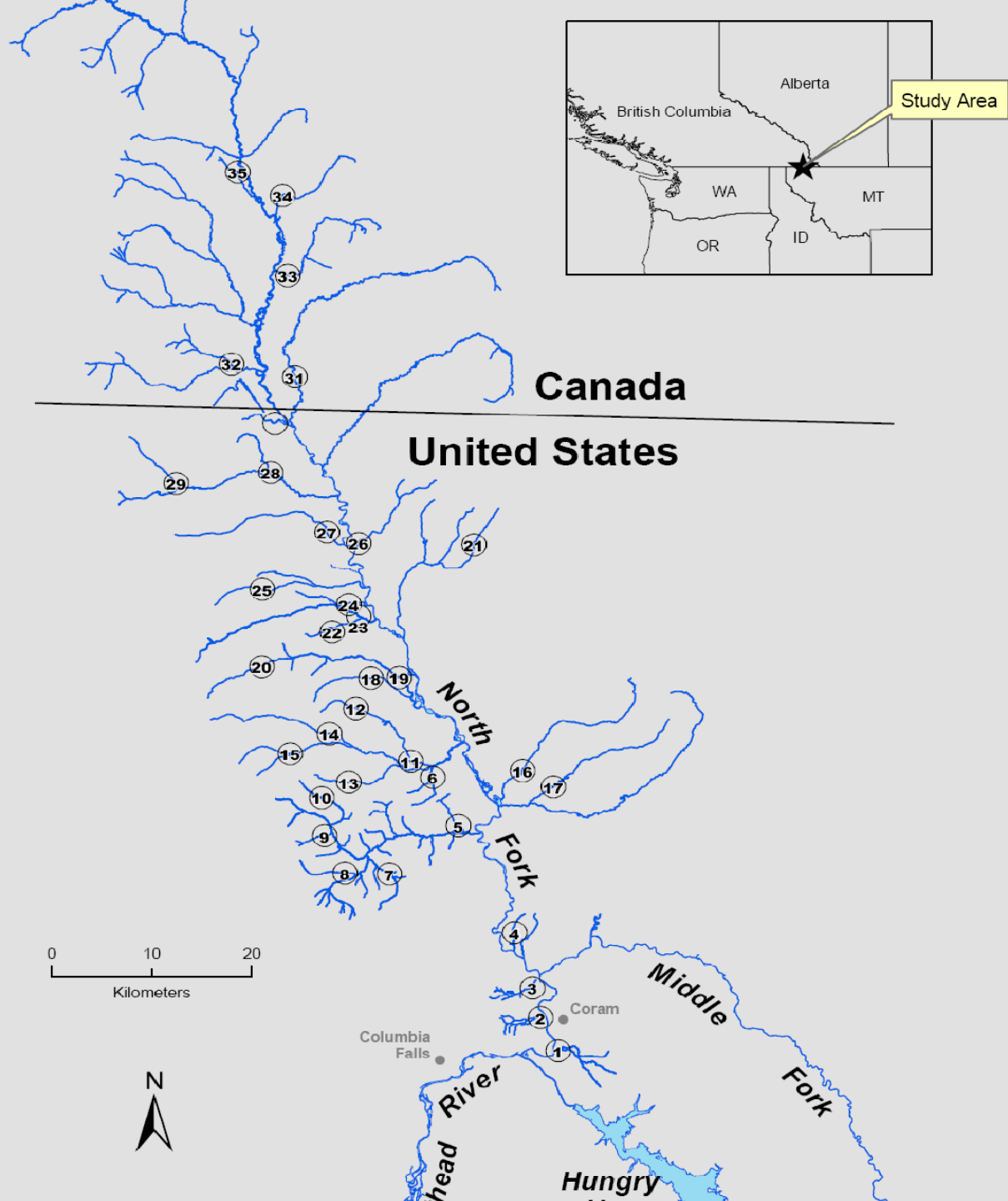
Data collection

Occurrence:

- Sampled 35 sites
- 971 fish (mean per site = 28)
- 7 diagnostic microsatellite loci
- Presence/absence of RBT alleles

Population admixture:

- % RBT alleles among individuals



Methods

Density estimates:

- Same sites as Boyer et al. (2008)
- 150 m reaches
- July-September
- 3-pass depletion
- Fish density
(fish > 75mm/m²)



Methods

Independent variables:

- Local-habitat: width, gradient, elevation
- Landscape: road density, number of road crossings, mean summer temperature, maximum temperature
- Neighborhood/Biotic: fluvial distance from source, abundance

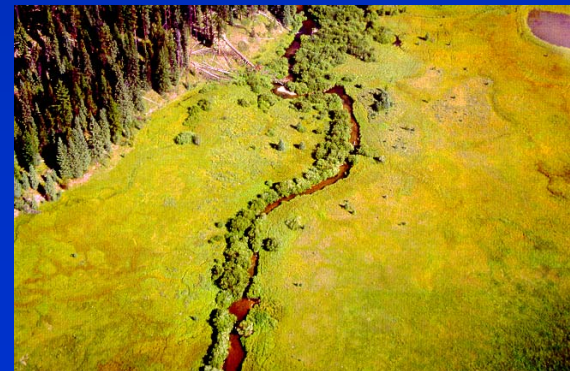
Methods- Regression Analyses

Logistic regression:


- Presence/absence
- Variable selection (Pairwise comparisons, correlations)
- 9 a-priori candidate models
- Model selection: Information-theoretic approach (AICc)


Linear regression:


- %RBT and density- dependents (X)
- Habitat, landscape and biotic characteristics independent variables (X)

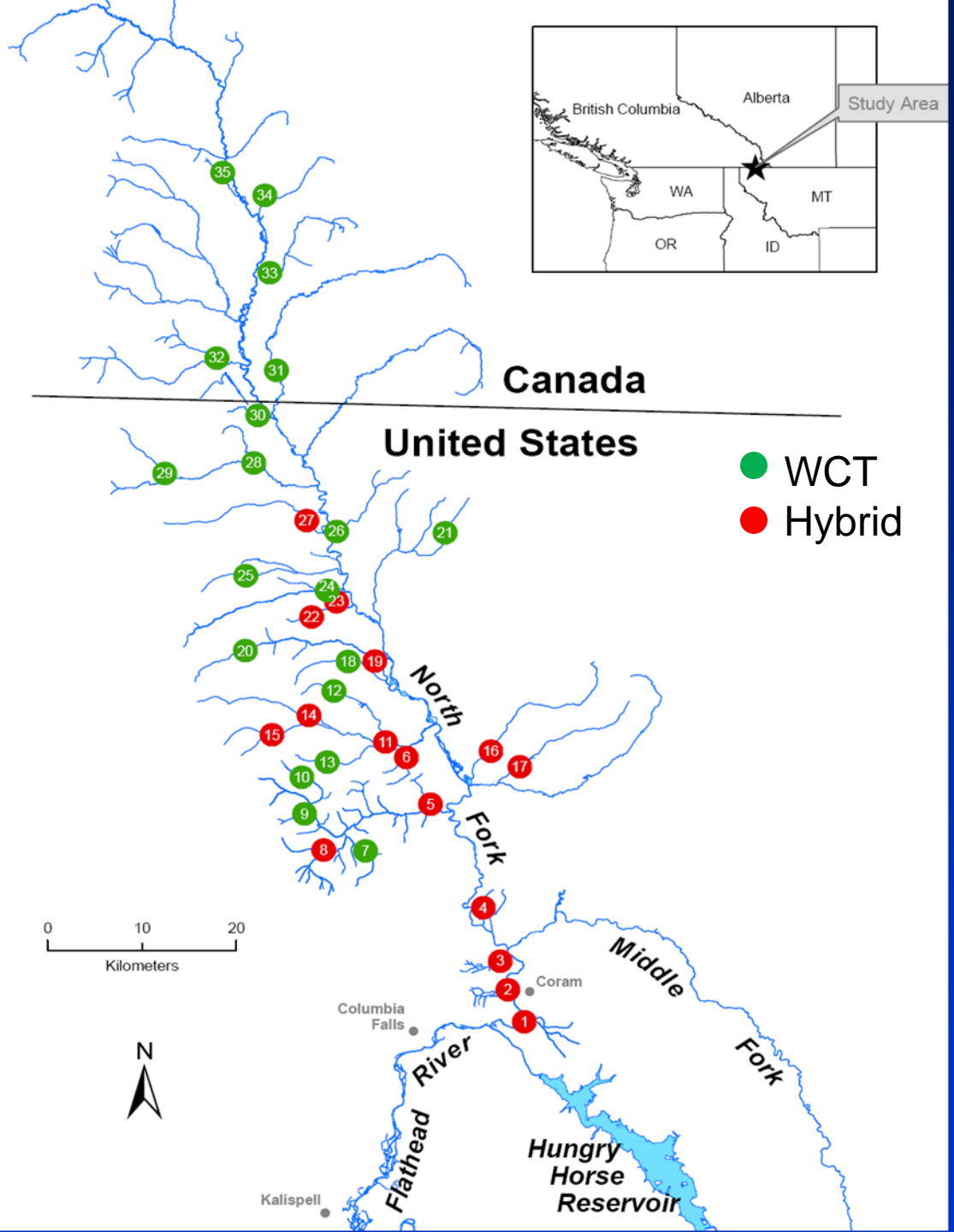


Results

 19 of 35 sites (54%) non-hybridized

 Genotypic gradient: WCT in the headwaters, Hybrids lower

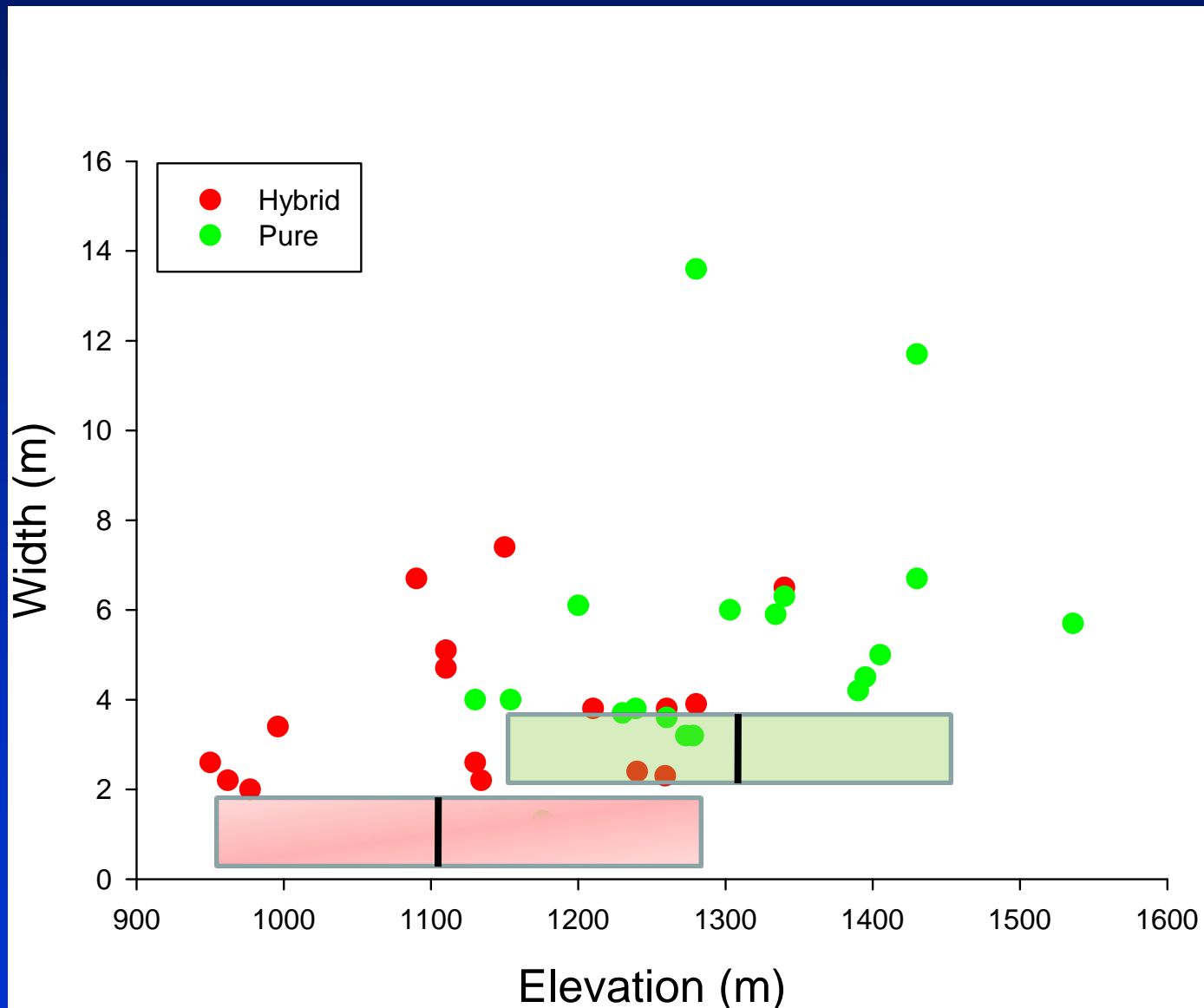
 Hybrids in small, low-elevation streams with warmer and more impacted by human disturbance



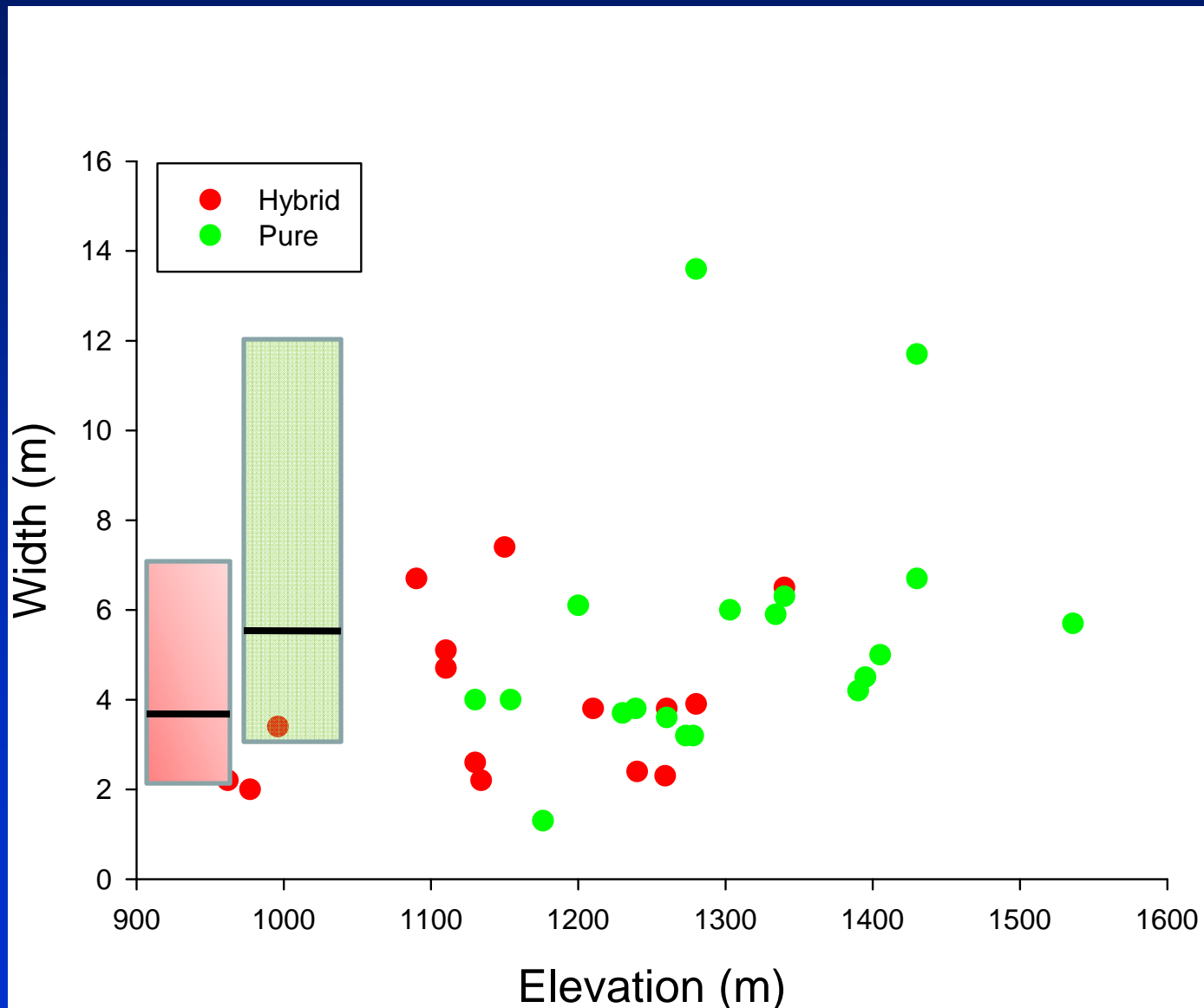
Logistic Regression Models

Model	Number of parameters	$\Delta AICc$	Akaike weight	% correct
Mean temperature, number of crossings, distance	3	0.00	0.4543	88.2
Mean temperature, distance	2	0.72	0.3175	88.2
Width, mean temperature, number of crossings, distance	4	2.06	0.1619	85.3
Width, mean temperature, road crossings	3	4.51	0.0477	82.4
Distance to source	1	7.41	0.0112	71.4
Width, distance	2	8.43	0.0067	68.6
Mean temperature	1	14.14	0.0004	67.6
Mean temperature, road crossings	2	15.16	0.0002	70.6

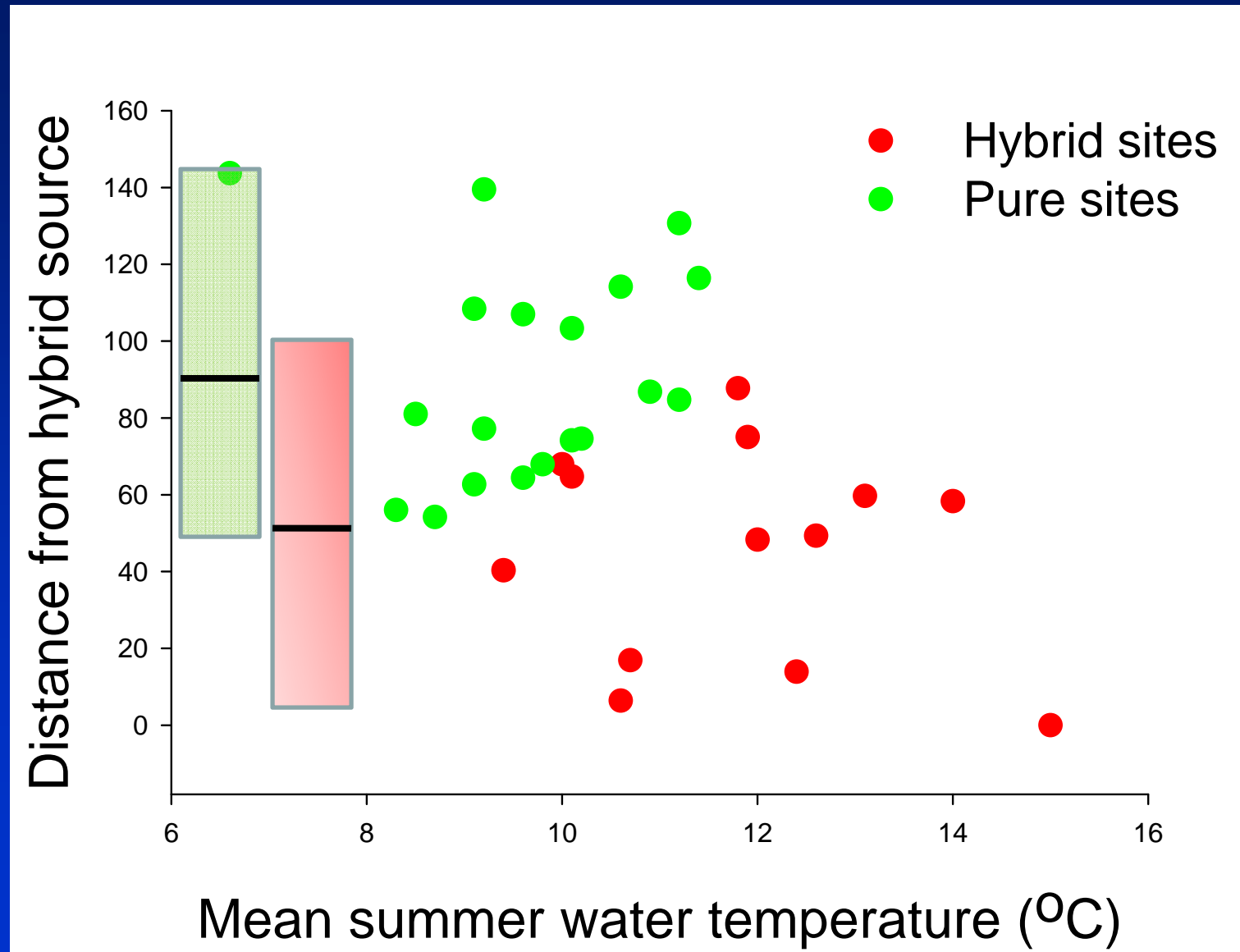
Width versus Elevation



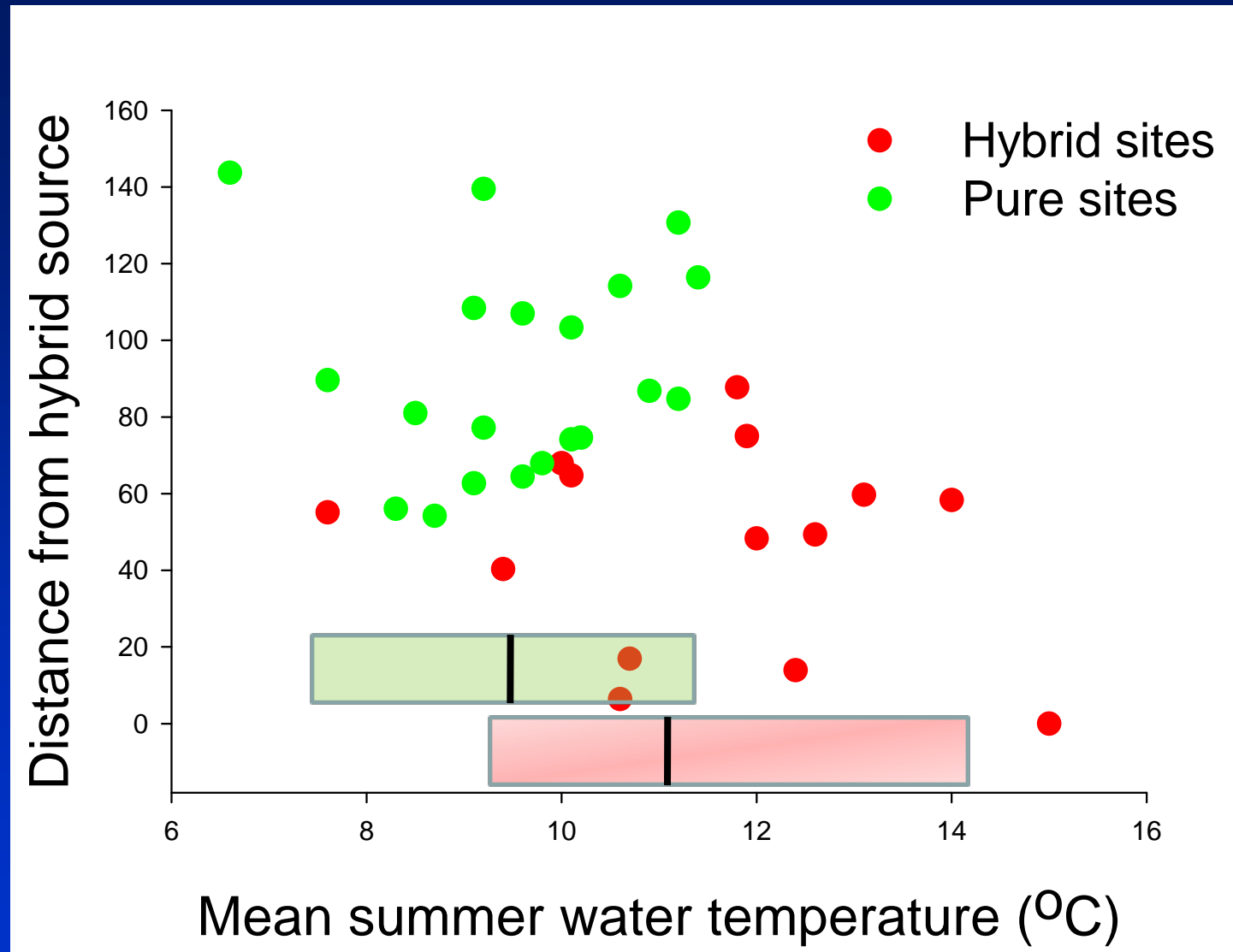
Width versus Elevation



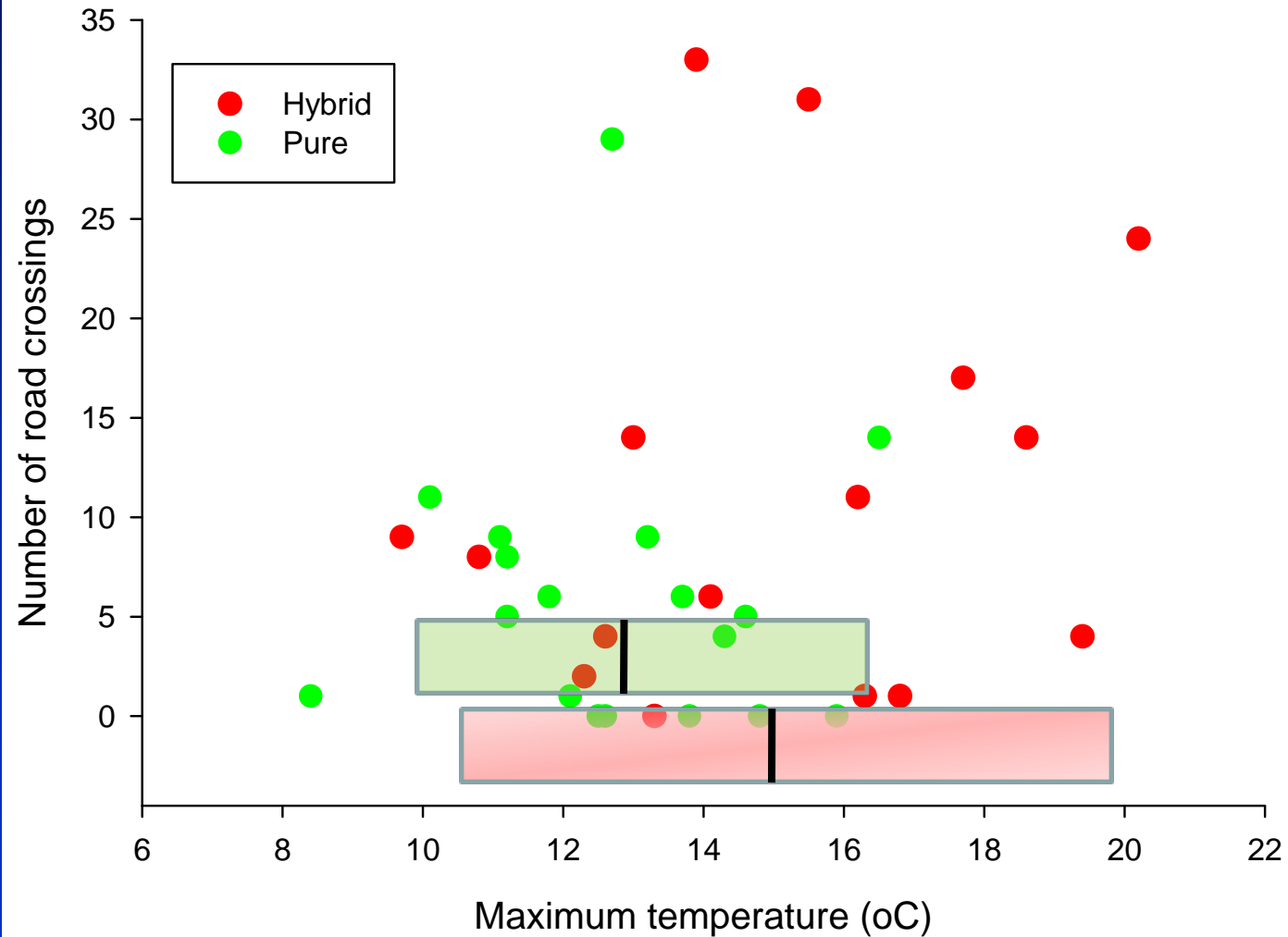
Distance to source versus Mean Temperature



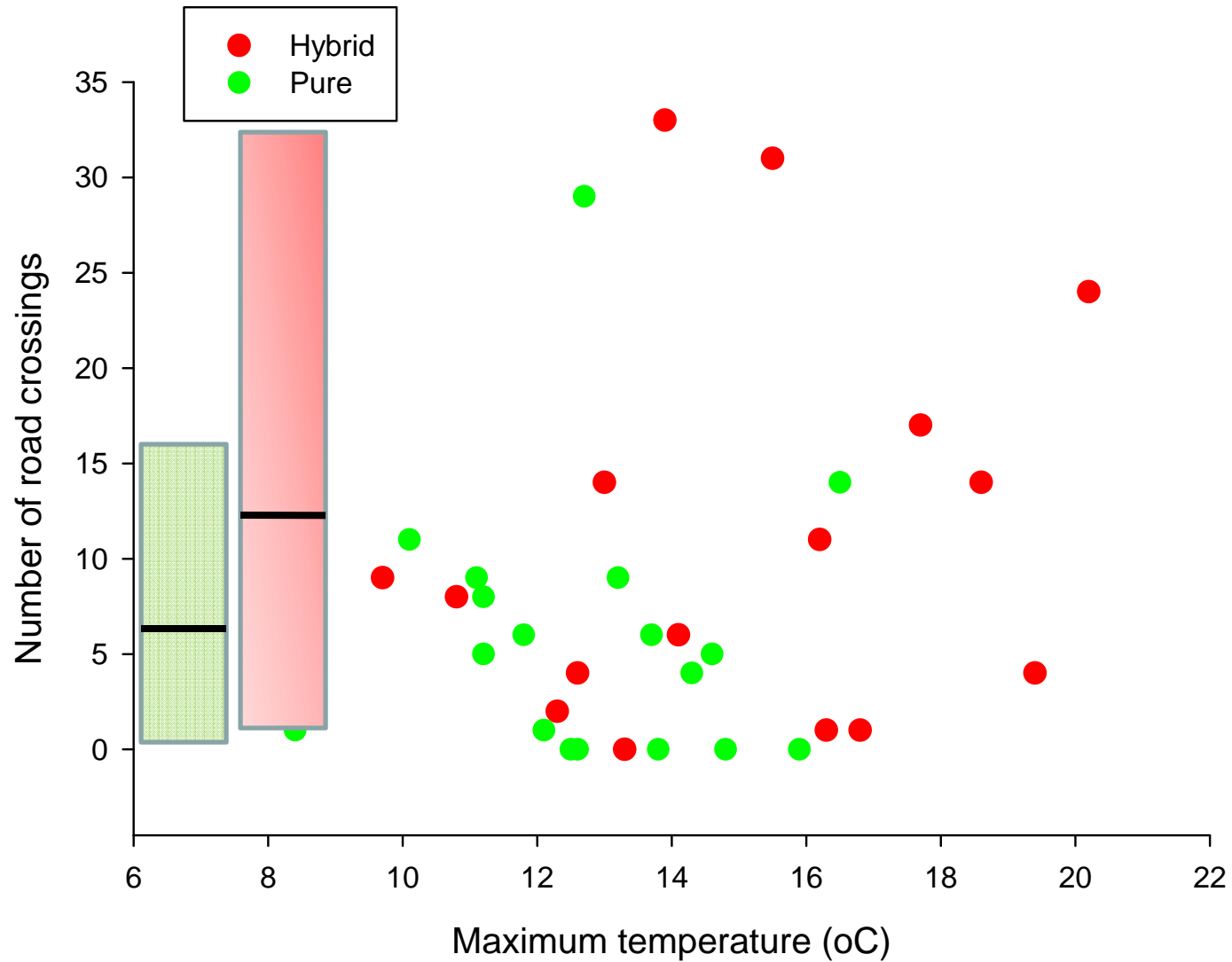
Distance to source versus Mean Temperature



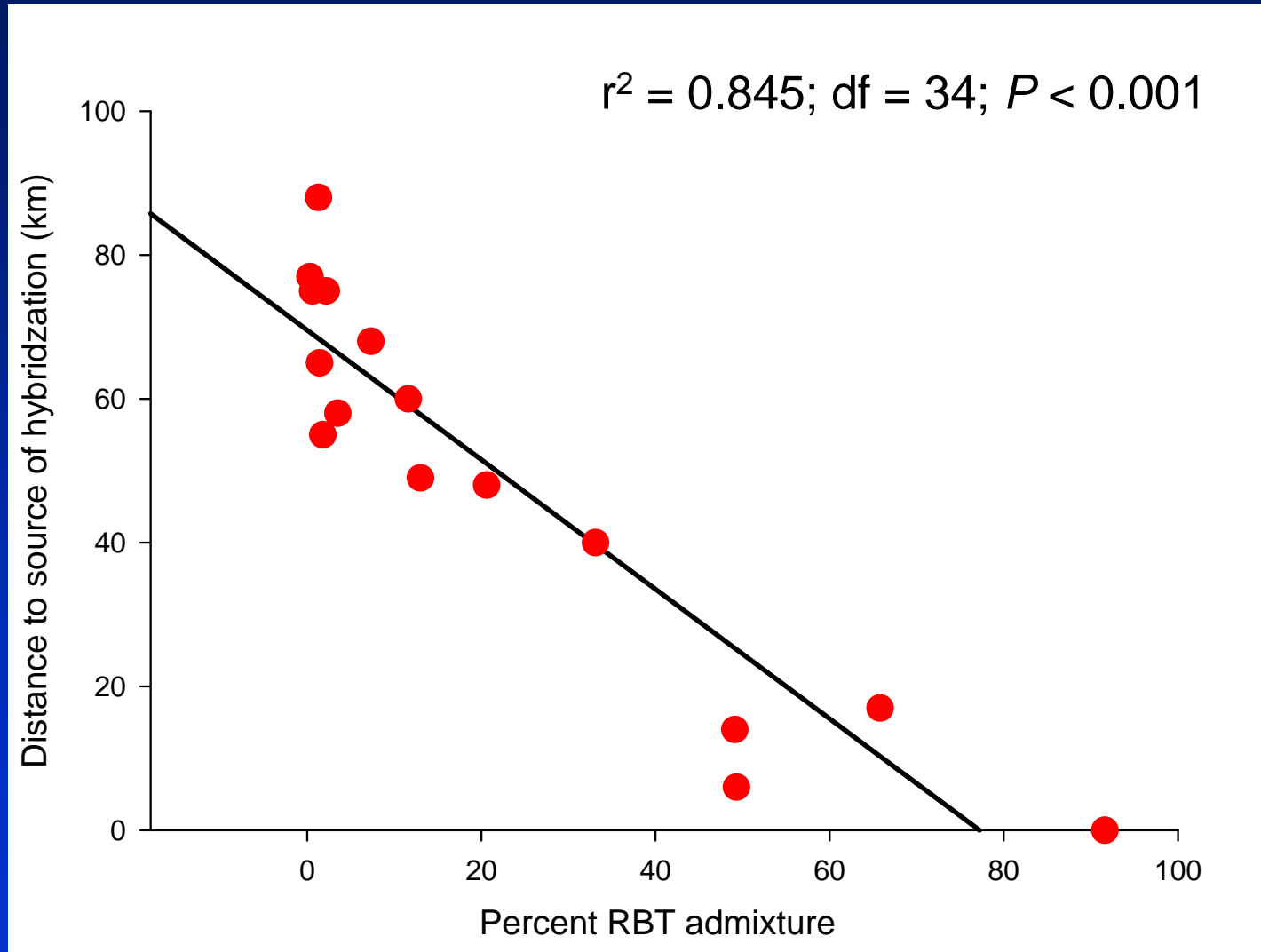
Road crossings versus Maximum Temperature



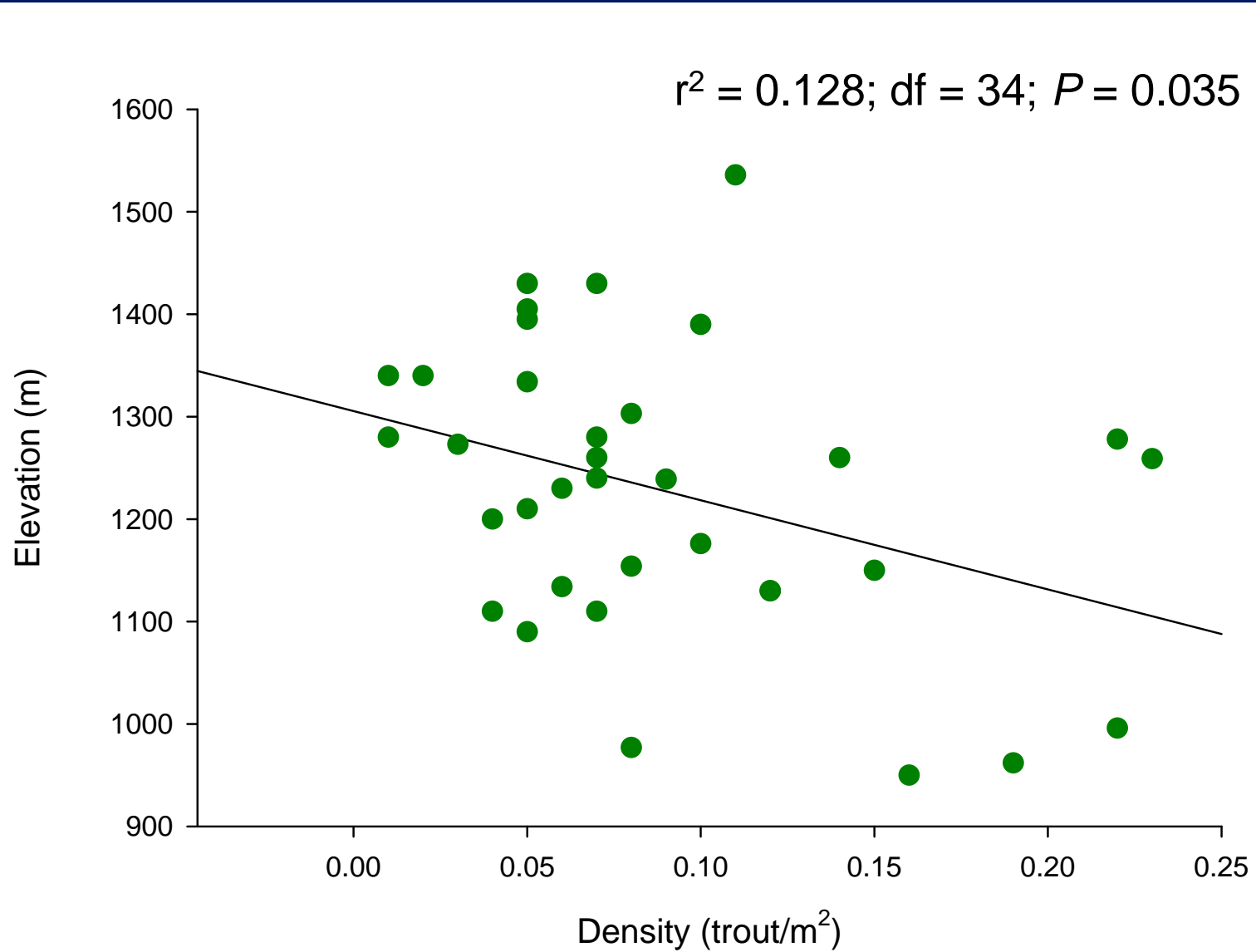
Road crossings versus Maximum Temperature



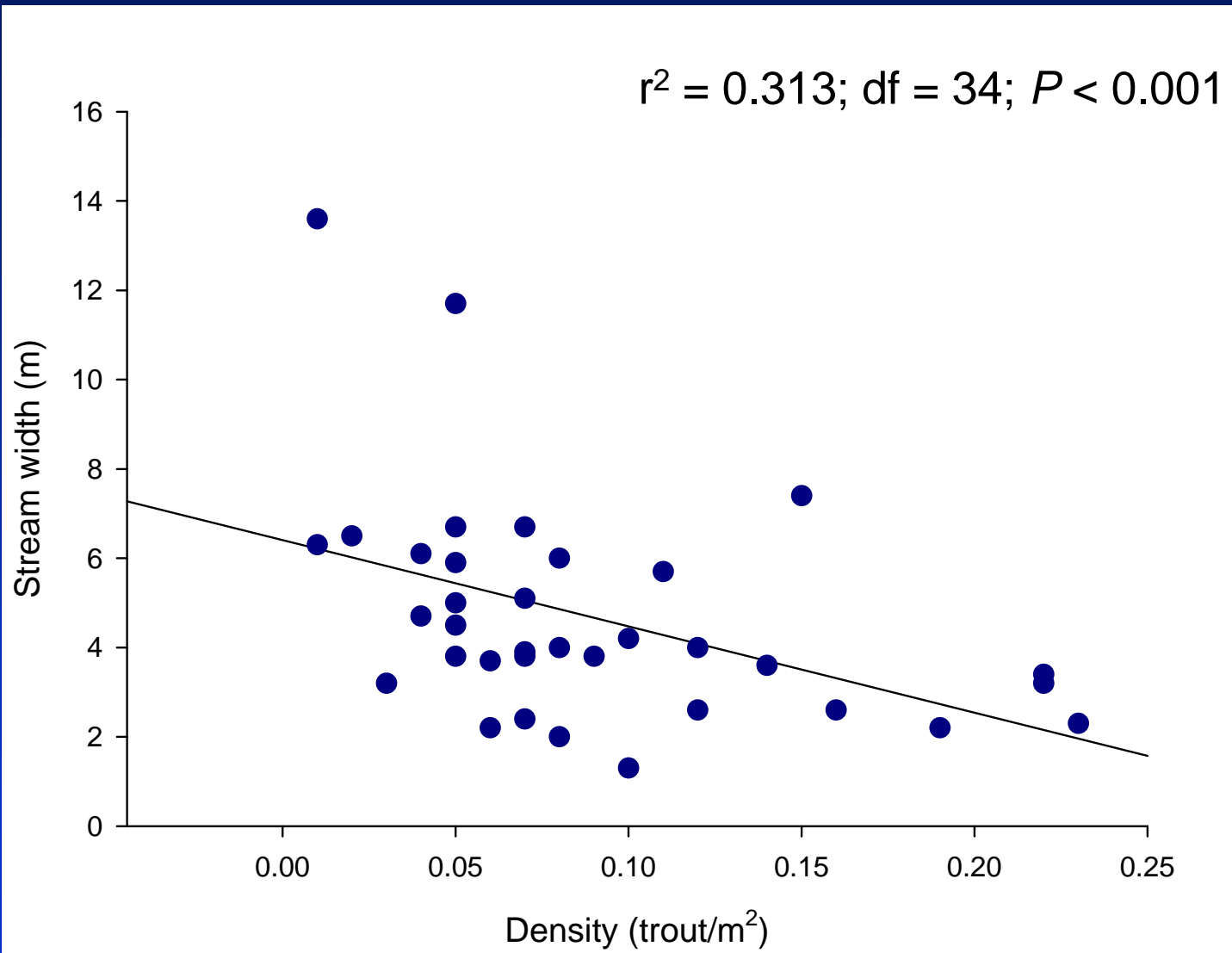
Percent Admixture versus Distance to Source



Density versus Elevation



Density versus Stream Width



Conclusions

- Hybridization increases in streams with warm water temperatures, high land-use disturbance and close to the primary source of hybridization.
- Managers may consider strategies for preserving non-hybridized WCT populations that attempt to eradicate populations with high levels of RBT admixture in warmer streams with high densities of hybrid fish.

Conservation implications

- There is no formal policy for treating hybrids under the ESA
- WCT denied listing under ESA
 - “natural populations conforming morphologically to the scientific taxonomic description of WCT are presumed to express the behavioral, ecological, and life-history characteristics of WCT” (USFWS 2003)
 - Hybrids = WCT
 - Headwater populations are secure

Genetic and Ecological Consequences

- Long-term persistence of WCT is uncertain
- Loss of locally adapted populations is irreversible and must be considered in management strategies



Habitat Degradation

Elk Valley, B.C.



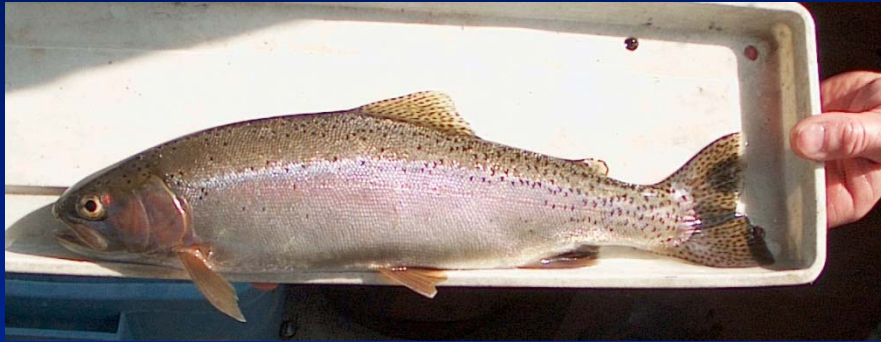
Elk Valley, B.C.



Foisy Creek, B.C.



Abbot Creek Fish Suppression



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