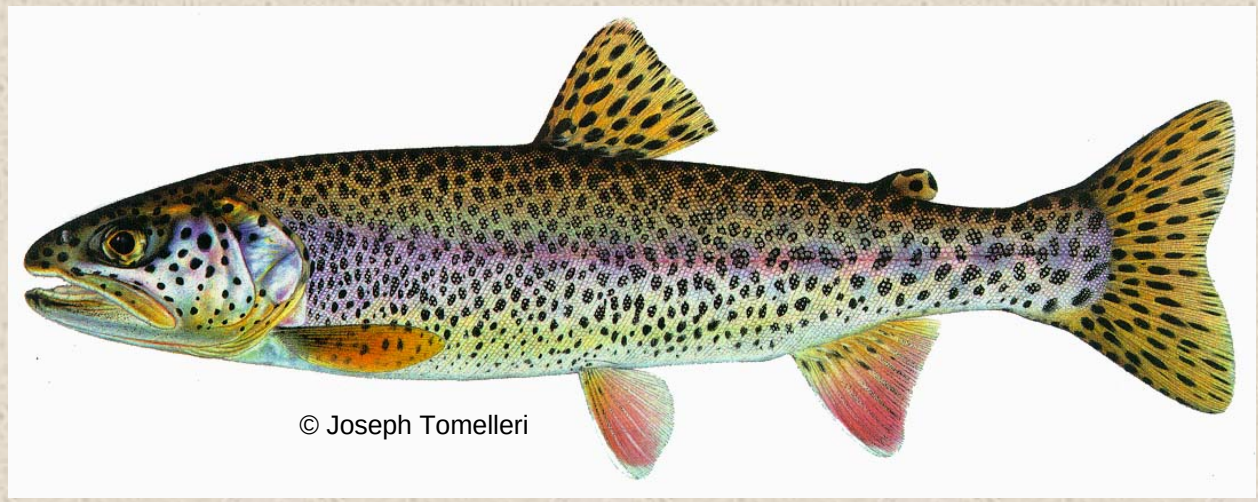
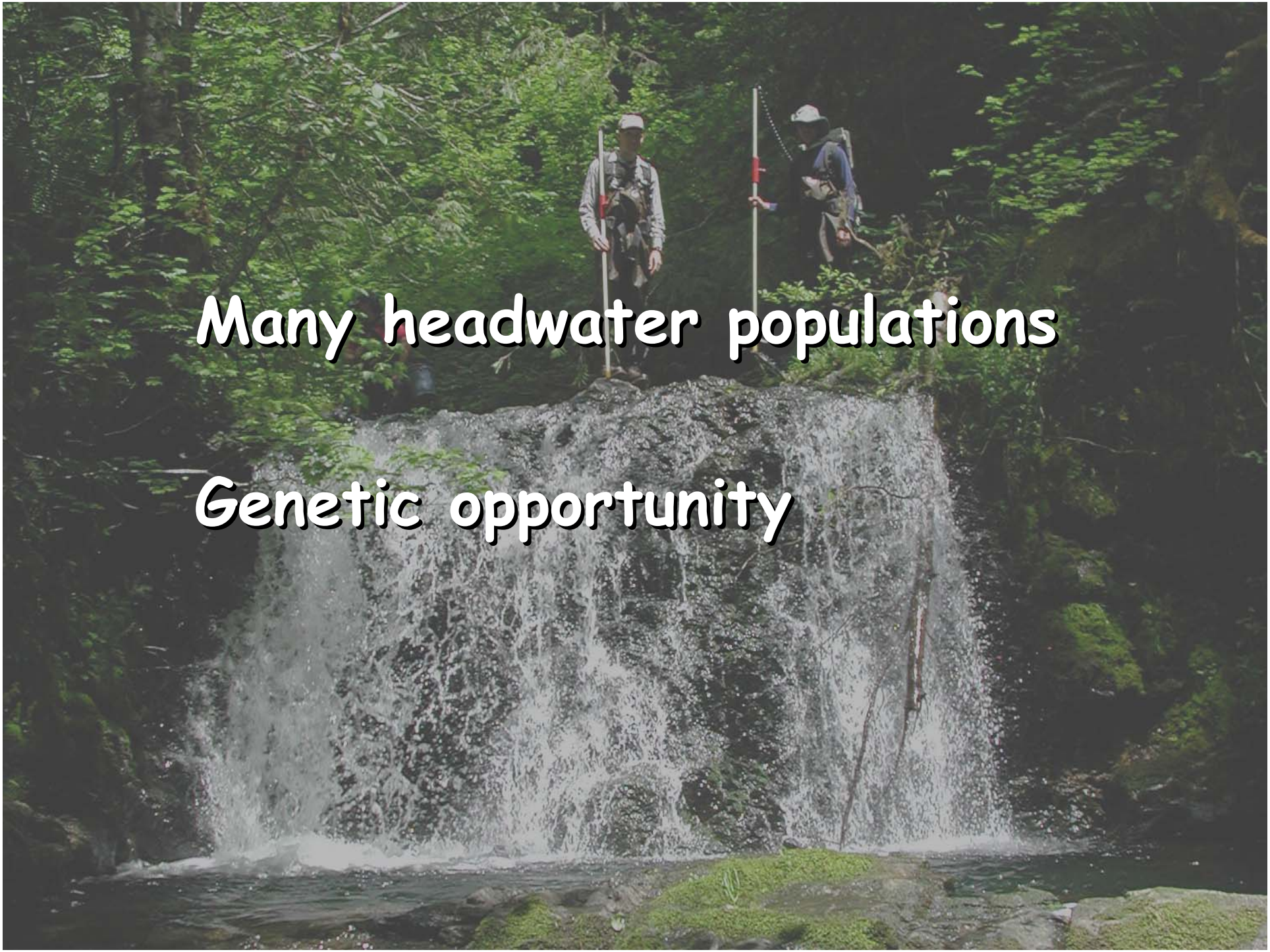
Cutts above the rest; waterfall-isolated coastal cutthroat trout, microsatellite genetic diversity, and watershed-scale habitat features



Troy Guy, Department of Fisheries and Wildlife, Oregon State University, Corvallis OR

Robert Gresswell, USGS-N. Rocky Mountain Research Station, Bozeman, MT

Michael Banks, HMSC, Department of Fisheries and Wildlife, Oregon State University, Newport, OR

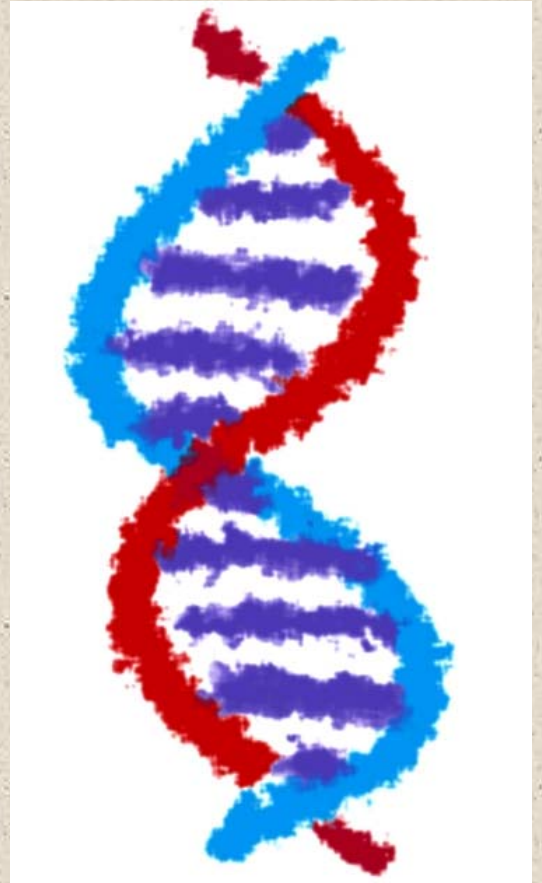

Many headwater populations
Genetic opportunity

Factors influencing genetic variation

- **Variation increase:**
  mutation
  migration

- **Variation decrease:**
  random genetic drift
  population bottlenecks
  founder effects
  inbreeding

- **Effective population size (N_e)**



Questions

What is the relative influence of genetic drift and geographic isolation on genetic structure?

How is watershed-scale habitat complexity and connectivity associated with genetic diversity?

Methods

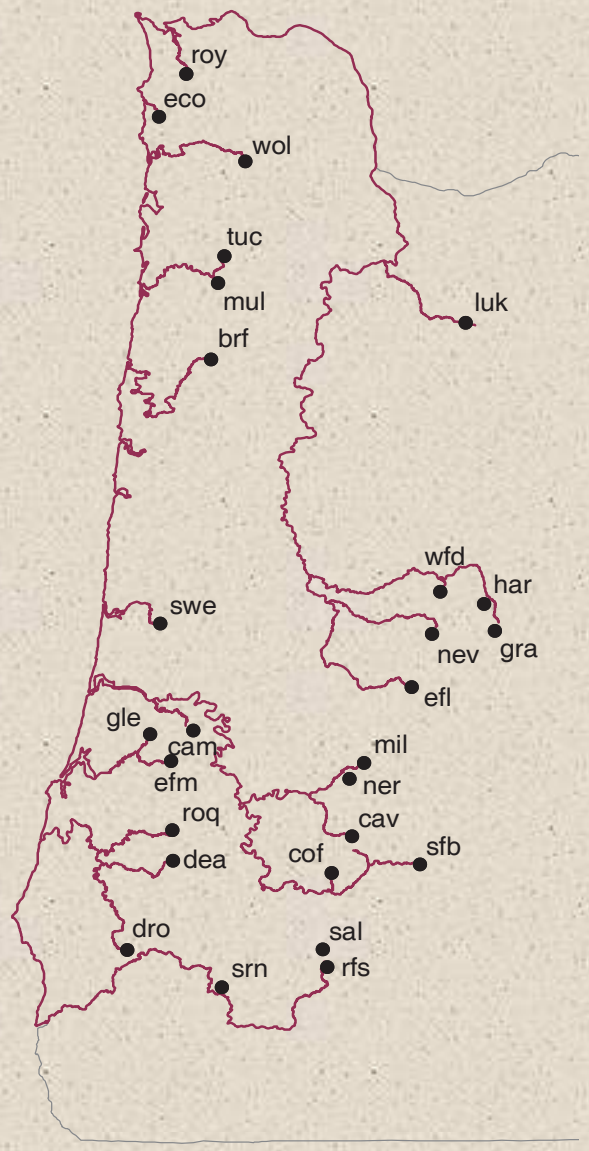
25 creeks randomly selected for analysis; excluded 1 one creek with RBT, characterized 3 additional (*n* = 27 sampling locations).

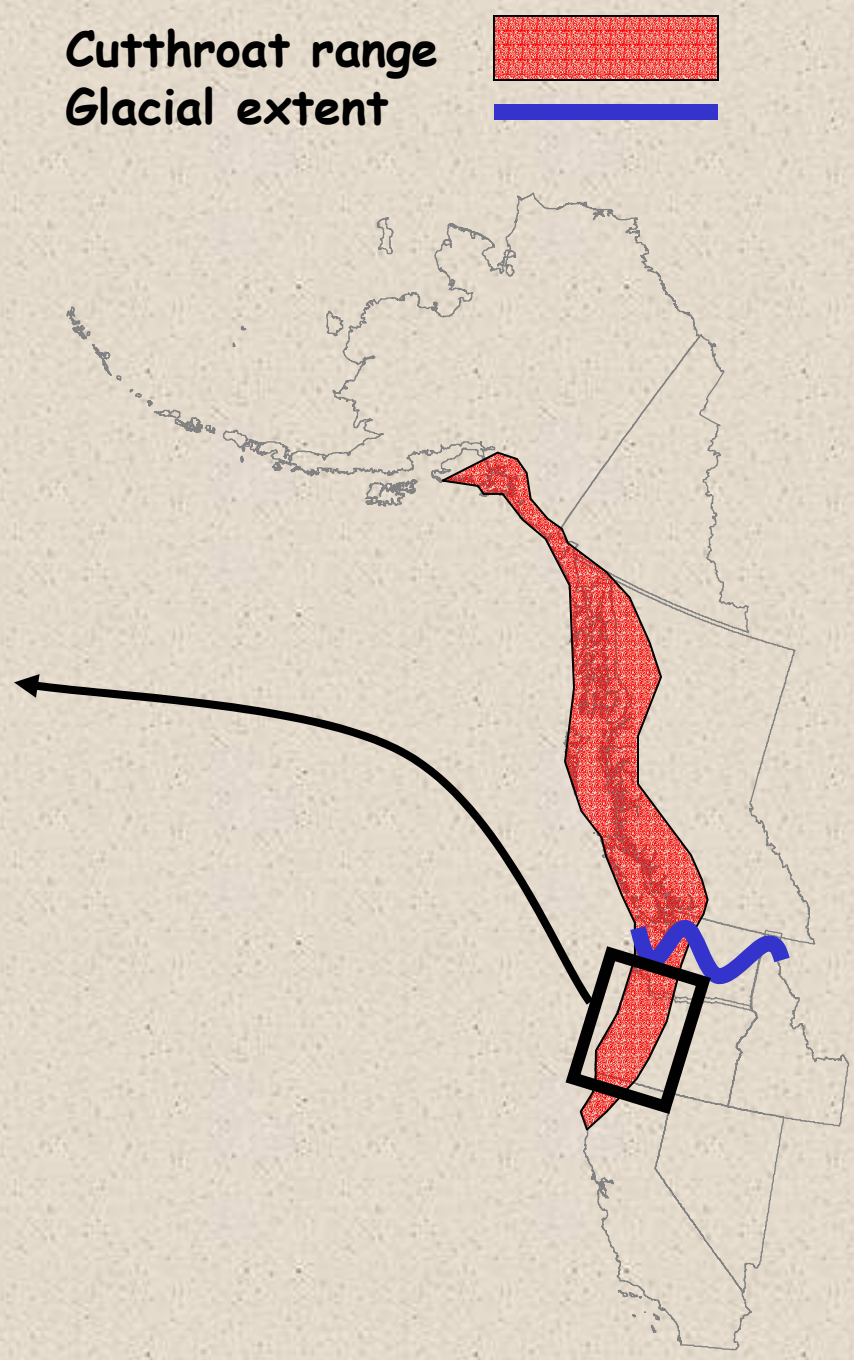
95 individuals per creek; where <95 were captured, all were used.

7 microsatellite loci:

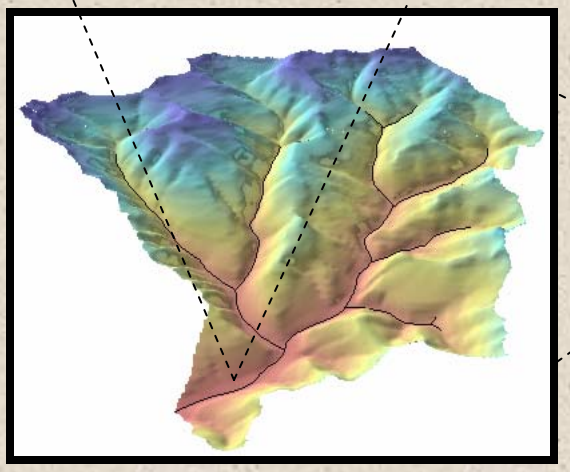
One102, 103, 108	Olsen et. al 1999
Omy77	Morris et.al. 1996
Ots4	Banks et. al 1999
Ots209, 212	Greig et. al. 2003

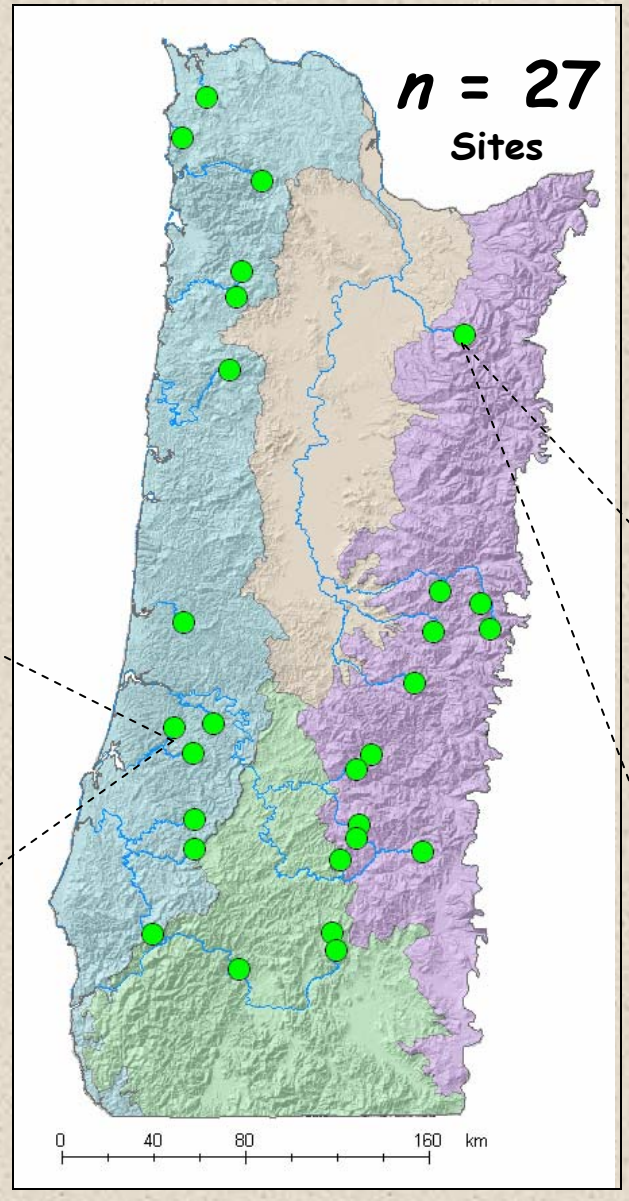
Sampling locations

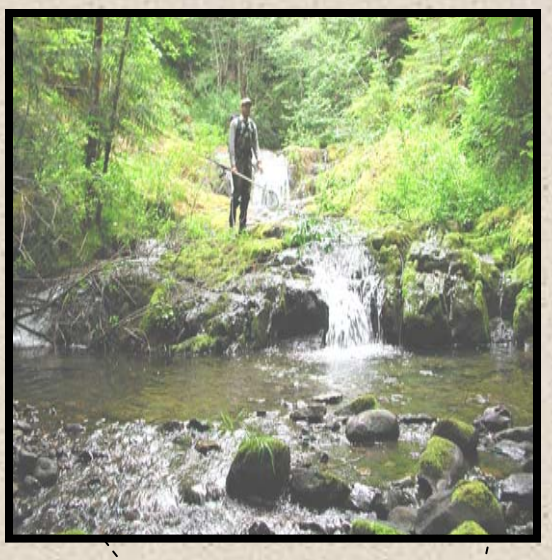


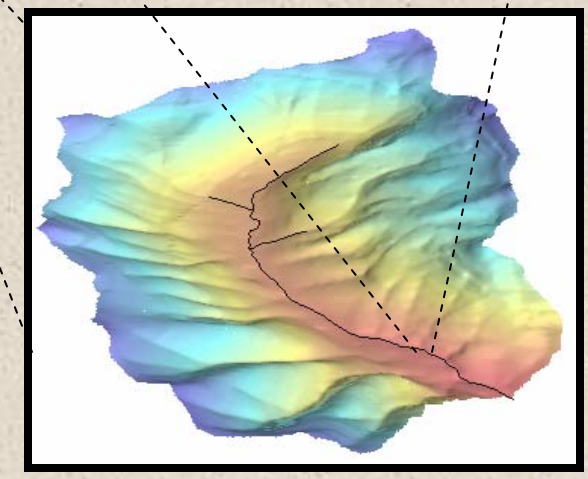


Sampling locations









Coast Range

- High erosion potential
- Low channel gradient
- Many tributaries

Cascade Range

- Low erosion potential
- High channel gradient
- Few tributaries

Results

Number of samples per basin ranged from 15 to 96 (mean = 80, *n* = 2232)

Genetic variability at 7 loci ranged from 1 to 14 alleles (mean = 5 alleles)

Expected heterozygosity for all loci ranged from 0.47 to 0.62 (mean = 0.56)

Population genetic assumptions satisfied

- Hardy-Weinberg Equilibrium, 11.1% failures
- Linkage Disequilibrium, 1.8% linkage

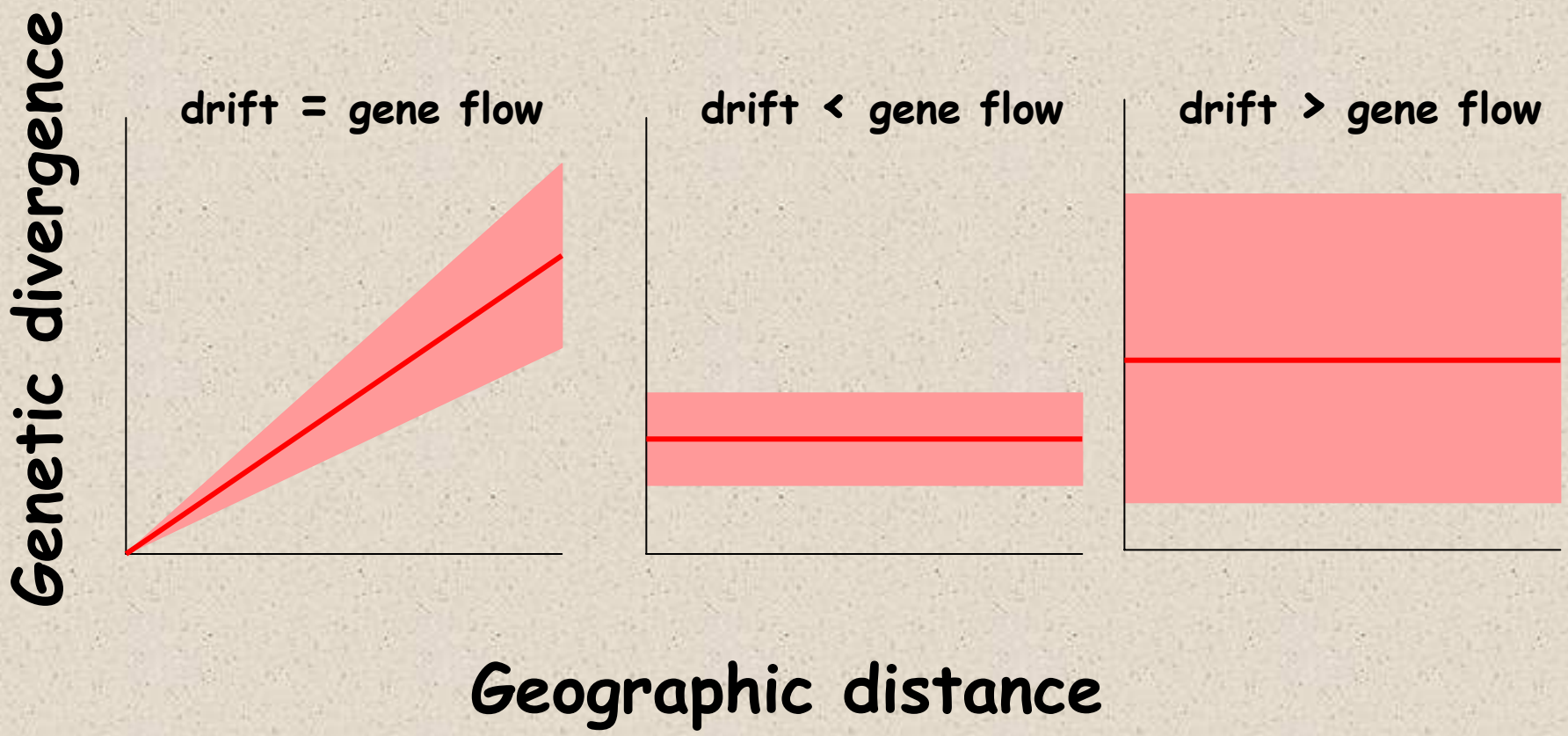
Strong population structuring among isolated basins (F_{st}):

	Min-Max	Avg
O.c. clarki (this study)	0.04-0.87	0.35
Comparisons		
O.c. lewisi (w/barriers) Taylor et. al. 2003	0.00-0.82	0.32
O.c. clarki (sea-run) Wenburg et. al. 1999	0.03-0.12	0.05

Factors affecting genetic variation

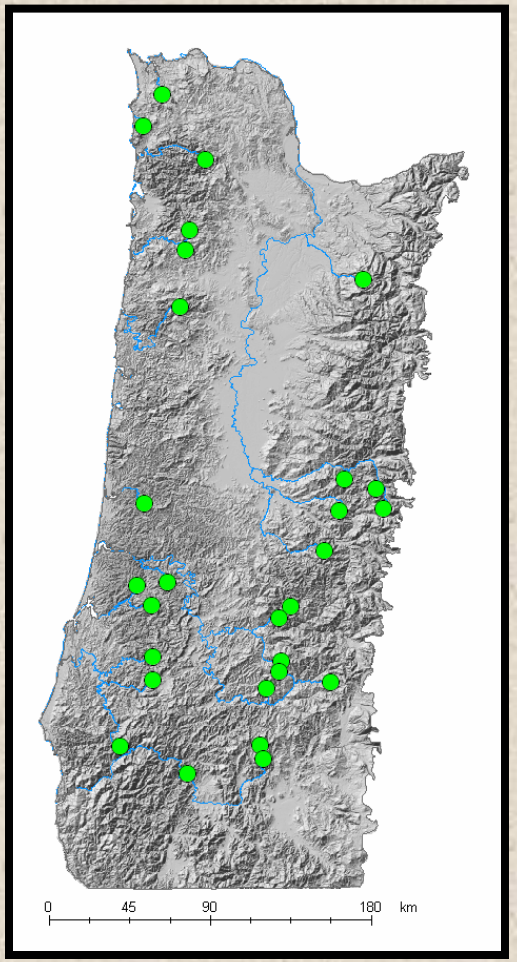
(isolation-by-distance and genetic equilibrium model)

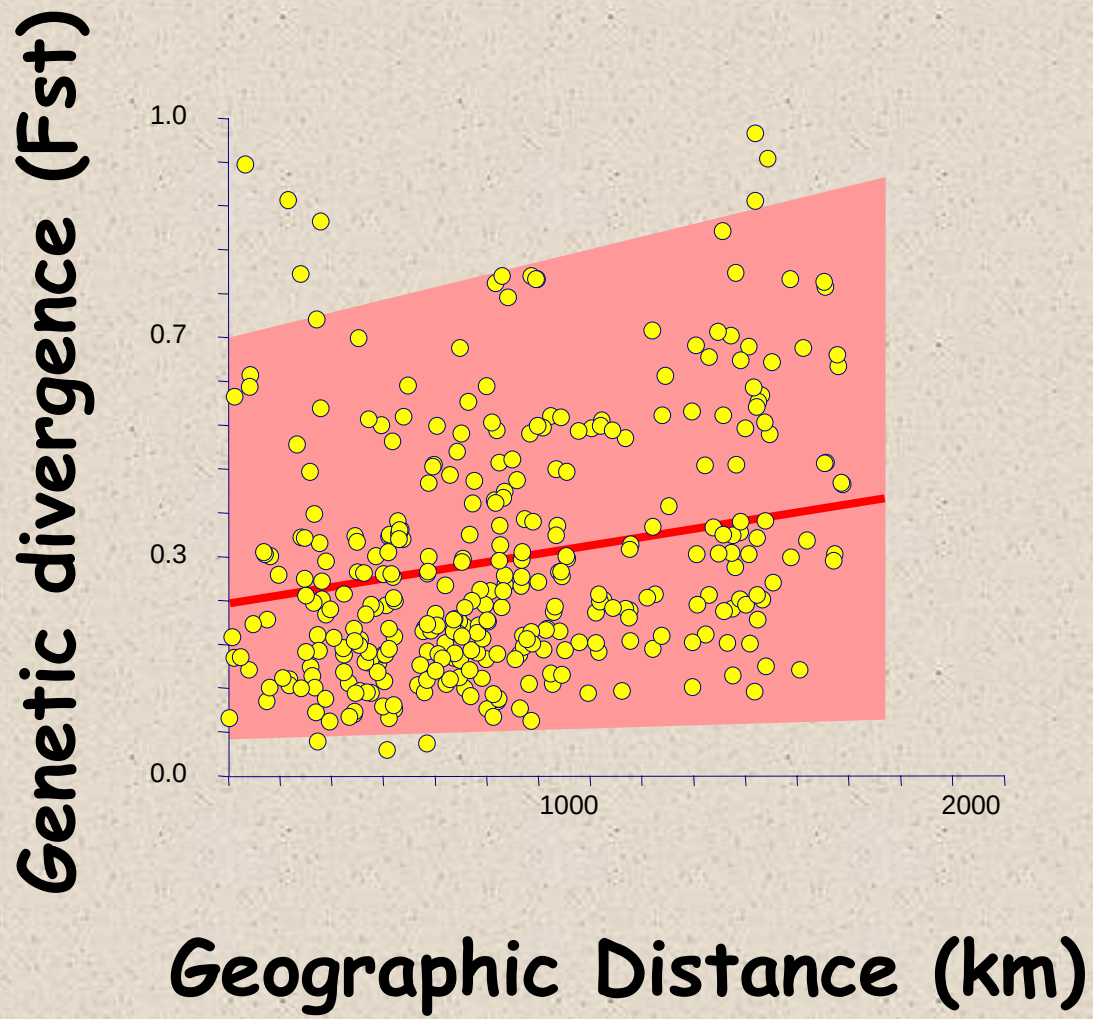
Modified from Hutchison and Templeton, *Evolution*, 53(6), 1999



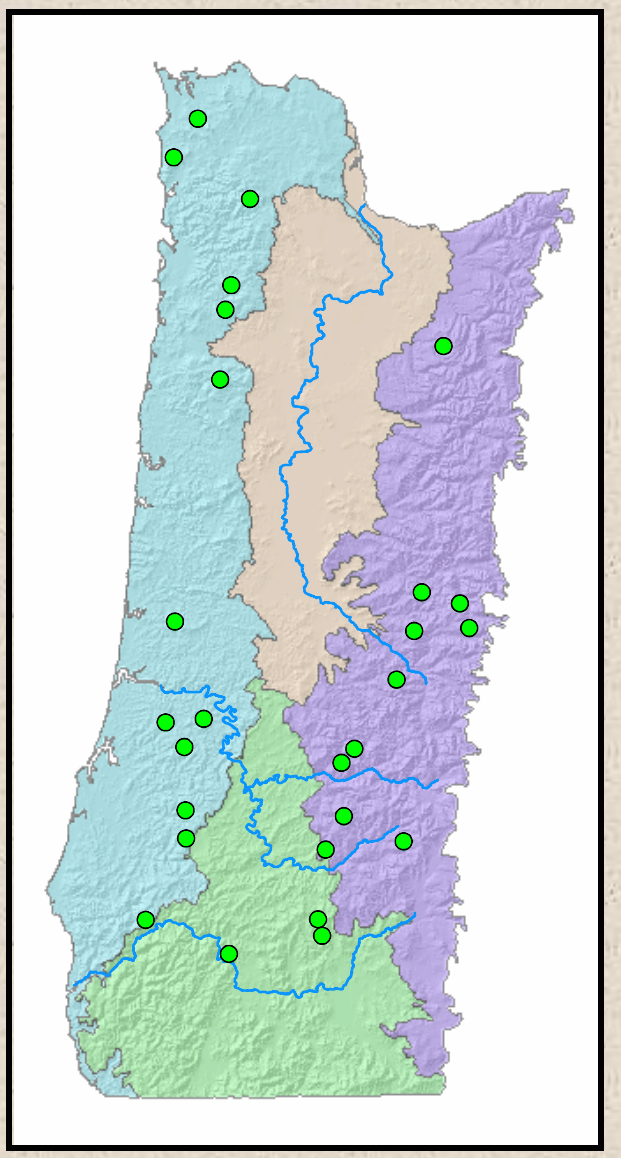
All sites

n = 27
IBD…Yes
Equilibrium…Yes

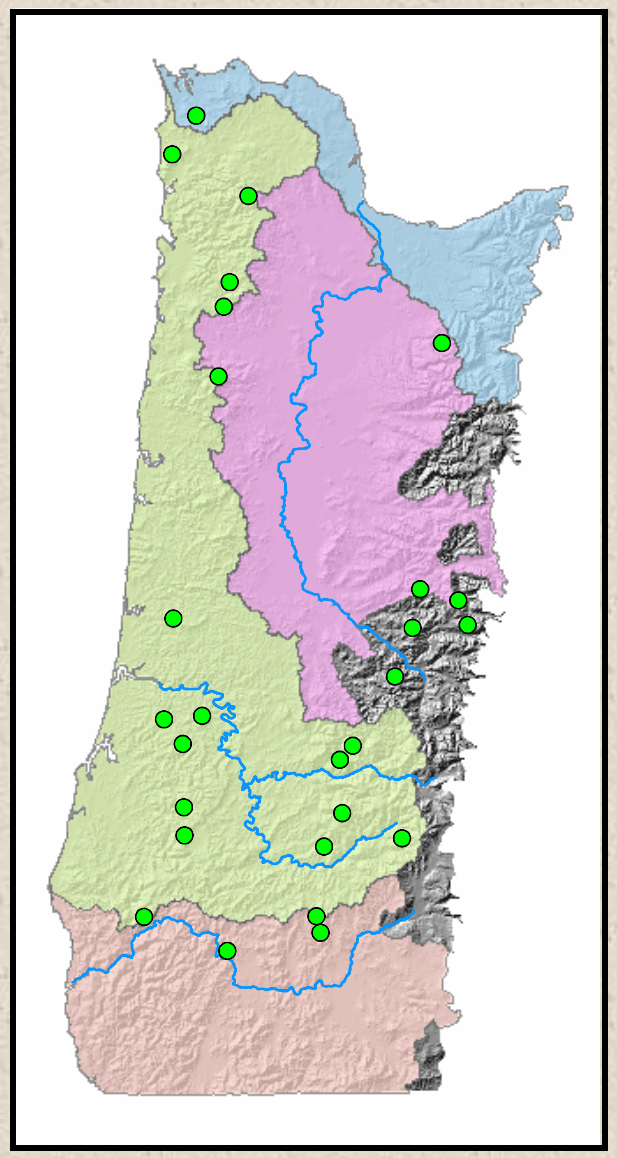




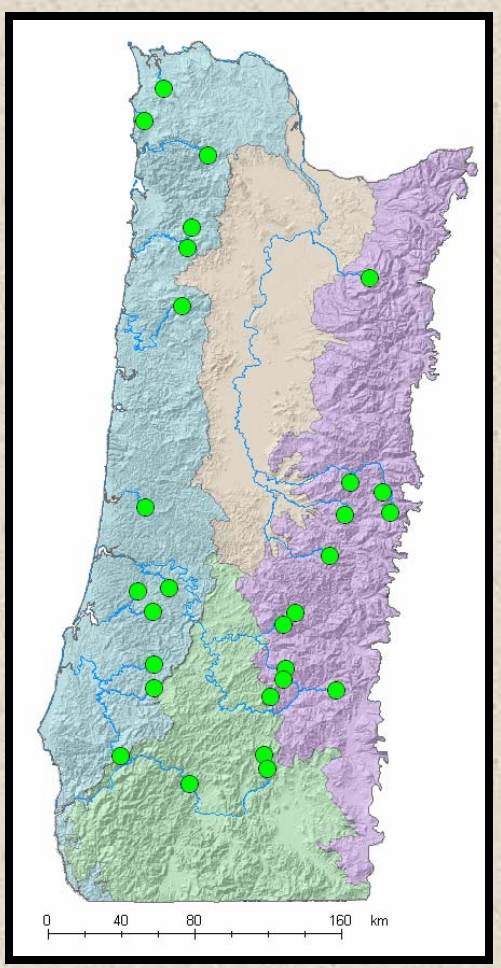
Ecoregion:
geology, elevation



Evolutionary Significant Unit (ESU):
genetic, ecological

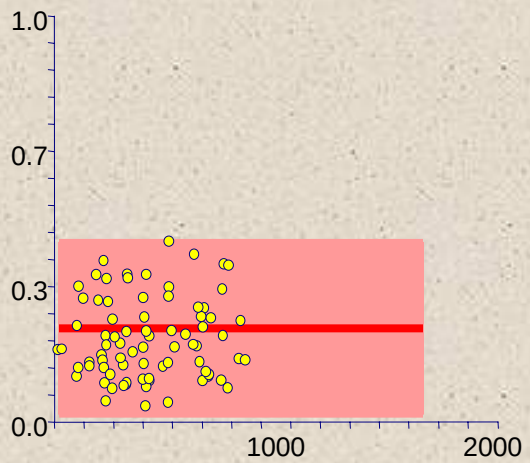


Ecoregion

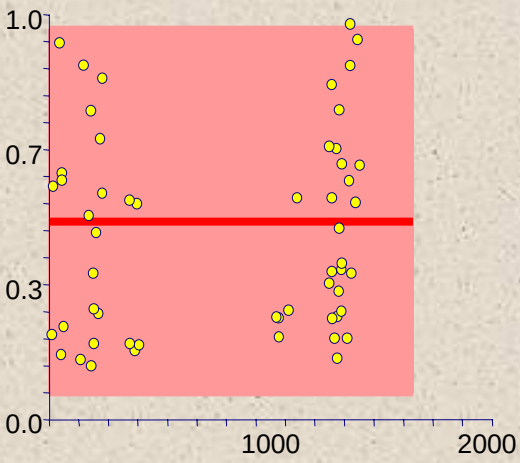


Genetic divergence (Fst)

Coast

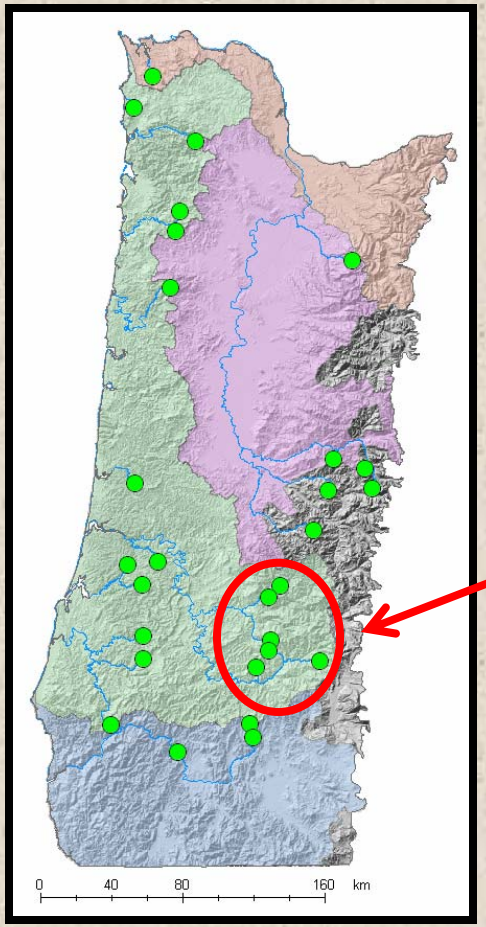


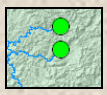
Cascade



Geographic Distance (km)

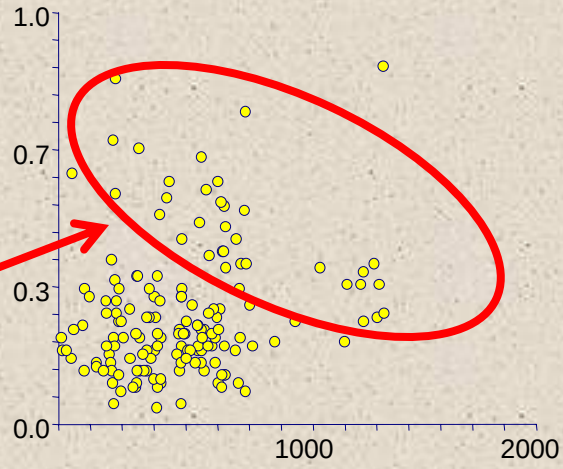
ESU's

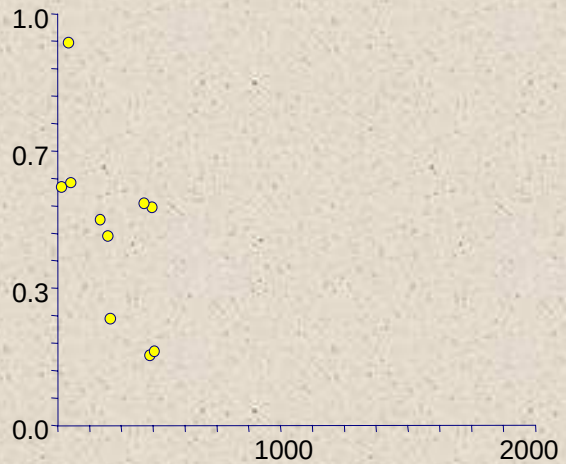


Coastal Oregon 

Upper Willamette

Genetic divergence (Fst)



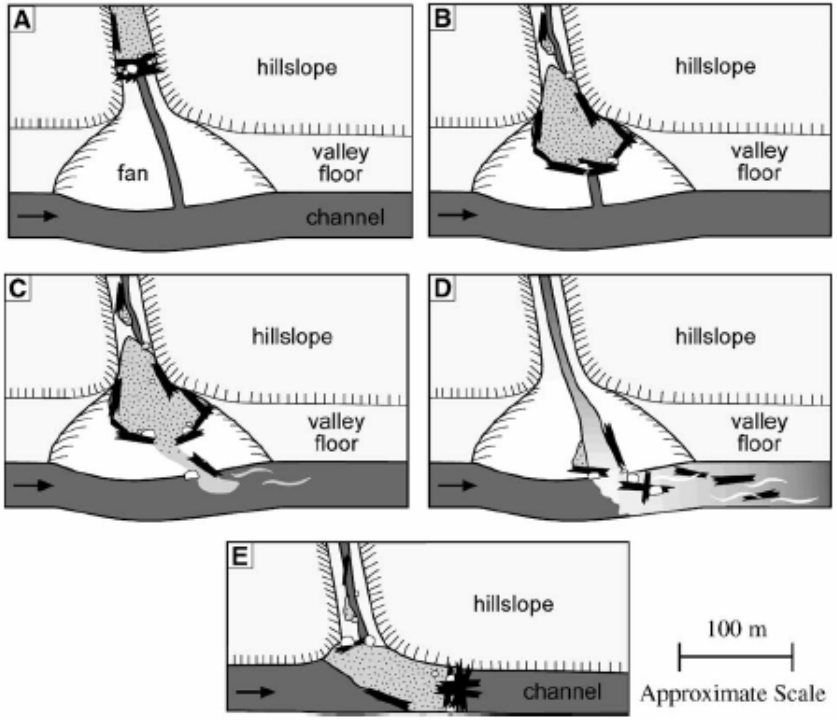


Geographic Distance (km)

Landscape structure and habitat disturbance

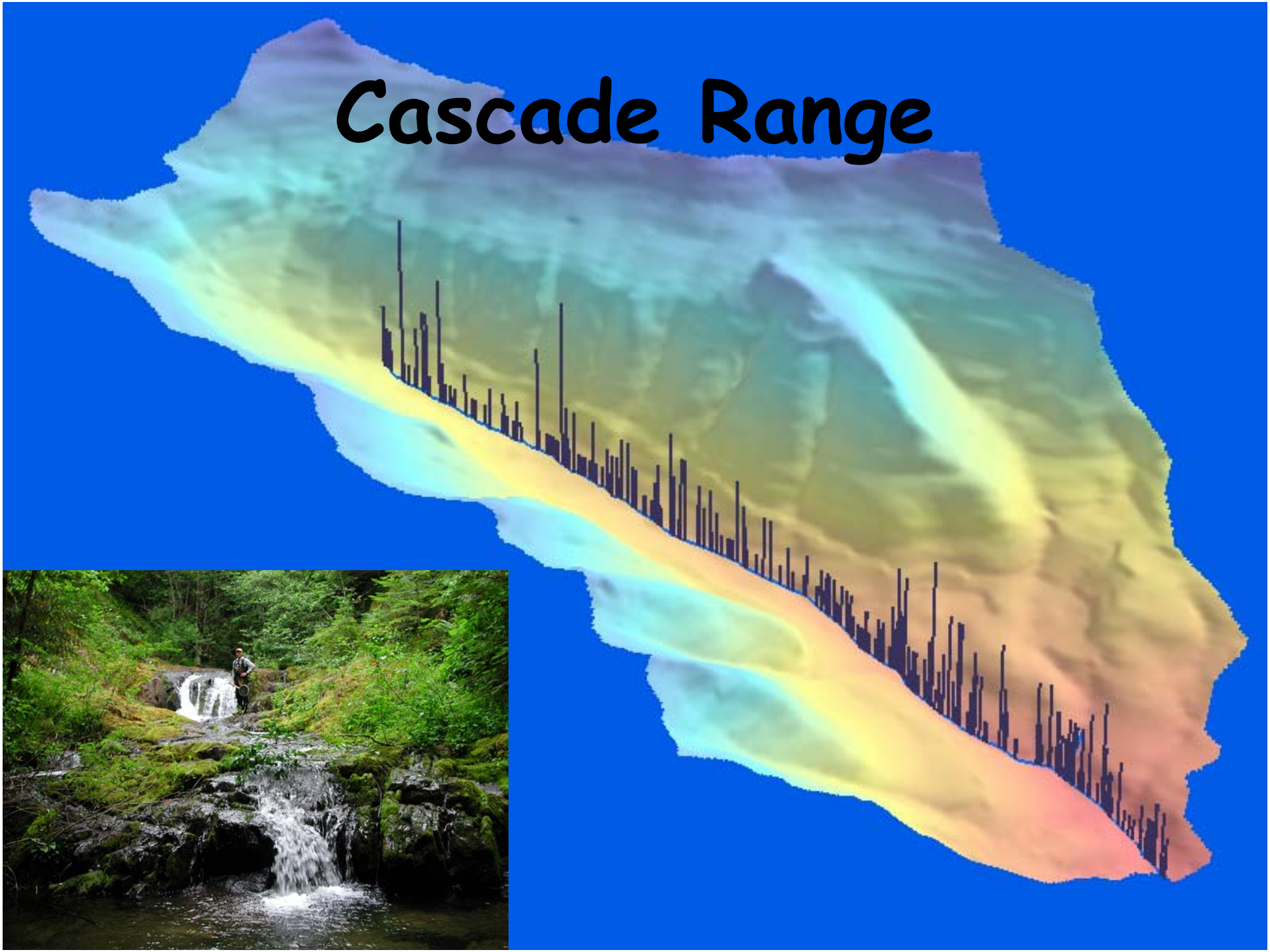
- Heterogeneous spatial patterns set the context for ecological processes

- Disturbance regimes create and maintain a mosaic of habitats that form the physical template for evolution

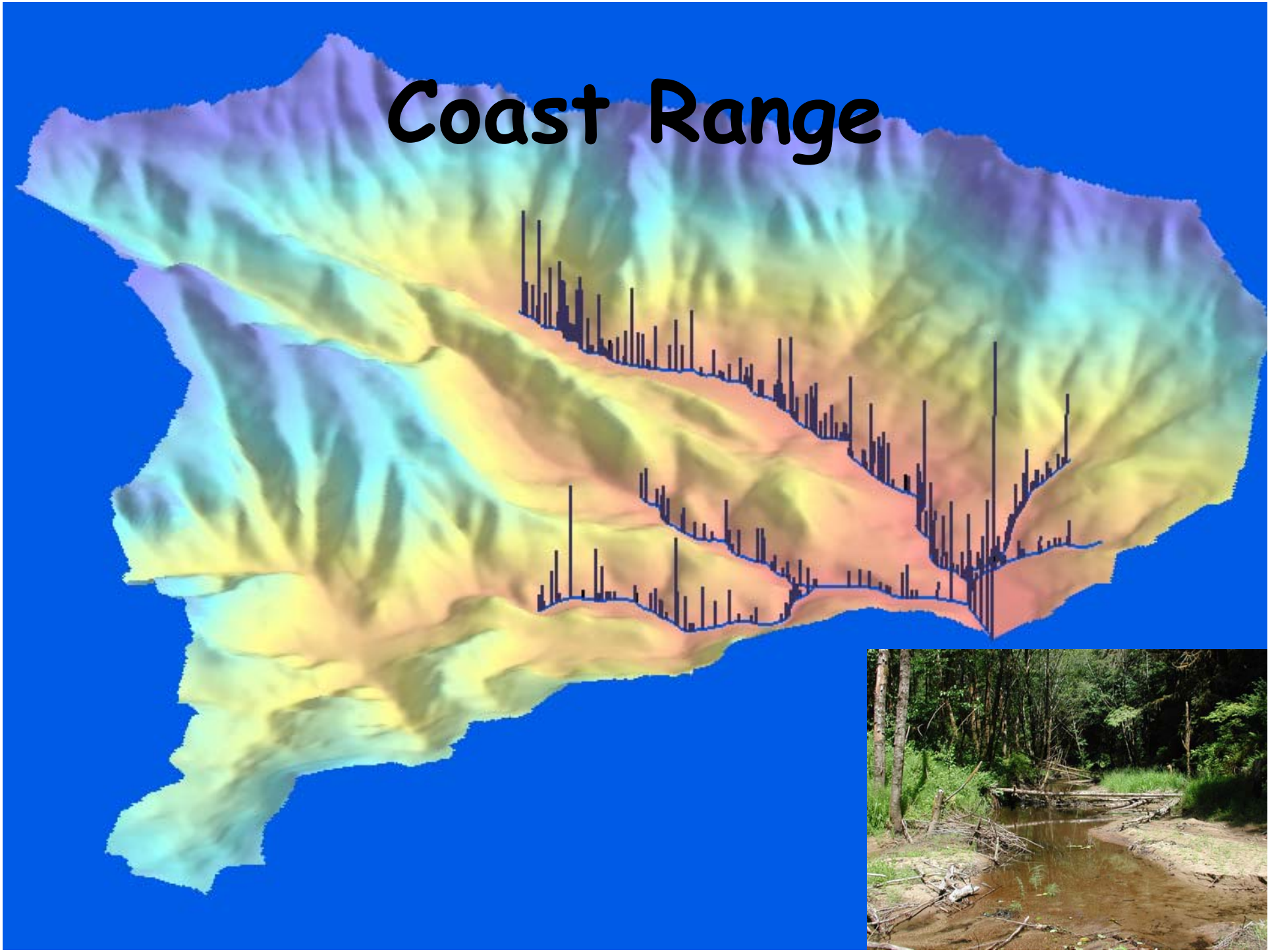


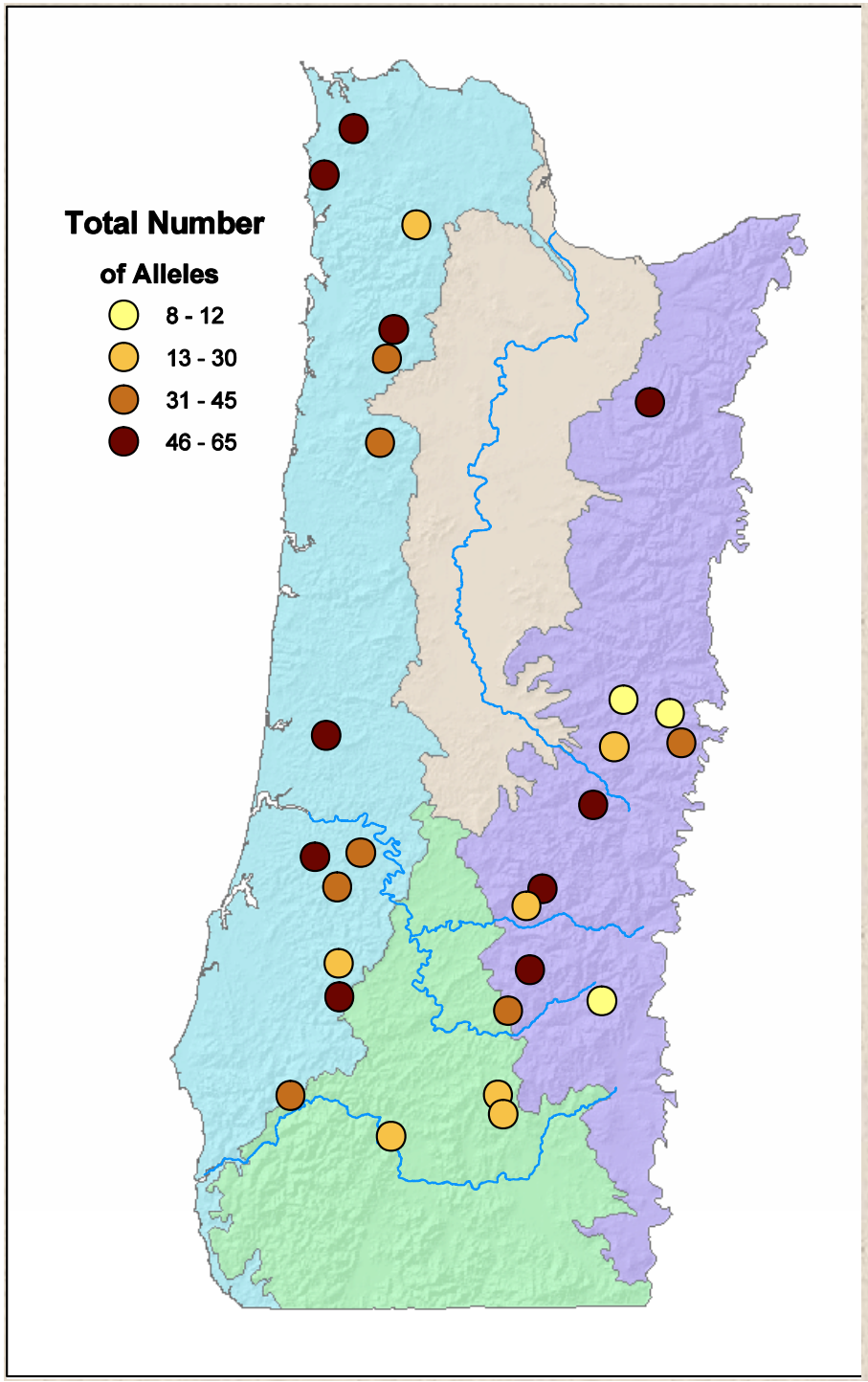
From May and Gresswell (2004) Geomorphology 57:135-149

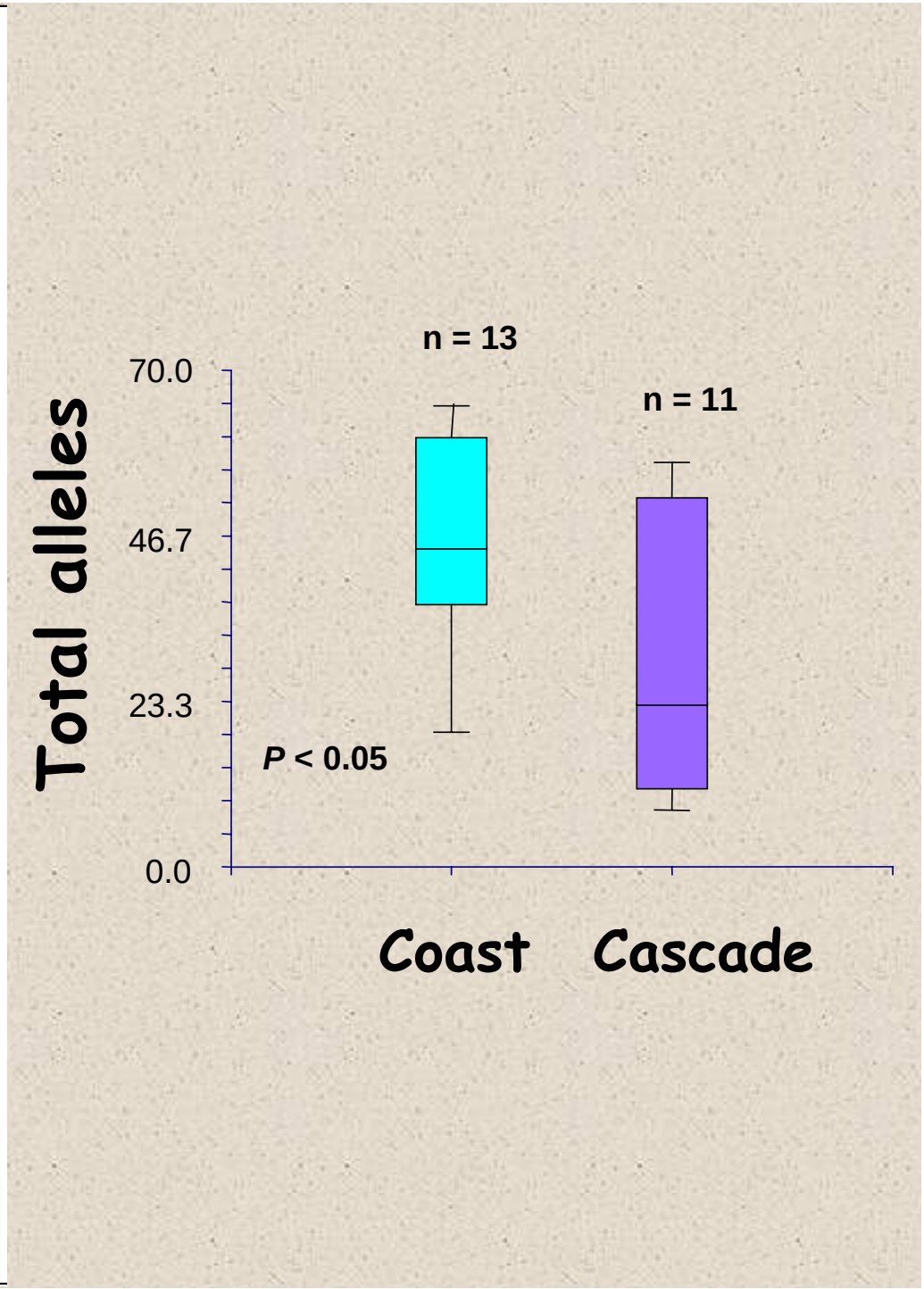
Cascade Range



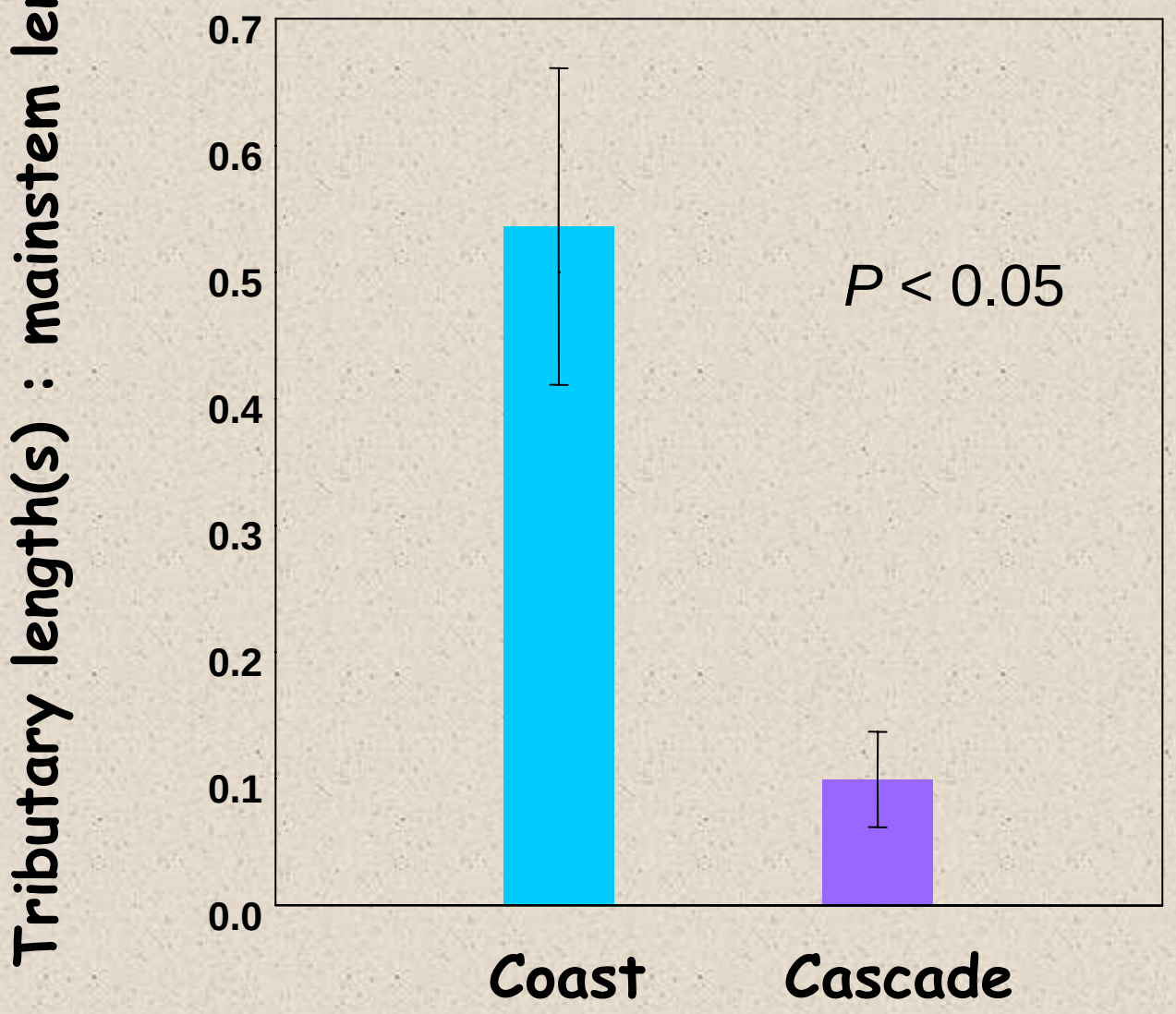
Coast Range



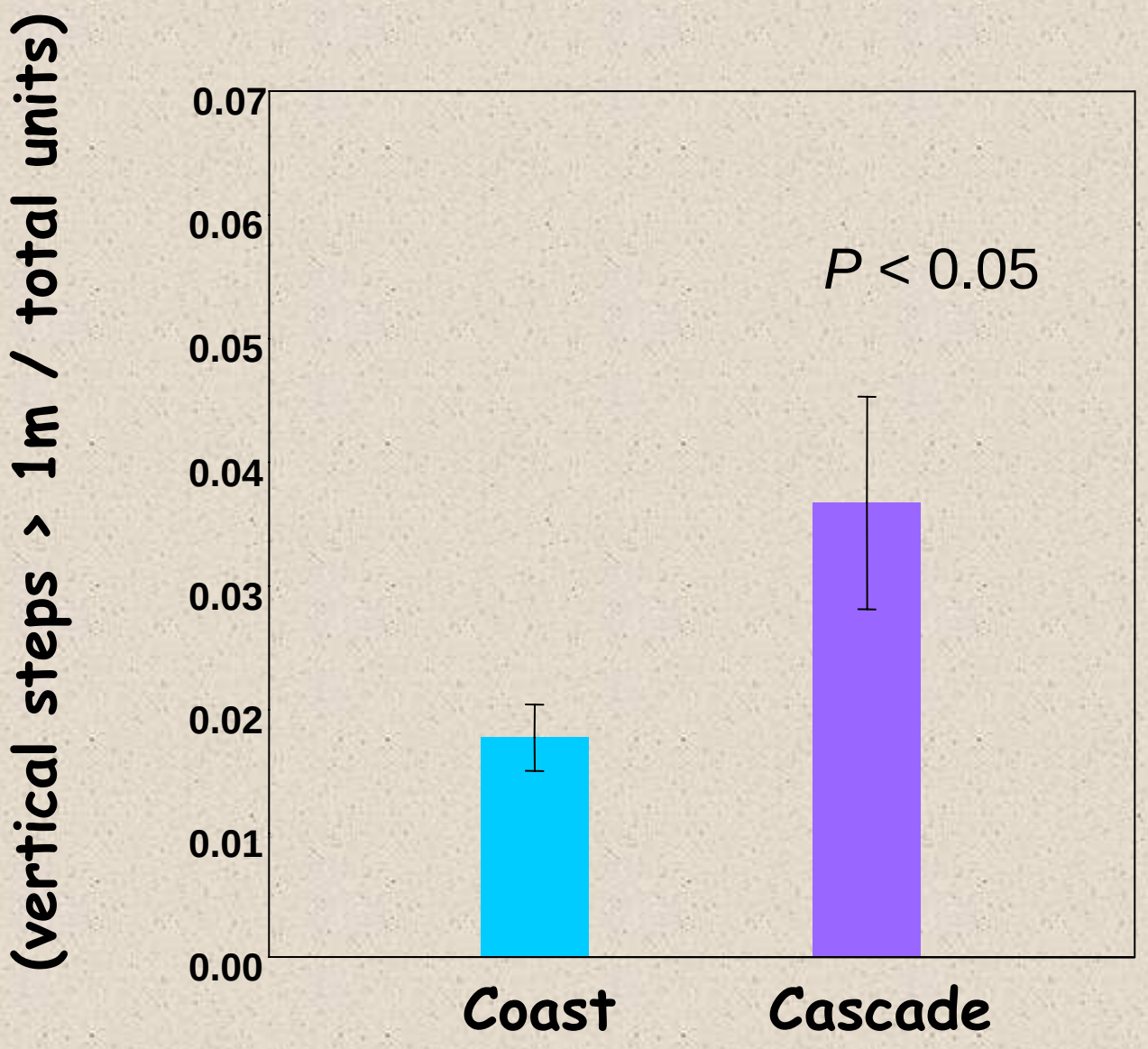

Total Number
of Alleles
8 - 12
13 - 30
31 - 45
46 - 65


Total alleles
70.0
46.7
23.3
0.0
n = 13
n = 11
P < 0.05
Coast
Cascade

Watershed complexity



Barriers to connectivity



Conclusions

Above barrier populations are strongly differentiated.

Regional environmental differences are associated with genetic diversity and strongly shape genetic structure.

Models describing genetic structure need to incorporate landscape heterogeneity

Acknowledgements

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OREGON STATE UNIVERSITY

Marine Fisheries

Genetics Lab

HATFIELD MARINE SCIENCE CENTER • OREGON STATE UNIVERSITY

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