

A photograph of three people standing on a rocky bank next to a powerful waterfall. The scene is dimly lit, with the waterfall's spray creating a bright, misty glow. The people are silhouetted against the light from the water. They are wearing dark clothing and carrying large backpacks, suggesting they are hikers or researchers in a rugged, natural environment.

# Naturally Isolated Coastal Cutthroat Trout Populations Provide Empirical Support for the 50-500 Rule

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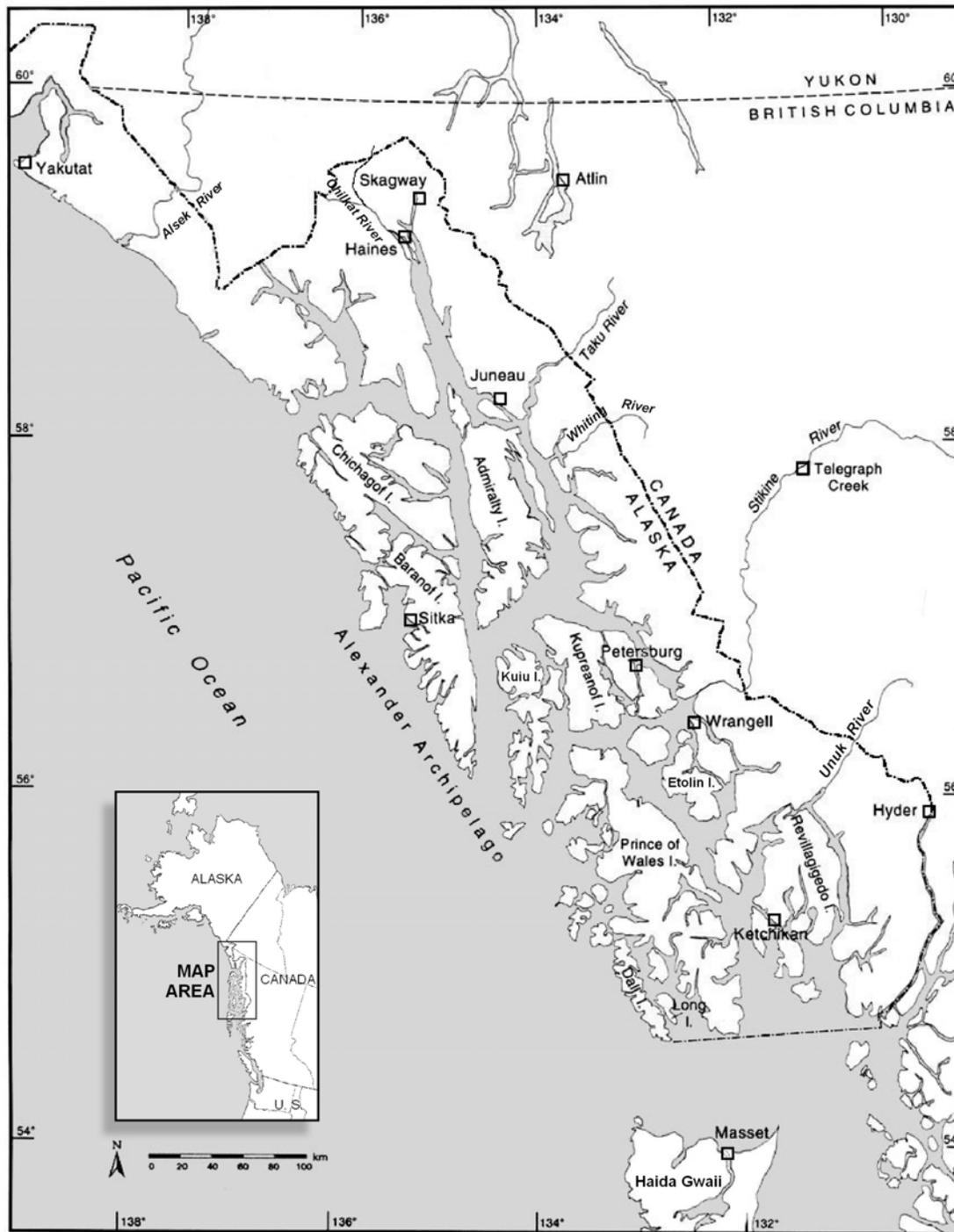
# Acknowledgements

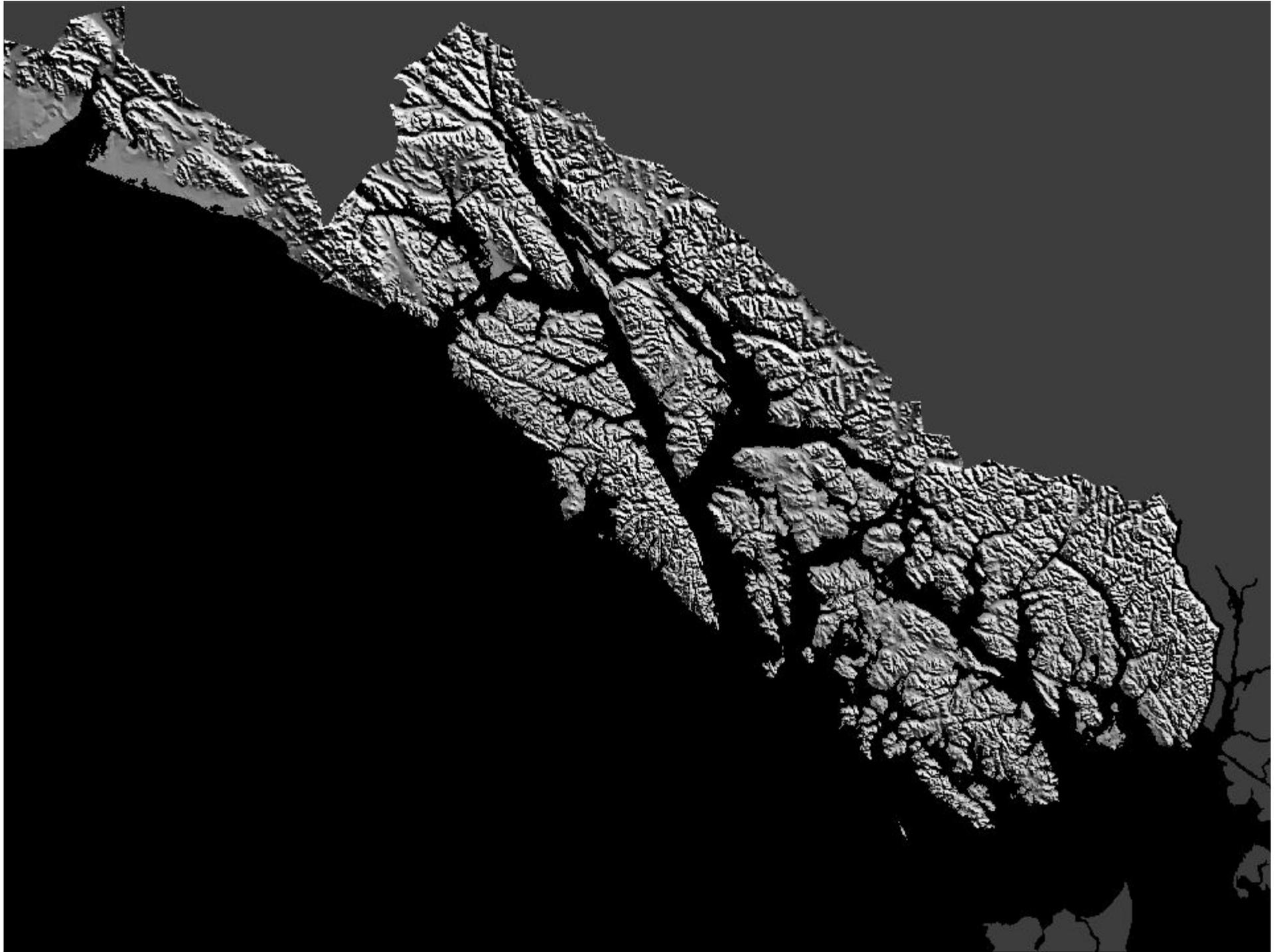
Fred Allendorf, Univ of Montana  
Chris Frissell, Pacific Rivers

Jamie Martin, Emil Tucker

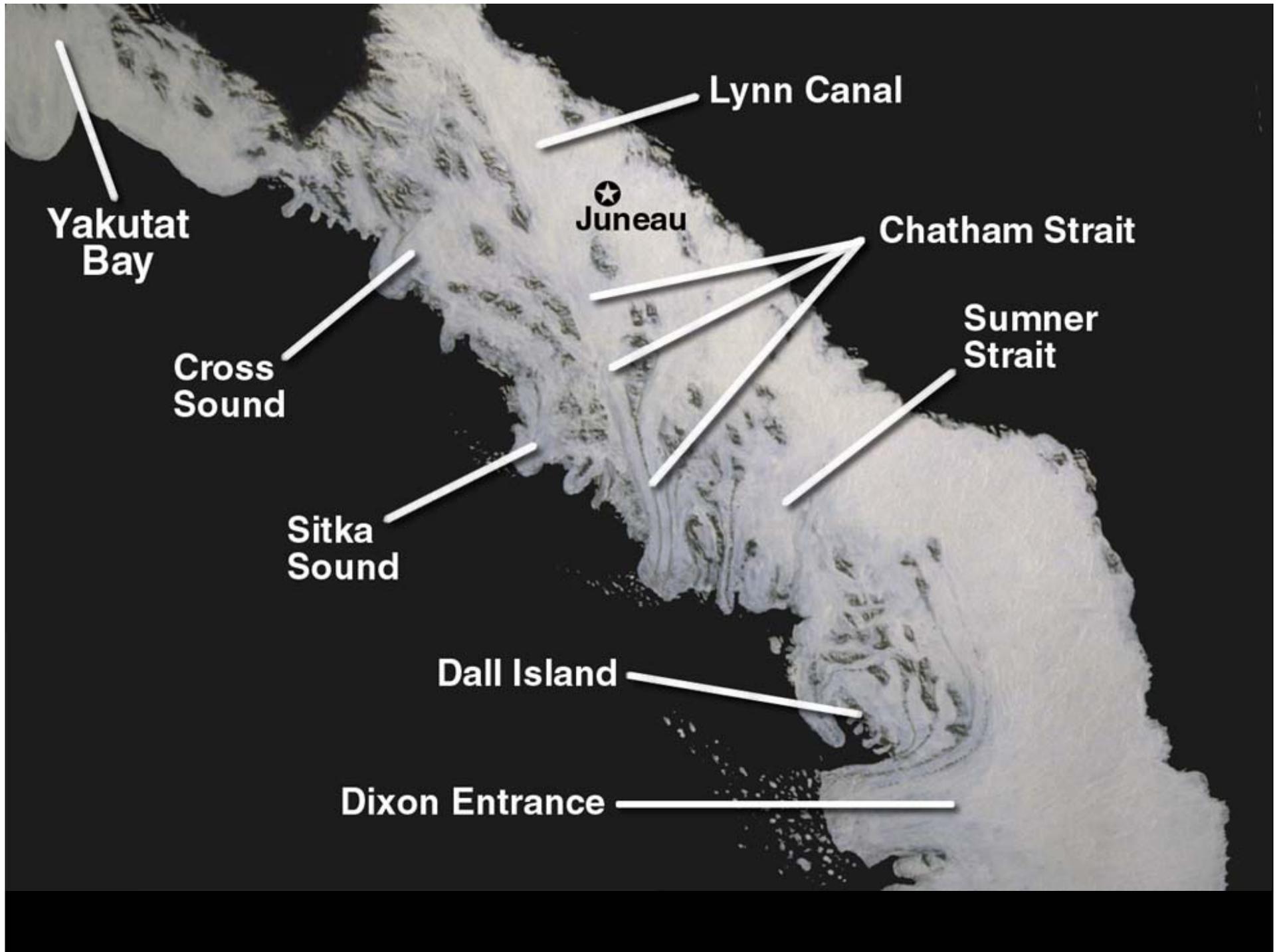
Tongass National Forest  
US Fish and Wildlife Service  
National Science Foundation

**Background:**  
Mechanism of Isolation









Yakutat Bay

Lynn Canal

★  
Juneau

Chatham Strait

Cross Sound

Sumner Strait

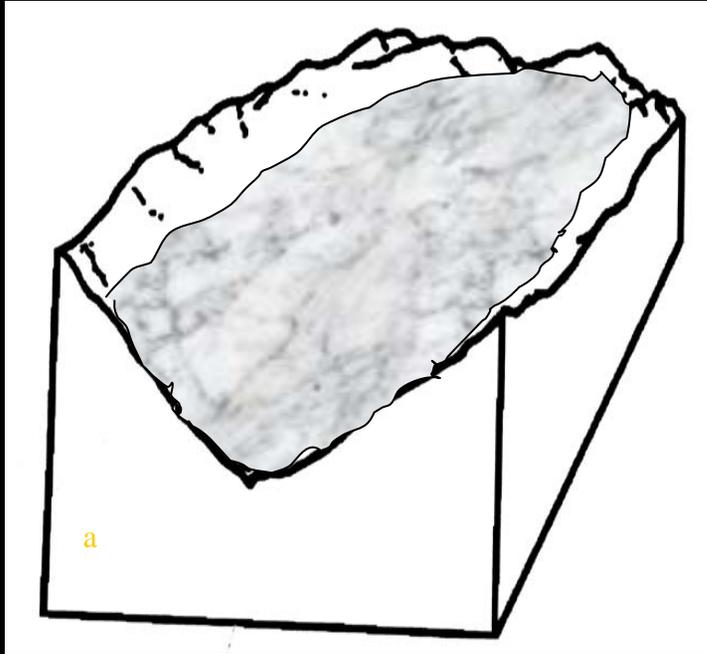
Sitka Sound

Dall Island

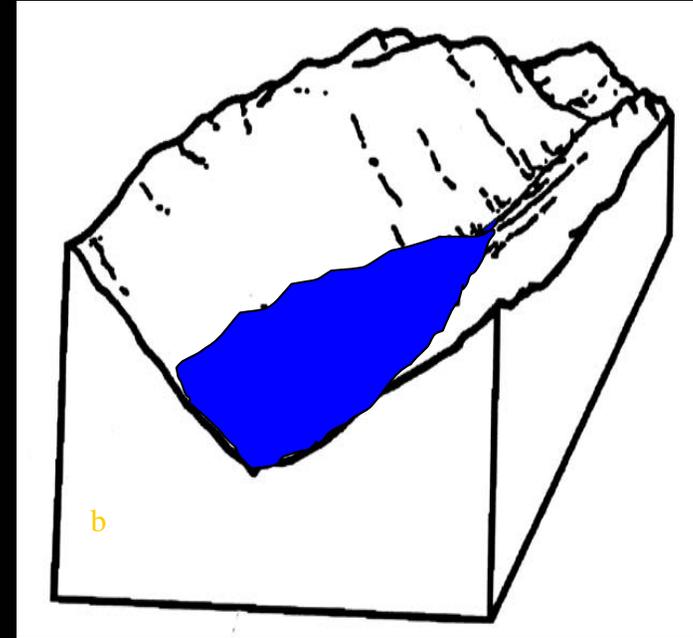
Dixon Entrance



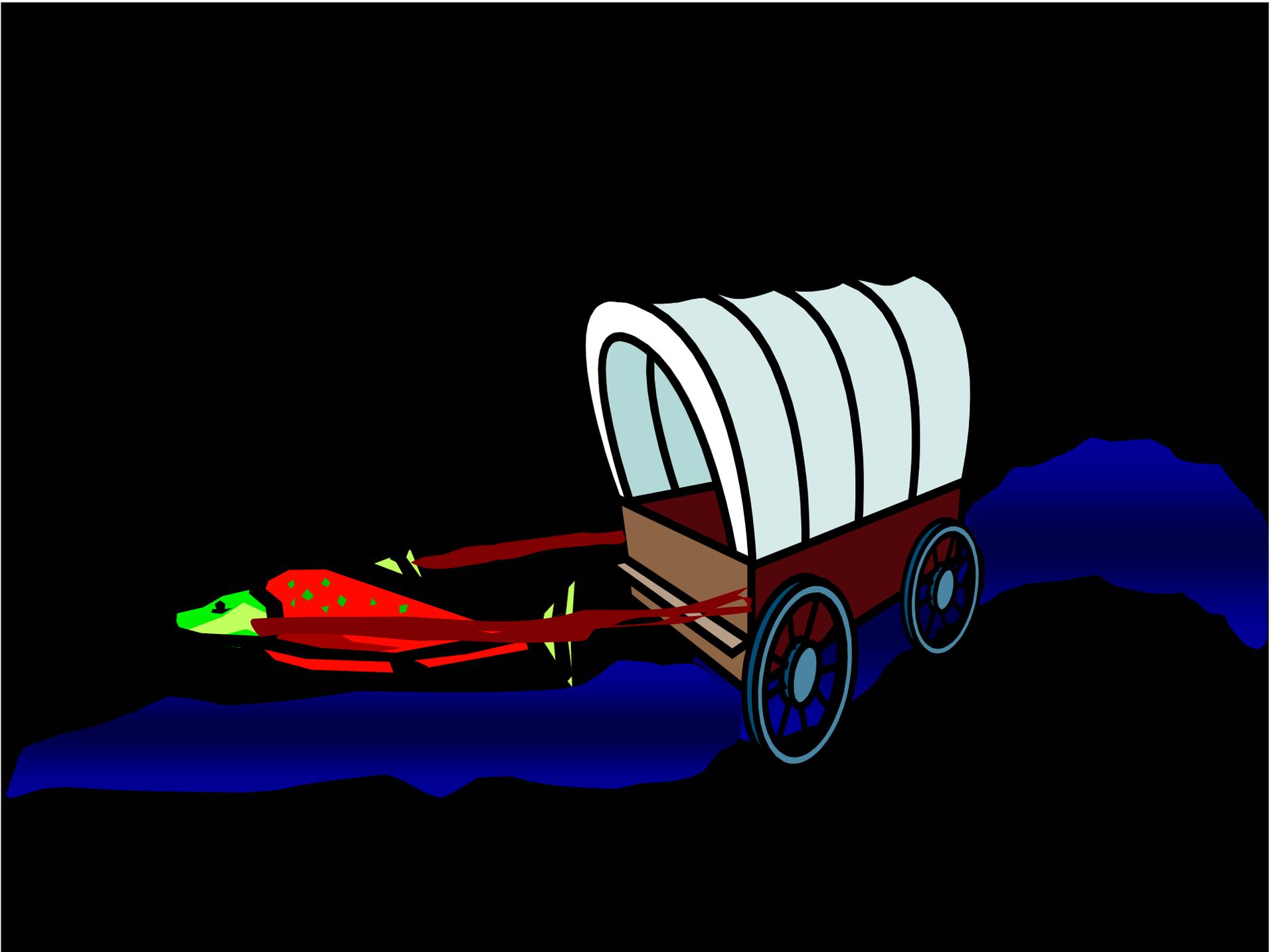
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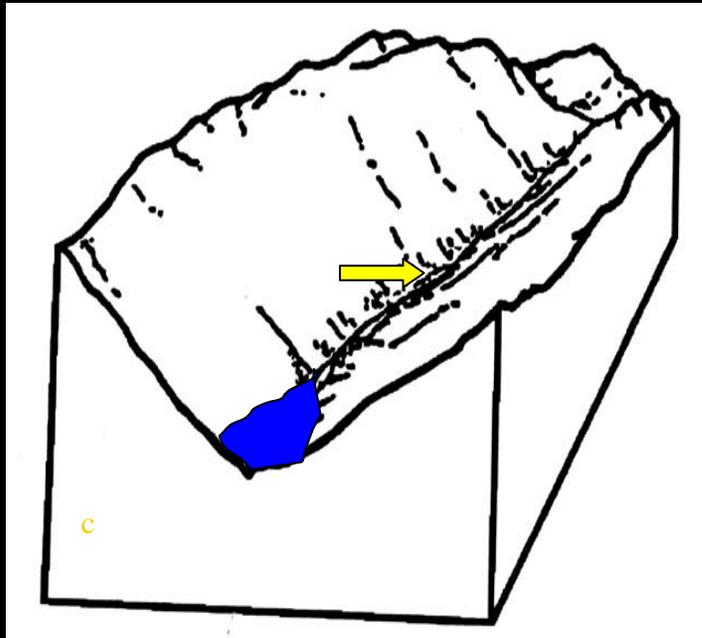


**Glaciers Covered  
Nearly All of SE  
Alaska During the  
Pleistocene**



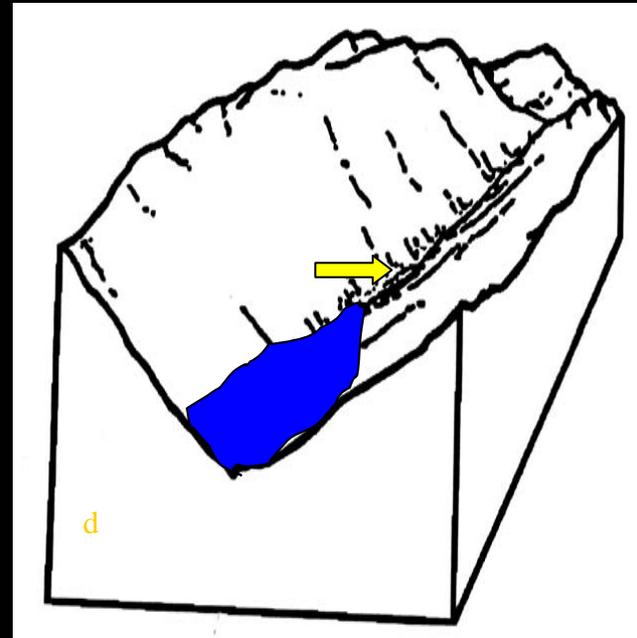
**Glaciers Retreat  
Sea Invades  
CA 13,500 yr BP**





**Land Rebounds  
Waterfalls Exposed**

**12,000-9000 yr BP**



**Global Sea Level  
Rise Complete**

**CA 5000 yr BP**





Coastal cutthroat trout  
*Oncorhynchus clarki clarki*



Dolly Varden  
*Salvelinus malma*



# Objectives

- Can persistence of isolated CCT (and DV) populations be predicted from habitat availability?
- How much habitat is required?
- How large is a “minimum viable population” of isolated CCT?

# Methods

## Key Assumption:

Absence of cutthroat trout above a waterfall implies a CCT population that failed

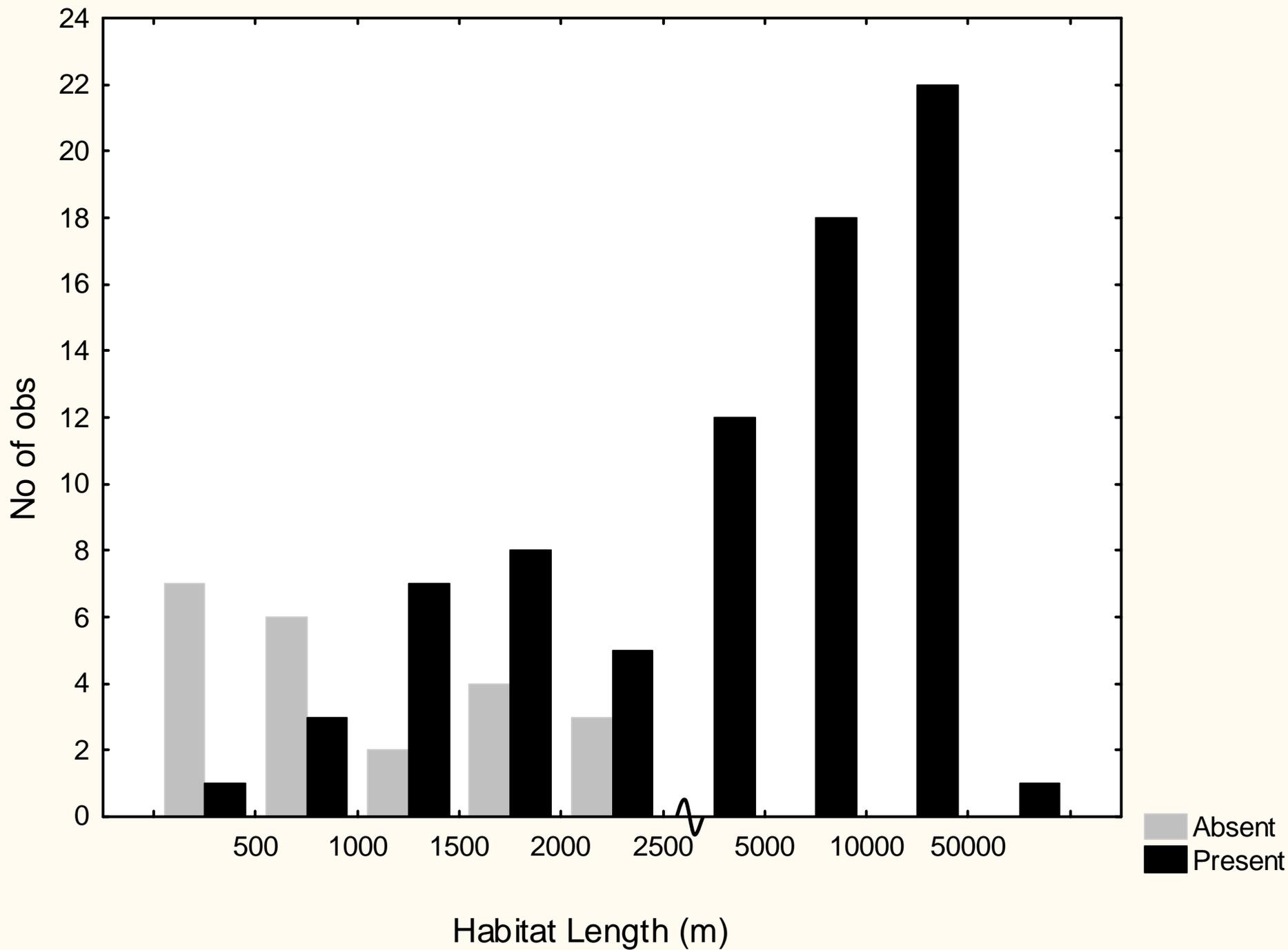


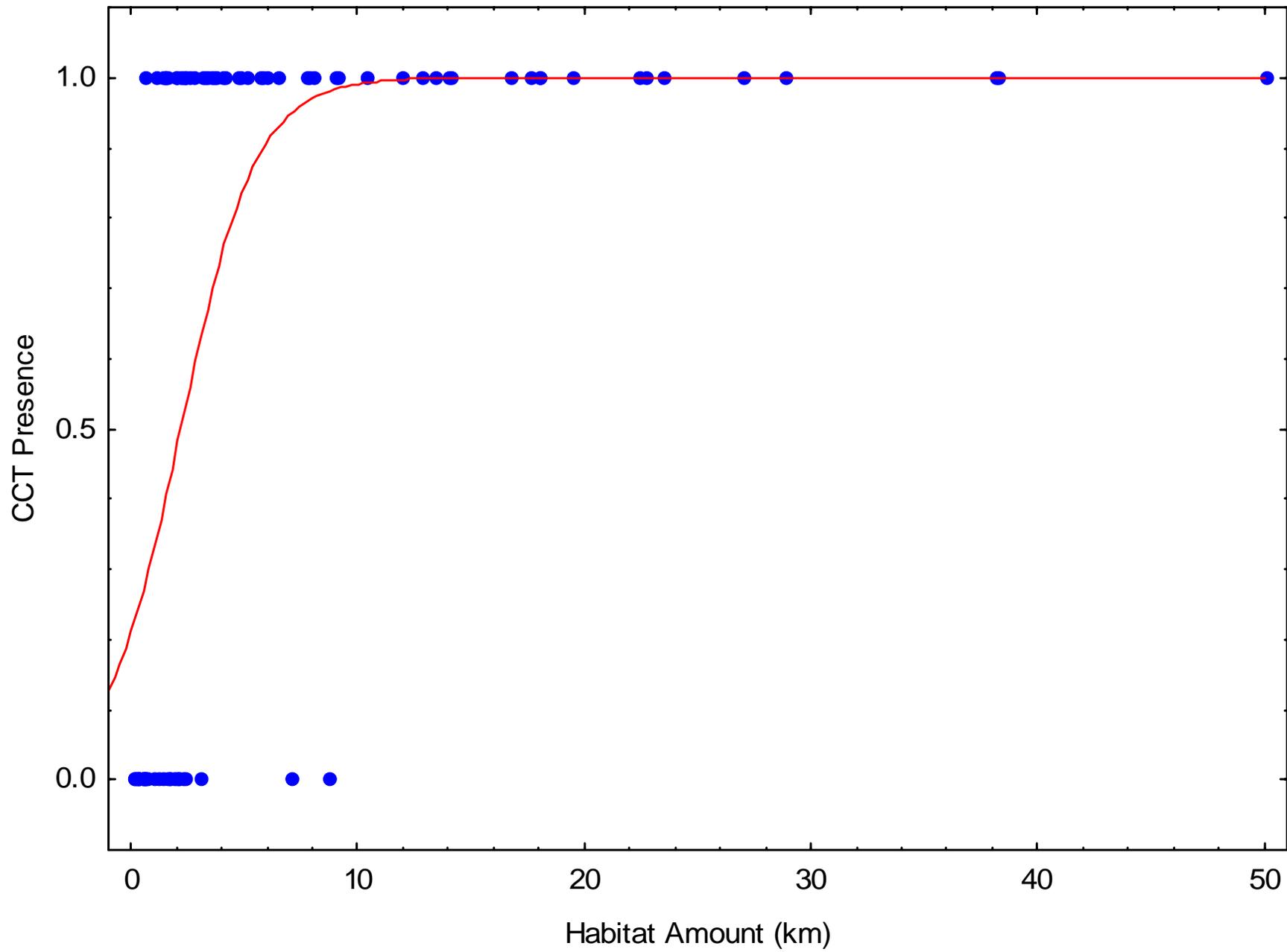


# Results

Assessed fish  
presence/absence in 124  
**naturally isolated** streams  
of a wide range of lengths  
(200 m to > 50 km)

Estimated typical adult fish  
density in a subset of 24  
streams annually for 1-6 years





<i>Spp</i>	<i>n</i>	$\chi^2$	<i>P</i>	<i>Odds Ratio</i>	<i>50% Length Threshold (km)</i>	<i>90% Length Threshold (km)</i>
CCT	54	45.22	<0.01	3.67	1.73	5.58
DV	74	42.96	<0.01	2.80	1.26	5.54

# How large is a viable population?

- Mean adult CCT density:
  - 0.39 +/- 0.08 fish/m (no DV)
  - 0.47 +/- 0.08 fish/m (DV present)
- A 5.5 km stream will generally contain ~2100-2600 adult fish

# Discussion

# White-spotted char in Japan

Morita, K. and S. Yamamoto, 2002. Effects of habitat fragmentation by damming on the persistence of stream-dwelling charr populations. *Conservation Biology* 16: 1318-1323

- Char were lost from 17 of 52 dammed sites
- Watershed area of 2.3 km<sup>2</sup> (~2.1km) required to maintain a pop. for 50 years
- Both space (watershed area) and time (isolation period) were important in explaining persistence

# Translocated cutthroat pops

Harig, A.L. and K.D. Fausch, 2002. Minimum habitat requirements for establishing translocated cutthroat trout populations. *Ecological Applications* 12: 535-551

- Watershed area of 14.7 km<sup>2</sup> (~6.7 km) required for >50% chance of establishing a "strong" population
- Low summer water temperatures decreased chance of successful establishment

# Inland cutthroat trout

Hilderbrand, R.H. and J.L. Kershner, 2000. Conserving inland cutthroat trout in small streams: how much stream is enough?. North American Journal of Fisheries Management 20: 513-520

- Stream length >8 km required to maintain high abundance
- Derived from actual density estimates and the 50/500 rule

# What is the 50/500 rule?

- Widely used rule of thumb
- To maintain sufficient genetic diversity for persistence
- Derived from genetic theory
- Uses “effective population size”
- $N_e = 50$  for short-term persistence, 500 for long-term
- The 500 part is hard to test!

To achieve  $N_e$  of 500:

$N_e/N$  is typically 0.2

-Need pop of ~2500 adults

Adult CCT density: ~0.4 fish/m

-Need ~6.25 km of habitat

# Conclusions

Likelihood of population persistence can be quite well explained by habitat quantity alone\*

About 5.5 km of stream are required for a high likelihood of long-term population persistence\*

# Conclusions

A population of about 2100-2600 adults has a high likelihood of persistence\*

The predictions of the 50/500 rule are supported\*



\*Your mileage may vary!