Environmental drivers of steelhead abundance in partially anadromous *Oncorhynchus mykiss* populations

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Key Characters in the Plot

Project Objectives

- Determine how environmental factors drive productivity of resident and anadromous *O. mykiss* ecotypes

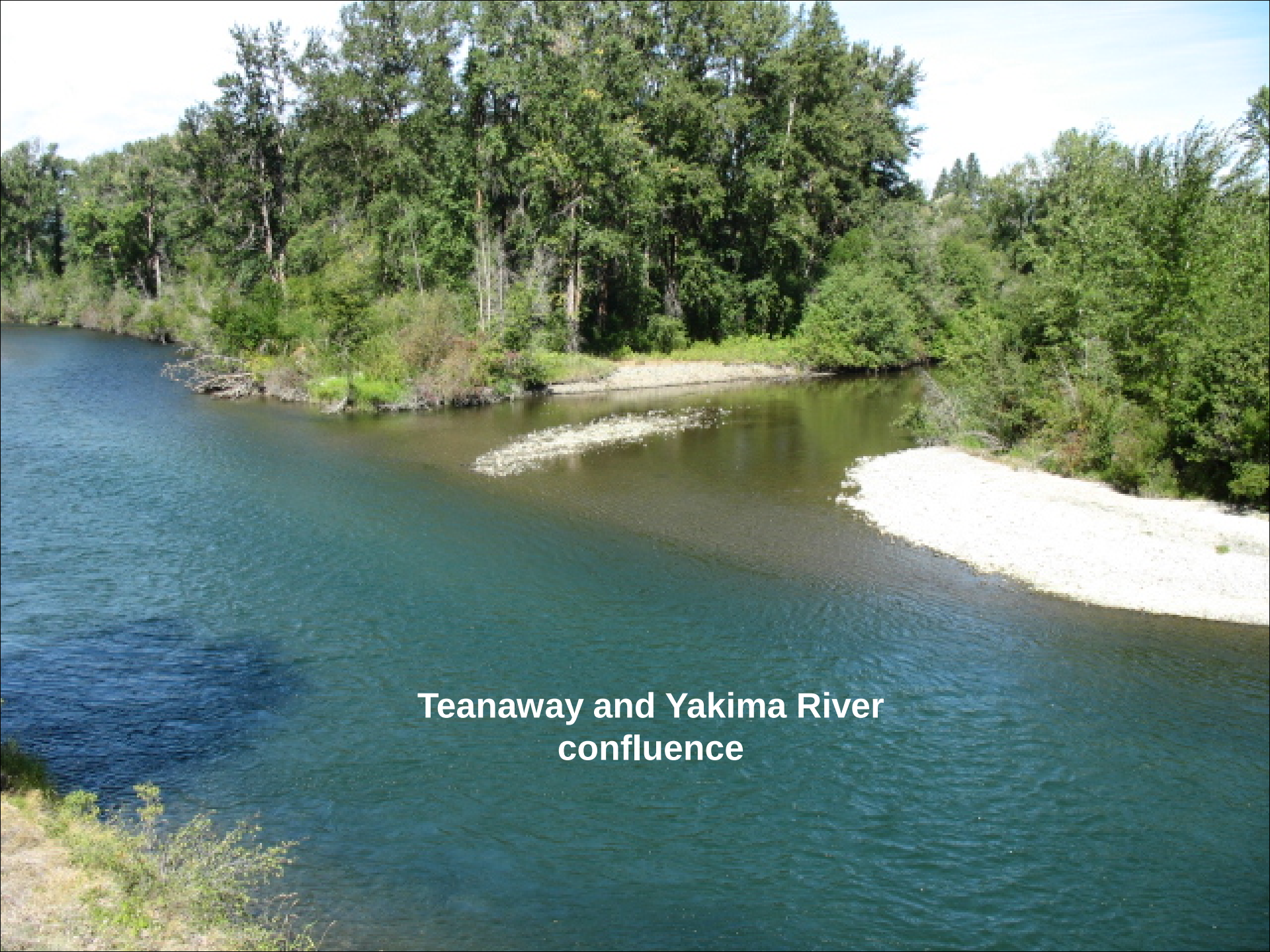
Test this understanding:

- Can the functional relationships of *O. mykiss* productivity to environmental factors predict the observed distribution of the two ecotypes in the Yakima Basin?

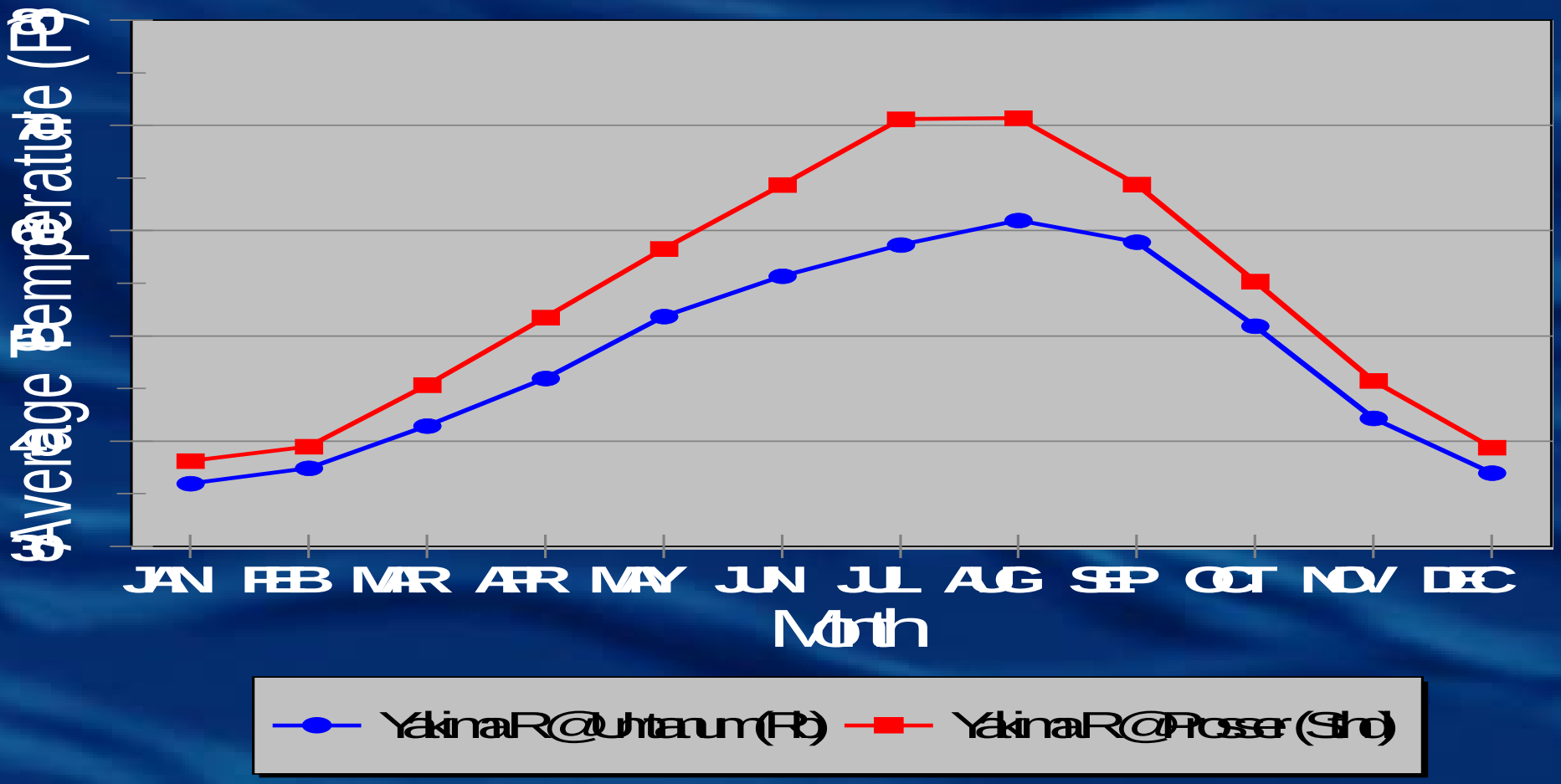
Examples of Resident Rainbow Streams within the Anadromous Fish Zones

	August	
Basin	Flow (cfs)	Temperature
McKenzie	2,600	54° F
Metolius	1,400	46° F
Upper Yakima	3,600	60° F
Upper Sacramento	10,000	55° F


Mainstem Teanaway


Teanaway and Yakima River
confluence

Yakima River Temperatures

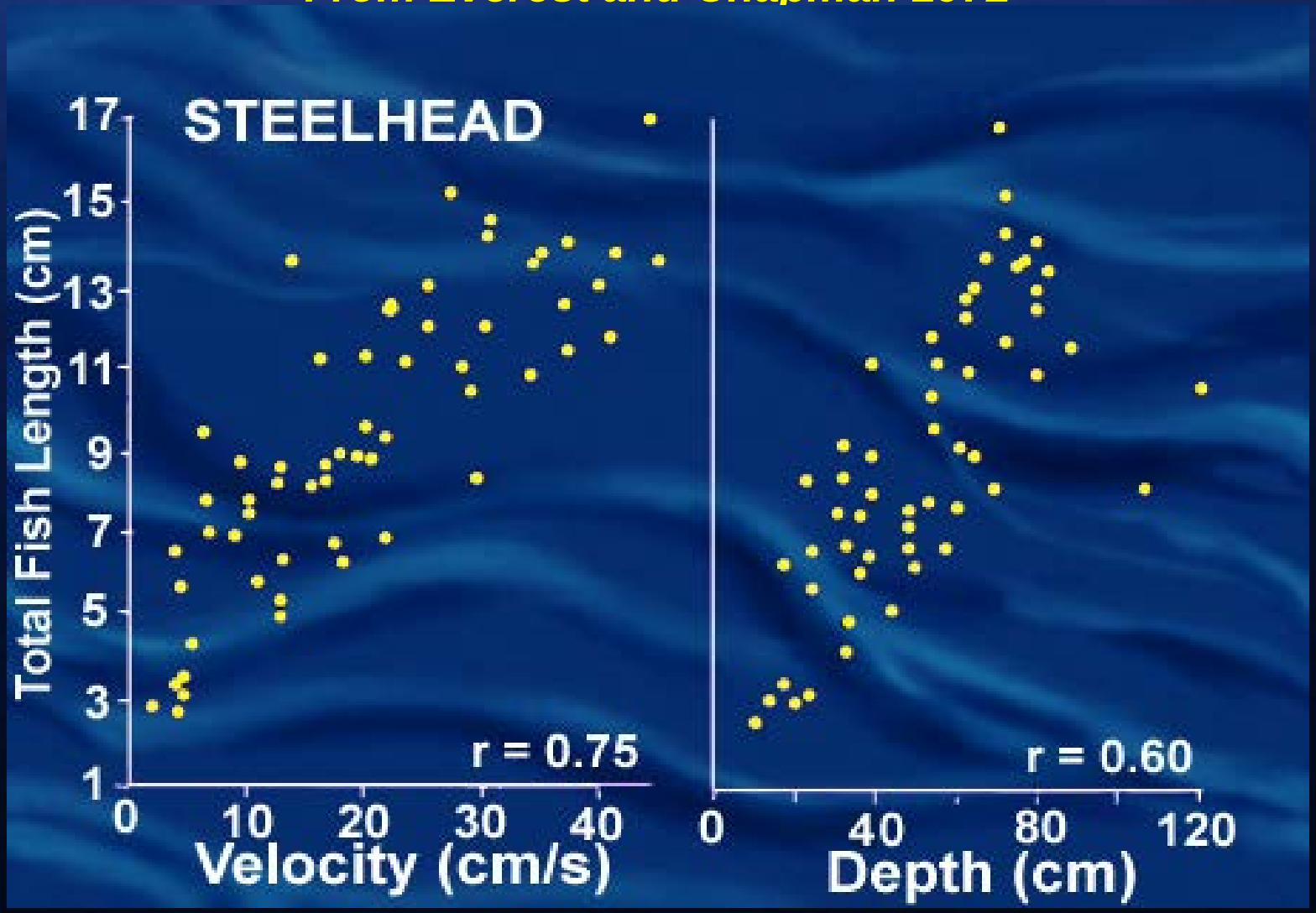


Rainbow And Steelhead Intermix And Produce Both Types

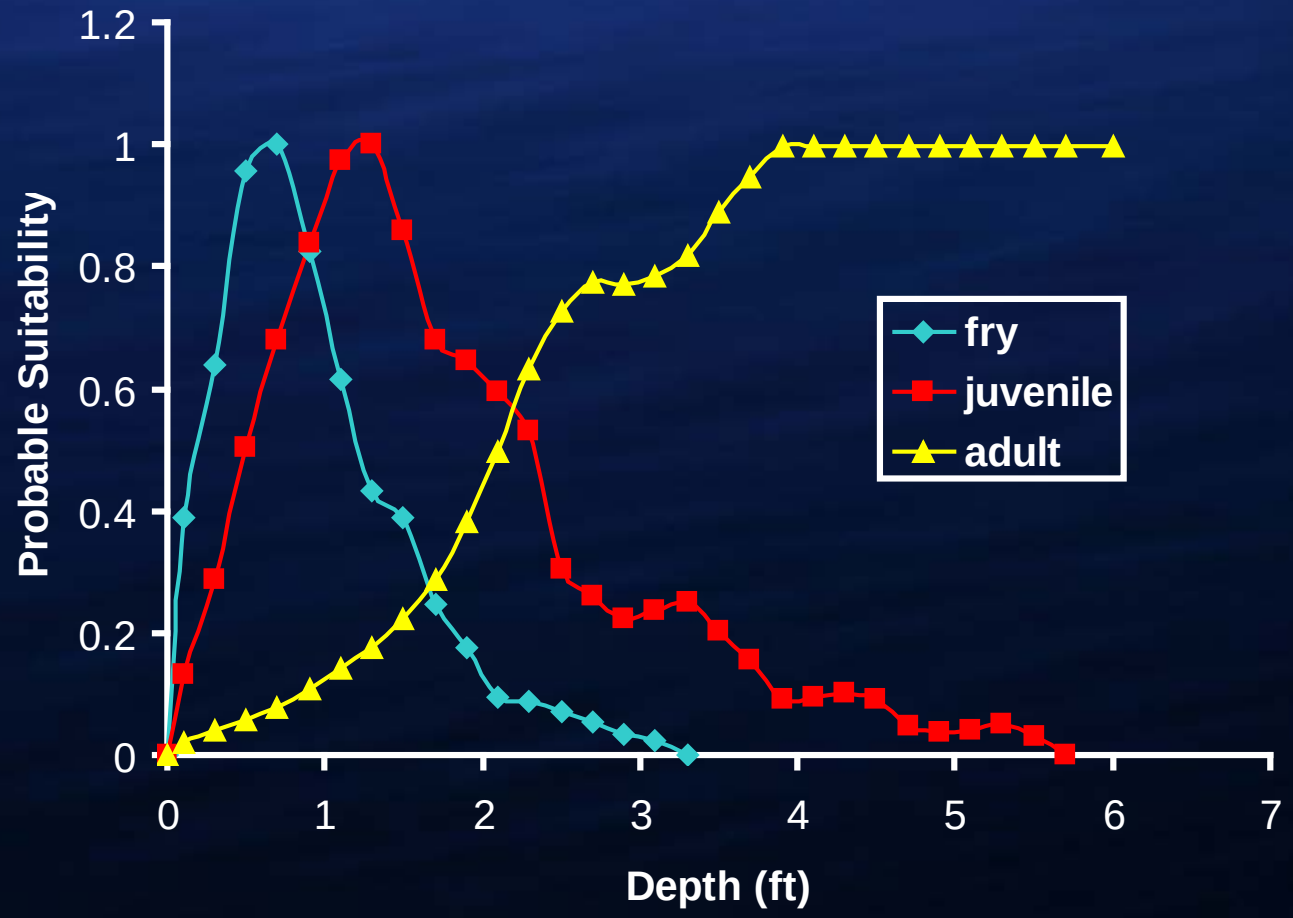
- Interbreeding of Rb x St is observed
- Genetics show similarity by basin, not by ecotype
- Breeding studies show each type produces some of the other
- Sr/Ca ratio in otoliths of spawners confirms cross parentage

Focal Point Depth and Velocity.

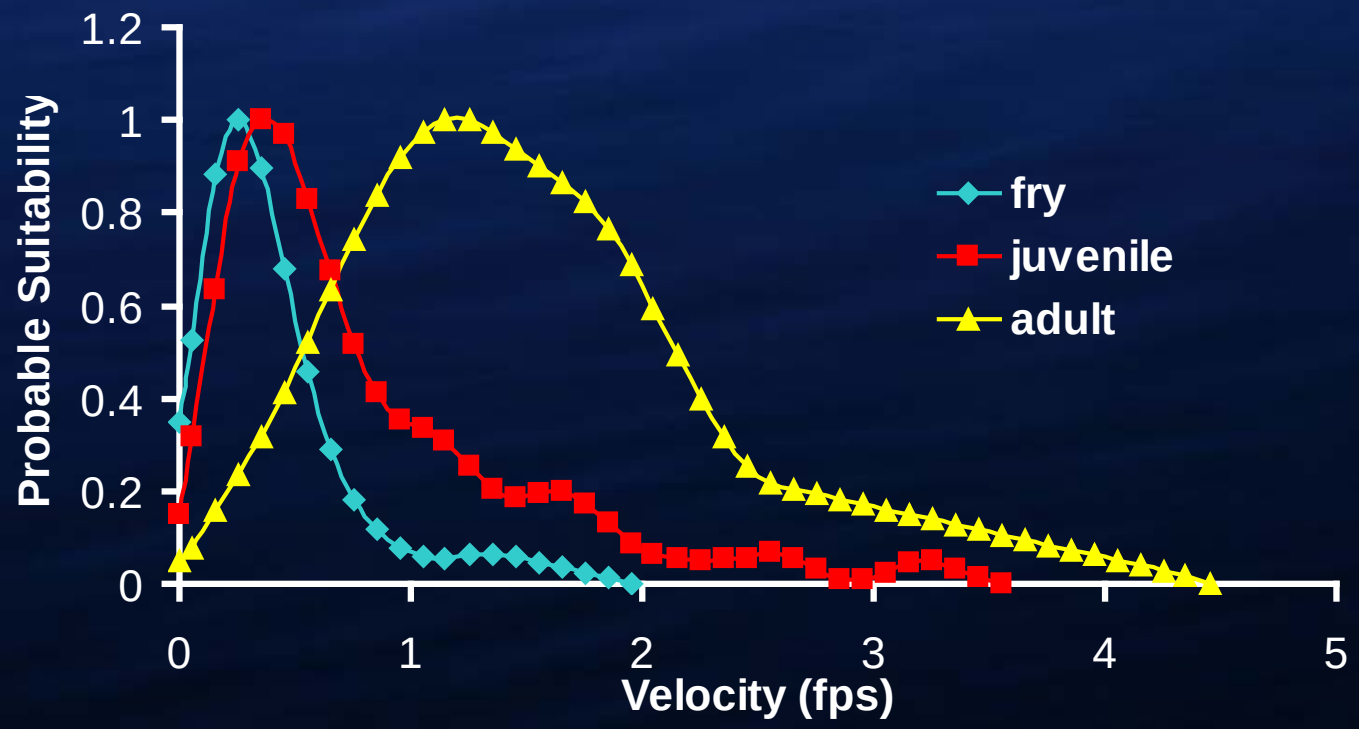
From Everest and Chapman 1972

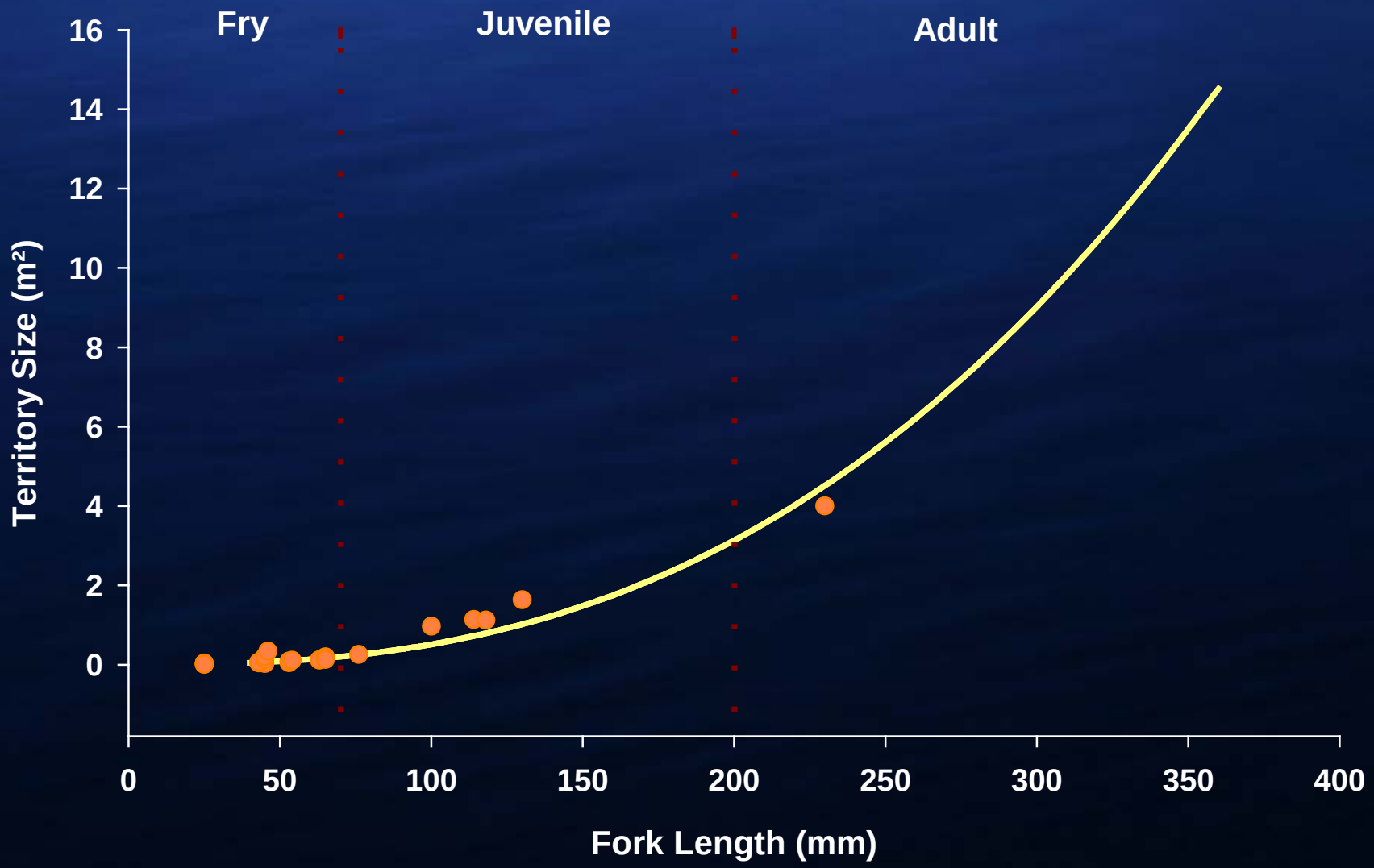


Depth Suitability for *O. mykiss*

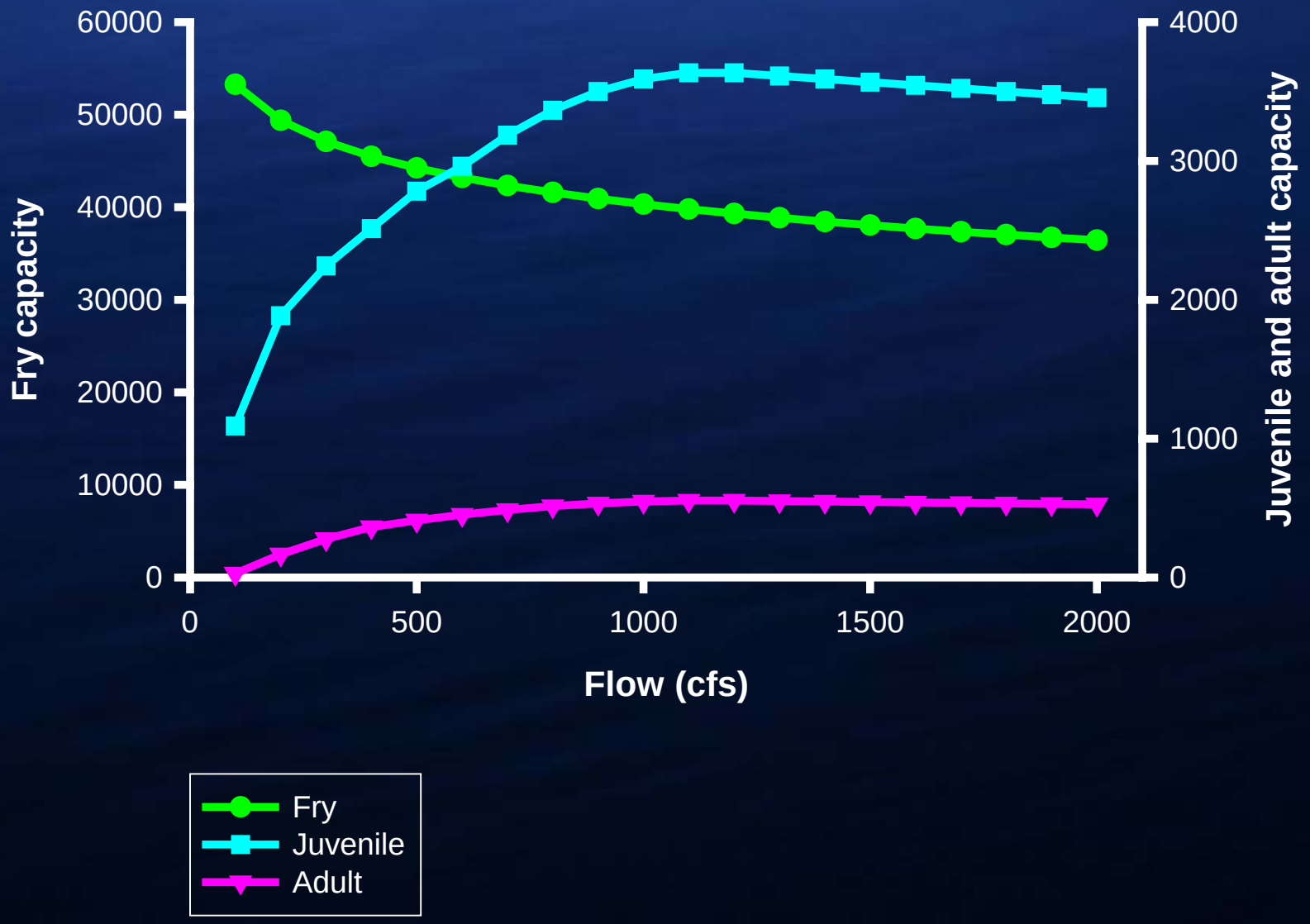


Velocity Suitability for *O. mykiss*

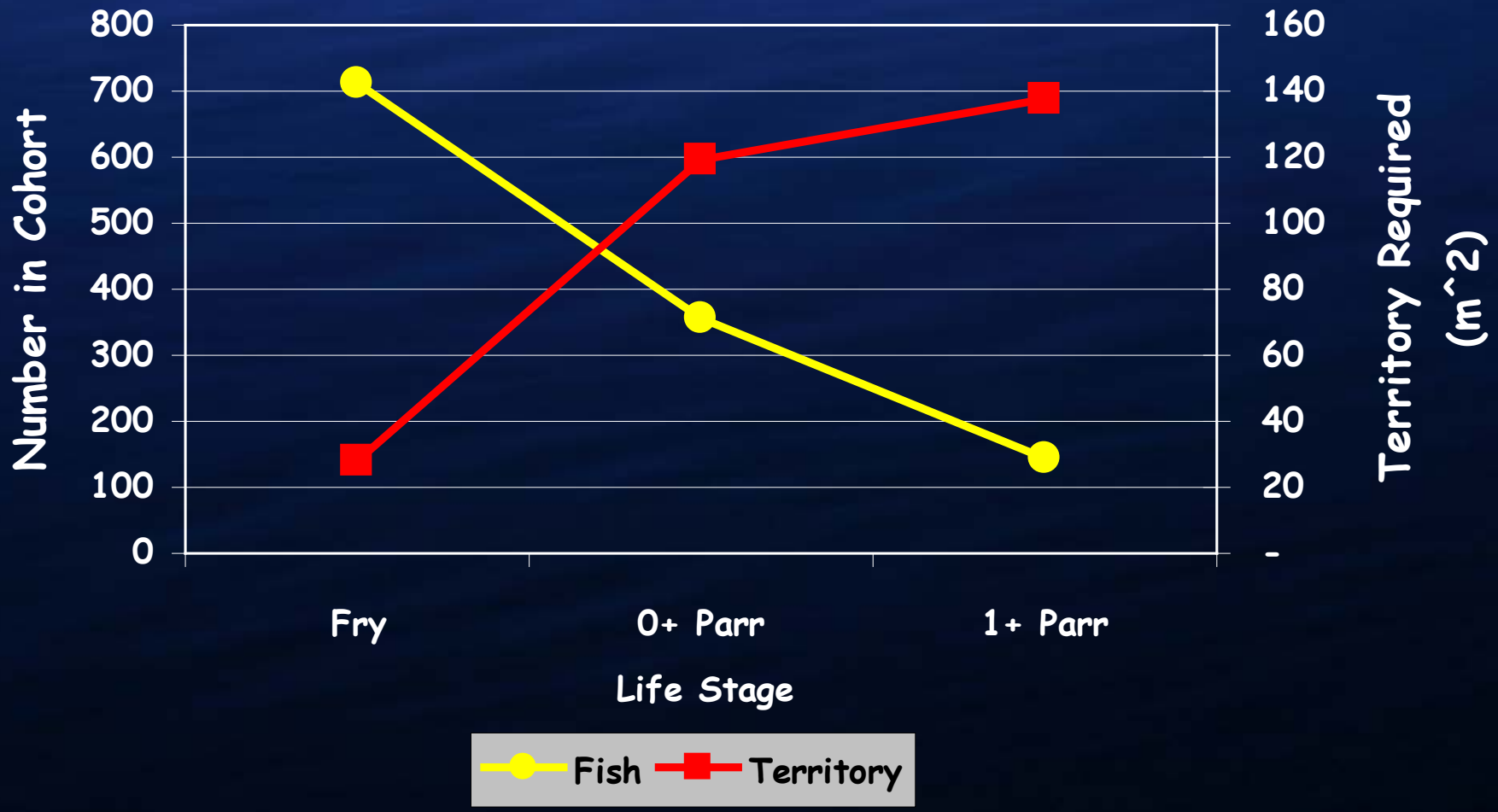




From Grant and Kramer (1990)


60000
50000
40000
30000
20000
10000
0
Fry capacity
4000
3000
2000
1000
0
Juvenile and adult capacity
0
500
1000
1500
2000
Flow (cfs)
Fry
Juvenile
Adult

Territory Needed for a Steelhead Cohort

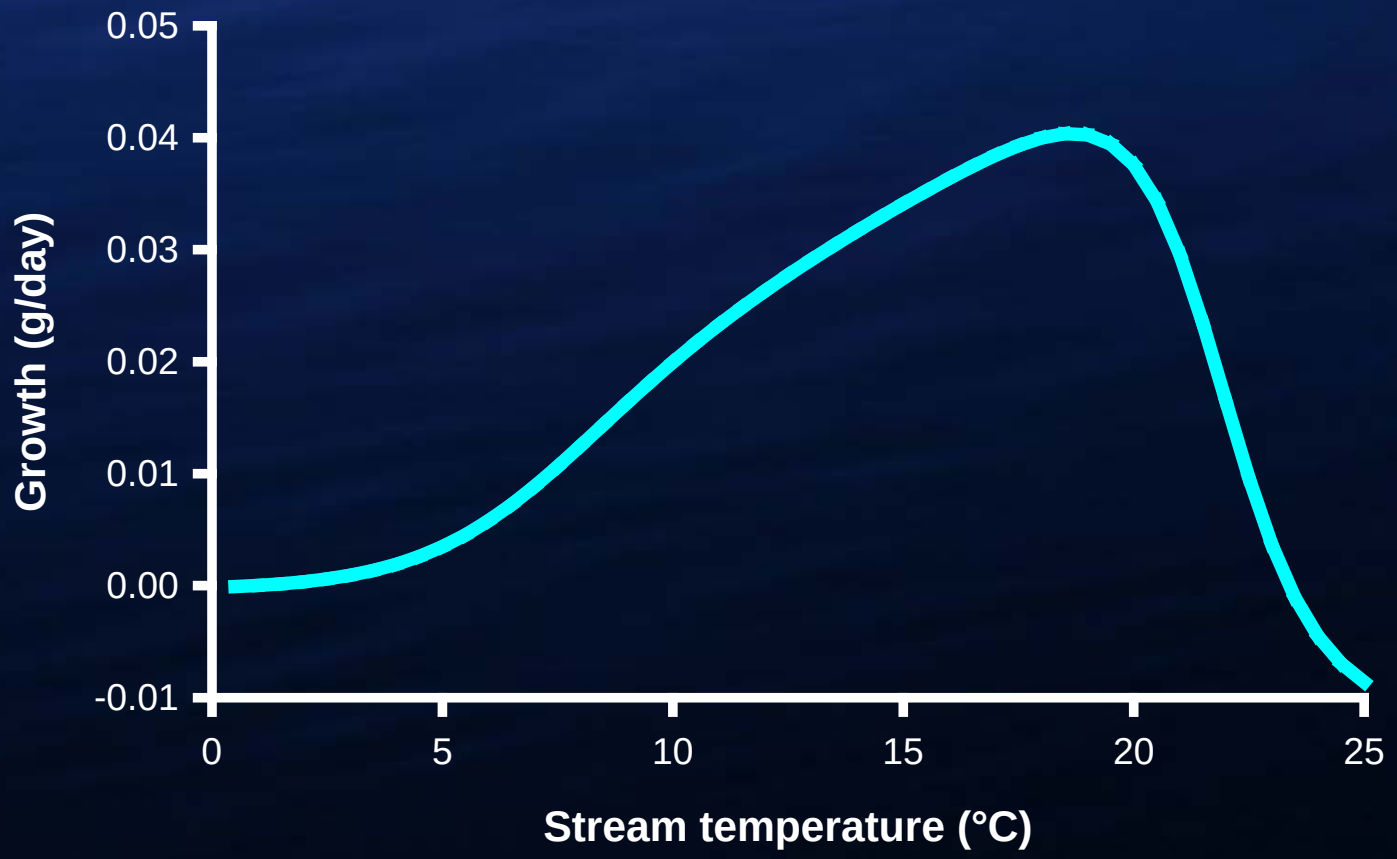


Modeling Growth in Freshwater

Growth = anabolic gains – catabolic losses

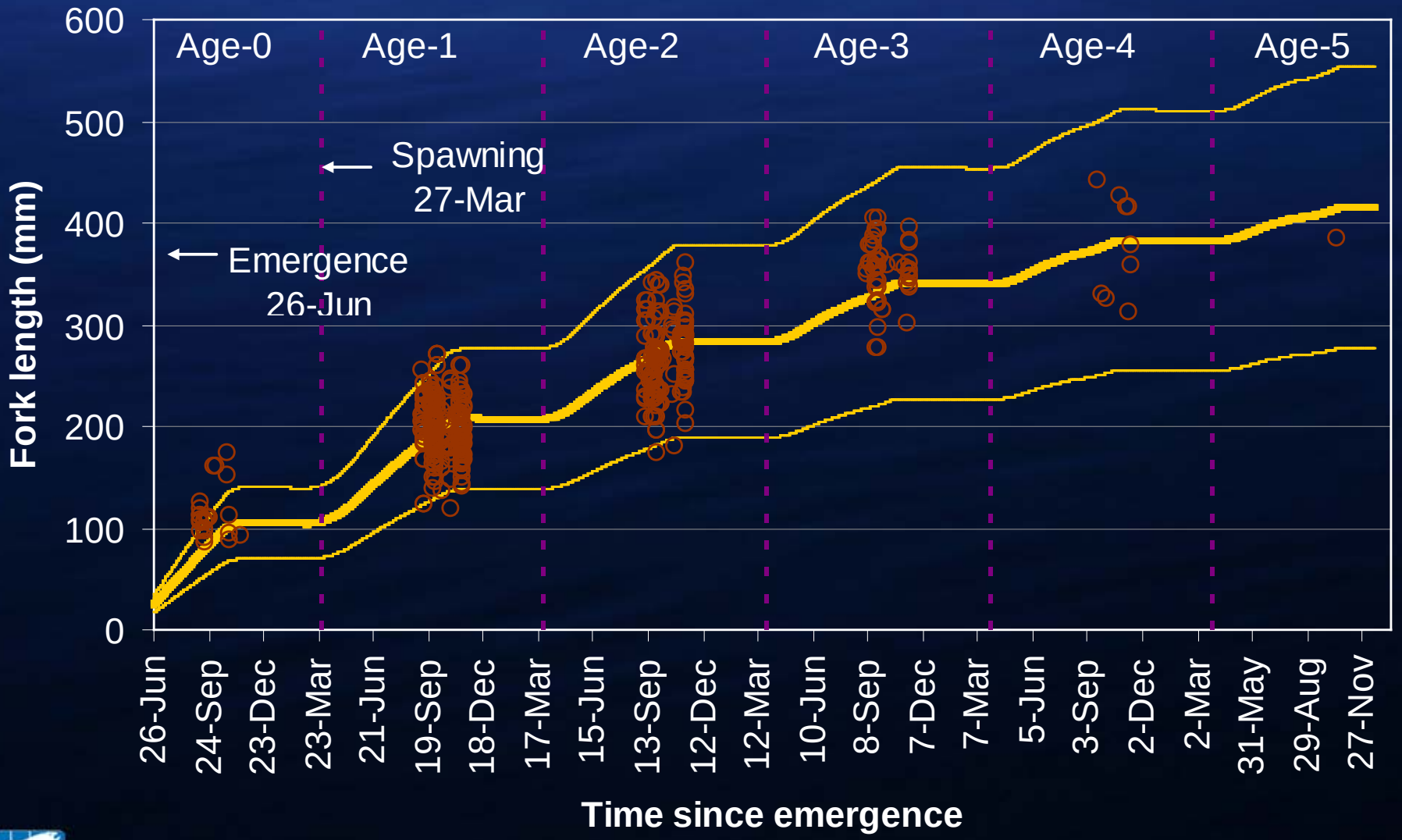
Factors influencing growth:

1) Temperature
2) Food availability

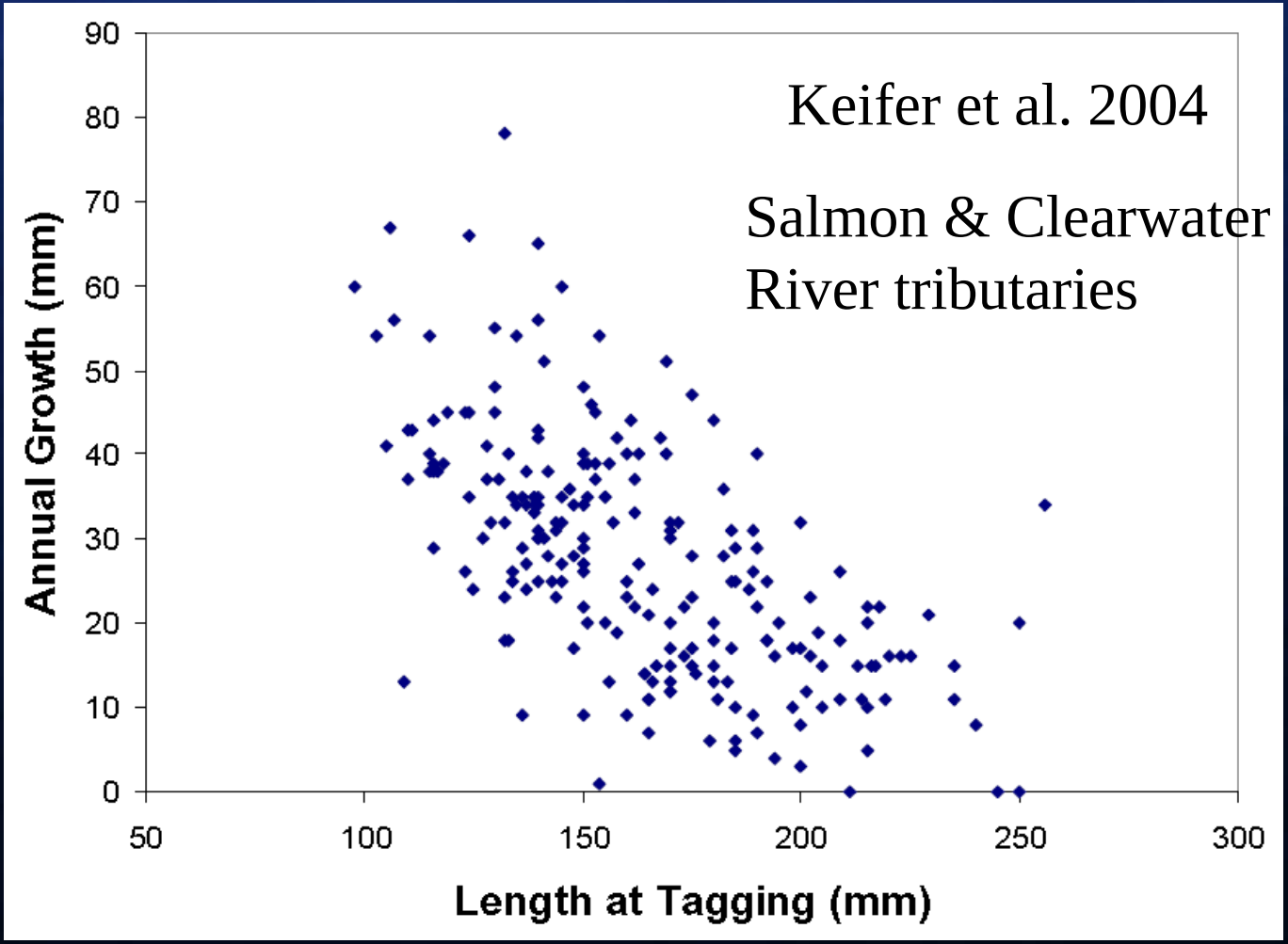


From Rand et al. (1993) and Mangel and Satterthwaite (2008).

Mainstem Growth

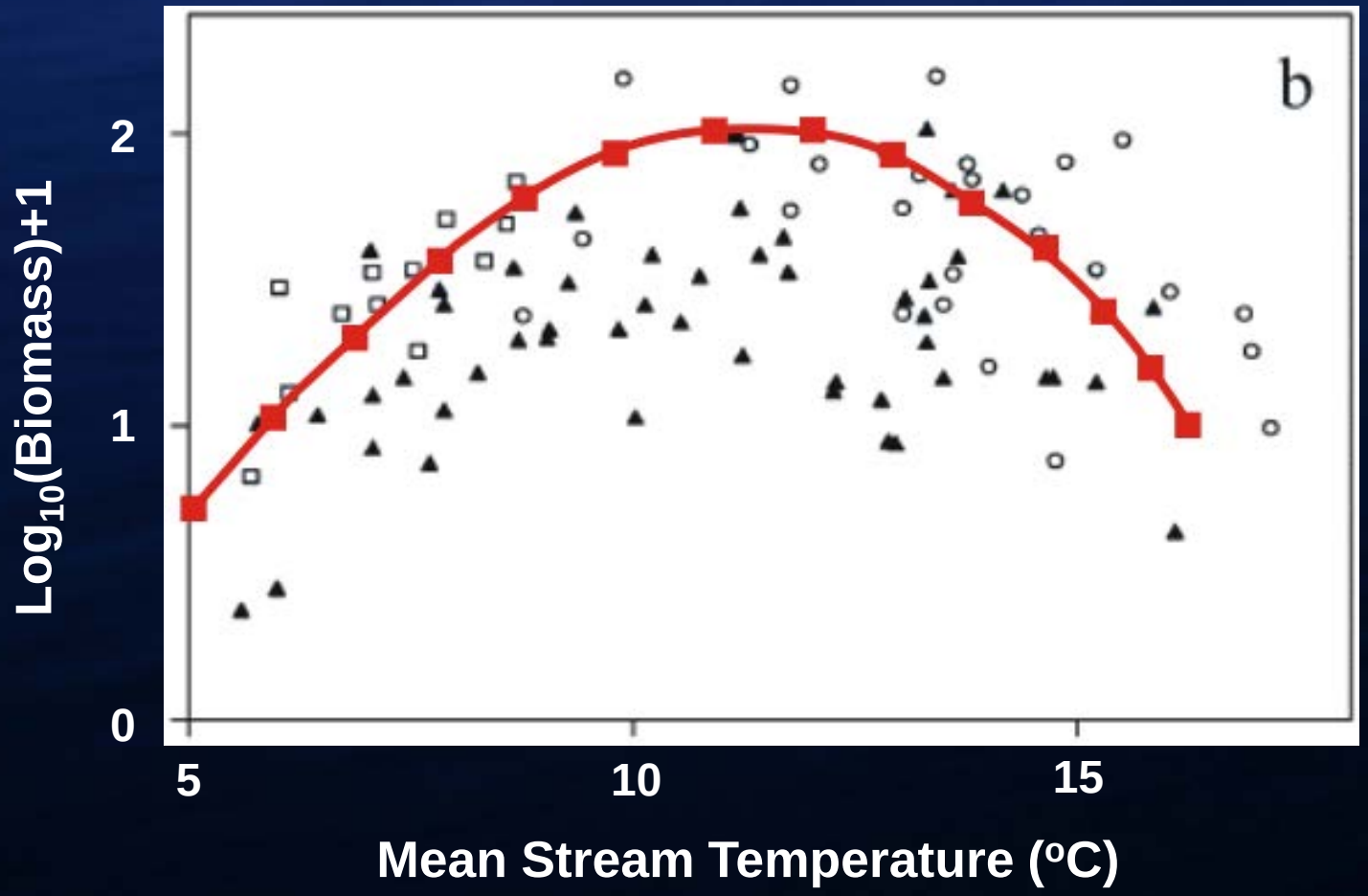


Growth of PIT-tagged Wild Steelhead Recaptured 1 yr after Tagging



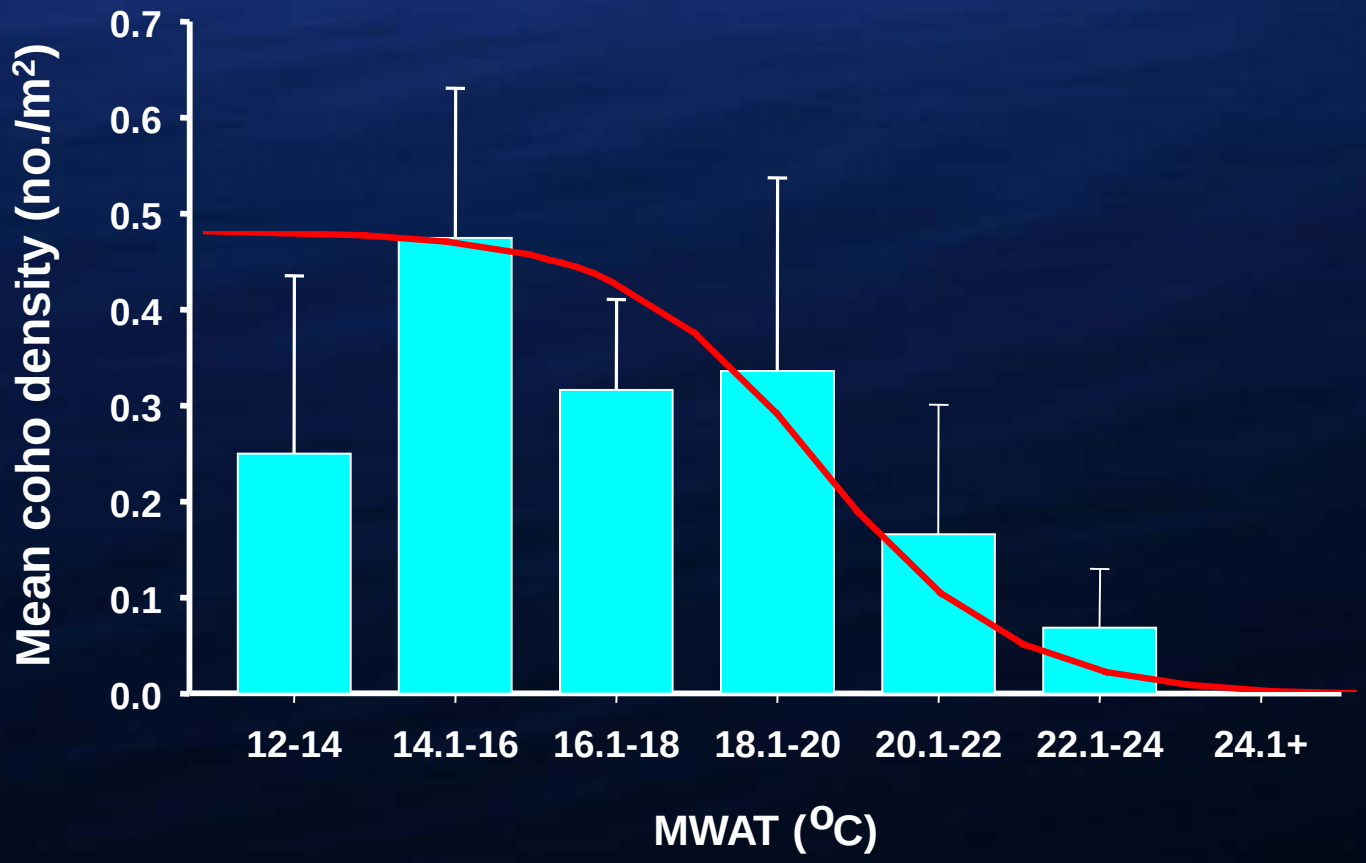
Relationship Between Temperature & Trout Biomass

Salt River Basin (Isaak and Hubert 2004)



Juvenile Coho Density vs. Temperature

260 Oregon Coast Sample Sites



Extended Bar shows 2 Standard Errors

Conclusions

- Channel size, flow and temperature are key factors that determine carrying capacity for resident fish over 250 mm, and may determine which of the two ecotypes will dominate
- Data are available in the Yakima Basin to predict how carrying capacity for *O. mykiss* will be affected by flow, temperature, and channel morphology
- We can test how well we understand the factors driving life history of *O. mykiss* by:
  - Using what we understand to build a life cycle model for *O. mykiss*
  - Plug in actual values for habitat and environmental factors,
  - Compare how the predicted and observed distributions of the two ecotypes match

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Growth is a Key Driver

- Growth determines size at age
- Size determines the area of habitat occupied
- Size at age determines winter survival in freshwater
- Size at smolting determines ocean survival

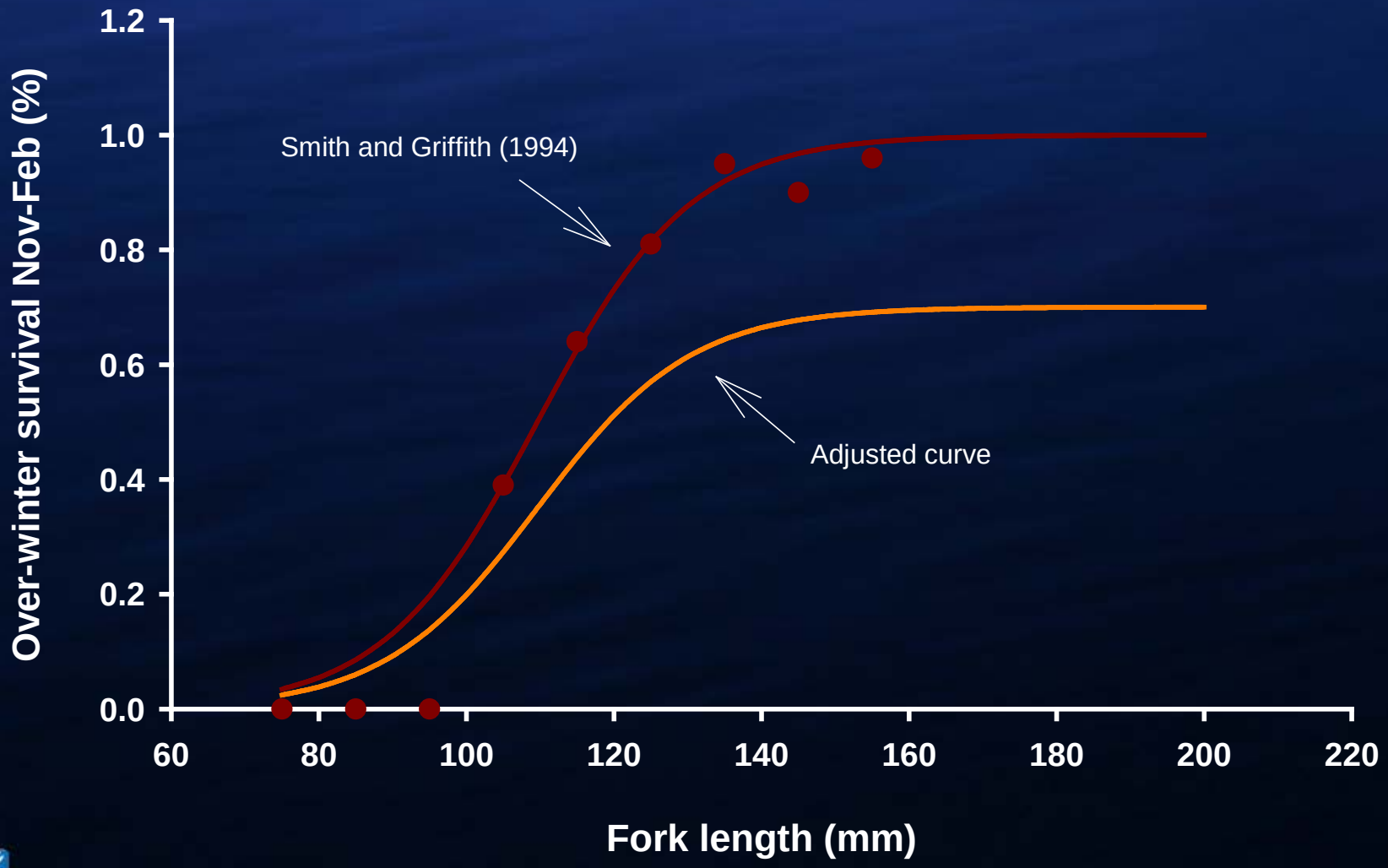
Hypothesis

Variation in flow conditions influence the distribution of the two ecotypes across subbasins

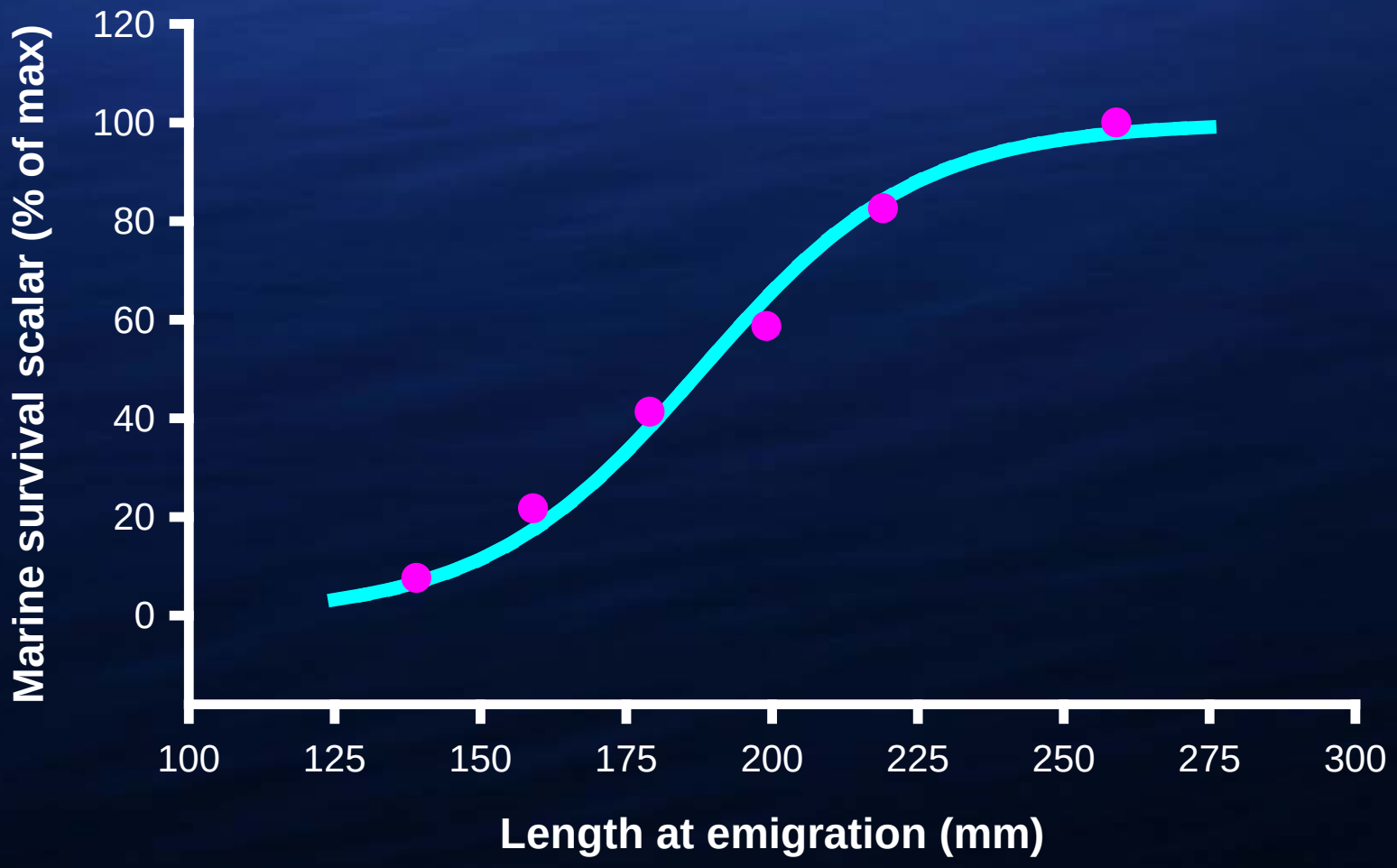
Hypothesis

Substantial declines in summer discharge will reduce carrying capacity for adult resident fish and promote a migratory life-history strategy

Over-winter Survival

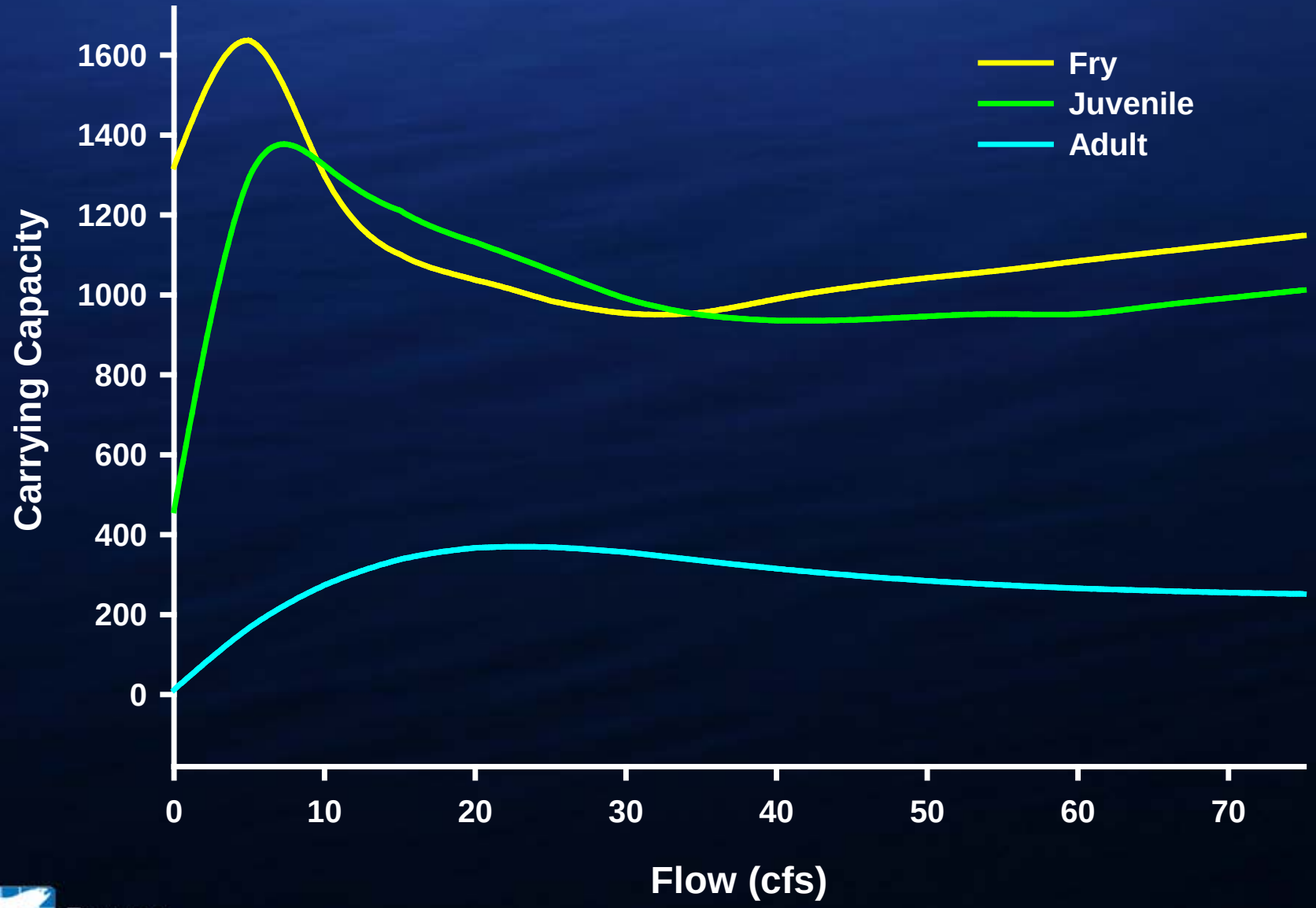


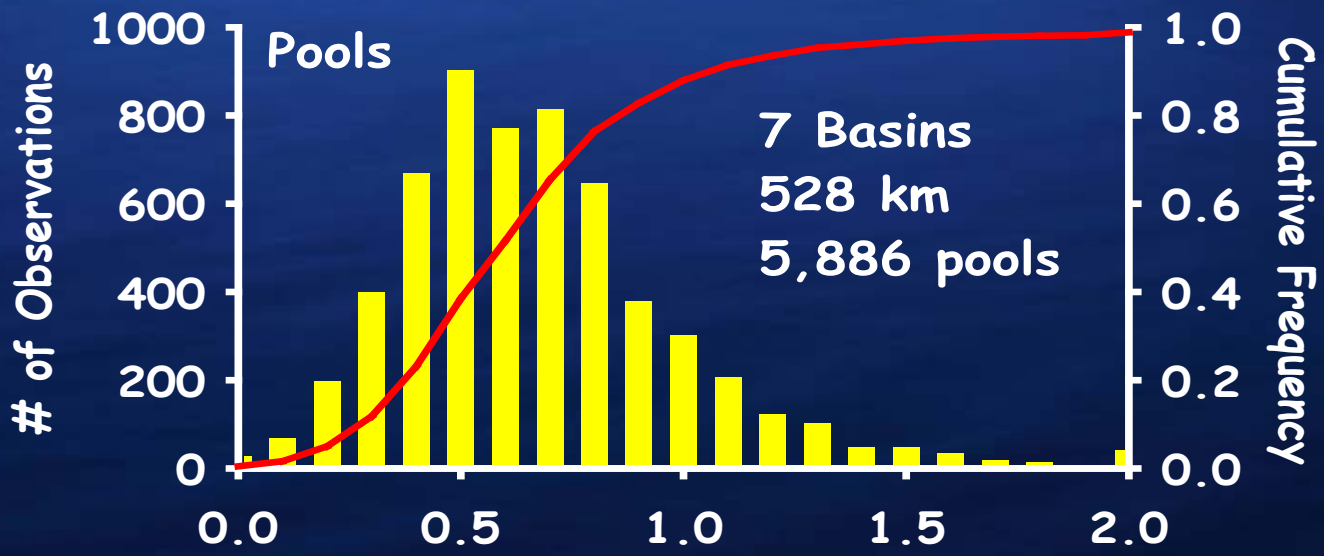
Marine Survival

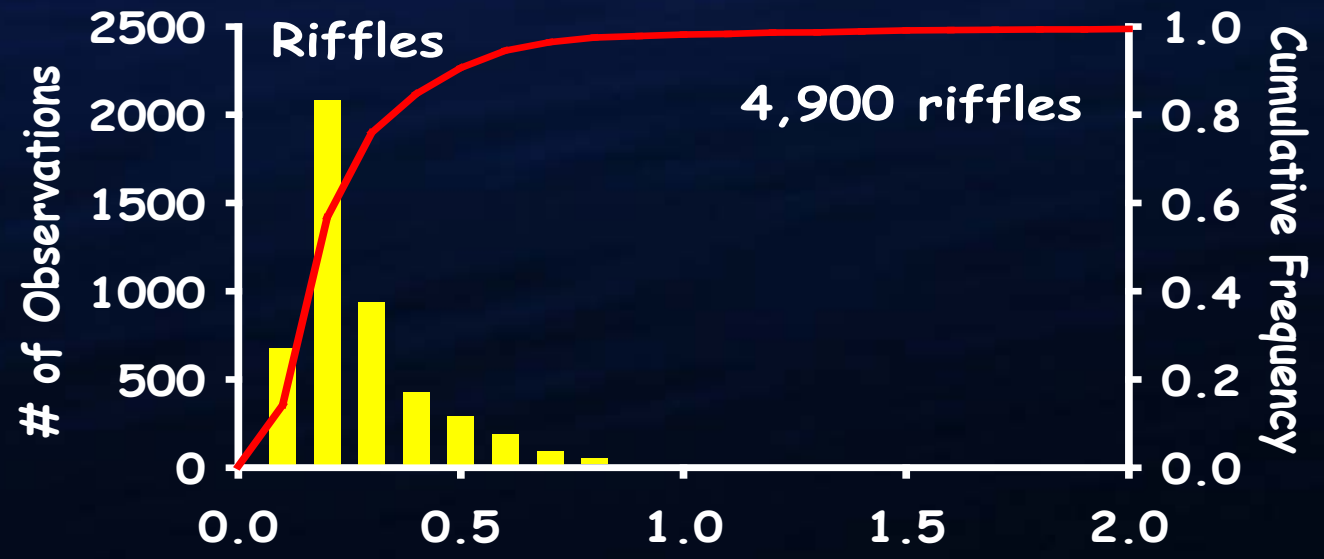


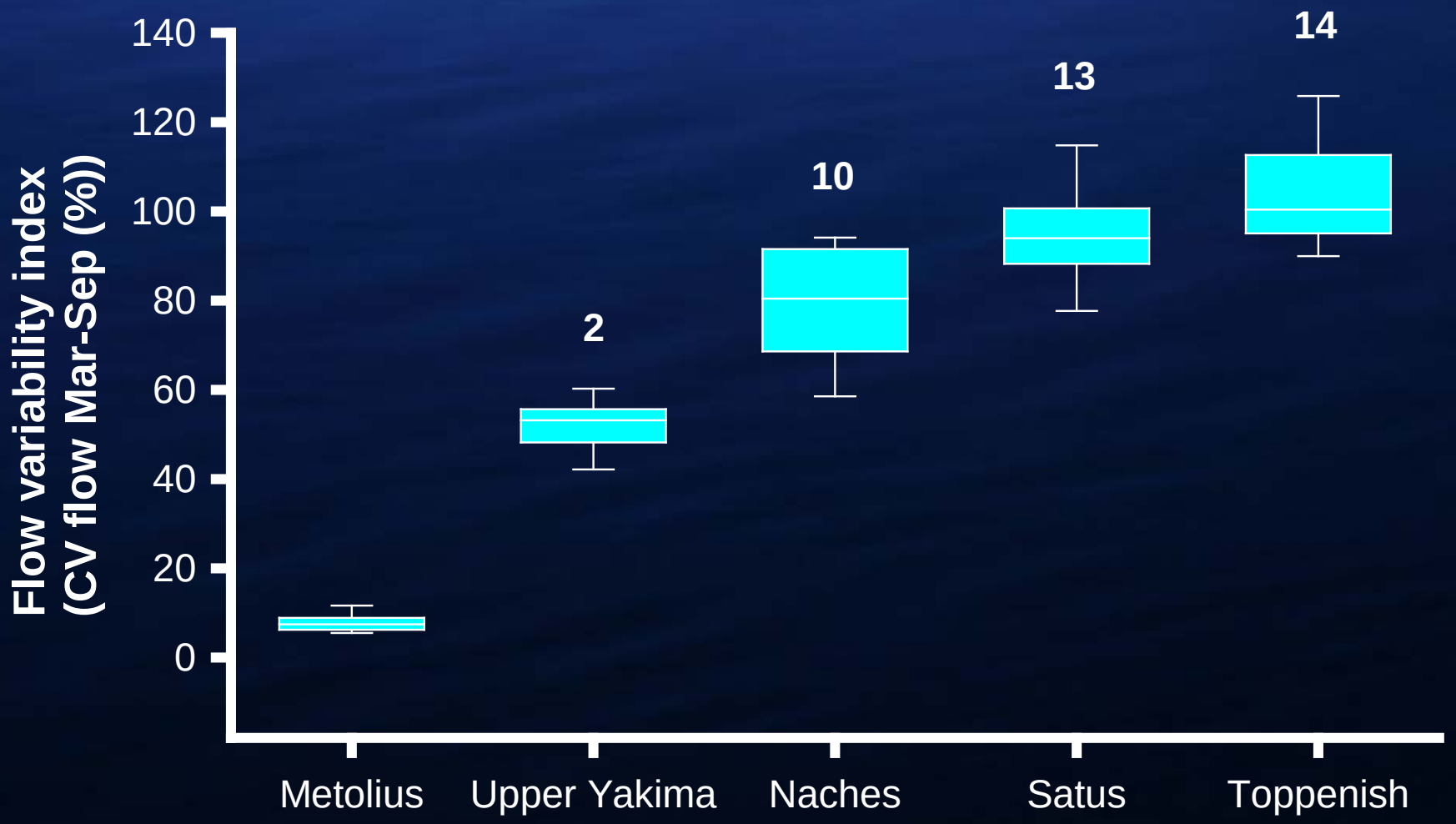
Data from Ward and Slaney (1989)

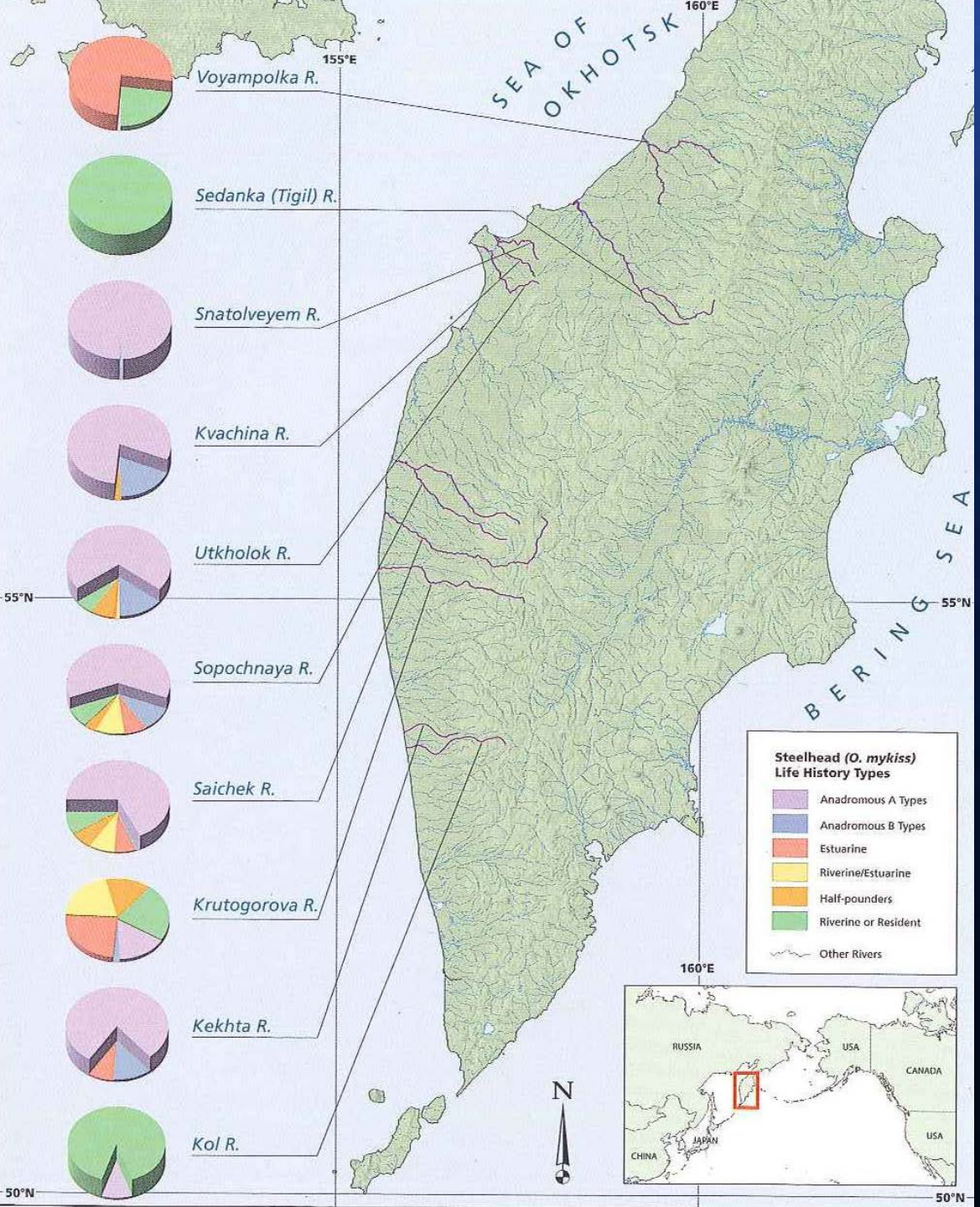
Rearing capacity = Habitat Area (m2) / Territory size (m2)

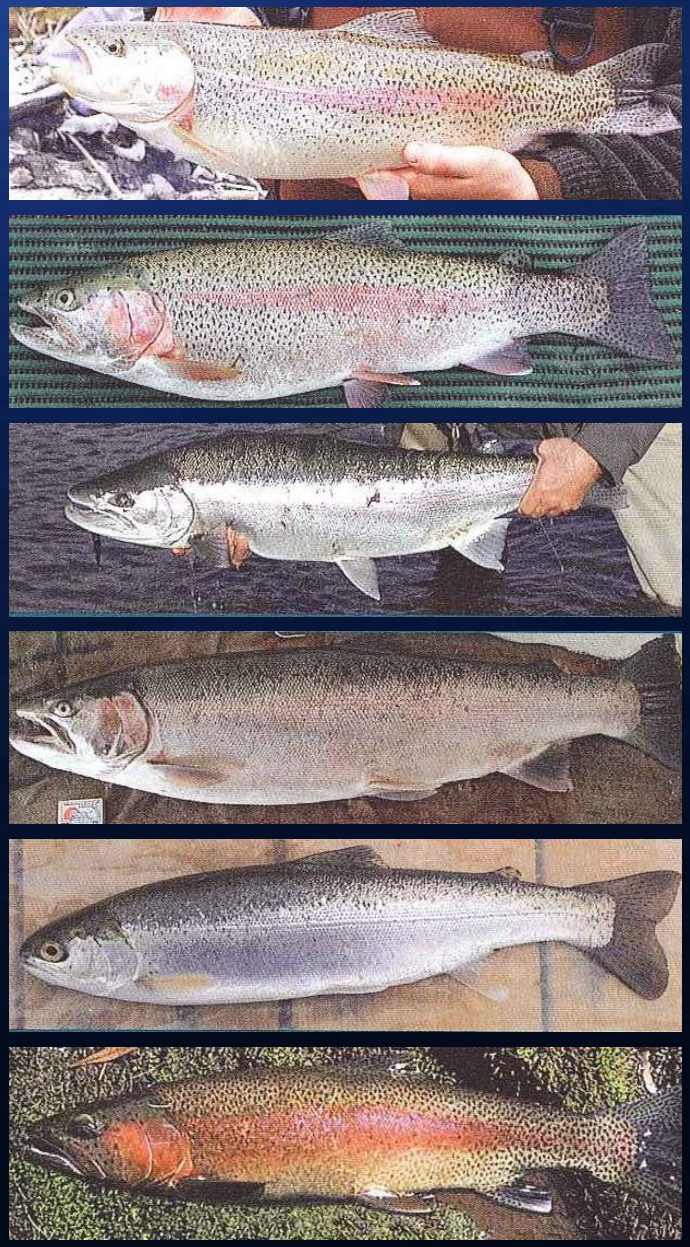



Pools
7 Basins
528 km
5,886 pools
# of Observations
Cumulative Frequency
1000
800
600
400
200
0
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.5
1.0
1.5
2.0


Riffles
4,900 riffles
# of Observations
Cumulative Frequency
2500
2000
1500
1000
500
0
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.5
1.0
1.5
2.0
Depth (m) (Upper Bound)


Flow variability index
(CV flow Mar-Sep (%))
140
120
100
80
60
40
20
0
2
10
13
14
Metolius
Upper Yakima
Naches
Satus
Toppenish





Atlas of Pacific Salmon (2005)

Tributary Growth