Ecology of the last great wild salmon rivers

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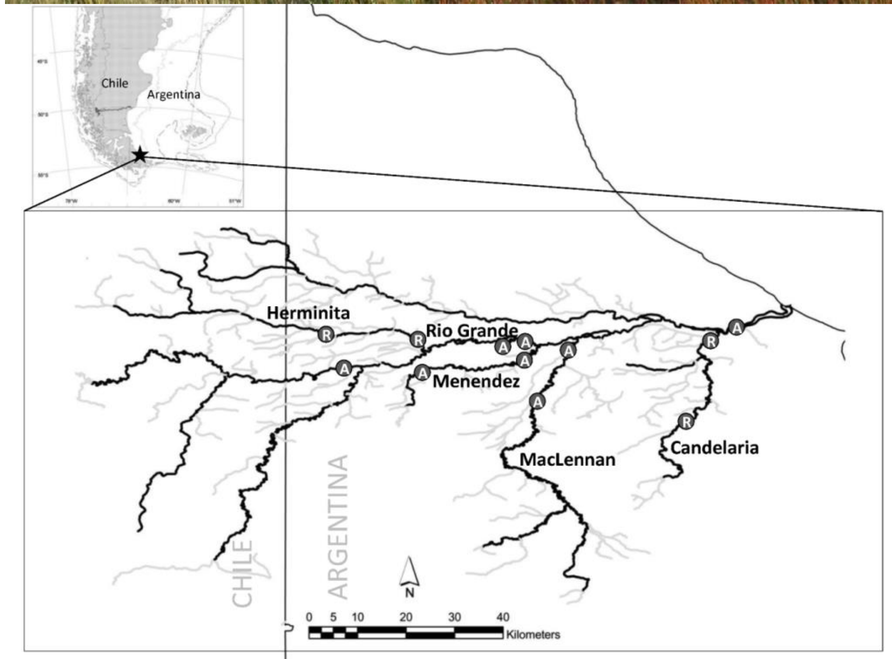
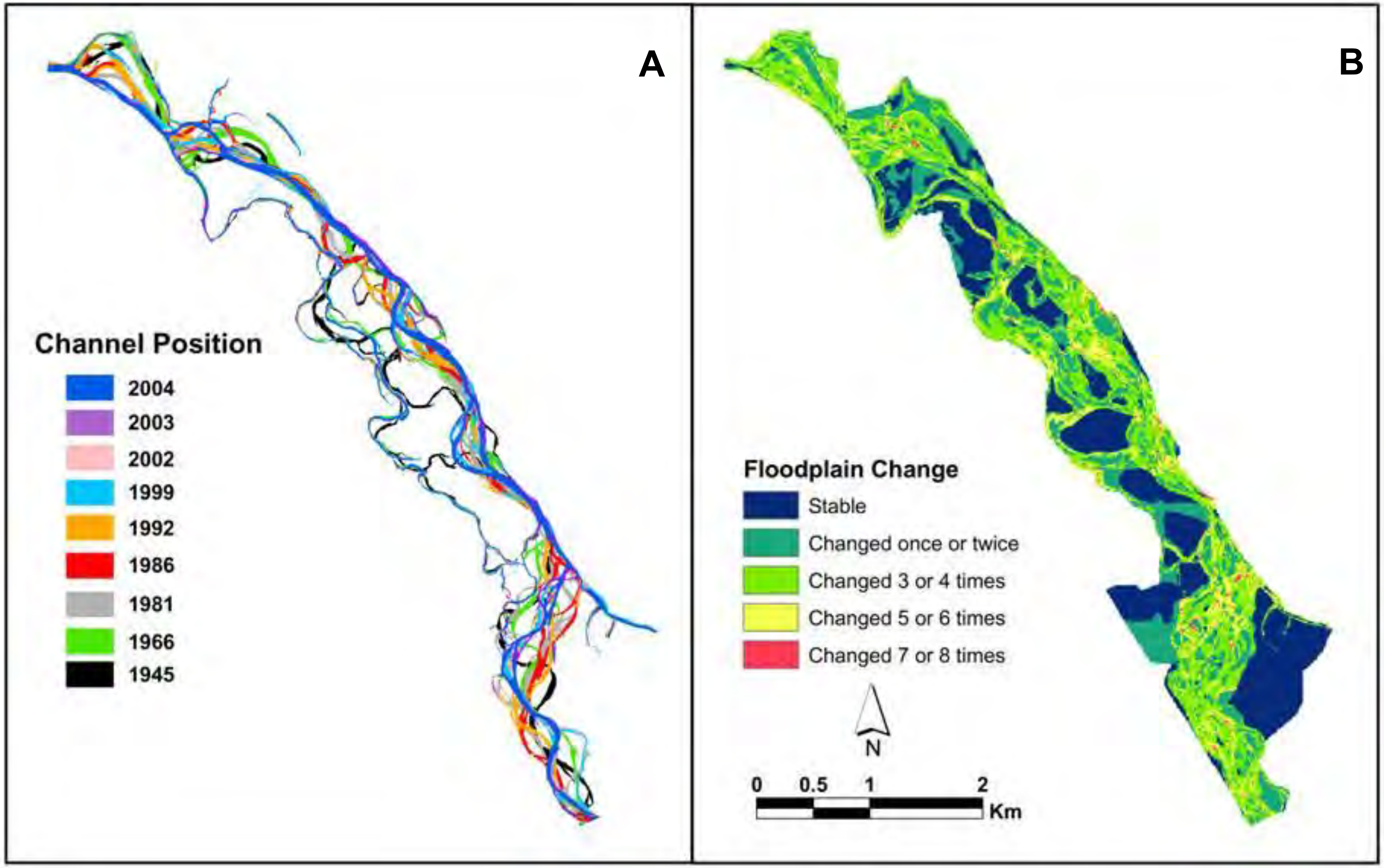
Webinar Dec 2019



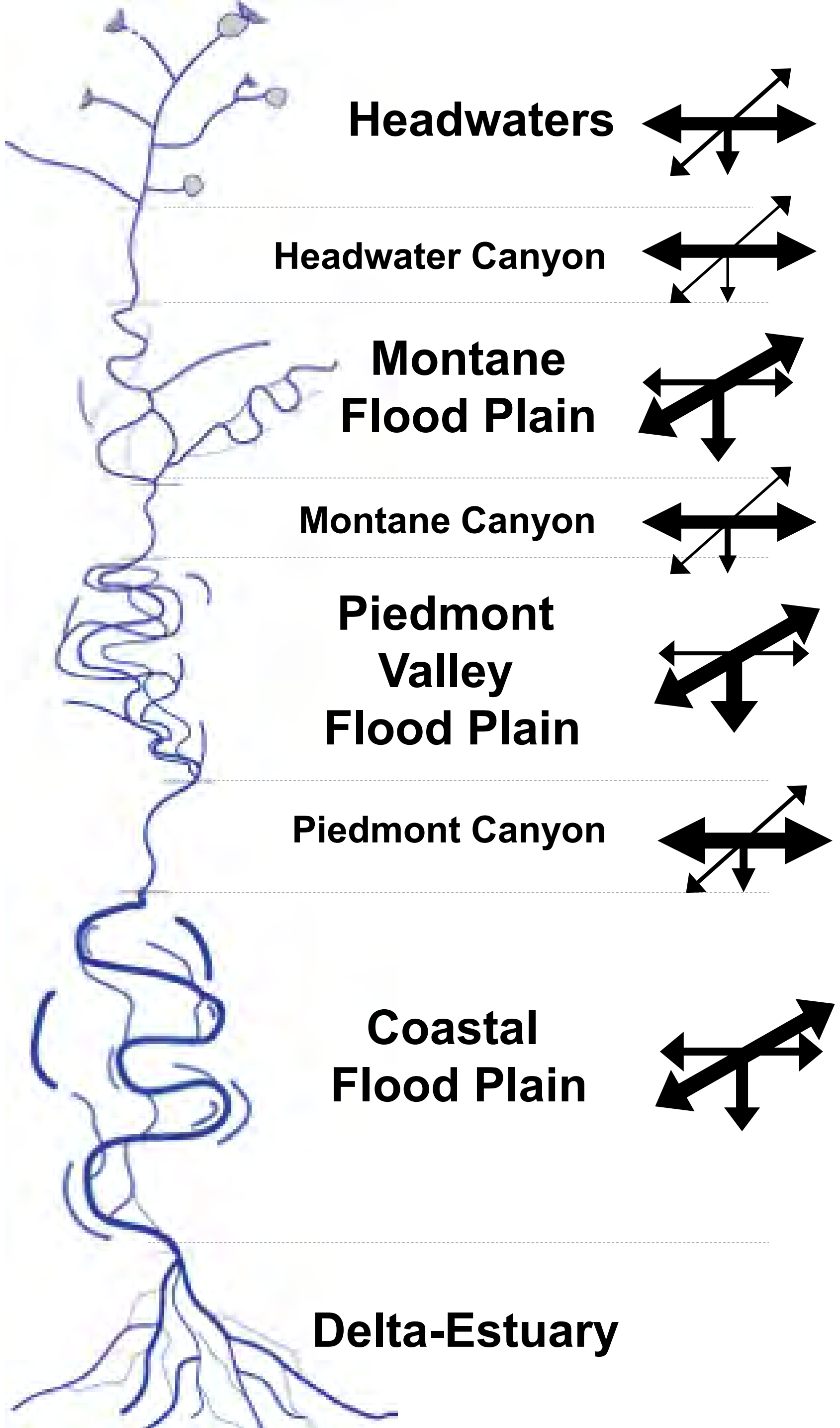
Rio Grande Brown Trout (*Salmo trutta*) test of the food availability hypothesis – 40,000 returning adults O'Neal, S. L. and J. A. Stanford. 2011. Partial migration in a robust brown trout population of a Patagonian river. **Transactions of the American Fisheries Society** 140(3):623–635.

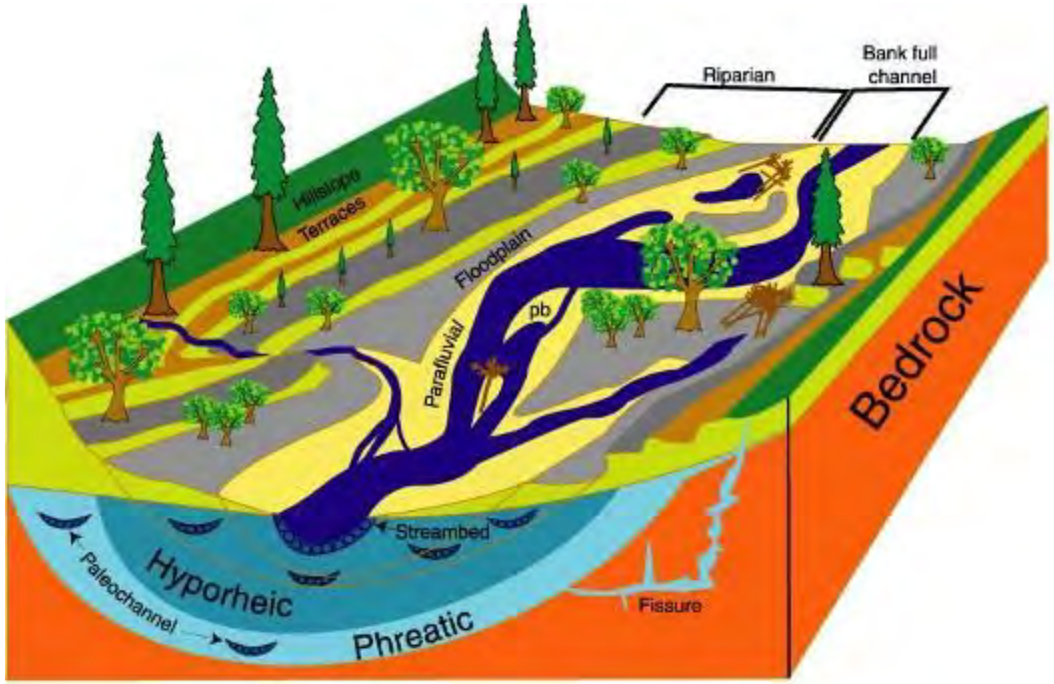
Age scrolled point bar – Krutogorova River, Kamchatka
A great example of the concept of a shifting habitat mosaic

Habitat change at the Nyack Flood Plain of the Flathead River, Montana
1945-2004



Whited et al.,2006. *Ecology*





Primary drivers of the SHM:

- Geomorphic setting (slope, geologic legacies)
- Climate (flow, temperature, fire)
- Cut and fill alluviation (sediments and wood)
- Ground- surface water interactions
- Plant succession
- Animal modifications (including humans)

Stanford, J. A., M. S. Lorang and F. R. Hauer. 2005. The shifting habitat mosaic of river ecosystems. Plenary Lecture. Proceedings of the International Society of Limnology *(Verh. Internat. Verein. Limnol.)* 29(1):123–136.

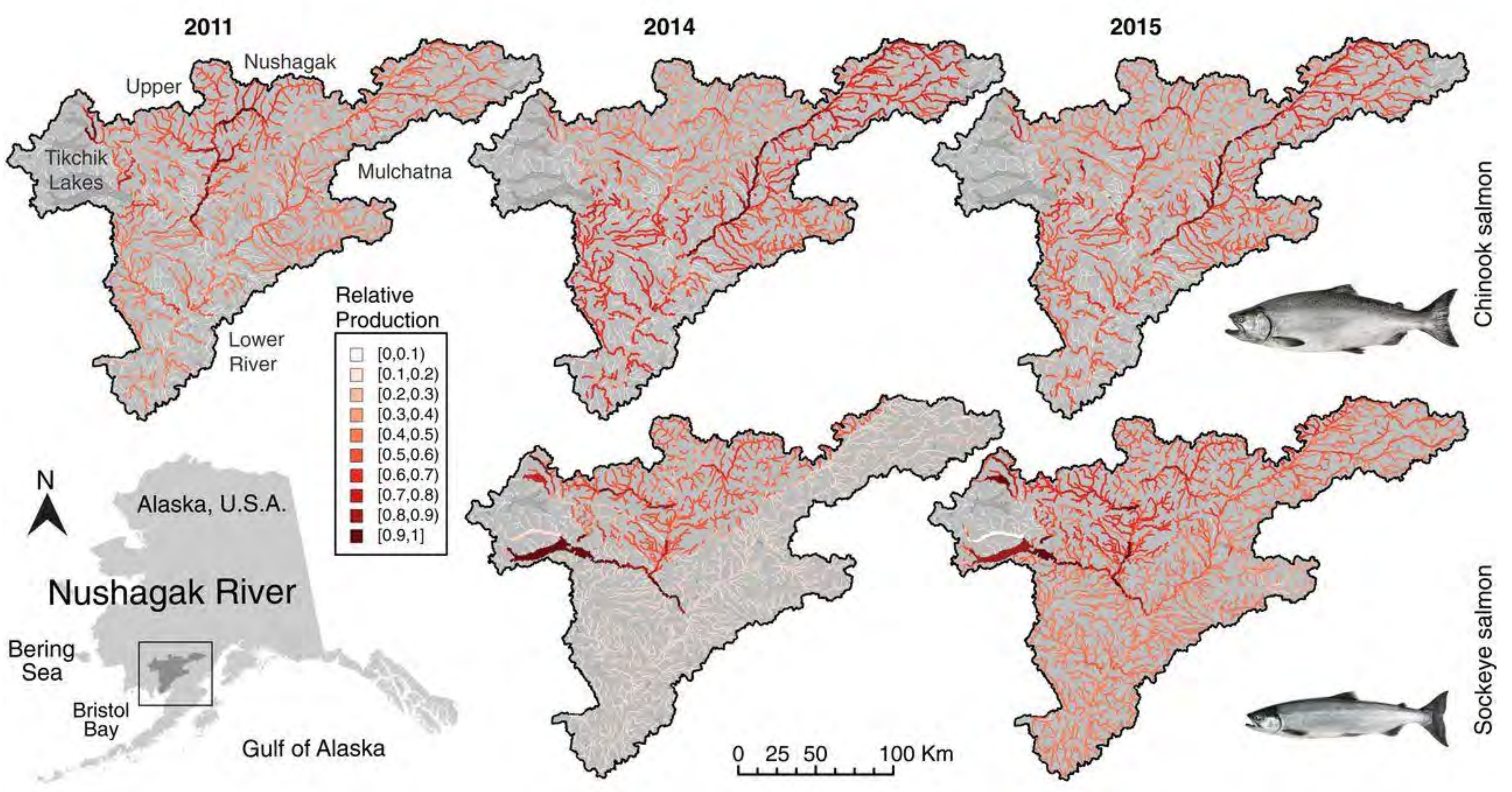
Dynamic, inter-connected habitats

Shifting habitat mosaics and fish production across river basins

by Sean R. Brennan, Daniel E. Schindler, Timothy J. Cline, Timothy E. Walsworth, Greg Buck, and Diego P. Fernandez

Science
Volume 364(6442):783-786
May 24, 2019

Fig. 1 Productive habitats for salmon shift across river basins.



Sean R. Brennan et al. Science 2019;364:783-786

Science
AAAS

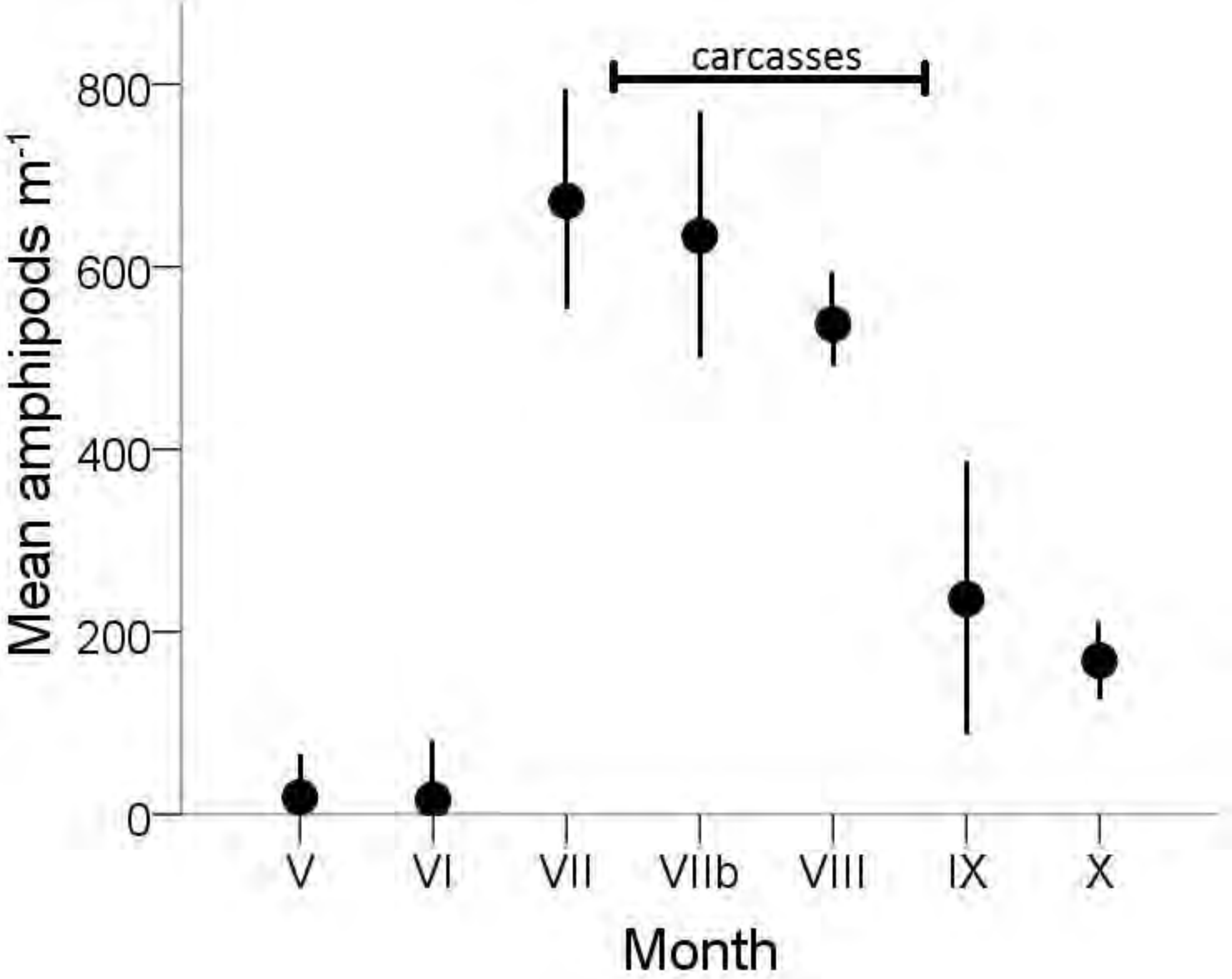
Salmonid Rivers Observatory Network (SaRON)

Flathead Lake Biological Station, University of Montana

100% female (12.8 mm), migrating at 12.8 cm s^{-1}

67 neonates per female

Anisogammarus kygi

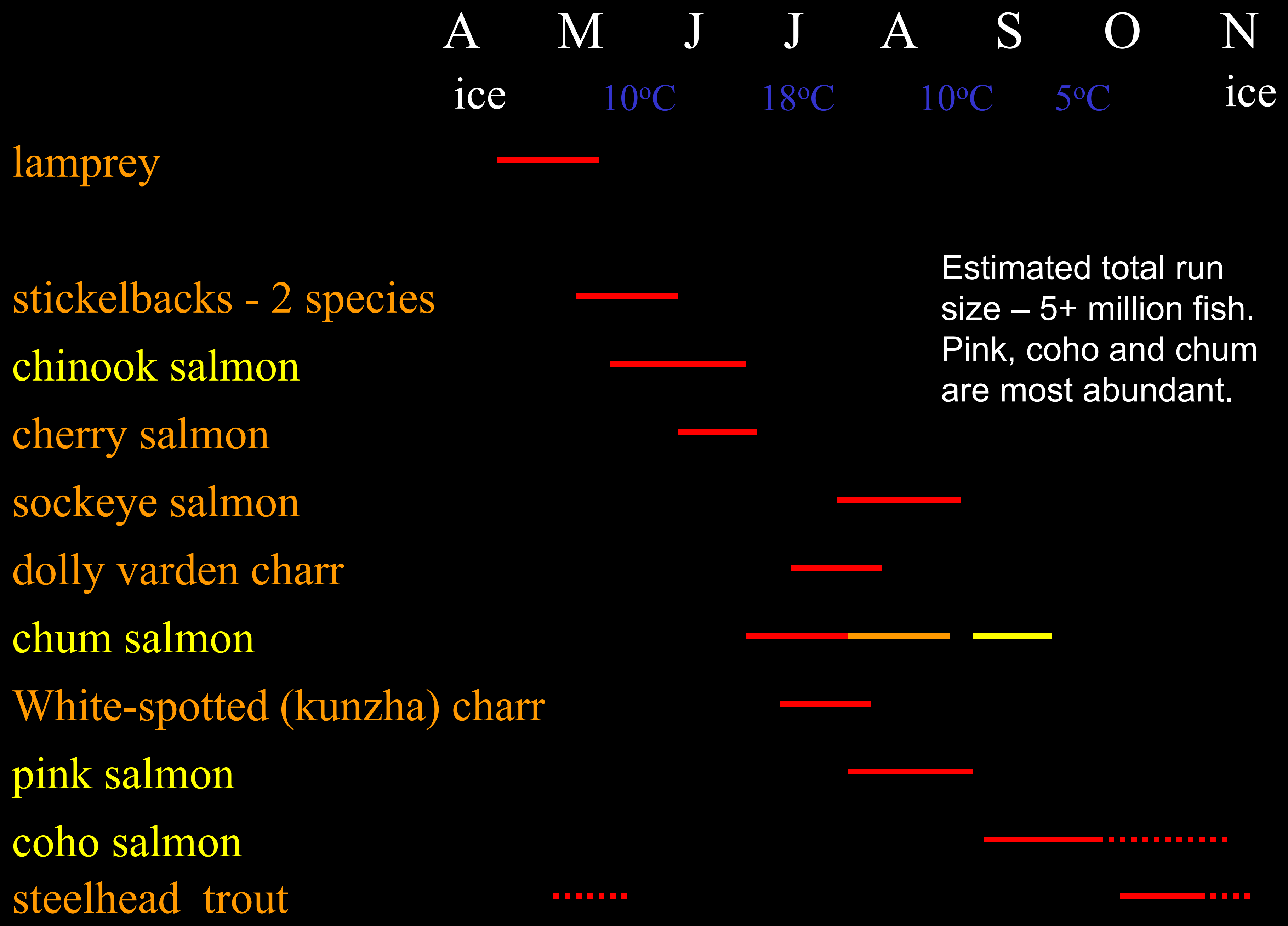


Kol – *O. mykiss* resident (rainbow)

Utkholok – *O. mykiss* anadromous (steelhead)

Same species, 6 life history strategies

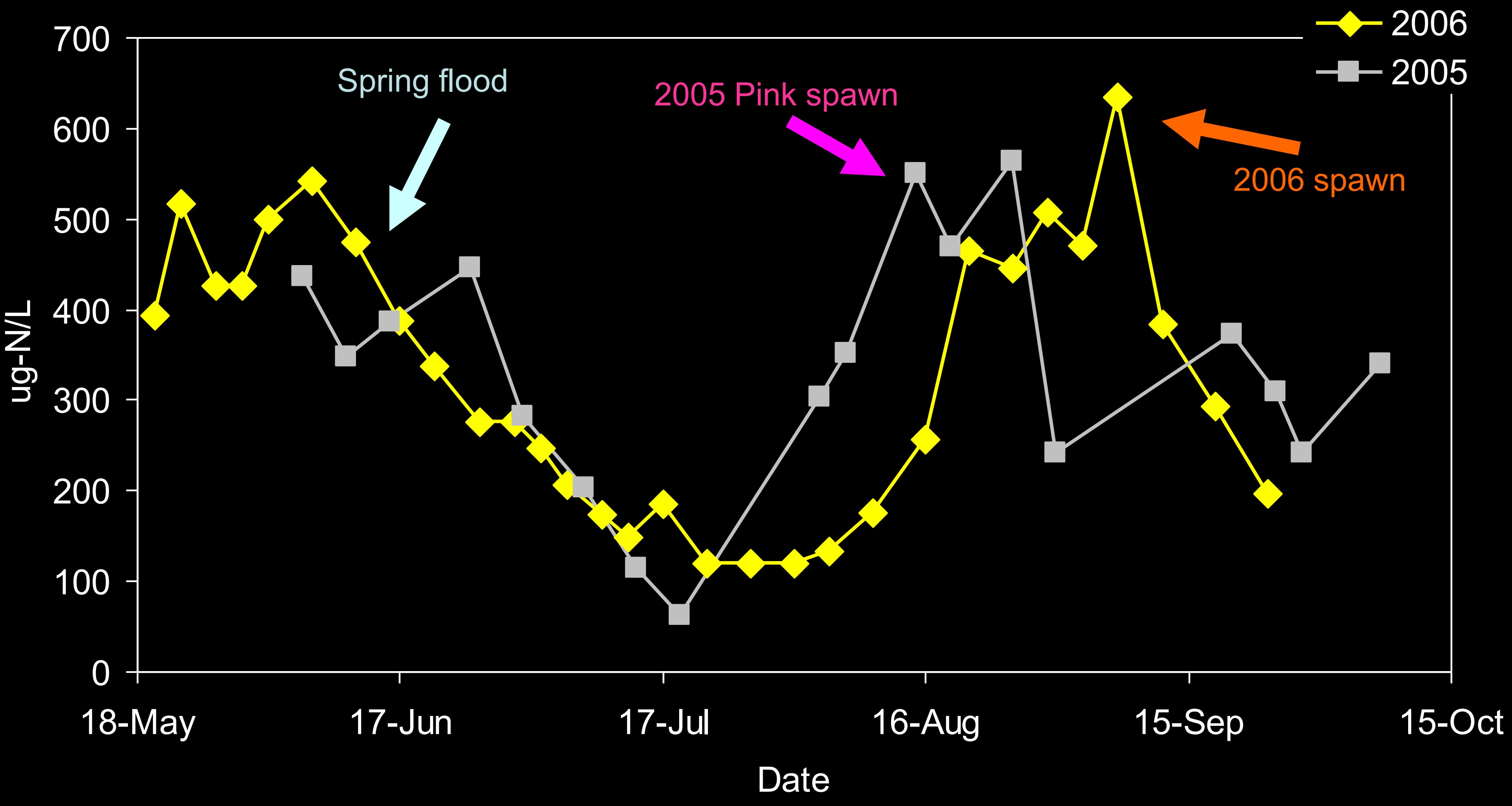
Run Timing by Species - Kol River, Kamchatka, Russia



Estimated total run size – 5+ million fish. Pink, coho and chum are most abundant.



Kol River Mainchannel Total Persulfate Nitrogen



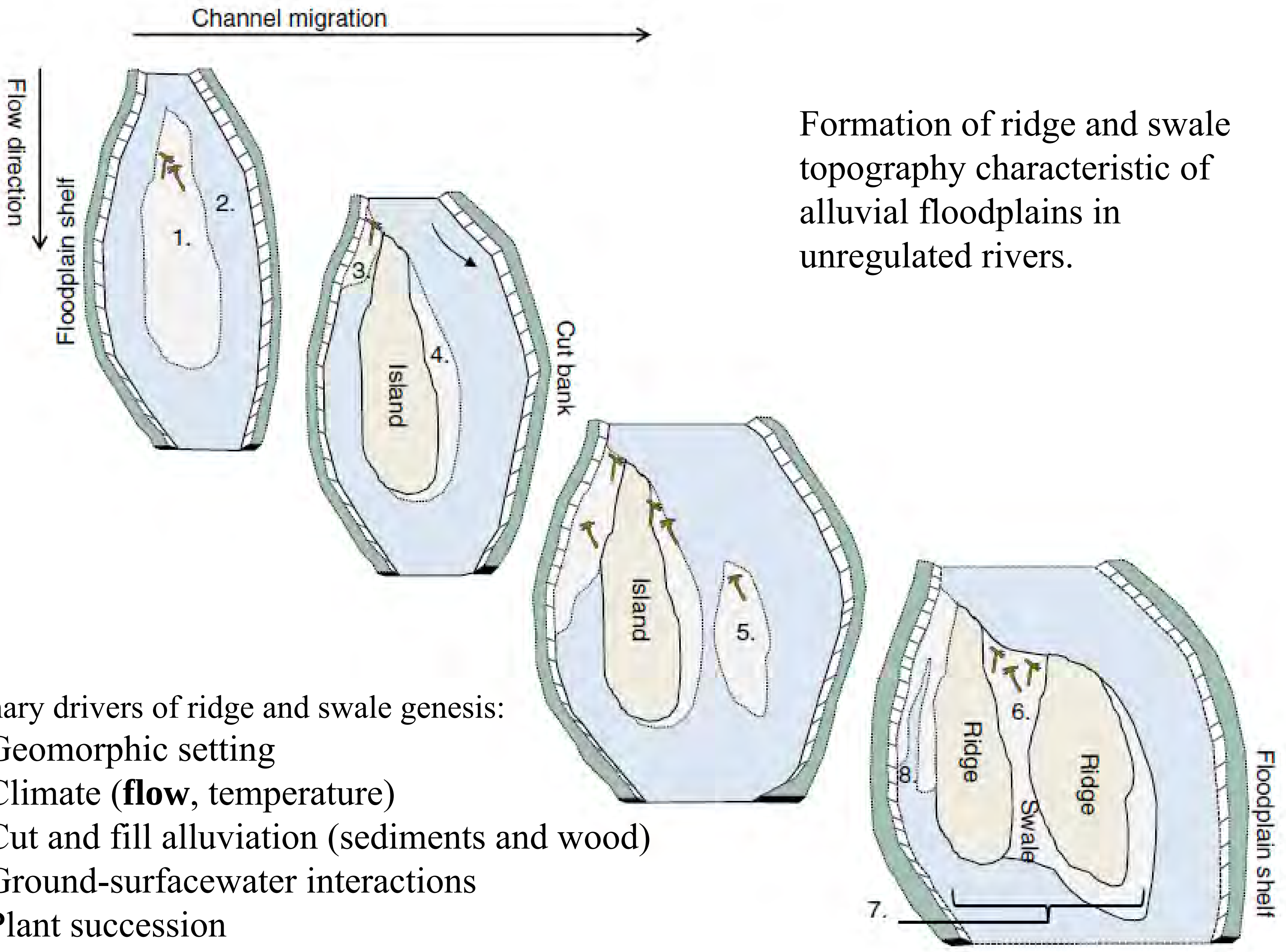
Salmon Subsidy of Foliar N

Morris and Stanford. 2011. Ecological Monographs

	molar C:N
• Kol floodplain	
– *Salix A*	13.7
– *Salix B*	12.6
– *F. camtschatica*	14.4
– Nettle	8.1
• Temperate broadleaf[1]	35.1
• Nyack cottonwoods[2]	38.1

1: McGroddy et al. 2004 *Ecology*, 2: Harner and Stanford 2003 *Ecology*

Formation of ridge and swale topography characteristic of alluvial floodplains in unregulated rivers.



Primary drivers of ridge and swale genesis:

- Geomorphic setting
- Climate (**flow**, temperature)
- Cut and fill alluviation (sediments and wood)
- Ground-surfacewater interactions
- Plant succession
- Animal modifications
- Biophysical connectivity

Mouw et al., 2014. RRA

Age scrolled point bar – Krutogorova River, Kamchatka

Разнообразие жизненных стратегий камчатской микижи

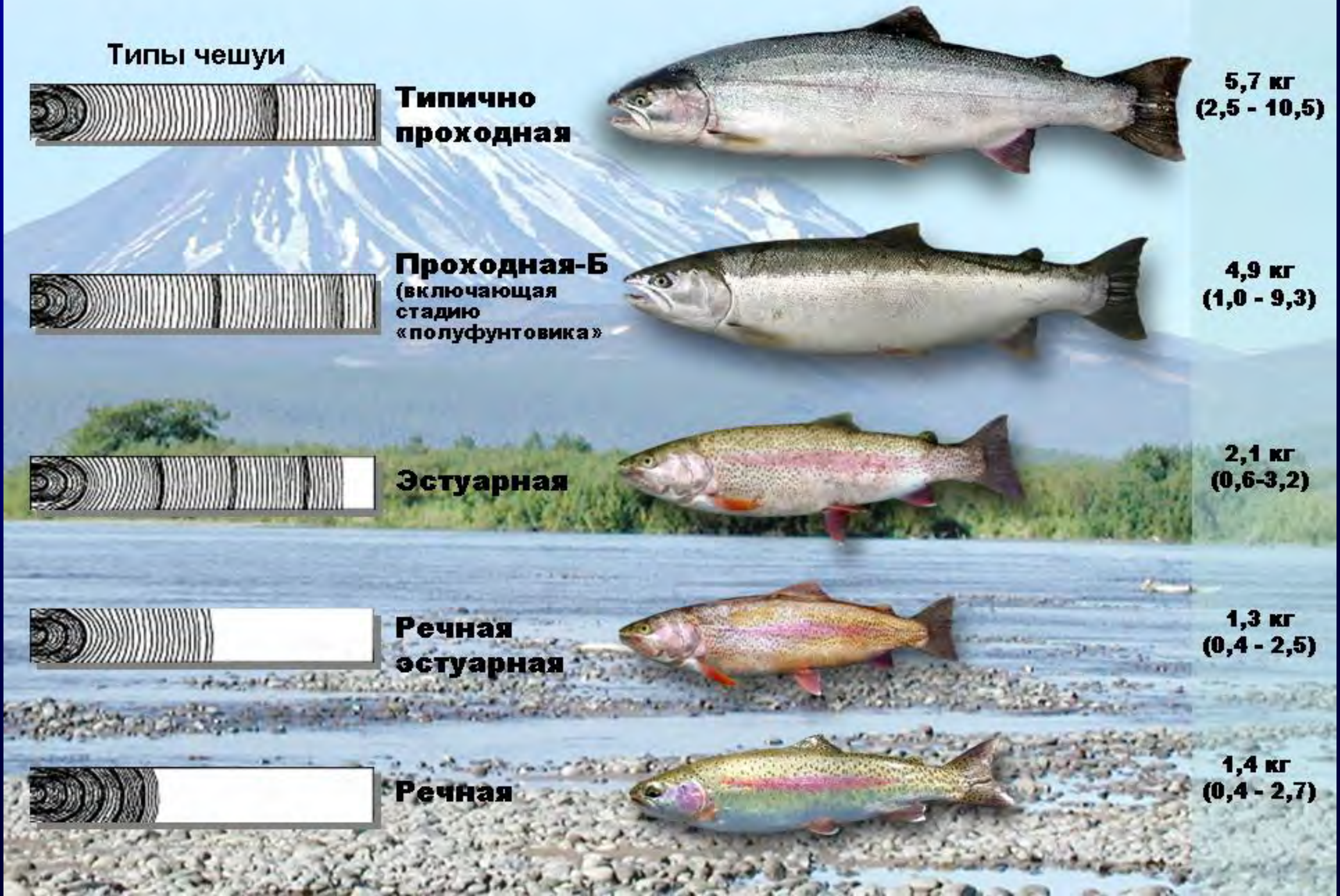
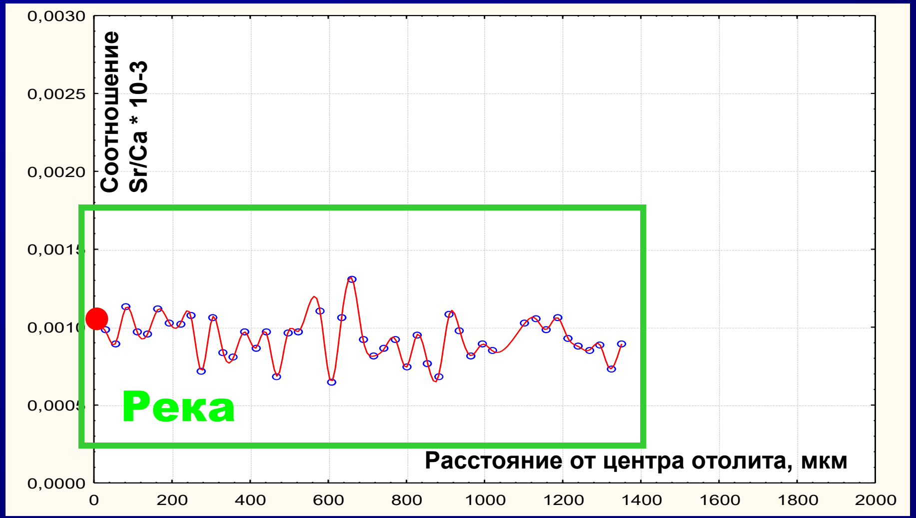


Схема образа жизни рыб с разной жизненной стратегией

Изменения типа жизненной стратегии

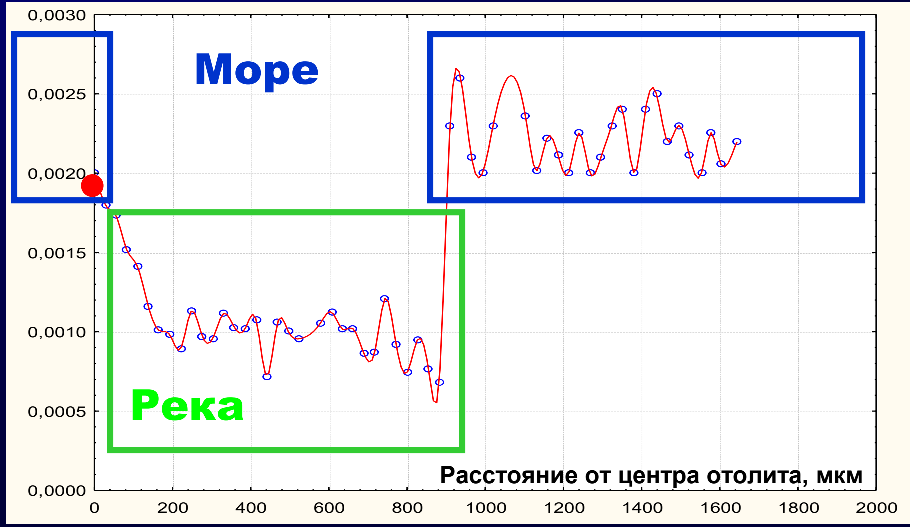
(по данным соотношения Sr/Ca в отолитах)



● Материнская особь – речная стратегия
— Потомок – речная стратегия

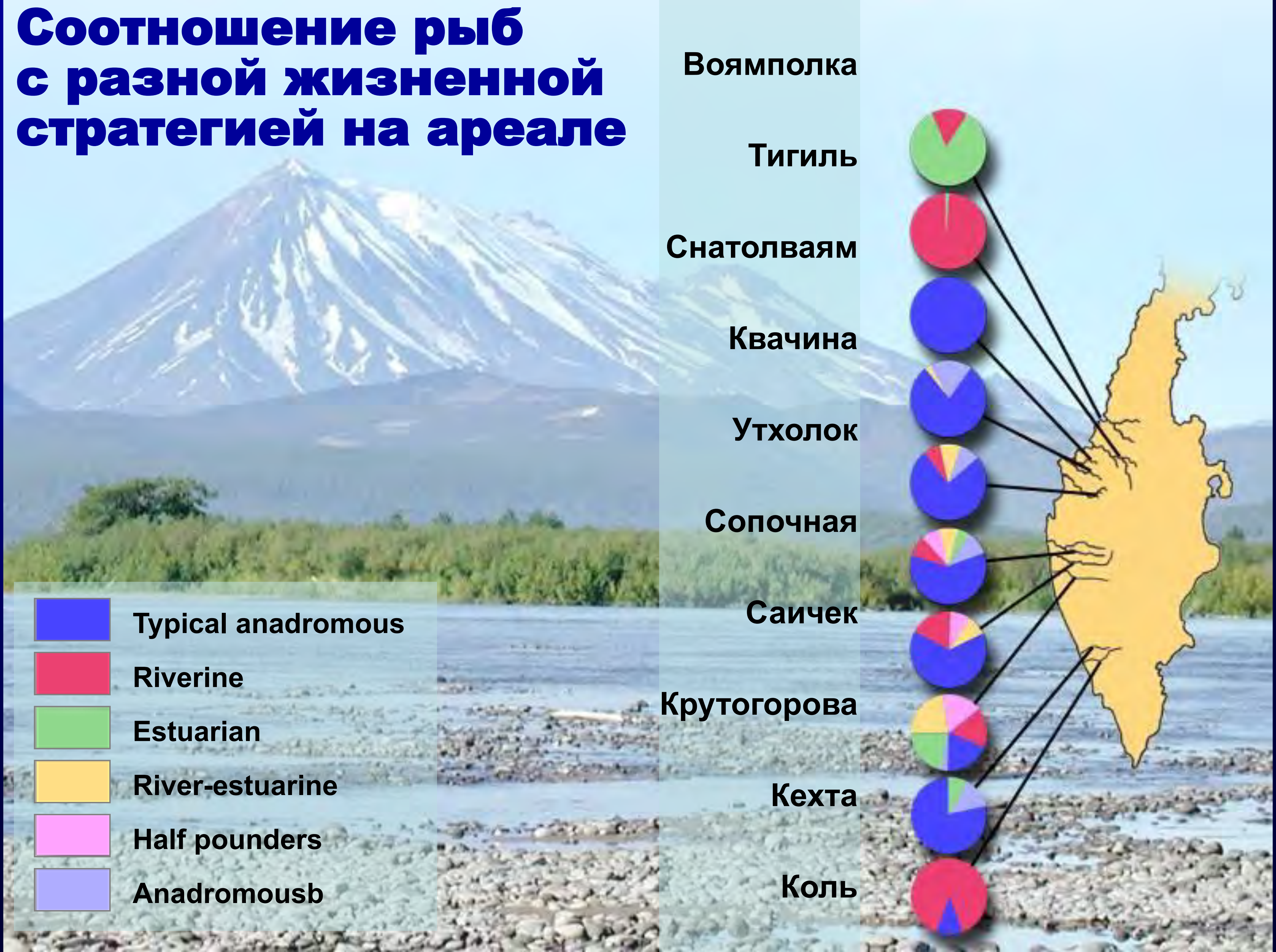
● Материнская особь – проходная стратегия
— Потомок – речная стратегия

● Материнская особь – речная стратегия
— Потомок – проходная стратегия



● Материнская особь – проходная стратегия
— Потомок – проходная стратегия

Соотношение рыб с разной жизненной стратегией на ареале



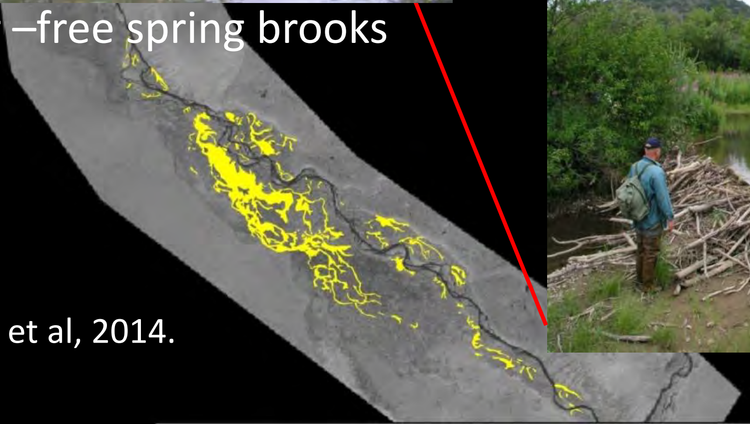
Floodplain Modification By Beavers

55% of aquatic off-channel habitats modified by beavers

Beaver –free spring brooks

Beaver –influenced spring brooks

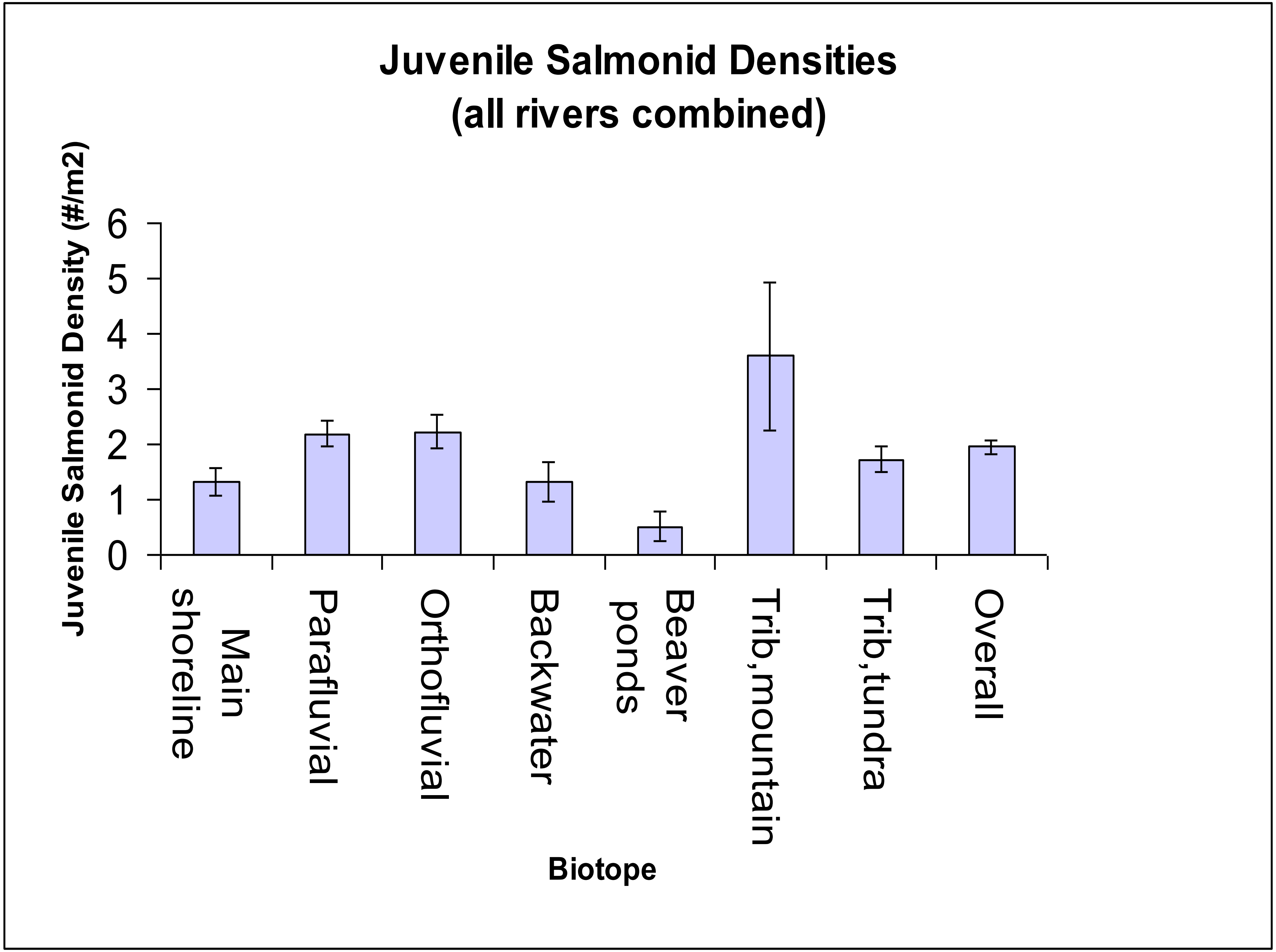
Early



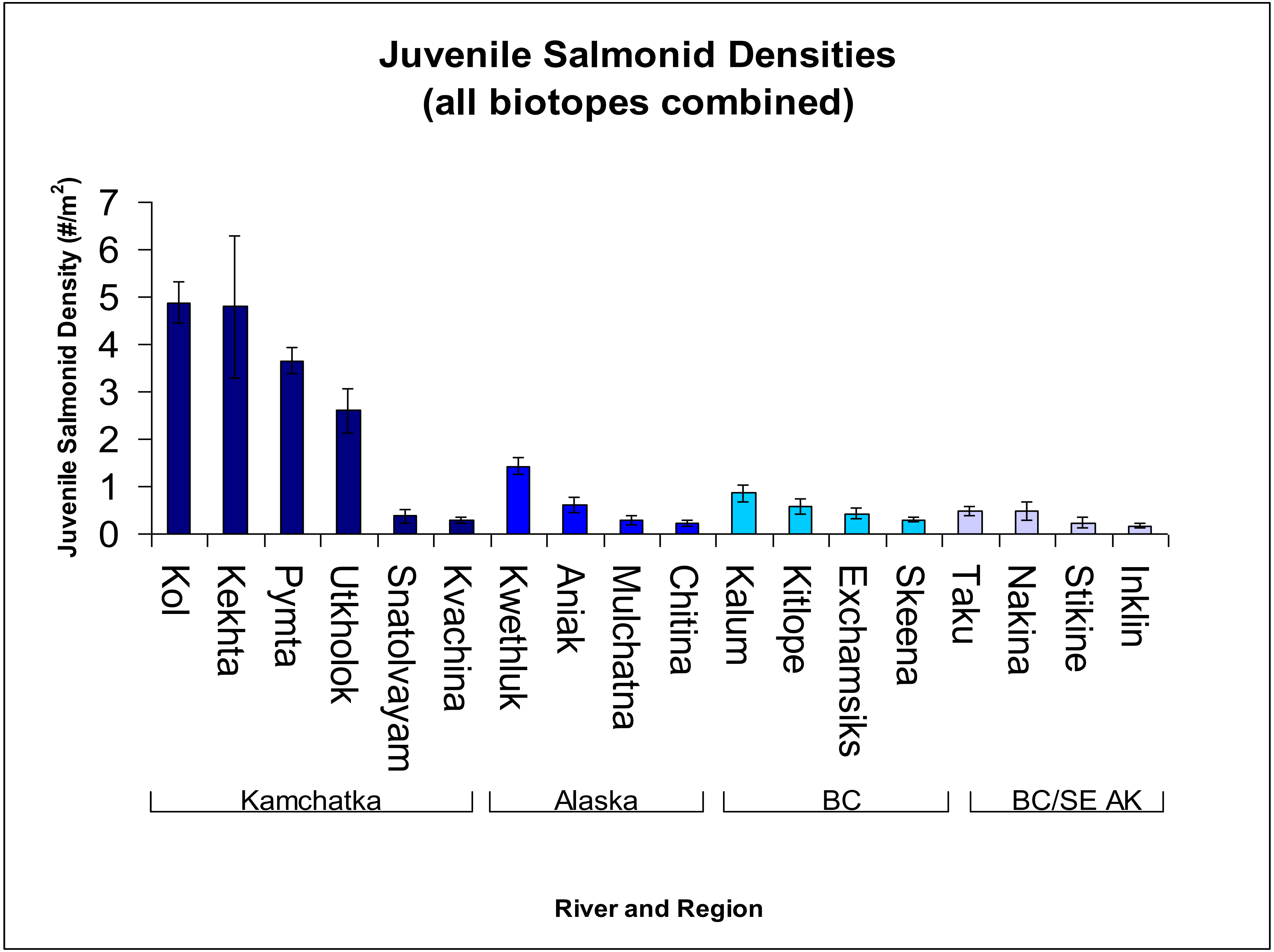
Mid

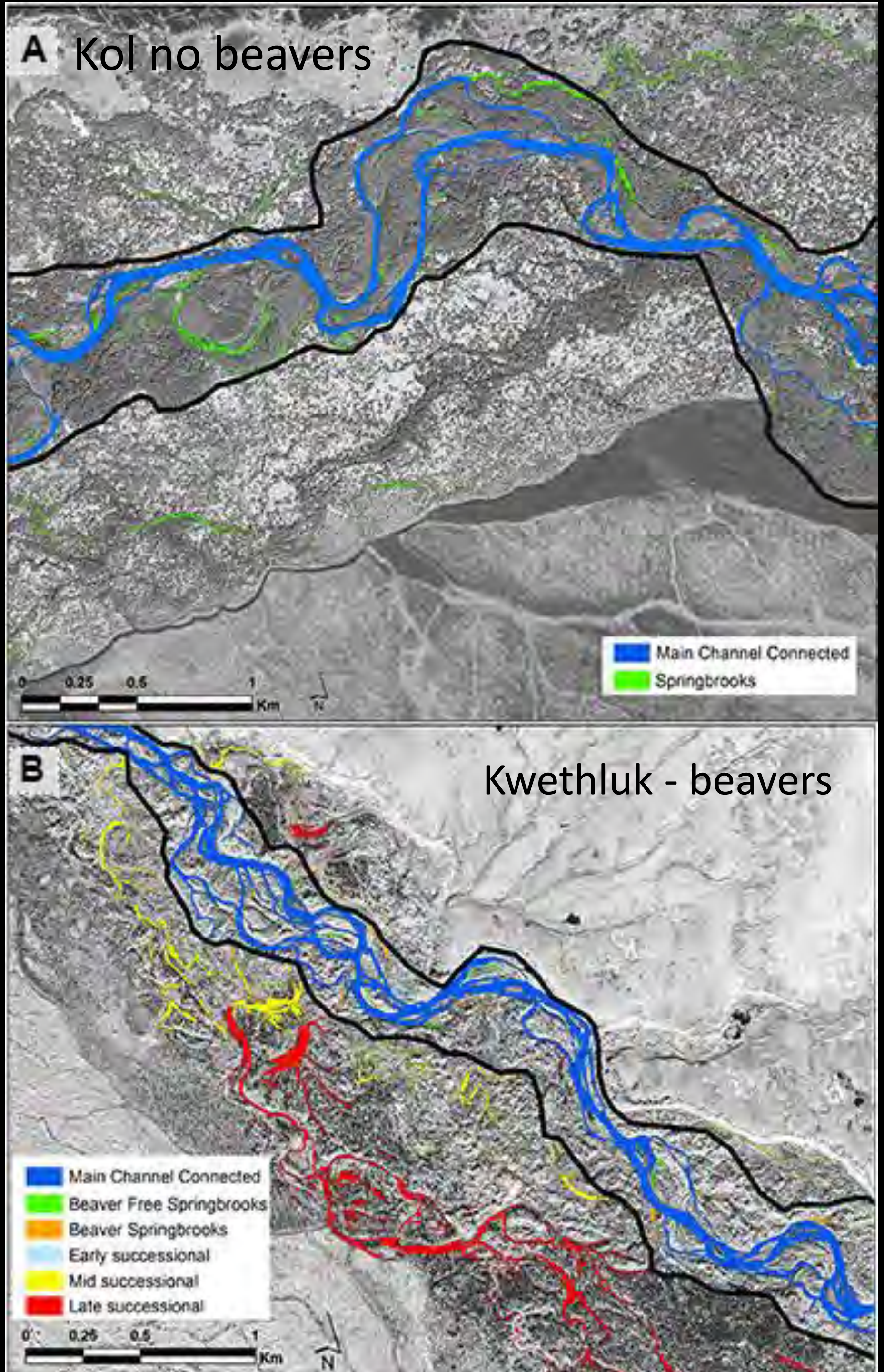
Late

Malison et al, 2014.
FWB



Juvenile Salmonid Densities
(all rivers combined)
Juvenile Salmonid Density (#/m2)
6
5
4
3
2
1
0
Main shoreline
Parafluvial
Orthofluvial
Backwater
Beaver ponds
Trib,mountain
Trib,tundra
Overall
Biotope

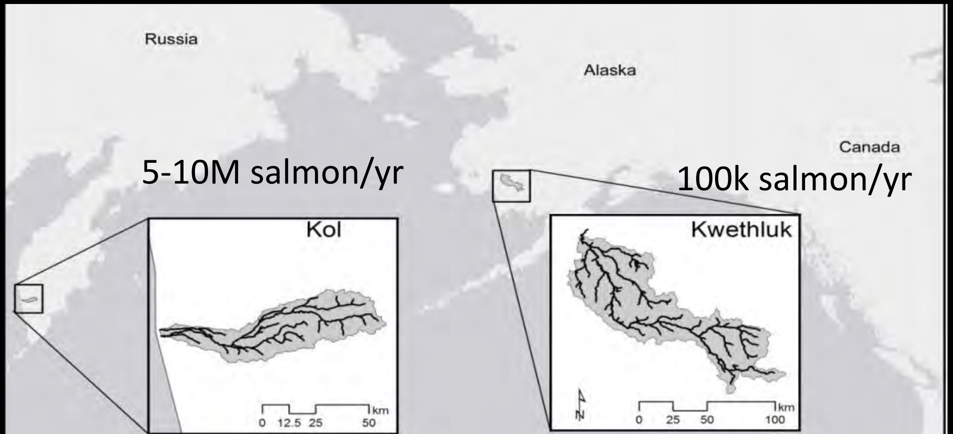

Juvenile Salmonid Densities
(all biotopes combined)
Juvenile Salmonid Density (#/m2)
0
1
2
3
4
5
6
7
Kol
Kekhta
Pymta
Utkholok
Snatolvayam
Kvachina
Kwethluk
Aniak
Mulchatna
Chitina
Kalum
Kitlope
Exchamsiks
Skeena
Taku
Nakina
Stikine
Inklin
Kamchatka
Alaska
BC
BC/SE AK
River and Region

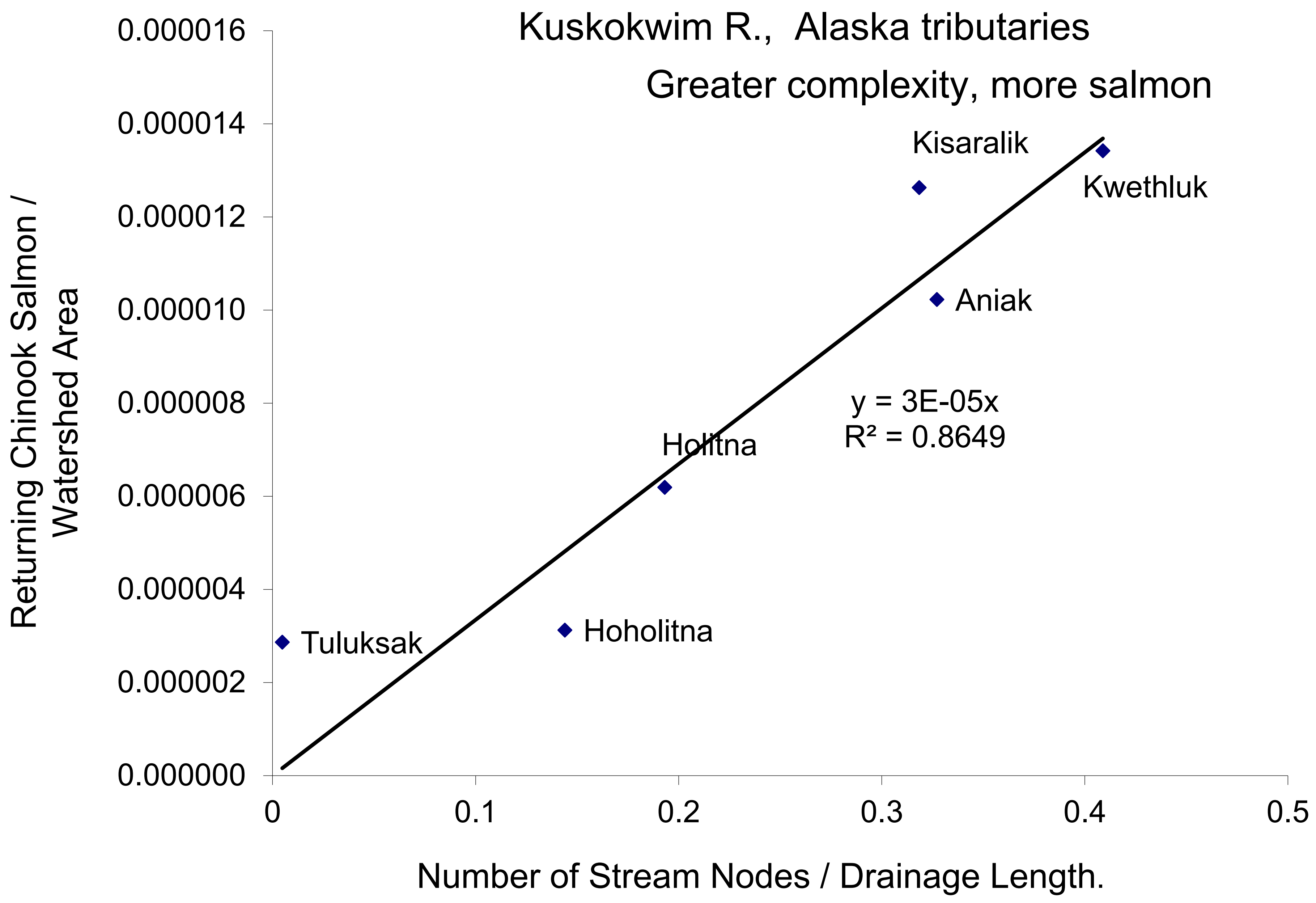


	Kwethluk	Kol
Floodplain slope	0.0020	0.0022
River width	42m	50m
Watershed area	3846 km^2	1502 km^2
Total Floodplain area	2.49×10^8 m^2	1.04×10^8 m^2
Total aquatic habitat	283 ha	409 ha
Main Channel total area	219 ha	325 ha
Off-channel habitat area	64 ha	84 ha
Spring brook total area	11 ha	83 ha
% off-channel spring brook area	0.17	0.99
Beaver pond area	51 ha	0

Huge mdn subsidy in the Kol

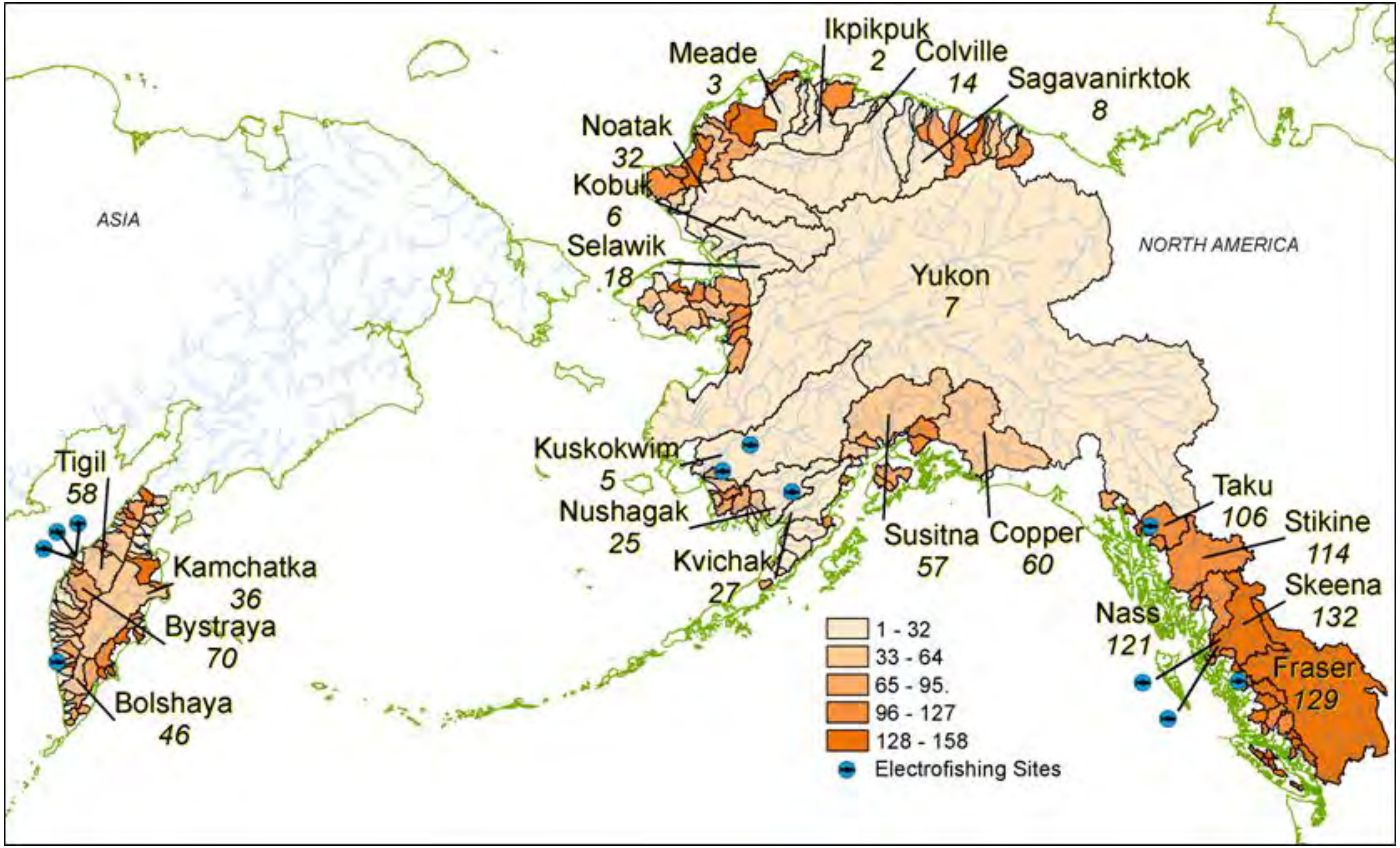
Malison, R.L., K.V. Kuzishchin and J. A. Stanford. 2016. Do beaver dams reduce habitat connectivity and salmon productivity in expansive river floodplains? **PeerJ** 4:e2403.





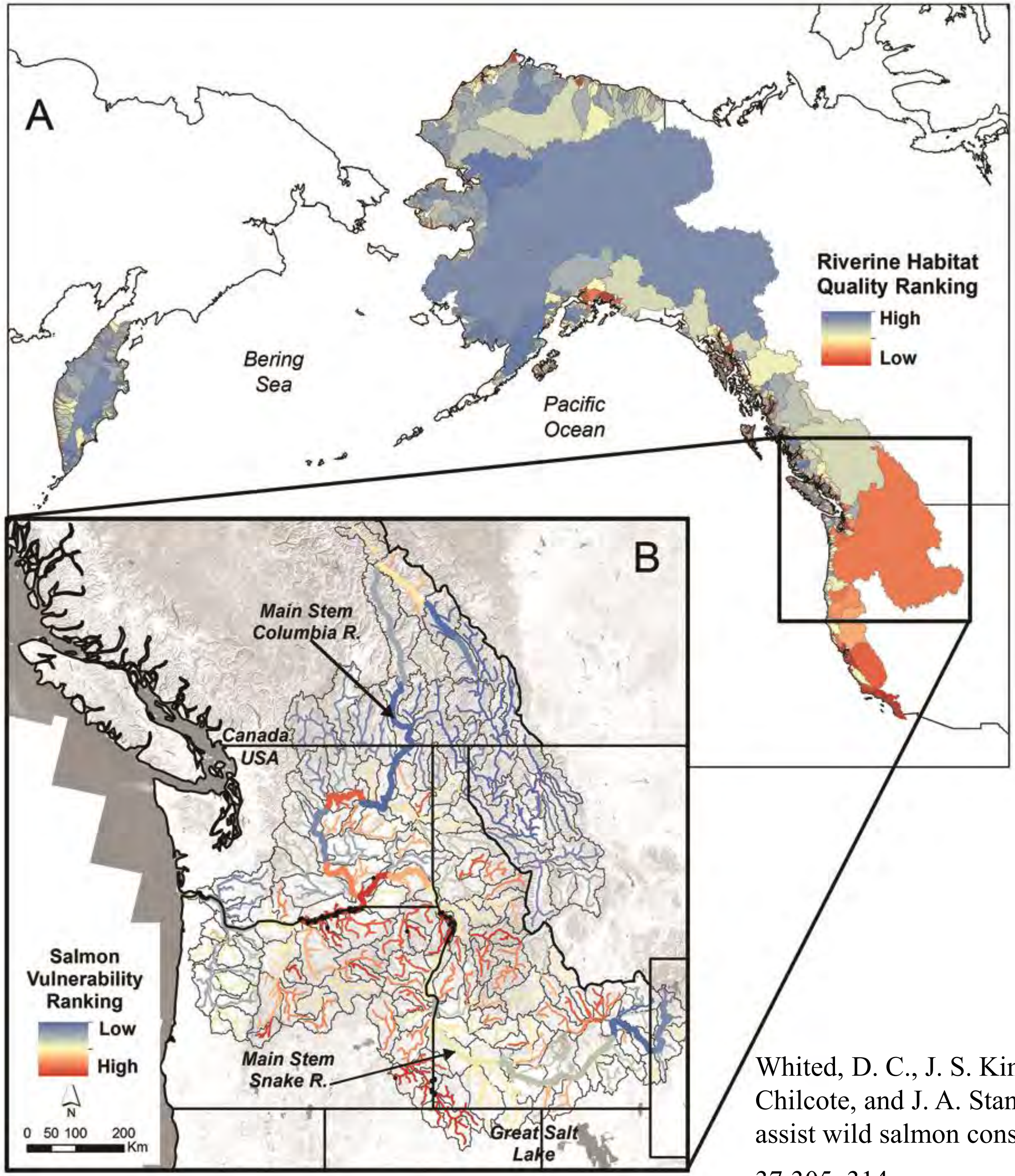
See Whited et al., 2012. Fisheries……. for Riverscape Analysis Project (RAP) tools and data for 1500 Pacific Rim Rivers

Ranking Rivers of the Pacific Rim by Physical Complexity



Rankings for the 158 catchments over 1,000 km^2 as mean of principal components and mean feature class physical complexity. Labels are for the 22 catchments larger than 10,000 km^2. Blue circles are SaRON sites.

Luck et al., (FLBS). 2010. Earth Surface Processes and Landforms **35**(11): 1330–1343.



Estimation of habitat quality for salmon given likely future conditions.

Much of the southern range becomes unsuitable.

Much of the northern range remains high quality; Kamchatka, Bristol Bay and western Alaska rivers are critical habitats.

Biophysical complexity buffers negative effects.

Great uncertainty about ocean conditions, harvest and hatcheries.

Whited, D. C., J. S. Kimball, J. A. Lucotch, N. K. Maumenee, H. Wu, S. D. Chilcote, and J. A. Stanford. 2012. A Riverscape Analysis Tool developed to assist wild salmon conservation across the North Pacific Rim. **Fisheries** 37:305–314.