



Nutritional and energetic status of inland Snake River & coastal Situk River kelts using blood plasma chemistry

Zachary L. Penney ¹, Christine M. Moffitt ^{1,2}, Brian Marston ³, Chester Woods ³, Bryan Jones ¹, and Jessica Buelow ¹

¹Department of Fish and Wildlife Resources, ² US Geological Survey, Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho, ³ Alaska Department of Fish and Game



Introduction & Objective

The physiological capacity for iteroparity between inland and coastal steelhead is not well understood. Inland steelhead generally exhibit lower rates of repeat-spawning than coastal populations. Coastal steelhead stocks can follow stream or ocean-maturing gonadal maturation strategies, whereas inland steelhead exclusively follow stream-maturing gonadal maturation strategies. No direct comparisons of physiological condition have been made between inland and coastal steelhead kelts. We provide an assessment of energetic status between inland Snake River basin and coastal Situk River kelts using nutritional factors measured from blood plasma.

Methods

Coastal kelts were sampled from the Situk River weir near Yakutat, AK in 2011. Inland kelts were sampled at three locations from the Snake River basin in 2010: 1) Potlatch River weirs, 2) Upper Clearwater River weirs and 3) Lower Granite Dam (Figure 1 & Table 1). Approximately 2 mL of blood was collected from the caudal vessel (Figure 1 A). Blood plasma samples were analyzed for five nutritional factors: protein, cholesterol, triglycerides, calcium, and glucose. Only natural-origin female kelts in good external condition were used for analysis.

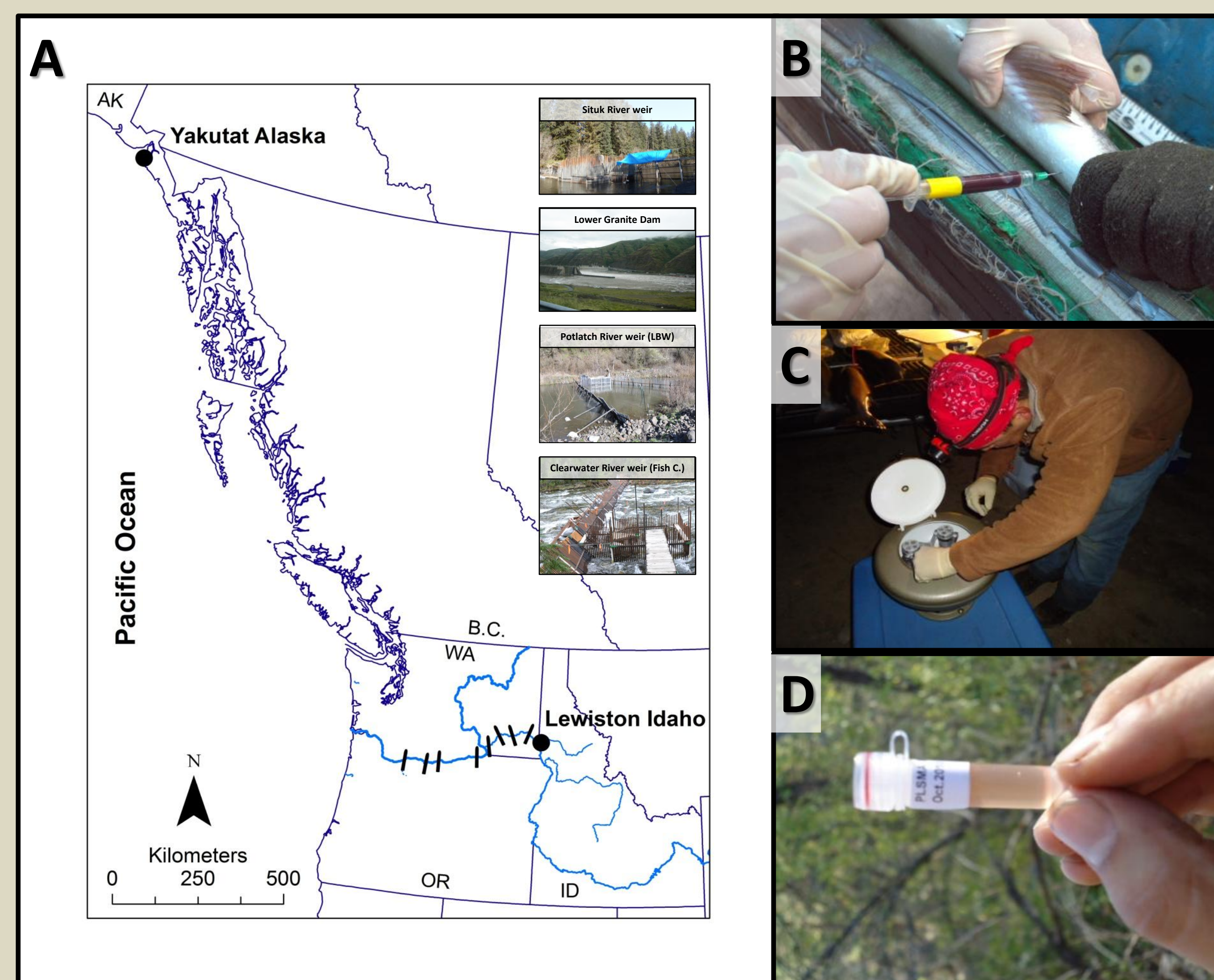


Figure 1: A) Sample sites for coastal and inland kelts. B) Blood collection, C) centrifugation of blood, and D) blood plasma fraction for analysis.

Results

Protein

Plasma protein was below detection limits (BDL) in over half of the kelts sampled at Lower Granite Dam and Potlatch River weirs, whereas plasma protein was detectable in the majority of kelts sampled from the Situk and Upper Clearwater River weirs. We found no significant differences between the Lower Granite Dam and Potlatch River kelts and no significant differences between Upper Clearwater and Situk River kelts using Chi-square analysis ($\alpha=0.05$) (Table 2).

Cholesterol, Triglycerides, Calcium, & Glucose

Plasma cholesterol, triglycerides, calcium, and glucose were consistently higher in Situk River kelts and lowest in kelts sampled at the Lower Granite Dam (Figure 2 & Table 1). Statistical comparisons showed that the nutritional factors of Situk kelts were significantly different than kelts in the Snake River basin (Table 2).

Table 1: Median, range, and proportion of kelts below detection limits at all sample sites.

System	N	Length (cm)	Protein (g/dL)	Cholesterol (mg/dL)	Triglycerides (mg/dL)	Calcium (mg/dL)	Glucose (mg/dL)	
Lower Granite Dam	50	Median	60.5	2.9	66.0	43.0	9.1	85.0
		Range	52.0 - 83.0	2.4 - 3.5	5.0 - 186.0	12.0 - 243.0	6.0 - 18.2	49.0 - 163.0
		# BDL (%)	0 (0)	37 (74)	0 (0)	9 (18)	0 (0)	0 (0)
Potlatch River weirs	47	Median	68.9	2.7 ^a	87.0	82.5 ^b	9.2	86.0 ^b
		Range	60.0 - 76.0	2.4 - 3.8	33.0 - 280.0	9.0 - 281.0	7.0 - 16.2	39.0 - 264.0
		# BDL (%)	0 (0)	32 (70)	0 (0)	0 (0)	0 (0)	0 (0)
Clearwater River weirs	25	Median	75.0	2.9	100.0	75.0	8.8	107.0
		Range	62.0 - 81.0	2.5 - 3.6	28.0 - 178.0	10.0 - 176.0	3.8 - 10.5	31.0 - 176.0
		# BDL (%)	0 (0)	7 (28)	0 (0)	0 (0)	0 (0)	0 (0)
Situk River weir	24	Median	79.5	3.7	130.5	233.5	12.8	136.5
		Range	61.0 - 87.5	2.7 - 6.0	55.0 - 242.0	55.0 - 576.0	8.1 - 15.6	64.0 - 191.0
		# BDL (%)	0 (0)	2 (8)	0 (0)	0 (0)	0 (0)	0 (0)

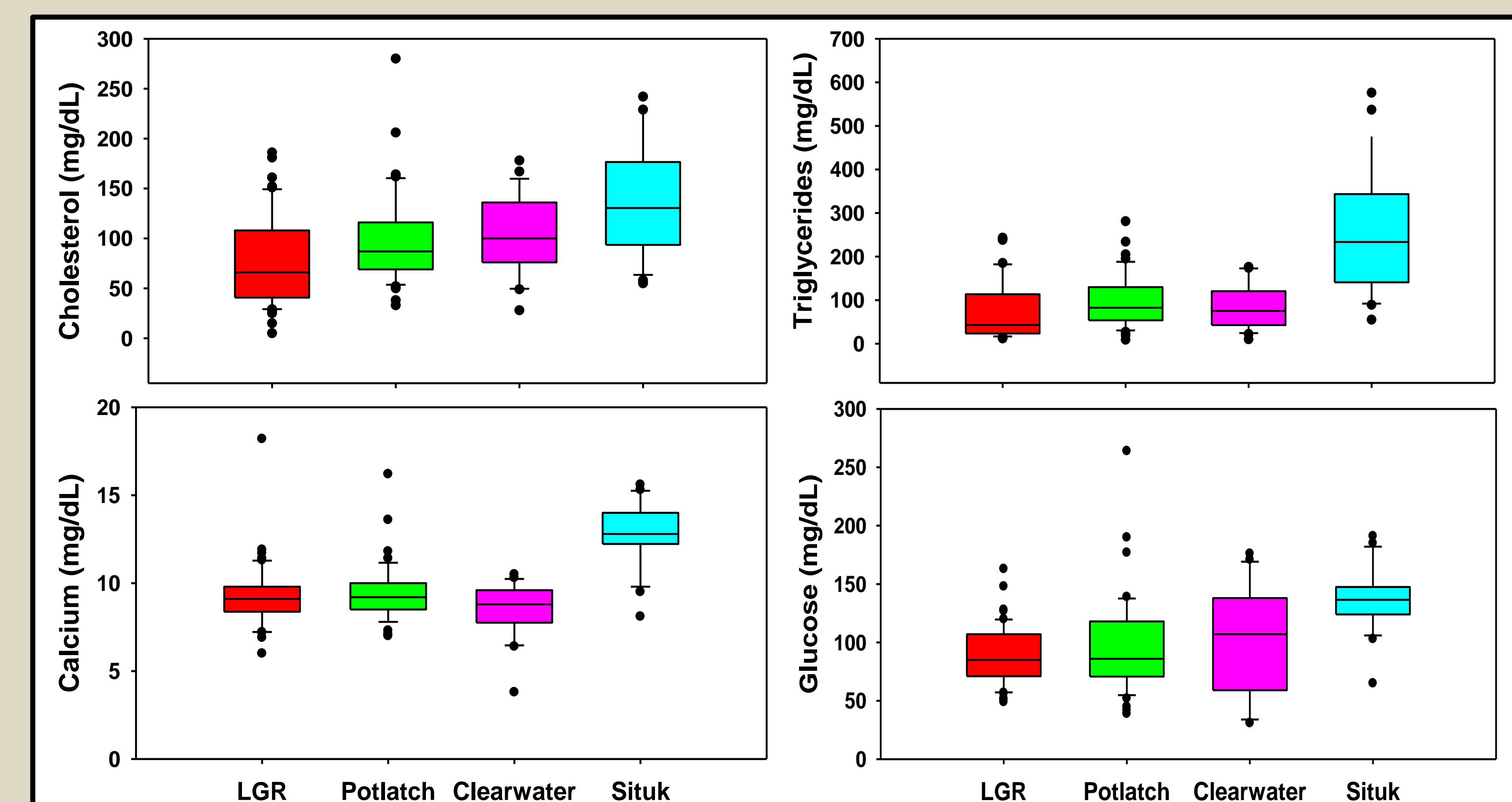


Figure 2: Boxplots of nutritional parameters from good condition natural-origin female kelts from inland (LGR, Potlatch, and Clearwater) and coastal (Situk) populations.

Table 2: Multiple comparison analysis using the Kruskal-Wallis test.

Comparison	Permutation P-values			
	Cholesterol	Triglycerides	Calcium	Glucose
Situk vs Lower Granite Dam	<0.01	<0.01	<0.01	<0.01
Situk vs Potlatch	<0.01	<0.01	<0.01	<0.01
Situk vs Clearwater	0.07	<0.01	<0.01	<0.01
Potlatch vs Lower Granite Dam	0.11	0.56	0.98	0.80
Potlatch vs Clearwater	0.98	0.94	0.13	0.89
Clearwater vs Lower Granite Dam	0.08	0.99	0.30	0.40

Discussion & Conclusions

All five nutritional plasma factors examined were highest in coastal Situk River kelts, suggesting that coastal kelts have more energy following spawning than inland kelts from the Snake River basin. Situk River steelhead are divided into two components: a stream maturing fall-run and ocean maturing spring-run. It was not possible to determine the re-entry timing of Situk kelts during sampling therefore we could not relate nutritional factors to variations in gonadal maturation strategy. However, the Situk River is a short system (35.6 km) compared to the Snake River, where steelhead generally swim over 750 km to reach natal spawning systems. This suggests that migration distance is likely an important factor to post-reproductive survival in steelhead. Our results provide physiological evidence that nutritional and energetic factors in the blood plasma of coastal kelts are significantly higher than inland steelhead.

Acknowledgements

Funding for this study was provided by the Columbia Inter-Tribal Fish Commission. We are grateful to the Alaska Department of Fish and Game, especially the Situk weir crew and Bob Chadwick for assistance and collaboration for sampling. We are also grateful to collaborations with Idaho Department of Fish and Game, especially Brett Bowersox and Tim Copeland for assistance with sampling in Idaho. Boling Sun, Andy Pape, Kala Hamilton, Will Schrader (U of Idaho) provided field and laboratory assistance. Housing and temporary laboratory facilities were provided by Mooring Lodge, Alaska Packaging Company provided dry ice shipments to Yakutat, and Yakutat Alaska Airlines assisted with sample transportation.

