



Understanding the elemental variation of threespine stickleback along the Sooke River



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Background

Fish play an important role in nutrient cycles in aquatic ecosystems. They take up dietary nutrients such as carbon (C) nitrogen (N) and phosphorus (P) and incorporate them into their bodies. Some nutrients that do not get incorporated are excreted in soluble forms, which can then serve as fuel for primary producers. **Because it often limits aquatic primary producers, the amount of P stored in fish bodies and the rate at which it is excreted can impact nutrient cycling and primary production.** The concentration and proportion of elements within fish bodies and wastes are highly variable. Previous studies have compared this variation between species, but within-species variation is poorly understood.

Threespine sticklebacks (*Gasterosteus aculeatus*) have well-documented elemental variation stemming in part from differences in bony armour. Among other armour traits, sticklebacks have dermal bone plates along their lateral sides. **Bone is very P-rich**, so the amount of P stored in the body is related to their armour investment. Armour investment historically varies with environment. Marine sticklebacks, which are almost exclusively fully plated, colonised freshwater environments in BC after the glacial recession. Subsequent parallel evolution resulted in reduced armour investment in freshwater populations, which are primarily low or partially plated. Therefore, **different environments may influence elemental composition.**

Study System

The Sooke River holds a gradient of unique habitats from marine to freshwater, within an interconnected system that contains stickleback populations theoretically descended from a common ancestor. Therefore, this system can tell us how landscapes might shape within-species variation, and by proxy, nutrient cycling.

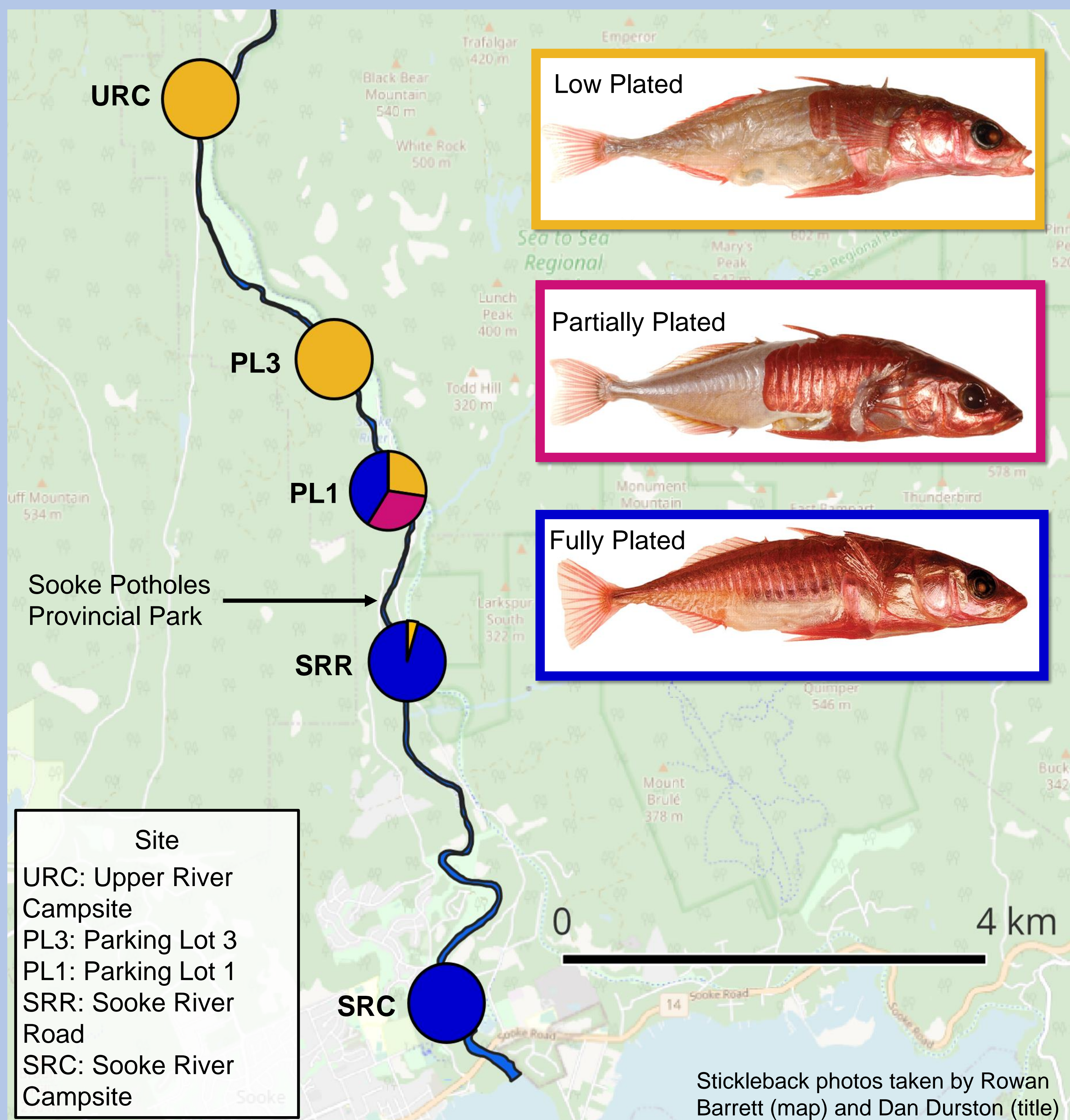


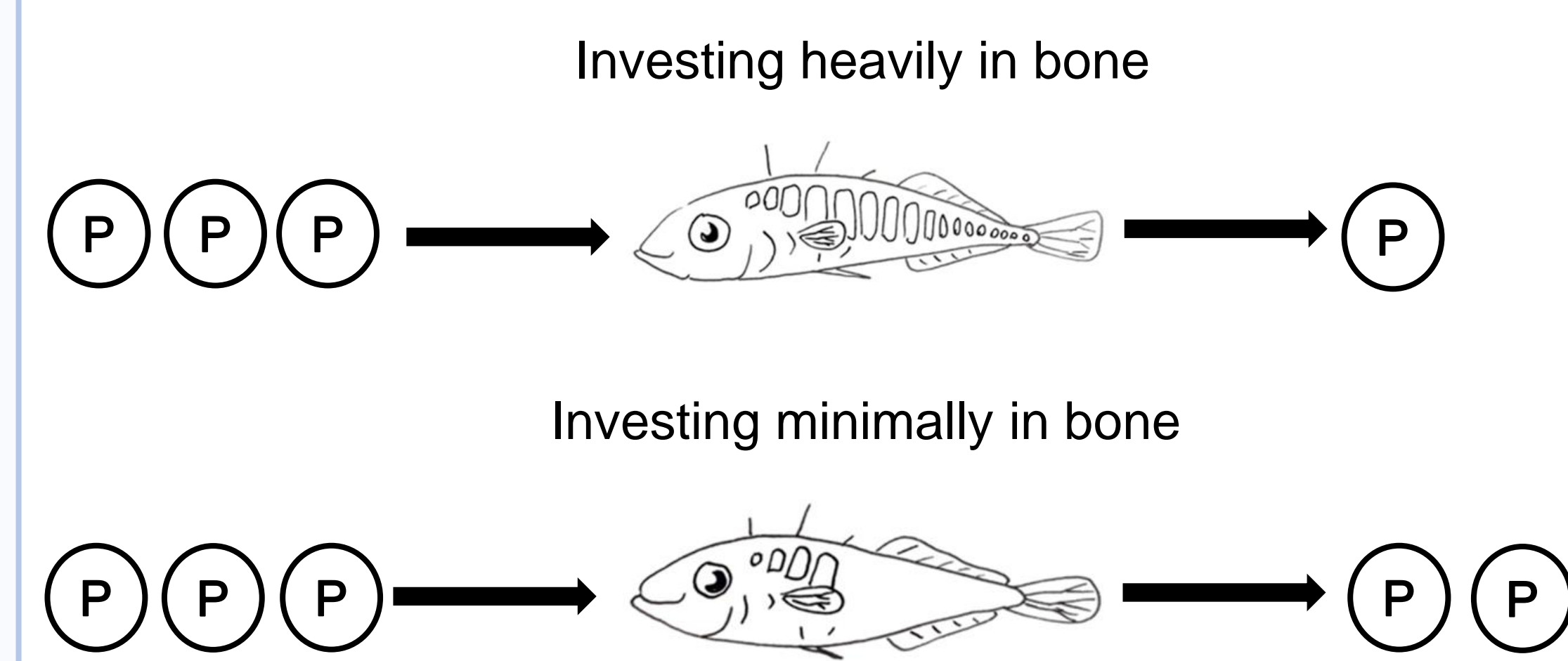
Figure 1. Proportion of plate morphs at each sample site along the Sooke River

Goals

- 1) Quantify variation in stickleback body %P, and P excretion rate
- 2) Determine whether site, bone investment, or other factors may drive this variation
- 3) Assess the relationship (if any) between whole body %P and P excretion rate

Predictions

- Body %P will increase with bone investment
- Individuals with higher body %P may take up more P from their diets so will excrete less P
- Sites with more fully plated fish will have higher body %P and lower P excretion rate



Methods

- 99 sticklebacks were collected from five locations along the Sooke River
- Excretion was measured in the field before euthanization
- Fish were dissected
- Body %P and P excretion rate were quantified using spectrophotometry

Results

- Plate morph varied predictably, with fully plated fish inhabiting the estuary and lower river sites, and low plated fish inhabiting the upper river sites (Fig 1).
- Stickleback body %P ranged between 2-6% of dry body weight, and this variation was partially explained by plate morph and site, where fully plated fish have significantly ($p < 0.05$) higher body %P than low plated fish (Fig. 2), and body %P declined with increasing distance from the estuary (Fig. 3)
- P excretion rate varied between about 0 and 2.5 $\mu\text{g}/\text{min}/\text{g}$ dry mass, with variation partially explained by site, but **not bone investment** (Fig. 4).

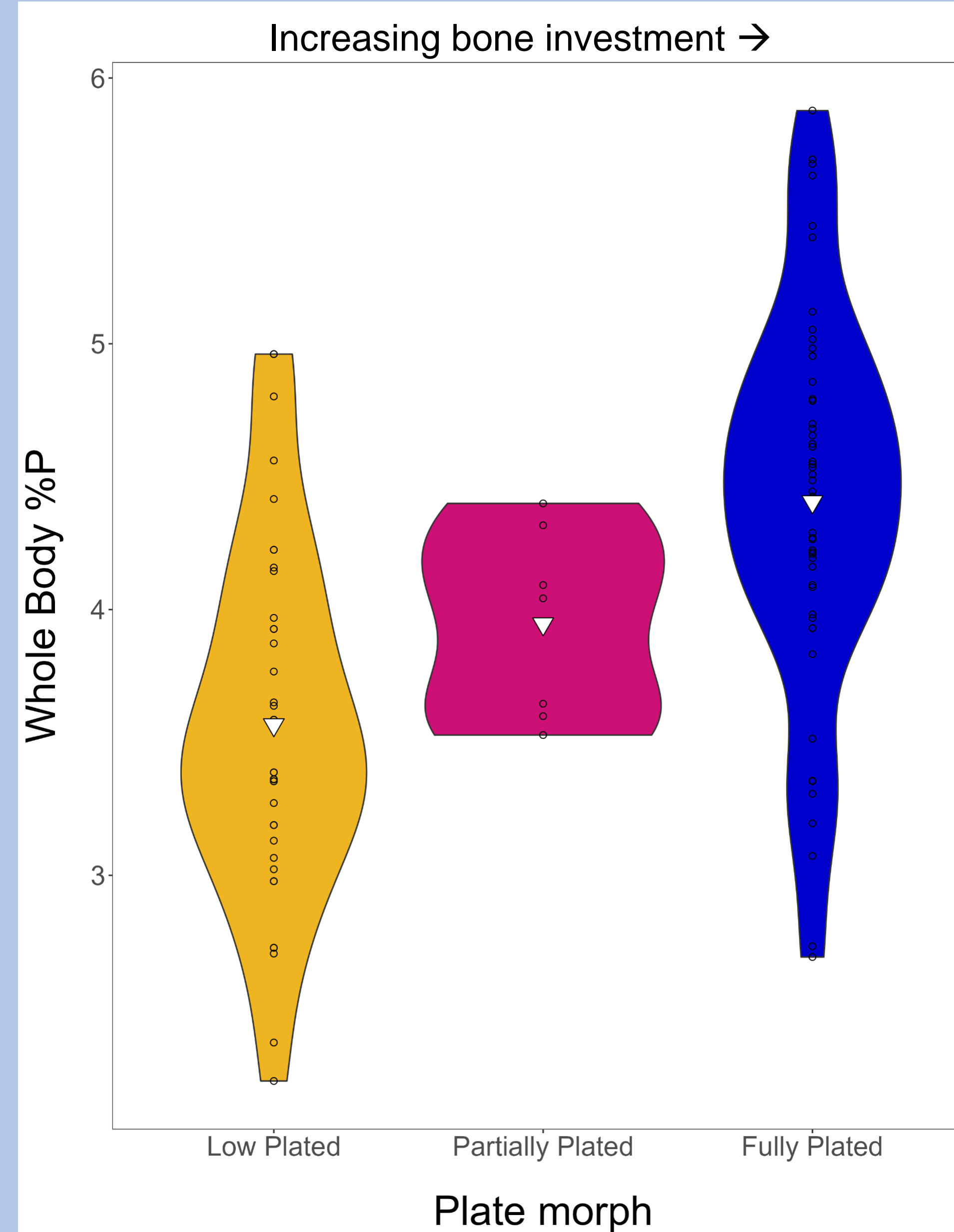


Figure 2. Body %P varies with plate morph

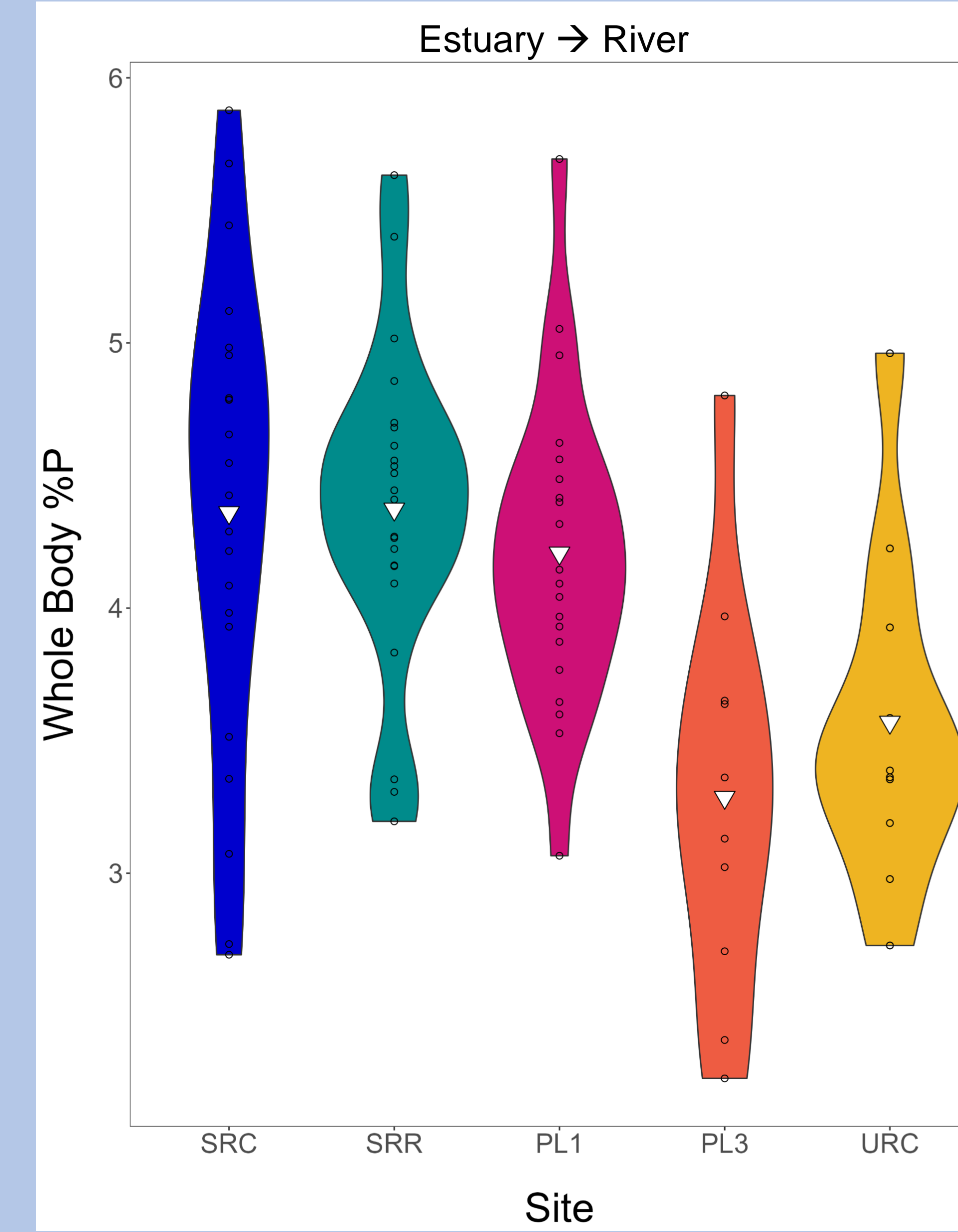


Figure 3. Body %P varies along the Sooke River

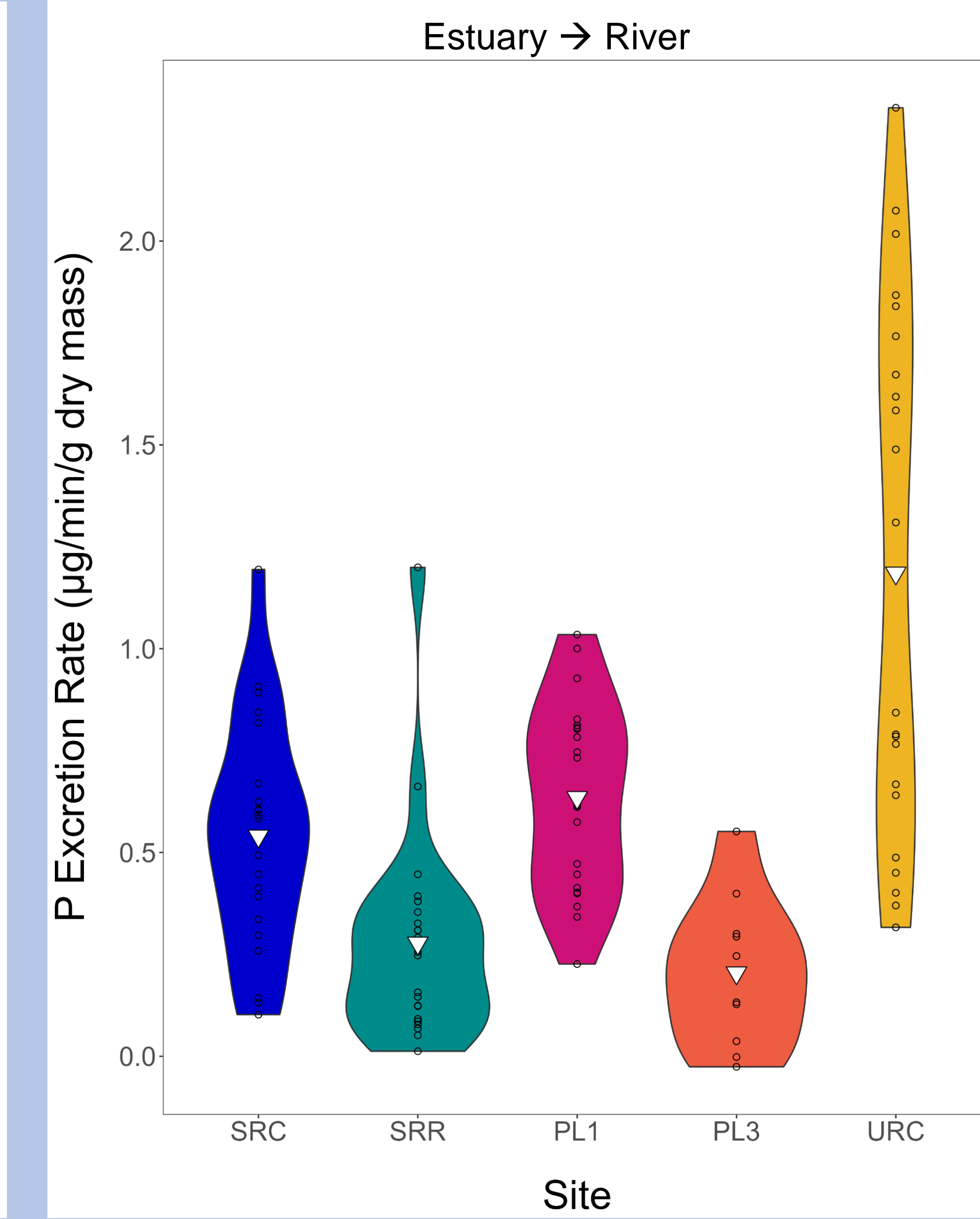


Figure 4. Excretion varies along the Sooke River

Conclusions

- Sticklebacks store P differently based on their site-associated differences in bone investment, and possibly other environmental factors; therefore, sticklebacks store nutrients differently depending on habitat
- Although there was no relationship between body and excretion P, the amount of P sticklebacks provide to primary producers via excretion may depend on habitat since P excretion rate still varied strongly along the Sooke River
- Because stickleback evolution has led to site-associated differences in bone investment, and these differences alter elemental composition in a predictable manner, we may be able to predict how fish mediated nutrient cycling changes depending on habitat

Future Research

Much of the variation in P excretion rate remains unexplained, and future studies should test the role of factors like consumption rate, elemental composition of the diet, and reproductive investment in driving variability in P excretion rates.

Acknowledgements

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