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Sediment copper bioavailability and uptake by *Salicornia* sp.

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Introduction

Vegetation can be regarded as a more appropriate tool than sediments for measuring contamination as plant-metal concentrations can reflect both chemical availability and bioaccumulation potential – both of which are toxicologically significant (Williams et al., 1994). The colonising halophyte, *Salicornia* sp., has previously been found to be a suitable tool for biomonitoring total copper concentrations in high-metal estuaries (Smillie, 2015).



Location map of sampled estuaries, Cornwall UK

This research sampled *Salicornia* sp. across estuaries in Cornwall, UK, that exhibited a range of metal pollution due to differences in historic mining activity. These were:

- The Gannel: lightly polluted for Cu, although high Pb soil concentrations
- Restronguet Creek: the most metal polluted estuary in the UK (Bryan and Langston, 1992)
- Lelant: moderate Cu pollution

Methods



Salicornia europaea

Sequential extraction procedure

Readily soluble metals (i.e., the mobile fraction) were extracted using deionized water.

Ammonium acetate for the exchangeable fraction. This mimics changes in oxidation status, with enzymes and root exudates, to release metals for plant uptake.

Combined, these two fractions are considered the bioavailable portion.

Organically bound and particulates are considered unavailable. Total sediment digestion utilised hydrochloric and nitric acid (Allen, 1989).

Vegetation sampling and processing

Salicornia sp. specimens were collected from each estuary and split into the roots and aerial portions. These were then dried to mimic the oxidative effect of the rhizosphere (Otte et al., 1993). These were then processed using acid digestion (Allen, 1989).

All analysis was undertaken using atomic absorption spectrophotometry.

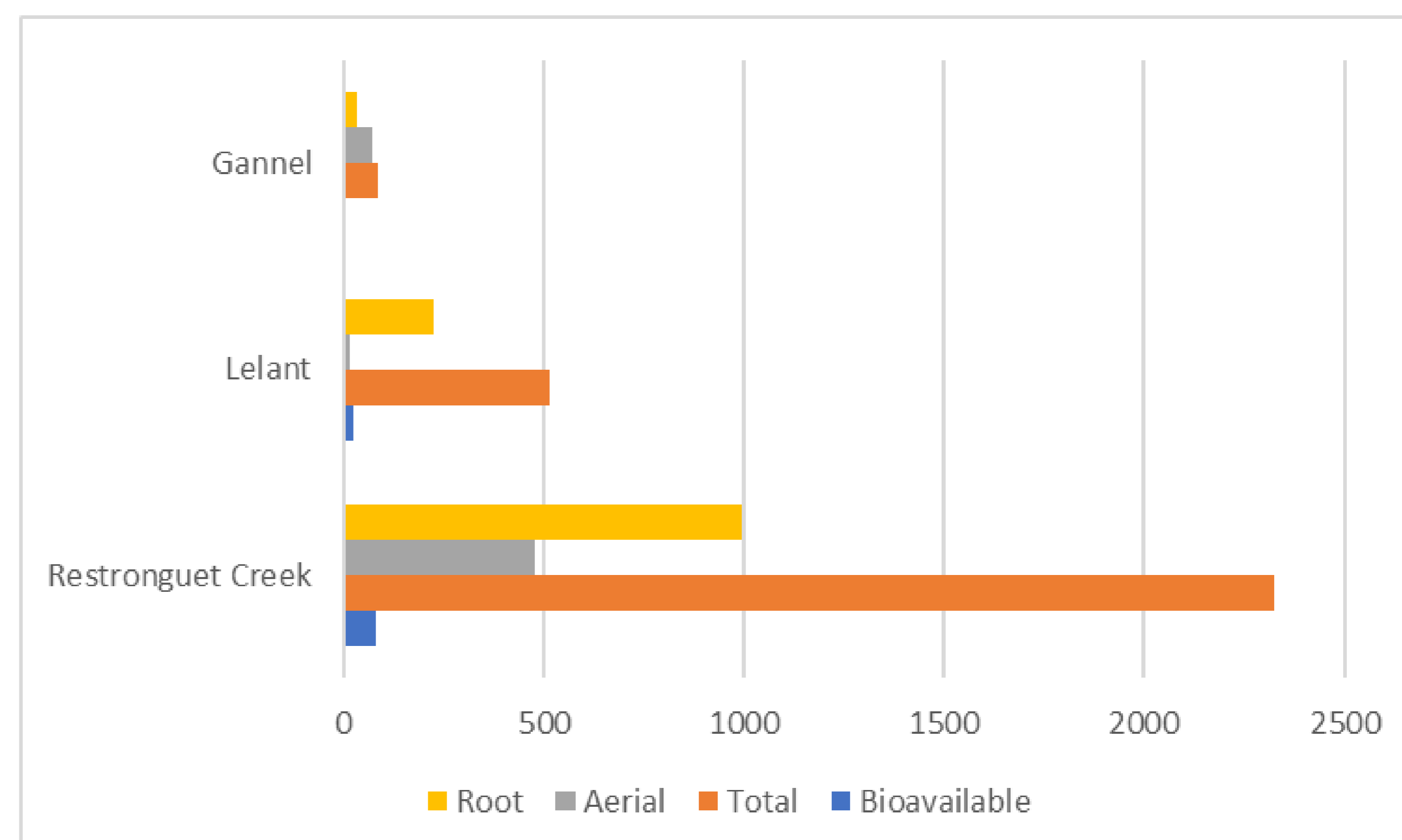
Results

Concentrations of copper in vegetation and sediment followed the trend :

Restronguet Creek > Lelant > Gannel

Cu concentrations in roots were far higher than the aerial portion in the polluted estuaries. The Gannel, however, recorded higher concentrations in the aerial portion than the root, although both were orders lower than the other estuaries.

To assess relationships, Spearman's rho was conducted. Results suggested no significant correlation between aerial and sediment. However, total, extractable and bioavailable portions were significant at the 95% level for root : sediment, but not for the soluble fraction.



Cu concentrations in sediment and *Salicornia*.

Relationship	Water	Exchangeable	Bioavailable	Total
Root:Sediment	0.64286	0.89286*	0.96429*	0.89286*
Aerial:Sediment	-0.36667	0.44352	0.53333	0.48333

Significance was calculated using Spearman's rho (where *p < 0.05)

Conclusions

Results of pollution status followed the same trend as reported in other research, confirming the extremely high copper status of Restronguet Creek and the lack of mining pulse in the Gannel.

The lack of correlation between aerial portion and sediment corresponds with Sousa et al. (2008), who reported that halophytes had generally low translocation factors. This lack of translocation, resulting in elevated root values in high-metal sediments confirms that *Salicornia* sp. can prove useful as an agent for phytostabilisation of polluted environments.

Significant correlations between root and sediment copper confirms that of Smillie (2015). The lack of relationship with the mobile portion may be symptomatic of the low levels of this fraction. The low salt marsh zone is a highly reduced environment. Under these conditions, metals tend to form insoluble sulphides, combined with tides washing out any existing soluble material.

Extractions using acids over a short time has been criticised (e.g., Otte et al. (1993)) as unrepresentative of the processes employed by vegetation. The use of such extractions did not provide any advantages to the use of total methods.

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