Differential effects and adaptations of sentinel organisms and implications for biomonitoring

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Introduction The River Sado Estuary

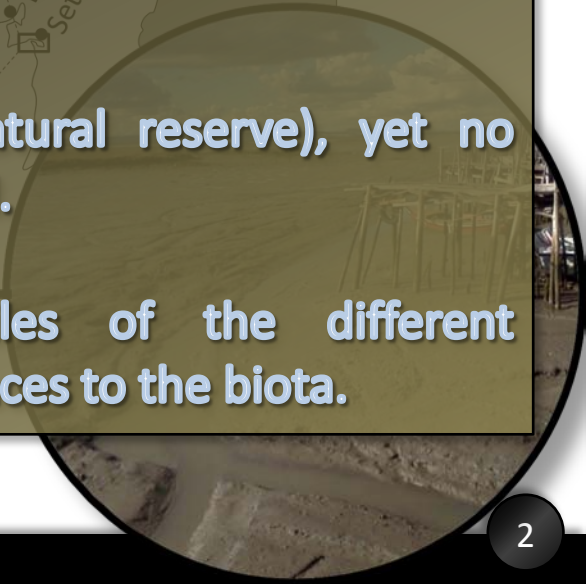
Highly diversified estuarine environment.

Previous research showed significant sediment contamination levels in the estuary, able to cause deleterious effects to organisms during laboratory bioassays.

Sediments from some areas the estuary have been found to hold complex mixtures of toxicants – organic and inorganic.

High priority for conservation (part is classified as natural reserve), yet no permanent biomonitoring programme has been developed.

The true extent of sediment contamination profiles of the different biogeographical areas is unknown, as well as its consequences to the biota.



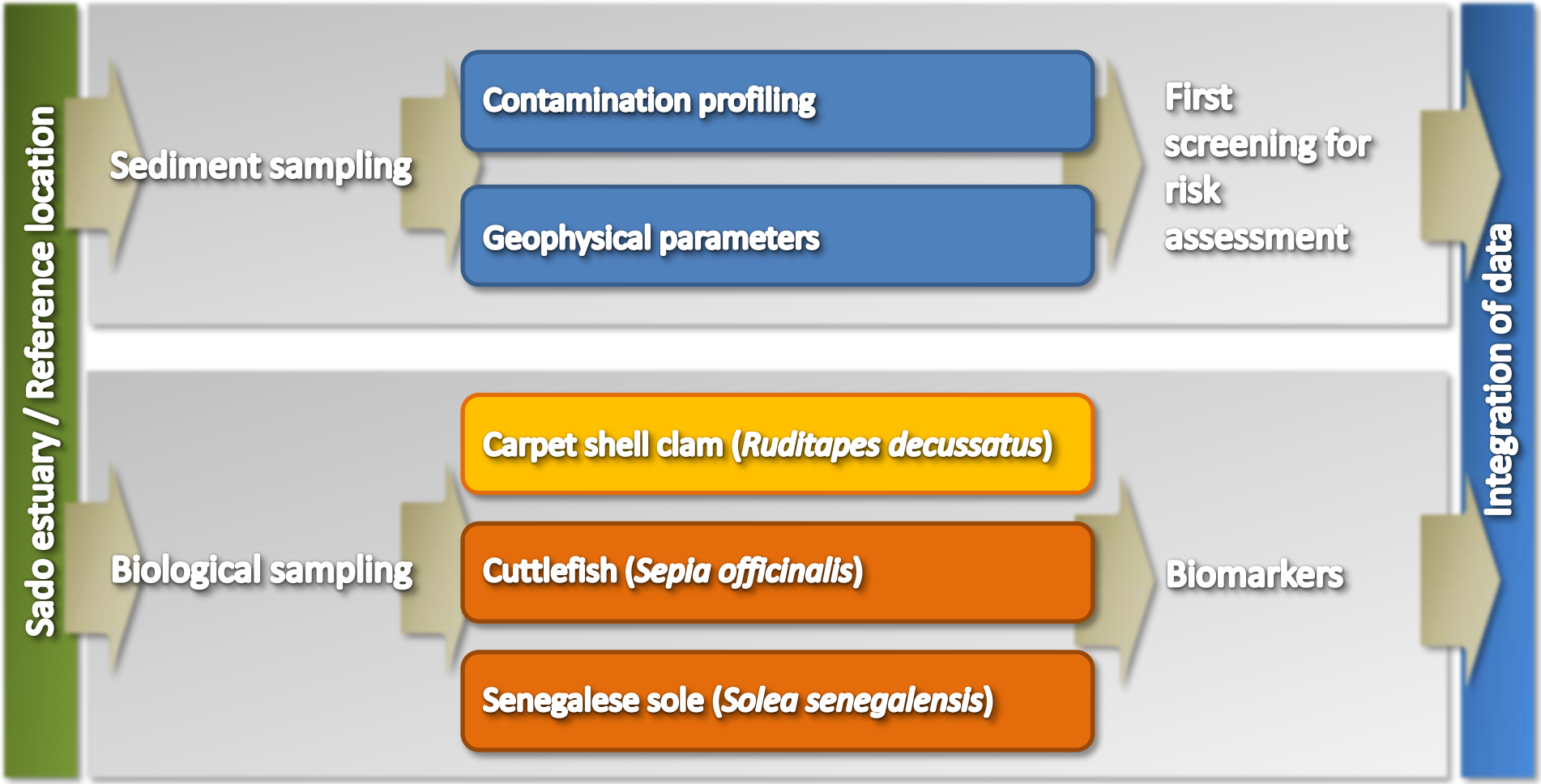
Objectives

- Provide an ecotoxicological appraisal of the Sado Estuary through a biomarker approach on three selected target species of commercial value and its integration with sediment contamination profiles.

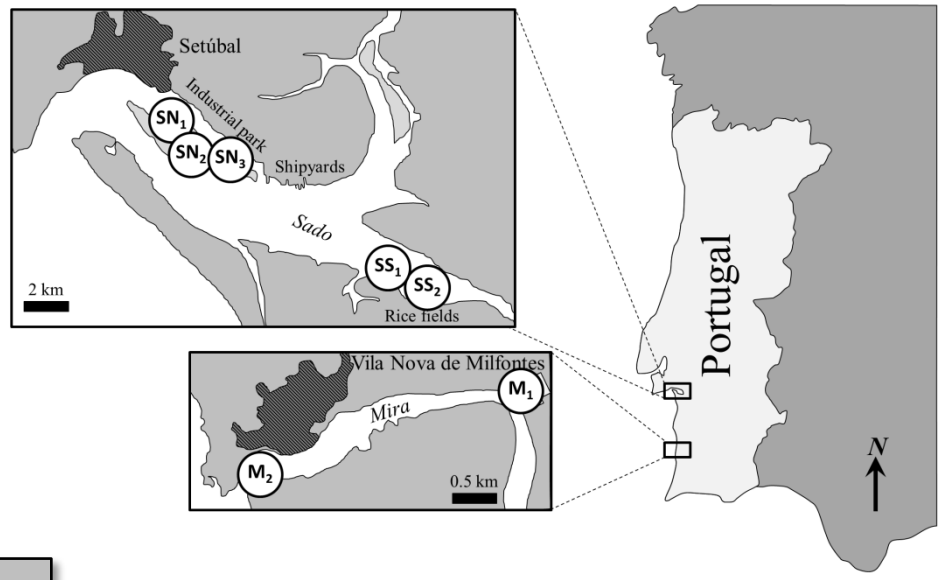
- Test and validate the employment of commercial estuarine species and biomarkers for biomonitoring purposes.

- To compare the potential responses to stressors between the different species and infer on potential adaptations, confounding factors and how they relate to the surrounding environment.

Methodology General outline

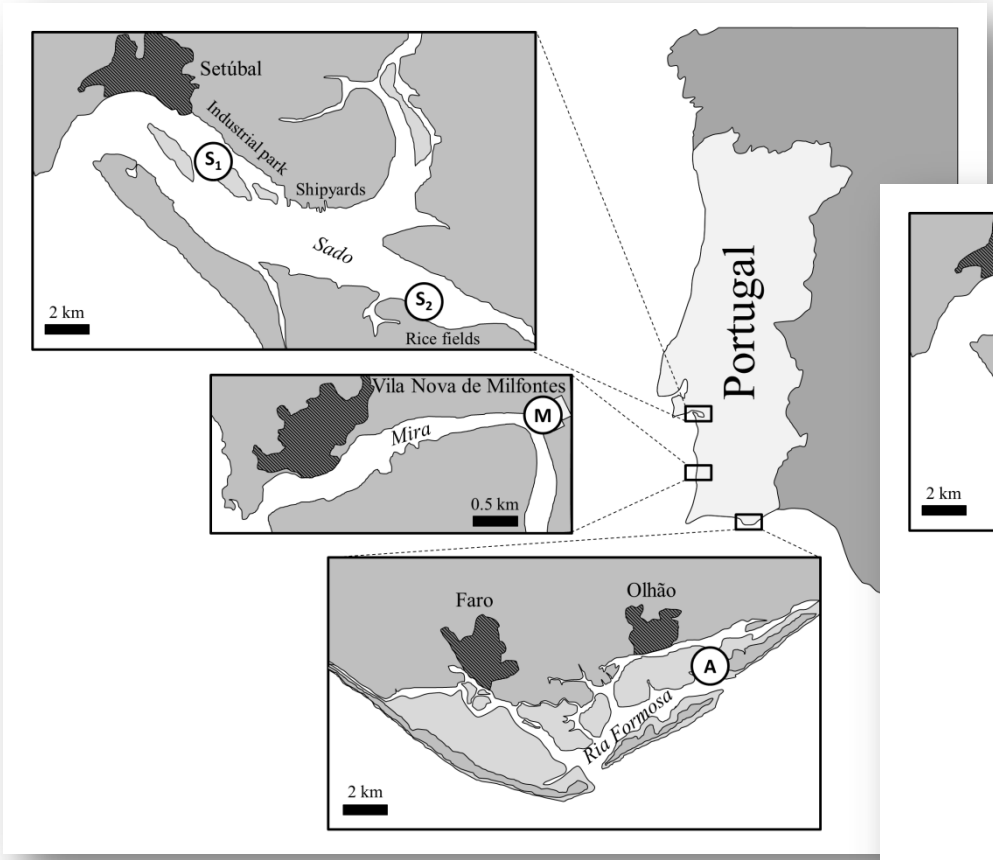


Methodology Sediment sampling



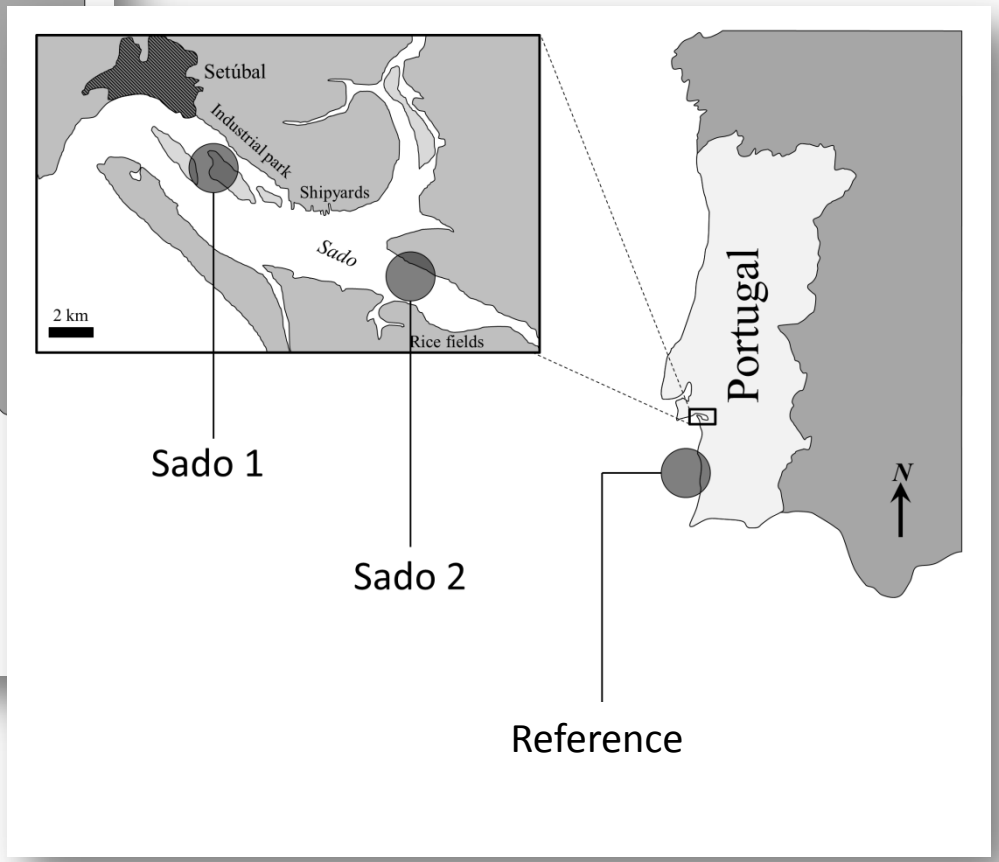
- **Sample batches**
  - Geophysical parameters
    - TOM
    - Granulometry
  - Pollutants
    - Elements: metals and metalloids
    - PAHs
    - Organochlorines

Methodology Biological sampling

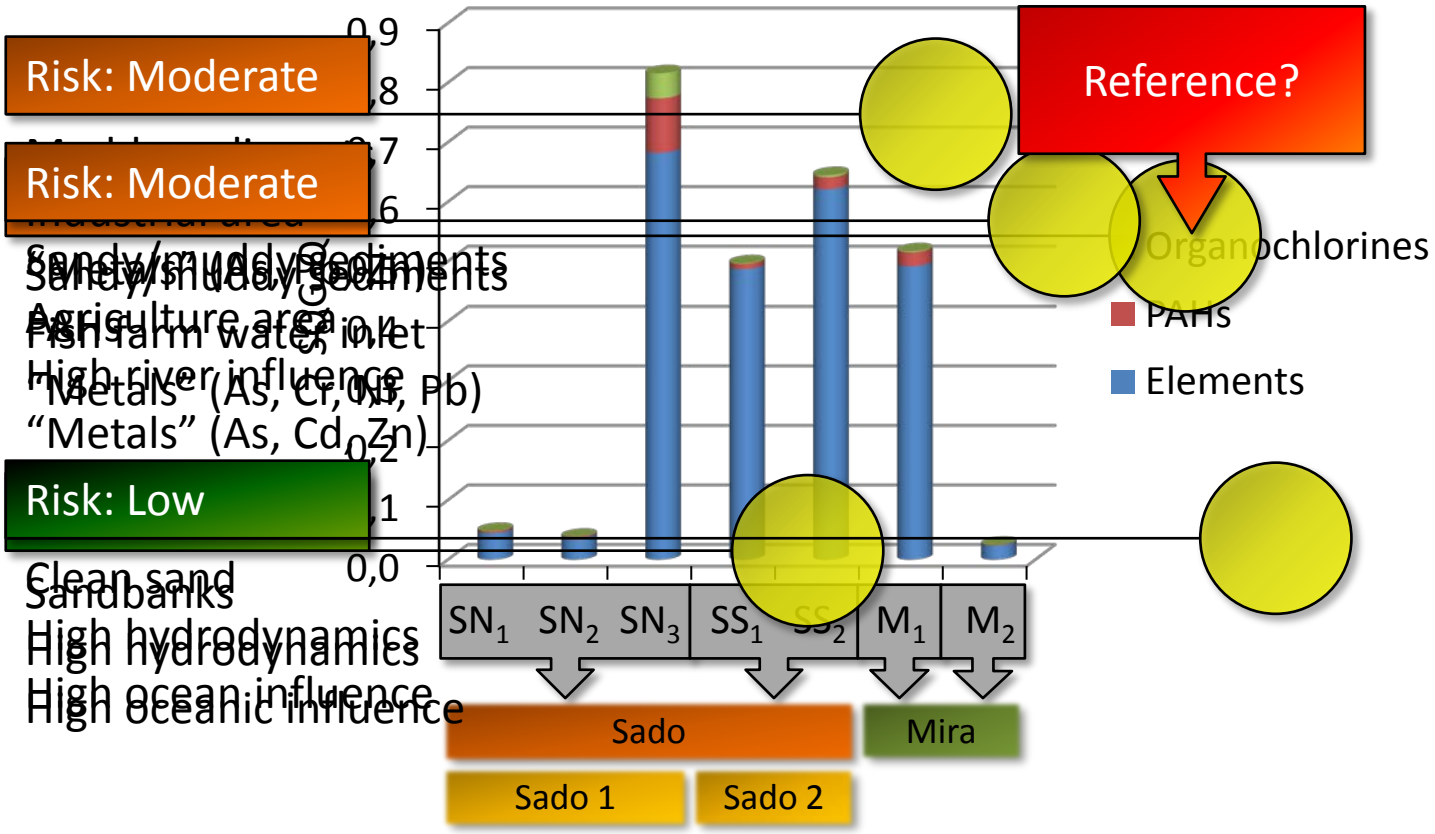


Clams

Cuttlefish and soles

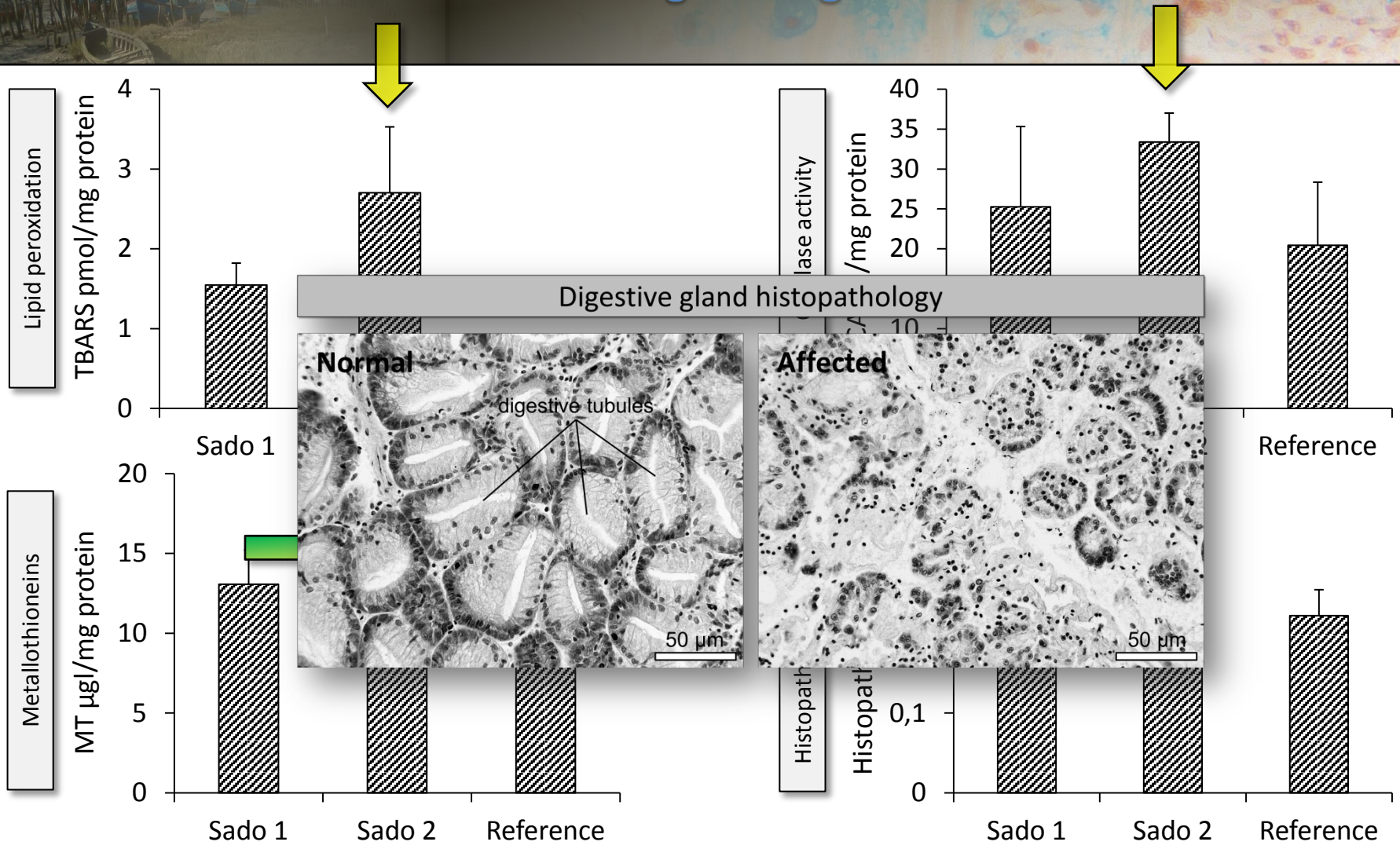


Results Sediment contamination profiling



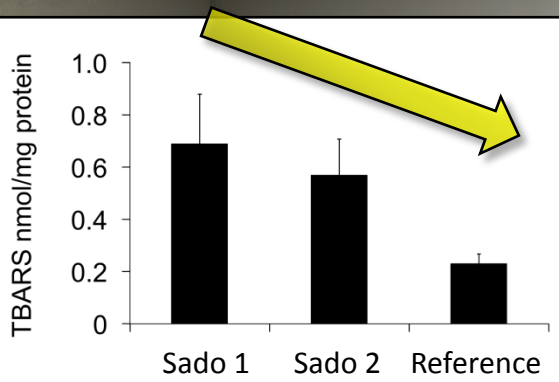
Sediment Quality Guideline Quotient approach according to Long & MacDonald (1998) *Hum. Ecol. Risk Assess*. 4, 1019–1039.

Results Biomarkers in clam digestive gland

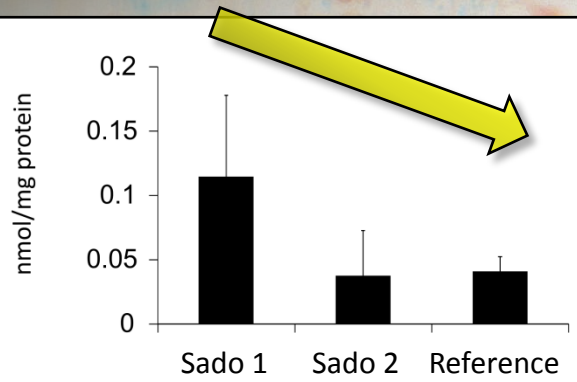


Results Biomarkers in cuttlefish digestive gland

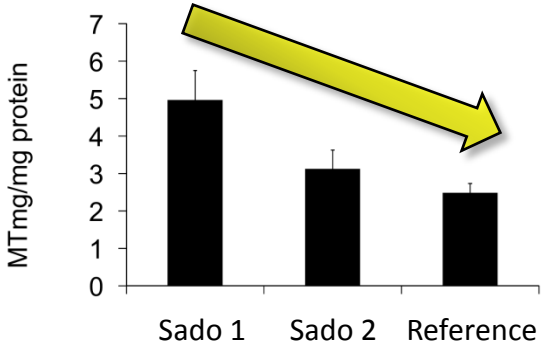
Lipid peroxidation



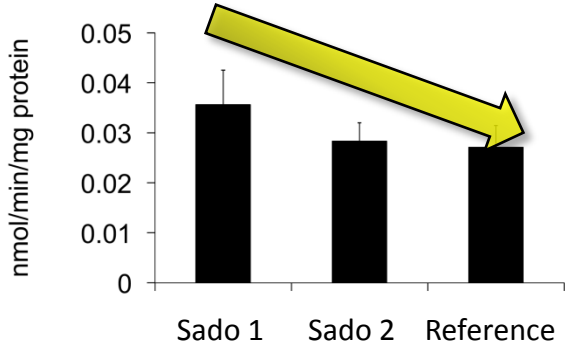
Total GSH



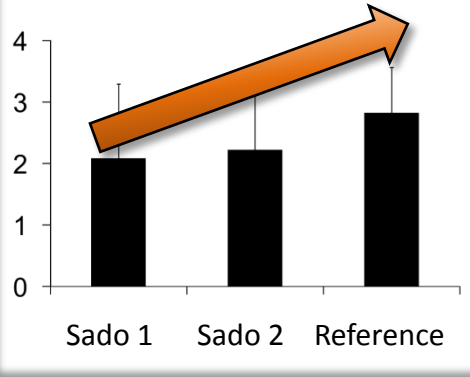
Metallothioneins



GST activity

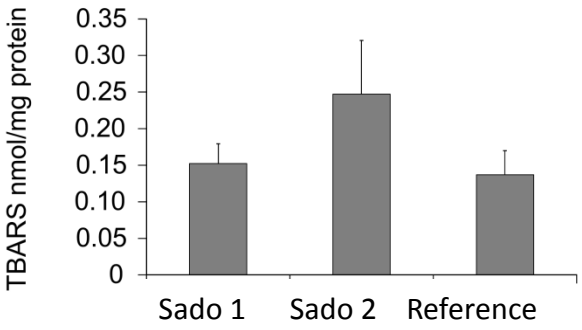


GSH/GSSG

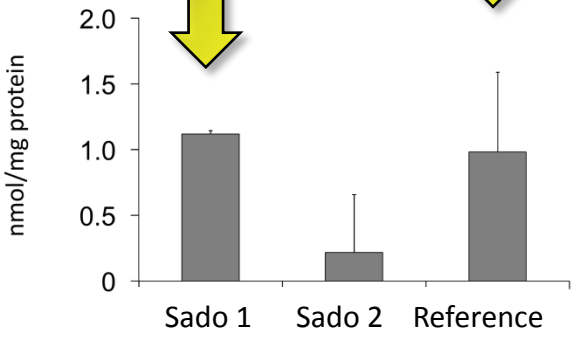


Results Biomarkers in cuttlefish gill

Lipid peroxidation



Total GSH



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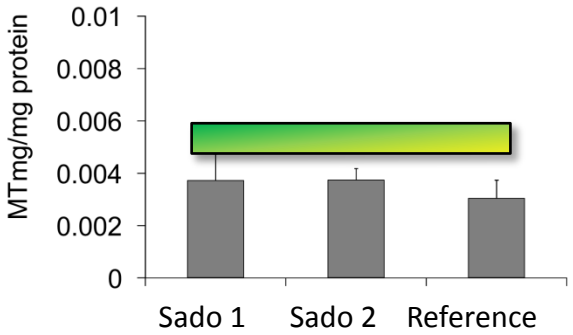
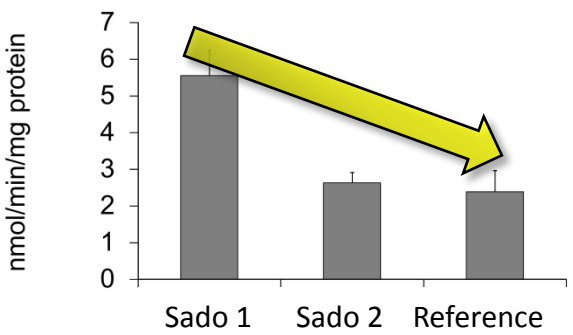
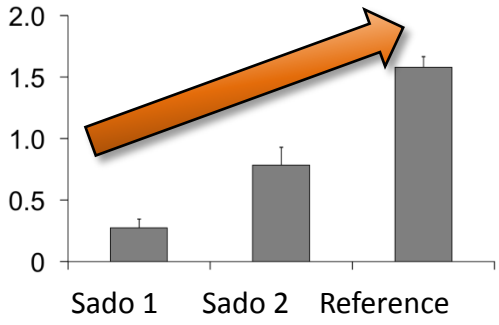


GST activity

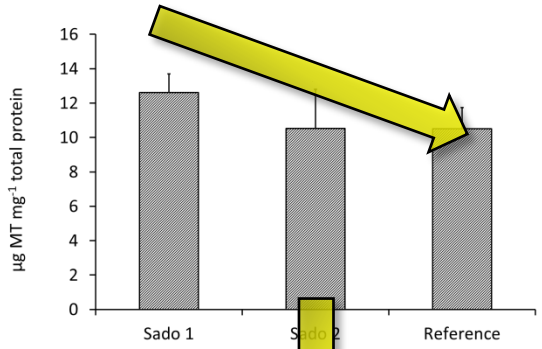


GSH/GSSG

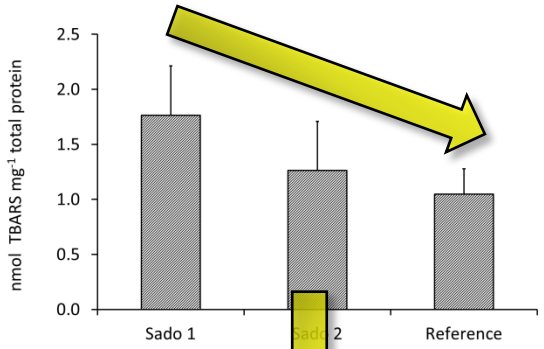


Results Biomarkers in fish liver

Metallothioneins

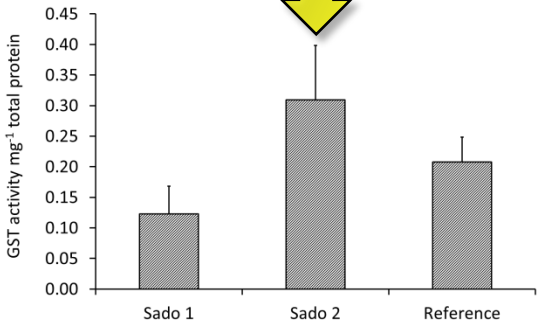


Lipid peroxidation

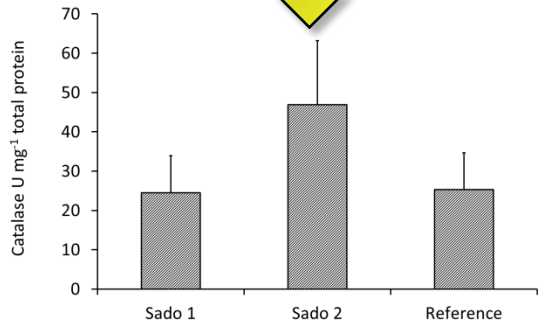


GST activity

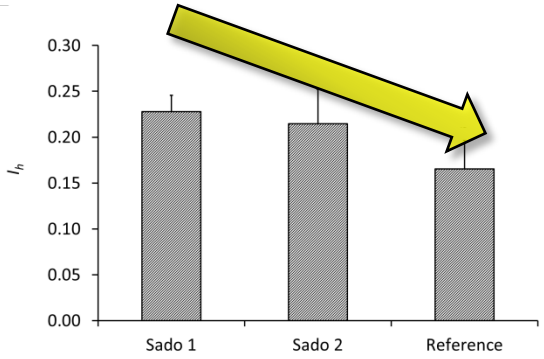
C



Catalase activity

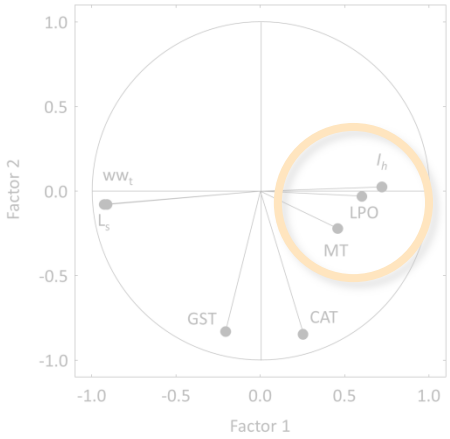


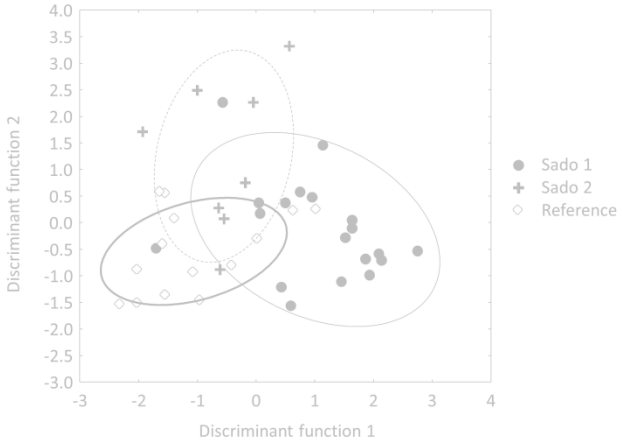
Histopathological indice



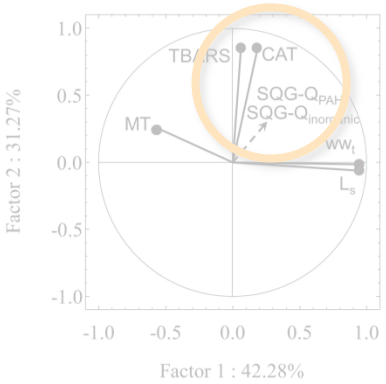
Results Statistical integration of data

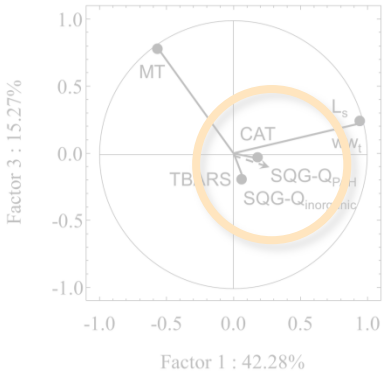
Flatfish

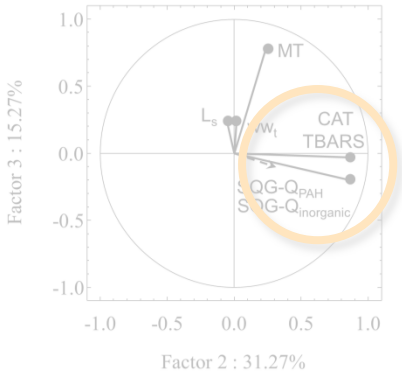




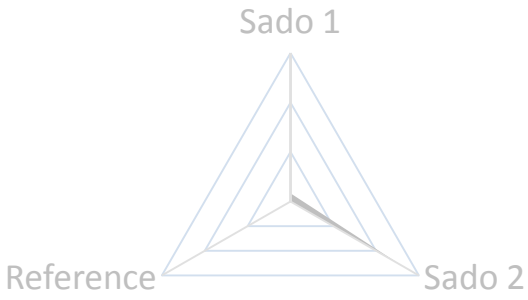
Clam



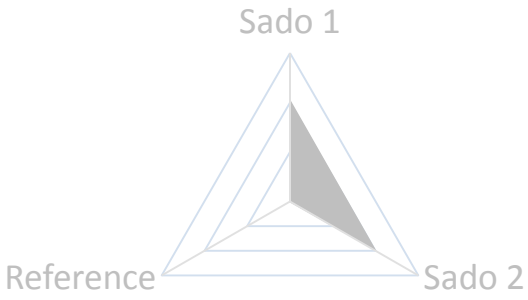




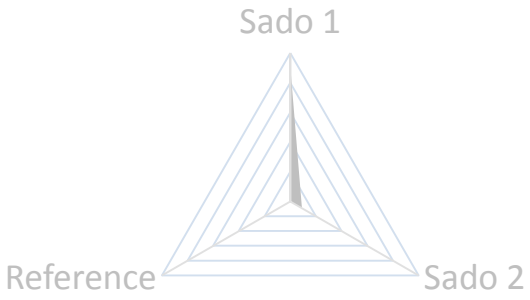
Results Integrated Biomarker Response*



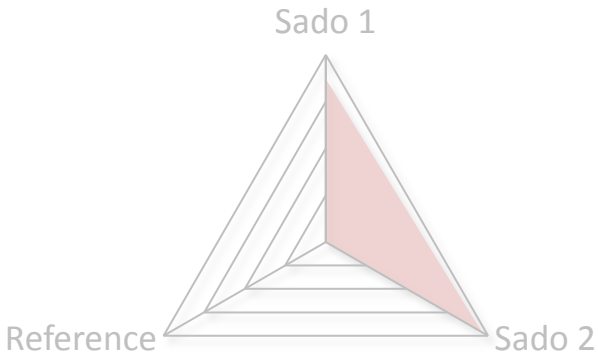
Clam



Flatfish



Cuttlefish



Combined

*Beliaeff B., Burgeot, T. (2002). *Environ. Toxicol. Chem.* 21, 1316–1322.

Discussion

Sediment contamination patterns are generally consistent with biological effects, especially those related to oxidative stress and histopathological traits.

The measured effects and responses are consistent to chronic, rather than acute, exposure to toxicants, thus indicating persistent exposure to environmental stressors and indicate a moderate impact of sediment contamination.

Organic contaminants, especially PAHs, account for the major differences between the biological effects.

Clams (burrowing filter–feeders) likely reflect their immediate surroundings while fish and cuttlefish are more efficient sentinels for wider areas.

Cuttlefish are promising newcomers in ecotoxicology but fish yielded a more complete overview of sediment contamination effects, even though not all responses were consistent.

Concluding remarks

- The biological effects are consistent with the species' habitat and behaviour (e.g. foraging *versus* burrowing). Null responses may indicate either impairment or adaptation of organisms to continuous, albeit low–level, stressors (e.g. anti–oxidant enzymes in fish), which constitutes an important confounding factor.

- The "big picture" for such complex ecosystems can only be retrieved through integrative, multi–endpoint and multi–species approaches. Commercial species from commercial fishing grounds proved solid candidate sentinels and may yield a link to human risk.

- The biomarker approach indicates that sediments are moderately contaminated by anthropogenic toxicants, causing adverse effects to organisms, however, long–term biomonitoring and sediment analyses are need to determine trends, sources of pollution and to develop effective management policies.

Acknowledgements

Thank you!

See also:

Rodrigo *et al.* (2013, in press). *Ecotoxicology* doi:10.1007/s10646-013-1140-3
Costa *et al.* (2013, in press). *Zoomophology* doi:10.1007/s00435-013-0201-8
Gonçalves *et al.* (2013). *Ecotox. Environ. Safe.* 95, 202-211.
Costa *et al.* (2013). *Aquat. Toxicol.* 126, 442-454.
Carreira *et al.* (2013). *Arch. Environ. Contam. Toxicol.* 64, 97-109.
Costa *et al.* (2012). *Aquaculture* 317/317, 61-67.

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