

## Effect on bioturbation by *Laeonereis* sp. in the Rio Doce Estuary

Sebastian S. Jensen<sup>1</sup>, Cintia O. Quintana<sup>1</sup>, Fabricio A. Gabriel<sup>2</sup>, Erik Kristensen<sup>1</sup>, Tiago O. Ferreira<sup>3</sup>, Angelo F. Bernardino<sup>2</sup>

<sup>1</sup> Department of Biological Sciences, Southern Denmark University, Denmark

<sup>2</sup> Departamento de Oceanografia, Universidade Federal do Espírito Santo, Vitória, Espírito Santo 29075 910, Brazil

<sup>3</sup> Departamento de Ciência do Solo, Escola Superior de Agricultura Luiz de Queiroz, ESALQ/USP, Av. Pádua Dias 11, Piracicaba, São Paulo 13.418-260, Brazil

The mine tailing spill into the Rio Doce estuary deposited significant amounts of heavy metals with impact on the benthos. This resulted in a 5-fold increase in metal concentrations and a 30% reduction in richness of benthic species. A pioneer polychaete species of *Laeonereis* sp. was found in large abundance in the estuary (1000 individuals m<sup>-2</sup>). This study investigated the effect of *Laeonereis* sp. bioturbation in sediment biogeochemical processes including benthic metabolism and exchange of metals across the sediment-water interface. Sediment cores were sampled at the Rio Doce estuary in areas previously examined for high iron content. The cores were kept in anoxic conditions for fauna elimination and pre-weighed live worms from the area were added into triplicate cores in three density treatments based on natural abundances in the area (low, medium, high density and control with no animals). Flux measurements of oxygen, dissolved ammonia and phosphate, as well as selected heavy metals (iron, manganese, zinc, chrome, nickel, copper, lead and cobalt) were performed regularly over a period of 32 days on cores. At the end of the period of flux measurements, cores were sliced in 1-2 cm depth intervals down to 18 cm and each sediment slice were analyzed for sediment characteristics, solid-phase iron, porewater ammonia, phosphate and selected metals. Preliminary results show fluxes of nutrients (PO<sub>4</sub> and NH<sub>4</sub>) during a flush-out period of approximately ten days, and the oxygen flux showed a generally 72.7 % higher consumption in the high worm density cores, indicating higher metabolic activity and ventilation of subsurface sediments. The fluxes of selected heavy metals show a general retention in the sediment, though iron, zinc, chrome, nickel, copper and lead were released towards the end of the experimental time. The top 3 cm of the sediment showed higher content of silt and clay (15.6-3.4 %), as well as lower median particle size (0.577-0.305 mm), indicating mine tailings remains mixed in the sediment. *Laeonereis* bioturbation likely leads to crucial biogeochemical changes in sub-surface sediments enriched with trace metals. Oxygenation of sub-surface sediments likely increase trace metal retention through increases in Eh potential, but were interspersed with periods of metals release to the water column. Benthic bioturbation is greatly important to biogeochemical reactions within estuarine sediments, as evidenced in metal contaminated soils of the Rio Doce estuary. *Laeonereis* worms significantly increased oxygen consumption and burrow ventilation of sediments, with measurable changes in the flux of nutrients and trace metals for periods of up to 30 days. Bioturbation likely influenced flux of metals in sub-surface sediments, with important effects on biogeochemical sedimentary reactions.

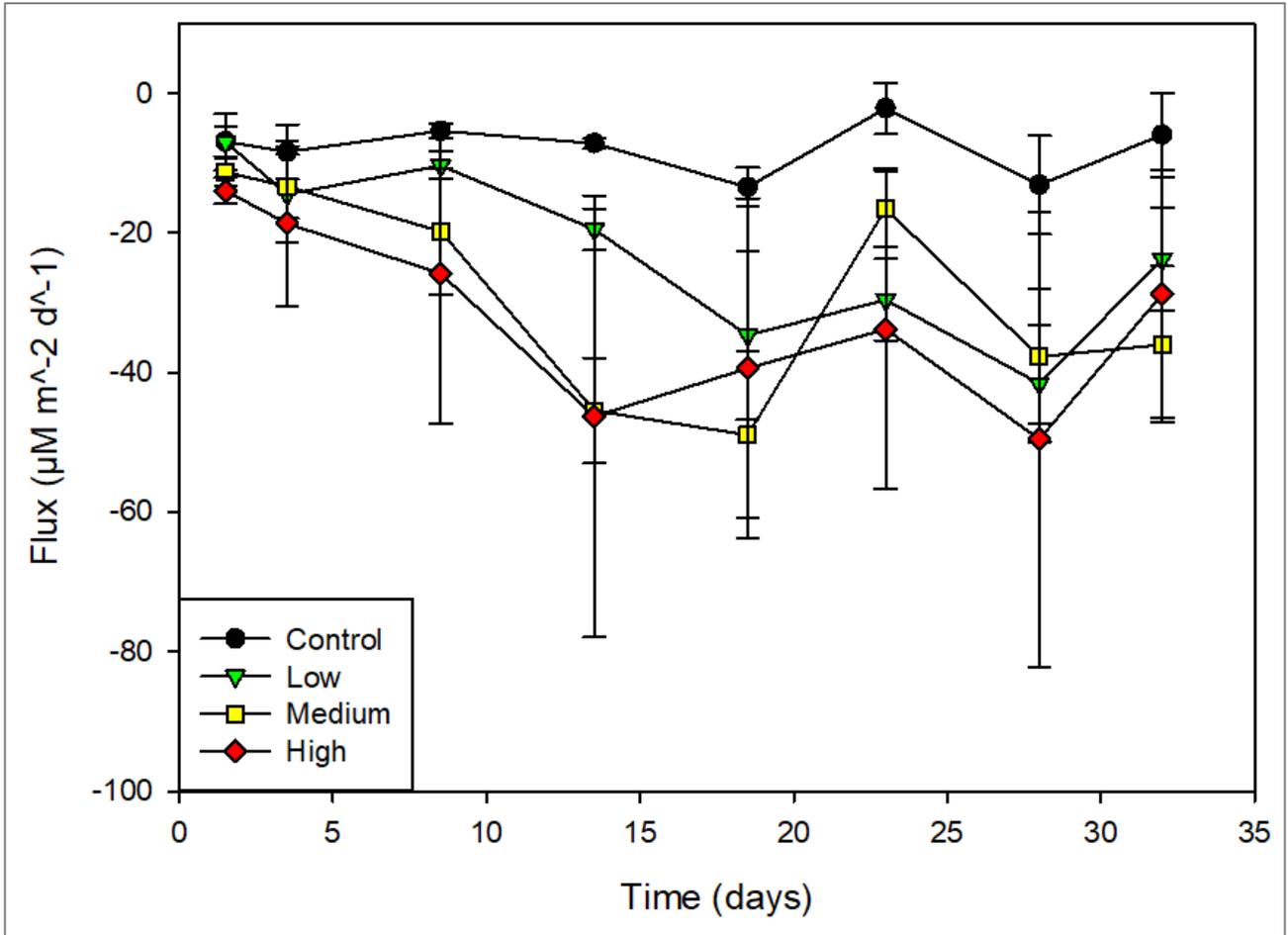


Figure 1: Average oxygen flux in over time. Average values of control (black), average of low (green), average of medium (yellow) and average of high (red) all shown.

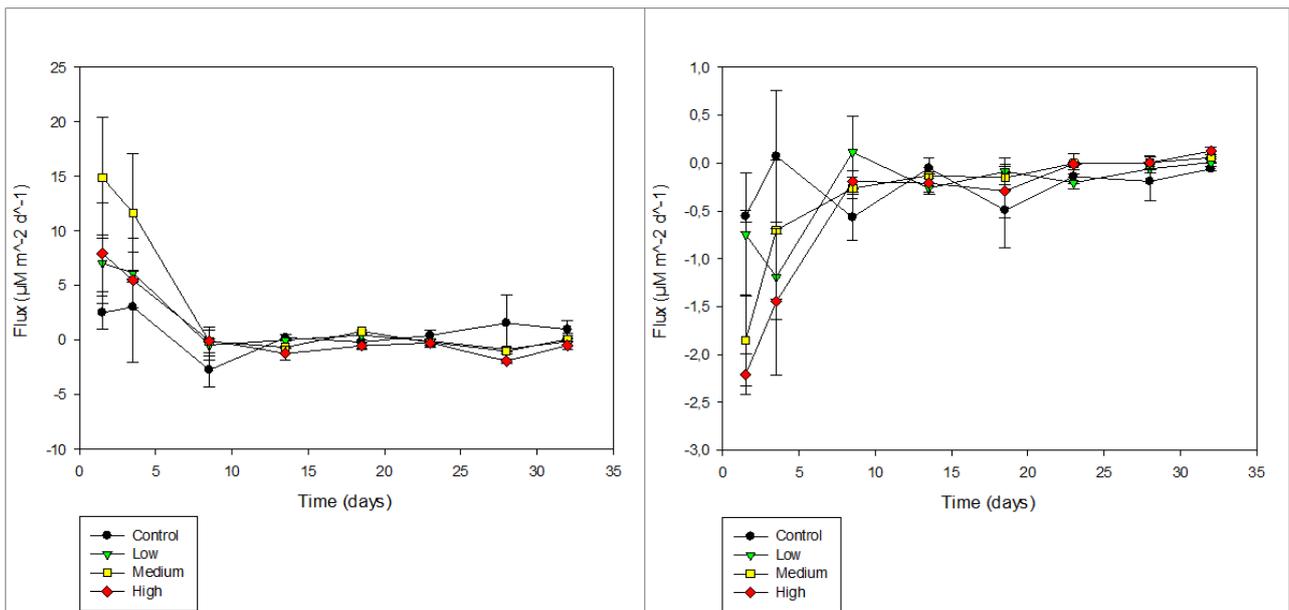


Figure 2: Nutrient flux of phosphate (left) and Ammonia (right). Average values of control (black), average of low (green), average of medium (yellow) and average of high (red) all shown.

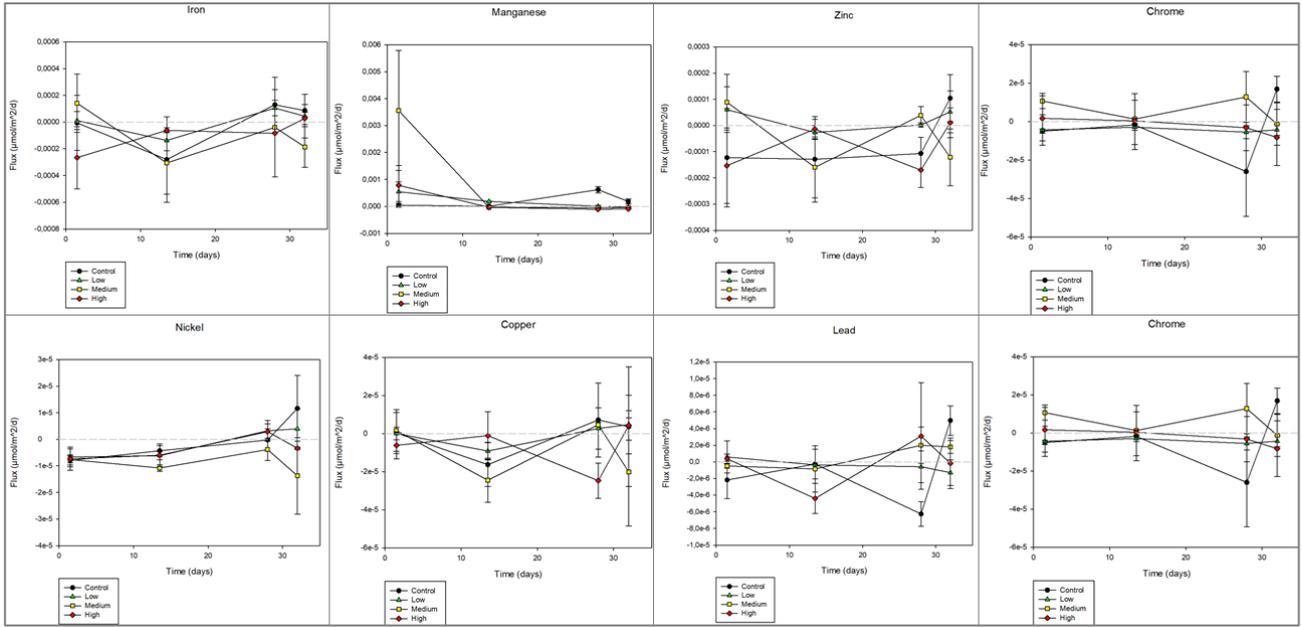


Figure 3: Flux over 32 days of eight selected heavy metals. Top row from left to right: Iron (Fe), Manganese (Mn), Zinc (Zn) and Chrome (Cr). Bottom row from left to right: Nickel (Ni), Copper (Cu), Lead (Pb) and Cobalt (Co). Average values of control (black), average of low (green), average of medium (yellow) and average of high (red) all shown.

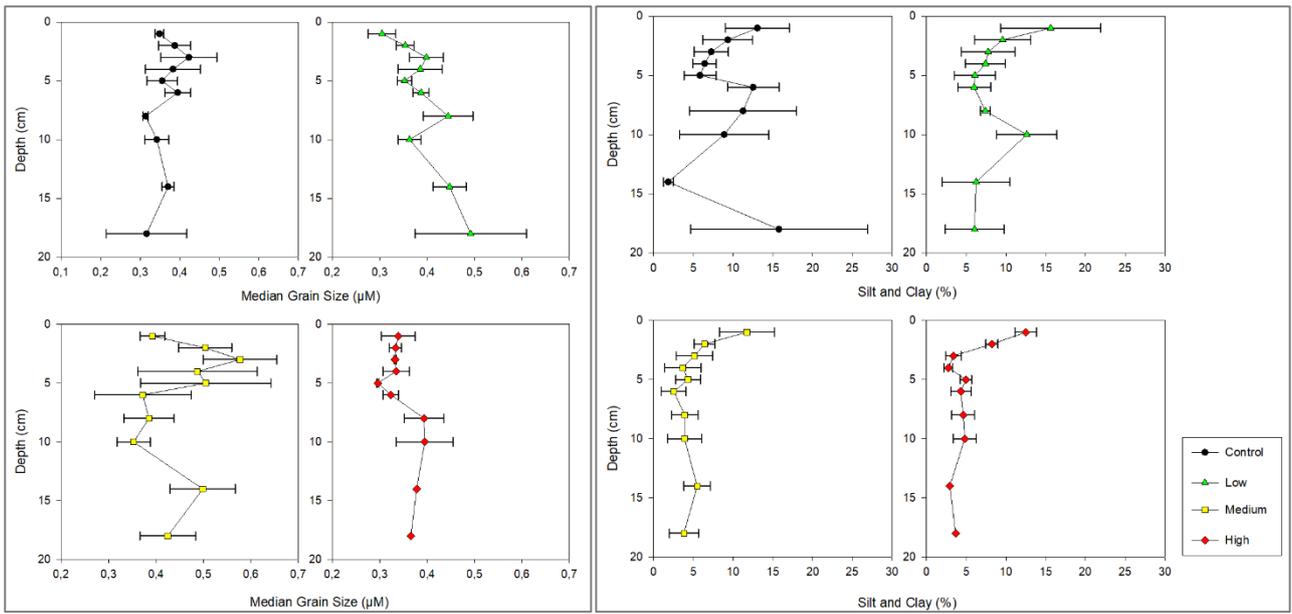


Figure 4: Median grain size (left) and percentage of silt and clay (right). Average values of control (black), average of low (green), average of medium (yellow) and average of high (red) all shown.

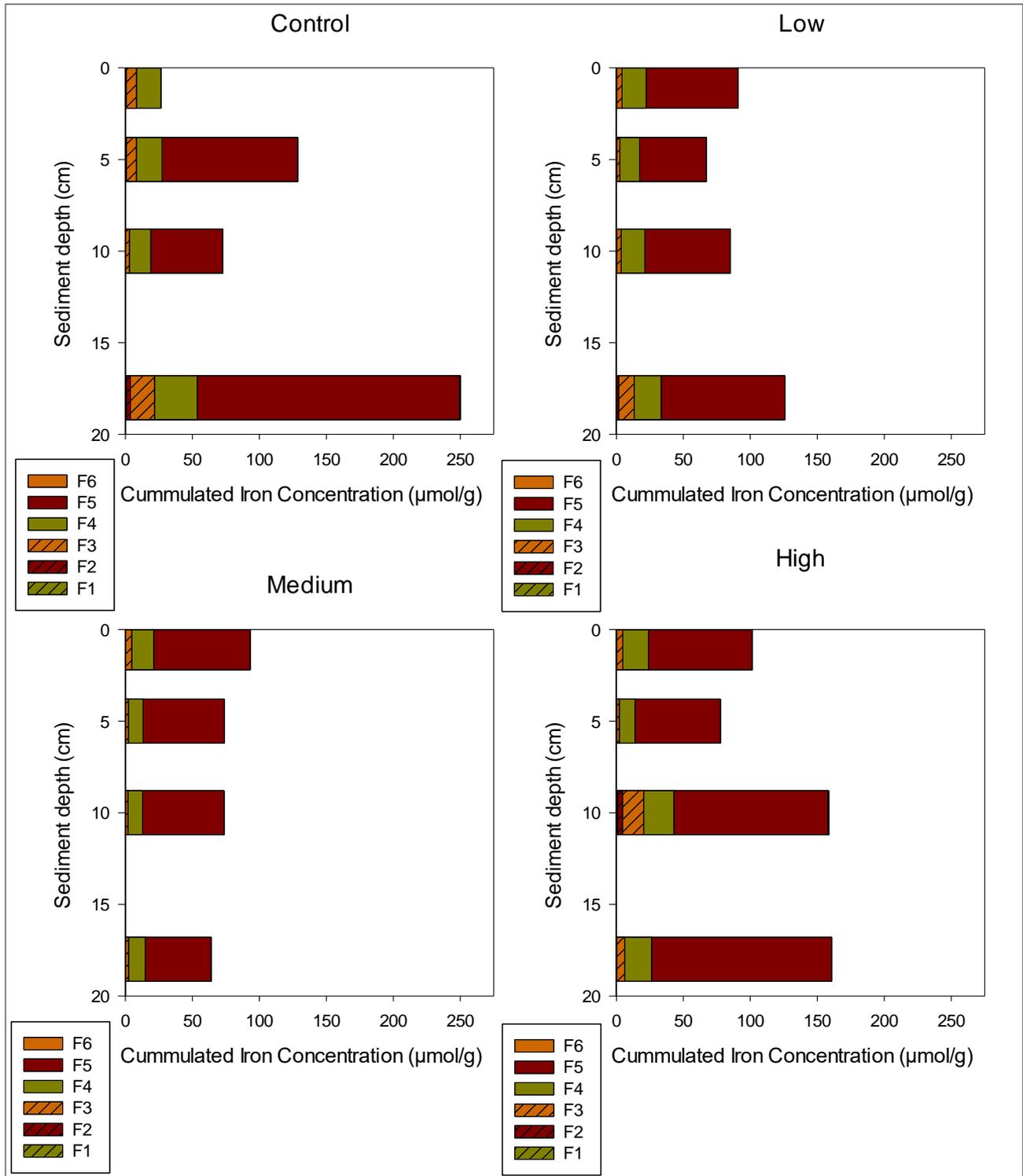


Figure 5: Fe-fractions in sediment. F1 is the Soluble and exchangeable fraction, F2 is the fraction bound to carbonates, F3 is the fraction associated with ferrihydrate-Fe and trace metals, F4 is the fraction associated with lepidocrocite and associated trace metals, F5 is the fraction associated with crystalline Fe oxides and associated trace metals and F6 is the fraction associated with pyrite.