



MASTER THESIS PROJECT

**Biomonitoring of rare earth elements in southern Norway:
Distribution, fractionation, and accumulation patterns in
*Mytilus spp.***

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SUMMARY

Growing extraction and usage of rare earth elements (REEs) for medical and industrial applications has resulted in its increased discharge into the marine environment as emerging contaminants. Using *Mytilus spp.* as a chosen bioindicator organism, this study analyzed the mussel soft tissue concentrations of 15 REEs, in particular Gd, at four sites in southern Norway around the vicinity of an industry producing Gd-based MRI contrast agents (GBCAs). Spatial distribution of REEs, shale-normalized REE fractionation patterns, and correlations with mussel size were all determined to assess potential impact of anthropogenic REEs at the site. It was seen that in *Mytilus spp.*, total Σ REE, Σ LREE, and Σ HREE increase along with mussel size. The REE fractionation pattern in the soft tissue resembled that of the organic matter phase, characterized by LREE enrichment over HREE, while also displaying negative Ce and positive Gd anomalies reflective of the surrounding seawater REE patterns. While Gd anomalies remained conserved in most of the sites, a notable fourfold Gd anomaly ($Gd/Gd^* = 4.4$) was found at the site downstream of the GBCA industry outfall, indicating uptake of excess anthropogenic Gd. This study constitutes the first assessment of REE composition of marine bivalves in Norway, and will be useful for future biomonitoring studies of REE contamination.