The role of native and/or invasive ecosystem engineers in explaining biodiversity (RMP 4.2)

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Ecosystem engineering has been defined as a biologically mediated modification of the physical and/or chemical environment that is relatively large. Thus, ecosystem engineers are known to modify habitats, which may facilitate or inhibit conditions to specific members of the community. As a result, many engineers function as keystone species with a large impact on the biodiversity, functioning and stability of ecosystems. However, the mix of facilitative and adverse effects makes that the net effect of ecosystem engineers on overall diversity is not always evident. The net effect may be even less clear in case an invading ecosystem engineer takes over the habitat from a native (ecosystem engineering) species.
Ecosystem engineers can affect biodiversity by two main mechanisms: (1) modifying physical (e.g., ameliorating harsh conditions) and/or chemical (e.g., sediment biogeochemistry) environment, and (2) enhancing the structural complexity of the system. Ameliorating of harsh conditions may affect biodiversity via facilitation processes. In coastal systems, the most harsh conditions are expected at transitions from deeper to more shallow depths. Accordingly, the relative importance of ecosystem engineering may be hypothesised to vary between different elevation zones. The effect of a modified sediment biogeochemistry on diversity may be hypothesised to be related with the level of organic enrichments and oxygen input into the sediment. Modification of structural complexity can affect biodiversity e.g. via shelter from predation. Modification of physical and/or chemical environment may enhance system stability as temporal variations can be buffered. However, an integrative view of the overall net effect of ecosystem engineers on biodiversity is still lacking, due to a lack of good across-system comparisons at a larger scale. The current proposal aims at addressing this gap in our knowledge.

The objective of our RMP is to compare the relative importance of ecosystem engineering for biodiversity and stability across different types of native and/or invasive ecosystem engineers (e.g., coral reefs, seagrass meadows, bivalve banks, algae meadows, salt marshes, etc.), going from:

1) shallow (intertidal) areas towards deeper water
2) cooler Northern latitudes to warmer Southern latitudes and in some cases even tropical areas.

Across these spatial scales we want to establish:

A. the importance of ecosystem engineering for biodiversity by comparing species occurrence patterns in plots with and without the dominant (invasive) ecosystem engineer. The data will be used to derive assembly rules, showing facilitation and/or inhibition.
B. the relative importance of the 2 main mechanisms: (1) modification of the physical and/or chemical environment versus (2) enhancing the structural complexity of the system. This will be achieved by comparing the biodiversity effect of native and/or invasive ecosystem engineers that strongly vary in this respect.
C. the consequences of ecosystem engineering for ecosystem functioning and ecosystem stability, e.g., by using a (conceptual) modelling approach conform van de Koppel et al. (2002, Am. Nat. 159: 209-218) and van de Koppel & Rietkerk (2004, Am. Nat. 163: 113-121).

Our aim is to use existing databases. For those systems where there are insufficient data to analyse topic B, essential data will be collected.
To further establish the relative importance of the mechanisms by which ecosystem engineers affect biodiversity, we aim for a small collaborative experiment (following common experimental designs) in which we use artificial structures that either result in large complexity, or that result in a large change in physical and/or chemical environment. However, regarding the limited funding, such collaborative experiments must be made compatible with ongoing research programmes of the various participants.