

1 **Habitat classification scheme for unconsolidated sediments: an integrated method for** 2 **the north east shelf of South Africa**

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7 **Background**

8 Habitat classification is a system used to define and categorize habitat types using standard
9 terms and descriptors in a consistent way. Classification is often based on geophysical,
10 oceanographic and biological data. Although appearing uniform, unconsolidated sediments
11 form complex habitats; including sand waves, rippled bed forms, biological creations like
12 polychaete tube fields and bioturbated surfaces from organism movement and burrowing
13 activities. Thus, they provide habitat structures for highly diverse and dominant groups of
14 benthic marine infauna. The unique geomorphological setting and local oceanographic
15 features along the east coast shelf of KwaZulu-Natal (KZN), particularly at the wider KZN
16 Bight, play an important role in influencing the seafloor habitat structures. Considering the
17 recent knowledge on macrobenthic community structure, distribution, feeding mechanisms,
18 local habitat drivers and sediment distribution along the KZN shelf, it is evident that sediment
19 attributes such as grain size (sand, mud and gravel), sediment texture and sorting influence
20 the distribution of macrobenthic assemblages. Hence, spatial variability of macrobenthic
21 communities, their various species complements, functional traits and biological attributes
22 can reveal the combined effects of multiple habitat and environmental gradients. The growing
23 focus on the study of macrobenthos in South Africa has prompted the need to identify and
24 describe the types of habitats which they are found in or adjacent to where they are
25 associated. Most existing habitat classification schemes were developed for specific
26 geographical points that are not comparable to others. Our aim for this study is to provide a
27 method and the first coarse classification scheme for sediment habitats of subtropical east of
28 South Africa.

29 **Methods**

30 With various methods relevant to conduct benthic habitat characterisation, here we make a
31 first attempt at integrating geological and biological methods applicable to the east coast of
32 South Africa's seafloor habitat classification. The sampling stations were set along transects
33 that divide the focus areas into three sub-regions; northern KZN (north of Richards Bay),
34 central KZN (uThukela) and southern KZN (Durban). Each station was surveyed using a
35 remotely operated vehicle (ROV) for video recordings of habitat and epifauna, a drop-camera
36 for still photography with a quadrat stand for quantified visual assessment of habitats and
37 sediment grab samplings within the depth range of 40-175m. Analysis for the underwater
38 videography and photography included borrowed methods from coral reef coverage to
39 develop a novel method that is validated and ground-truthed by physical sampling of
40 sediments for sedimentological properties and biodiversity assessment. The classification
41 scheme was put together with reference to existing, accepted schemes and previous data on
42 the sedimentary characteristics of the KZN shelf. The process of identifying and
43 characterising the habitats was focused on unconsolidated sediments at a fine scale. Distance-
44 based redundancy analysis (dbRDA) ordination plots was conducted to evaluate the
45 relationship between sediment types that best describe the variation in macrobenthic
46 assemblages among the sampled stations. A principle canonical analysis (PCA) was used for
47 visualization of sediment distribution in relation to selected environmental variables.

49Results

50This study developed a six-level hierarchical classification scheme commencing with the
51higher realm (marine environment) at level one, followed by the three broad habitats
52(continental shelf, slope and abyssal plain) differentiated based on physiographic features and
53characteristics of water column. Level three differentiates between the photic and aphotic
54zones and the fourth level identifying unconsolidated benthic habitats based on substrate type
55(gravel, sand, mud, biogenic structure etc). Level five focuses on each of the substrate types
56at a finer scale, with level six linking the macrobenthic assemblage to their associated habitat.

57Data analysis from underwater videography, photography and sediment samples revealed
58high habitat variability between the sampled regions, despite a common region (coastal
59topography and species biogeography) on the east coast. The dbRDA ordination plot revealed
60how various macrobenthic assemblages were correlated to the different sediment types. From
61the PCA, it was noted that the North of the Richards Bay sub-region was characterised by
62fine to very fine sand, significantly different to the muddy, fine to coarse sand habitats in
63uThukela sub-region. Offshore of the Durban was characterised by medium to fine sandy
64habitats with a mixture of sediment and reef habitats. The macrobenthic community
65assemblages agreed with the habitat differences in sub-regions in that they were not uniform
66and reflected the heterogeneous substrate type even over relatively short distances.
67Interestingly, although videography and still photographs pointed to soft sandy habitats,
68validation through grab sampling proved that there is an abundance of low-profile reef
69systems consistently smothered by a thin layer of sandy, muddy and gravel sediments.
70Sediment samples revealed macrobenthic communities unique to mixed sand/covered reef
71microhabitats and unconsolidated substrate habitats. In depth community analysis further
72revealed the decency of the fauna to the mixed habitat types in that the biological traits of
73some species require a hard substrate.

74Conclusion

75The habitat classification scheme developed in this study has shown how heterogeneous
76habitats along the shelf of KZN go beyond what is currently used as habitat scheme for
77planning and conservation purposes i.e. sand, mud and gravel. The two visual methods
78explored highlighted the limitations of using only the underwater videography and still
79photography data, as they reveal only the epibenthic characteristics of the seafloor habitat. On
80the other hand, sediment sample gave more detailed and relevant information about the
81various habitats present along the shelf. Thus, it is important to use two or more methods for
82identifying and characterising the seafloor habitats with regards to unconsolidated sediments,
83in particular if validating with actual benthic community attributes. The identified
84macrobenthic species/communities in relation to the types of habitats present along the KZN
85shelf reflect a broad range of habitats and biotopes unique to the east coast of South Africa.

86Knowledge generated from this study has provided baseline information for regional
87classification that can be incorporated in national conservation, protection and assessment
88schemes such as the National Marine Biodiversity Assessment and South Africa's Operation
89Phakisa Blue Economy Framework to increase our Marine Protected Area coverage. In
90addition, the study will contribute to the expansion of our local knowledge on Critical
91Biodiversity Areas.