Abyssal and hadal seascape ecology: understanding biodiversity, spatial patterns, and ecological processes across scales

Understanding how environmental heterogeneity structures biodiversity is a central question in marine ecology, and particularly so in abyssal and hadal environments. Seascape ecology provides a framework for investigating these relationships through four interconnected themes: composition, configuration, connectivity and context. Applying this multiscale framework requires robust biodiversity baselines alongside spatially explicit environmental information on geomorphology, habitat structure, and overlying oceanography.

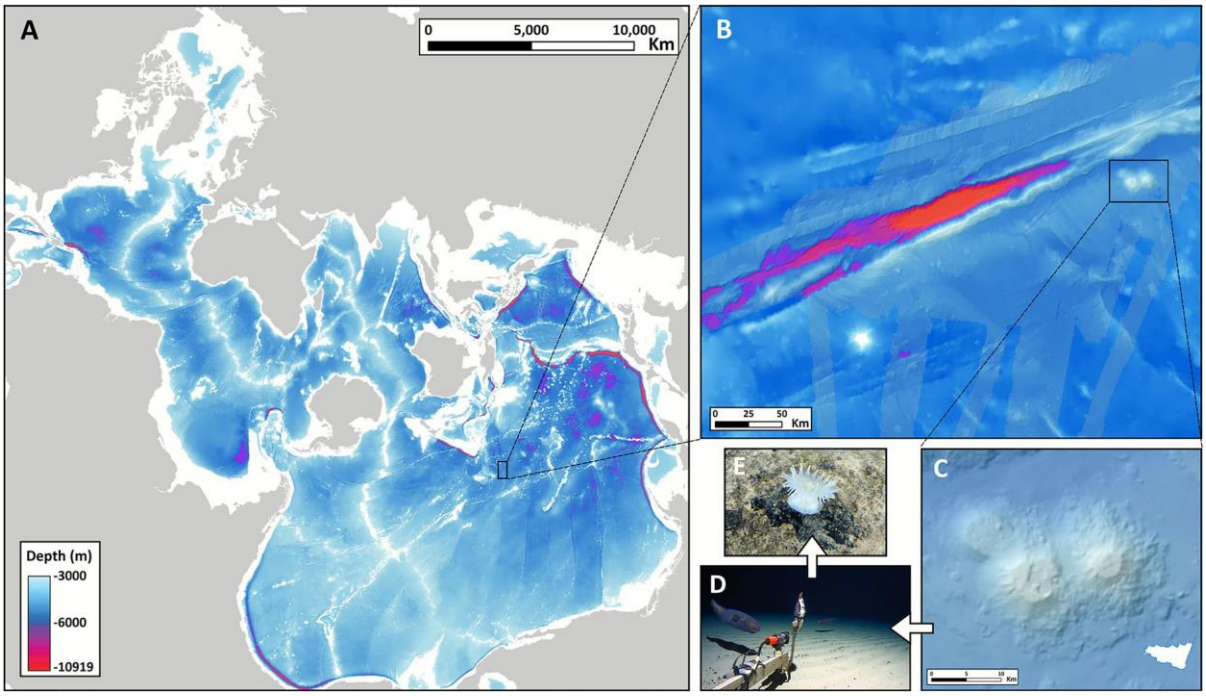
This talk synthesises recent work developing and applying this framework to abyssal and hadal environments, drawing on complementary studies from the Inkfish Marine Science programme combining biological observations from baited landers and crewed submersible with environmental characterisation across multiple spatial scales.

Seascape composition is established using image-based inventories from different hadal systems, documenting taxa and habitats. These also allow to resolve community structure across broad depth gradients. Examples from the Japan, Ryukyu and Izu-Ogasawara trenches, Nova Canton Trough and Tonga Trench will be given. Integrating biological observations with geological and oceanographic characterisation illustrates how seascape configuration (broad environmental gradients and local habitat heterogeneity) contributes to biodiversity patterns across abyssal and hadal seascapes. The effect of broader environmental context emerges through associations with productivity, temperature and disturbance. Examples from studies of mobile faunal assemblages, benthic habitats and scavenging amphipods will be given using data collected in Northwest Pacific subduction trenches and the Nova Canton Trough.

Together, these studies demonstrate a pathway from documenting biodiversity to quantifying its spatial organisation and investigating environmental drivers across spatial scales. They also highlight challenges in separating correlated environmental drivers and matching sampling resolution to ecological questions. Finally, this talk outlines priorities for advancing seascape ecology from conceptual framework to practical application.

See also:

Swanborn, D.J., Simon-Lledó, E., Thomas, E.A., Bond, T., McClain, C.R., Metaxas, A., Nester, G.M., Niyazi, Y., Bribiesca-Contreras, G., Clavel-Henry, M. and Marchiò, A., 2026. Deep ocean seascape ecology: gaps and pathways for application. *Landscape Ecology*, *41*(2), p.32.



Spillhaus square projection map of the world ocean for the seafloor showing the abyssal and hadal depth zones (A). Bathymetry data from the Global Bathymetric Chart of the Oceans (GEBCO Compilation Group 2024). Insets show seascape structure across mega- (B), meso- (C), macro- (D) and micro- (E) scales using data collected in the Nova Canton Trough during the Inkfish Open Ocean Program Nova Canton Trough expedition