Mapping coastal benthic biodiversity

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Thanks to the AC for use of their data and habitat maps
• Conversion of high resolution species data to biodiversity
  – Not just number of species, but ecological communities and habitats
• Theoretical approach
• Integrating different components
  – Hard and soft substrates
  – Intertidal and subtidal
• Interpolation across unsampled space
• The problem of in-between
  – Low intertidal – shallow subtidal
Mapping benthic ecology

Aerial photos
LIDAR
Side-scan, multibeam

Usual top-down approach:
- describe habitats from remote information

Sample and describe ecology within these habitats

Frequently these habitats don’t have distinctly different ecology

May not include environmental data

Second approach:
- use remote and environmental data to predict ecology
Remote information

- Bathymetry
- Backscatter/IF, aerial images

Direct sampling

- Sed data
- Ecol data

Ecological data

Ecol analysis

Ecological map
Sampling design not wholly driven by present information,
- some samples randomly allocated
- some spatially
Integrating soft and hard substrate measures

• Hard substrates
  – Often plants or colonial organisms
    • Percent cover
  – Animals usually enumerated
  – Cryptic animals usually ignored
  – Overhangs may have diverse communities
  – Transects
  – Rock pools
Integrating soft and hard substrate measures

- **Soft substrates**
  - Usually divided into epifauna and infauna
  - Epifauna may have plants and colonial organisms but usually not
  - Infauna usually numerically dominant especially in intertidal
  - Later on in process often need other measures such as burrows, mounds, tubes
Integrating soft and hard substrate measures

For epibenthos
• Keep surface area constant
• Determine a lower limit of resolution, e.g., 10cm to be used

Infana only measured in soft substrates
Integrating intertidal and subtidal

• **Sediment data**
  - Usually collected similarly

• **Epibenthos**
  - Larger areas often sampled in subtidal

• **Infauna variable**
  - grabs are larger than intertidal cores-
  - Cores slightly smaller because harder to pull out underwater
  - Often different mesh sizes used for grabs than cores
Integrating intertidal and subtidal

Differences in sampling area
• For abundances make assumption that aggregative behaviour will not spoil scaling and standardise to m²
• For numbers of taxa either
  – Present separately
  – Use species - area curves to predict number of taxa for specific area

Differences in mesh sizes either
• Present separately
• Presence/absence removing size limited taxa
Integrating intertidal and subtidal

Differences in sampling area

• **Subtidal quadrats**
  – Pair with smaller rocky quadrats nested within larger quadrats

• **Subtidal grabs**
  – Pair with soft-sediment intertidal quadrats, sieved at same mesh size e.g., 2mm

• **Intertidal cores**
  – Pair with single core taken within grab, sieved at smaller mesh size
Biodiversity

- Large amount of data from a single point
- Relatively easy to map
  - Number of species
  - Number of orders
  - Important species
- Not easy to map
  - Ecological communities or habitats
- Problems involve
  - Definition of boundaries
  - Multivariate analysis of ecological community data rarely produces distinct clumps
  - And there is no agreement on the degree of similarity that a community should share
  - Large numbers of clustering techniques usually with slightly different results
Ecological rules

• Aim is often description of broad habitat types, together with determination of
  – areas vulnerable to specific impacts
  – Functionally important areas
  – Recreationally or commercially important species

• Ecological classification rules can be developed to identify
  – key species, key functions and factors affecting vulnerability to threats

• These rules are usually combined hierarchically

• Have the advantage of overcoming differences in scale of sampling and differences between sampling that incorporates cryptic and non-cryptic
Ecological rules

Intertidal example

1. Did the sites have densities of adult Macomona, Austrovenus, or Paphies (or some combination of these) greater than or equal to 226 individuals per m² (3 individuals per core)?
2. Did the sites have high diversity at a high taxonomic (order) level (e.g., amphipods, polychaetes, bivalves)? And if so, were there high numbers of large organisms, burrowing organisms, surface mobile bioturbators, tube builders or suspension feeders?
3. Were the sites dominated by polychaetes? And if so, were they tube-builders, deposit feeders or large predators/scavengers?
4. Were the sites dominated by bivalves? And if so, were they invasive, deposit feeders or suspension feeders?
5. If the sites were not dominated by either polychaetes or bivalves, were they dominated by large animals or surface bioturbators?
Interpolation

- Remote information
- Environmental data
  - Depth, currents, waves, sediment type
  - Modelled sediment plumes
  - Variable resolution but often continuous
- Whatever works
  - Spatial polynomials
  - Distance to reefs, ports
  - Contaminants
  - Anchorage statistics
Which allows us to generate maps
The very shallow subtidal, low intertidal 3 - 7 m

- Most difficult to get any broader-scale information, e.g., aerial photos, side-scan, multibeam
- Hard to sample
  - Often has waves
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Conclusions

- Progressing slowly
- Products not much different to previous decade but underlying information and science is better
- Still don’t really know how to best present boundaries and uncertainties