An Overview of Multibeam Sonar Data Processing for Benthic Habitat Mapping at Deakin University

Daniel Ierodiaconou, Alexandre Schimel, Alex Rattray, Jacquomo Monk, Rozaimi Che Hasan & Sean Blake
Multibeam data for ecological modelling

“traditional” Automatic Unsupervised Classification approach

Backscatter Mosaic

Segmentation
Multibeam data for ecological modelling

“traditional” Automatic Unsupervised Classification approach

Backscatter Mosaic → Segmentation → Classification

Ground-truth

- Habitat Type A
- Habitat Type B
- Habitat Type C
- Habitat Type D
Multibeam data for ecological modelling

“traditional” Automatic Unsupervised Classification approach

Backscatter Mosaic → Segmentation → Classification → Final map

Ground-truth
Multibeam data for ecological modelling

Ecological Modelling approach

Backscatter Mosaic

Ground-truth

Classification

- Habitat Type A
- Habitat Type B
- Habitat Type C
- Habitat Type D
Multibeam data for ecological modelling

Ecological Modelling approach

Backscatter Mosaic

Ground-truth

Classification

Relationship analysis

Habitat Type A
Habitat Type B
Habitat Type C
Habitat Type D
Multibeam data for ecological modelling

Ecological Modelling approach

- Backscatter Mosaic
- Ground-truth
- Classification
- Relationship analysis
- Final map

Legend:
- Red: Habitat Type A
- Blue: Habitat Type B
- Green: Habitat Type C
- Orange: Habitat Type D
Multibeam data for ecological modelling

Ecological Modelling approach

Other predictors?

Ground-truth

Other variables?

Relationship analysis

Other types of output?
Multibeam data derivatives
(Rattray et al., Est. Coast. & Shelf Sciences. 2009)
Multibeam data derivatives
(Rattray et al., Est. Coast. & Shelf Sciences. 2009)
Benthic habitats maps
(Rattray et al., Est. Coast. & Shelf Sciences. 2009)

classes are mixed brown algae and invertebrates (MBI), mixed brown algae (MB), mixed red algae and invertebrates (MRI), mixed brown and mixed red algae (MBMR) and no visible biota (NVB).
Habitat suitability maps
(Monk et al., Cont. Shelf. Res. 2011)

Known ecology:
Planktivorous schooling fish.
Inhabits deeper reefs near sheer drop-offs

MAXENT: AUC 0.74 & Kappa 0.73

<table>
<thead>
<tr>
<th>Variable</th>
<th>Relative contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bathymetry</td>
<td>33.3%</td>
</tr>
<tr>
<td>Proximity to reef</td>
<td>30.0%</td>
</tr>
<tr>
<td>Backscatter</td>
<td>18.2%</td>
</tr>
<tr>
<td>Rugosity</td>
<td>11.1%</td>
</tr>
<tr>
<td>Eastness</td>
<td>3.7%</td>
</tr>
<tr>
<td>Northness</td>
<td>1.7%</td>
</tr>
<tr>
<td>BPI</td>
<td>1.3%</td>
</tr>
<tr>
<td>Max. curvature</td>
<td>0.01%</td>
</tr>
</tbody>
</table>
Developing the range of predictors
Exposure
(Rattray, Ierodiaconou et al., in preparation)

Bathymetry combining LiDAR & MBES

Moonlight Head

Cape Otway

Apollo Bay
Exposure
(Rattray, Ierodiaconou et al., in preparation)

Orbital velocities 1m above the seafloor
More multibeam–derived predictors?
“Deakin invests $5 million in Warrnambool marine research initiative” Sept 2011

- *Yolla* Research Vessel
- Kongsberg EM2040C
- Applanix PosMV
- Caris HIPS&SIPS
- IVS Fledermaus
- Staff
Wilson's Promontory Marine National Park
Backscatter Angular Response

**Biota Classes**

- Mixed Brown Algae-MB
- Invertebrates-INV
- Mixed Red algae & Invertebrates-MRI
- Mixed Brown Algae & Invertebrates-MBI
- No Visible Biota-NVB

**Substratum Classes**

- Reef
- Reef/Sediment
- Sediment
Combining angular response & mosaic?
(Che Hasan et al., in preparation)

1. Create a backscatter mosaic.
Combining angular response & mosaic?
(Che Hasan et al., in preparation)

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2. Segment the mosaic using a region-growing algorithm.
Combining angular response & mosaic?
(Che Hasan et al., in preparation)

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2. Segment the mosaic using a region-growing algorithm.
3. Compute mean angular response from segments.
Combining angular response & mosaic?
(Che Hasan et al., in preparation)

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2. Segment the mosaic using a region-growing algorithm.

3. Compute mean angular response from segments.

4. Extracting features from the 30-50 deg. Interval (incl. mean, least square slope, skewness, kurtosis).
1. Create a backscatter mosaic.

2. Segment the mosaic using a region-growing algorithm.

3. Compute mean angular response from segments.

4. Extracting features from the 30-50 deg. Interval (incl. mean, least square slope, skewness, kurtosis).

5. Create rasters of features by assigning feature value to segment
Combining angular response & mosaic?
(Che Hasan, Ierodiaconou, Monk & Schimel, *in preparation*)

<table>
<thead>
<tr>
<th>Biota class</th>
<th>Overall accuracy (%)</th>
<th>Kappa coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>MB</td>
<td>79.8</td>
<td>0.66</td>
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<tr>
<td>INV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MRI</td>
<td></td>
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<tr>
<td>NVB</td>
<td></td>
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</tr>
<tr>
<td>MBI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Substratum class</td>
<td></td>
<td></td>
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<td>Reef</td>
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Combining angular response & mosaic?
(Schimel, Rzhanov, Fonseca, Mayer & Immenga, in preparation)
Combining angular response & mosaic?
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“Themes”

“2D histograms”

BS level (dB)

Grazing angle (deg)
Combining angular response & mosaic?  
(Schimel et al., in preparation)

Estimating the **homogeneity**
of a given segment
Combining angular response & mosaic? (Schimel et al., in preparation)

Estimating the **homogeneity** of a given segment
Estimating the similarity between two segments
Combining angular response & mosaic?
(Schimel et al., in preparation)

Estimating the similarity between two segments
Combining angular response & mosaic?

(Schimel et al., in preparation)
Combining angular response & mosaic?
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Combining angular response & mosaic?
(Schimel et al., in preparation)
Fish school
HMCS MacKenszie (EM2040 data)
(112 m long, draft 30 m, height 12 m)
Frequency response?
Thank you

For more information, contact:
Alex: a.schimel@deakin.edu.au
Daniel: iero@deakin.edu.au