

Acoustic classification of nearshore seabed habitats based on echo-integration and visualisation

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Outline

- Hierarchical classification
- Background- reef mapping for fisheries assessment
- Factors affecting acoustic classification of seafloor habitat
- Comparison of echo integration and visual echo interpretation
- Reef characterisation
 - Profile
 - Rugosity
 - Patchiness
 - Dominant Algal Species
- Minimum mapping unit
- Conclusions

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Classification

- Hierarchical classification structure
- Defined decision rules
- Use different tools at different levels of hierarchy

Geomorphic Type					
Back-consolidated			Unconsolidated		
Bio-geomorphic Unit					
Reef		Overgrown		Vegetated	
Substratum Ecotype					
High Profile Medium Profile Low Profile		Sand Silt/Sand Mud		Sediment Algal Bed	
Modifiers					
Modifier	Example	Modifier	Example	Modifier	Example
Structure	Complexity Patchy	Porosity	High Wedges Hills	Orientation	Diagonal Face-Parallel Face-Perpendicular
Dominant algae	Fucoxanth Phaeocystis Diatoms Macrocystis	Dominant coral	Sponges Heterocystans Scallops Mush	Species	Dominant Microphyte Perennial Annual

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Background

Tasmanian Commercial fishery worth \$194 million annually

Over 90% from reef dwelling species, rock lobster and abalone

Ongoing work to establish species-habitat relationships

Different species at different spatial scales

Abalone 10's - 100 meters

Banded Mowong 100m - km's

Management requires spatial information on reef distribution and structure



Rock lobster



Abalone



Banded mowong

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Factors affecting acoustic classification of seafloor habitat

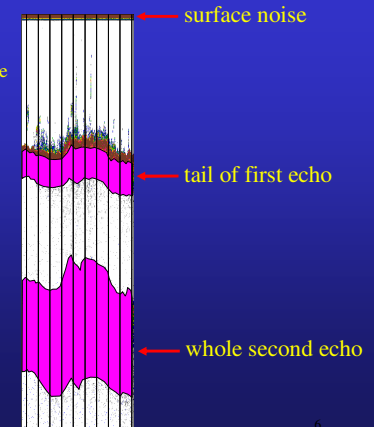
Single beam sounders for shallow (0–40m) coastal habitats
 Simrad ES60 with 120kHz 10° beam width transducer

Sounder settings	Operational factors	Environmental conditions
Ping rate	Vessel speed	Swell
Power output	Vessel stability	Wind
Pulse length	Transducer orientation	Water depth-footprint size
Calibration		

What effect changing these factors will have on the repeatability and robustness of acoustic habitat classification?
 What are the optimal settings?

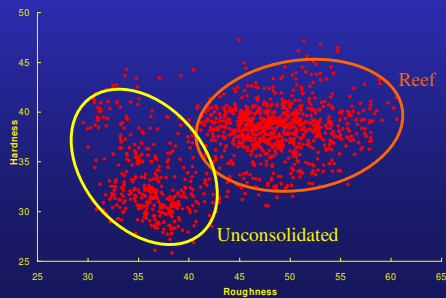
Echo integration

- Many AGDS available
- SonarData's EchoView software
- RoxAnn style approach
- Roughness- tail of first echo
- Hardness- whole second echo
- Bin data to account for ping to ping variation
- Optimal sounder settings?



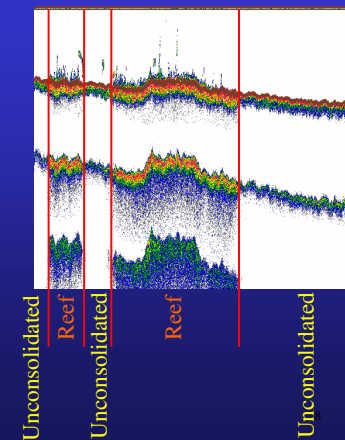
Echo integration

Reef and unconsolidated substrates fall into discrete clusters based on roughness hardness
 Use ground truth data to help classify roughness hardness data
 Overlap due to mixed integration bins and variation in acoustic returns



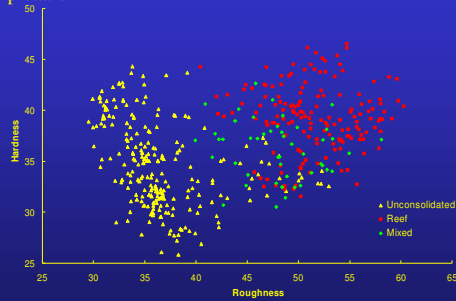
Visual echo interpretation

- Compare colour, shape and intensity of first echo and second echo
- Profile and depth of echogram
- Relies on visual contrast between habitats
- Good for 'sharp' boundaries
- 'Trained operator'
- Where to draw boundary?
- Patchy habitats?



Comparison of echo integration with visual echo interpretation

Echo integration of 50m bin data with corresponding visual echo interpretation



Over 90% agreement between echo integration and visual echo interpretation for classification of reef and unconsolidated substrates

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Comparison of echo integration with visual echo interpretation

Echo integration and visual echo interpretation can be complementary in classifying habitats at the highest hierarchical levels

Conflicting classifications can act as a flag for error checking

Both need good ground truthing to assist in classify habitats

Both affected by the quality of the acoustic data

Need to assess the repeatability and accuracy of each of these methods against ground truthing

Habitats do not always fall into a neat classification system, there will always be some classification error!

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Reef characterisation

Knowledge of species-habitat interactions increasing for commercially valuable species

Link habitat mapping and assessment with fisheries management and stock assessment

Remote classification of reef structure

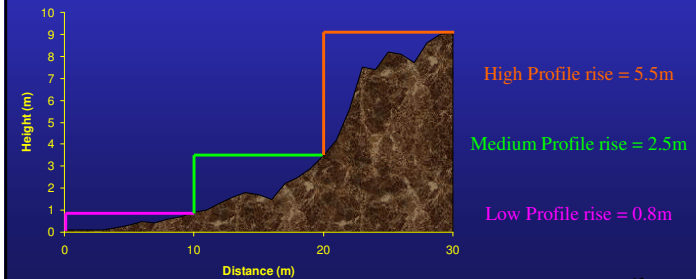
- Profile
- Rugosity
- Patchiness
- Dominant algal species

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Reef Profile

Vertical rise/fall of reef over 10 meters

Use sounder detected bottom to calculate profile



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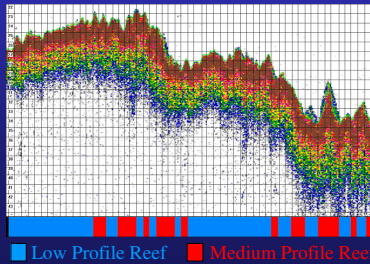
Reef Profile

90% agreement between visual and automated estimates of reef profile

Need to validate against video/diver estimates

Effect of ping rate and vessel speed on these measures?

Are there depth effects due to footprint size?



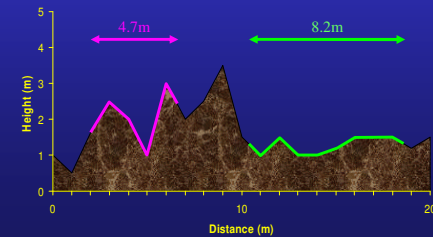
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Reef Rugosity

Calculate rugosity as ratio between distance measured following bottom contour and linear distance

Traditionally done by laying chain of known length across bottom contour and measuring linear length (Luckhurst & Luckhurst 1978)

Higher indices equate to more complex bottom



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Reef Rugosity

Use sounder detected bottom and GPS positions to calculate rugosity indices

Need to validate against traditional diver estimates

Effect of vessel speed, ping rate, water depth and swell on these measures?

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Patchy Reef

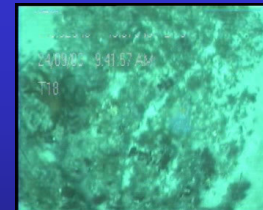
Patchy reef common in certain areas

Ecologically different to continuous reef

Patchiness can occur at range of spatial scales from meters to 100s of meters

Ability to characterise depends on

Track spacing
Vessel speed/ping rate
Water depth/footprint size



Minimum Mapping Unit

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Minimum mapping unit

Minimum mapping unit is the smallest area that can be mapped as a discrete habitat within a defined classification system

Minimum mapping unit is defined by the following:

Track spacing- as track spacing increases the level of interpolation required increases. This leads to an increase in the minimum mapping unit

Vessel speed/ping rate- both vessel speed and ping rate effect data density. As data density decreases the minimum mapping unit will increase

Increasing data density will not help classification beyond the discrimination ability of the acoustic sounder being used

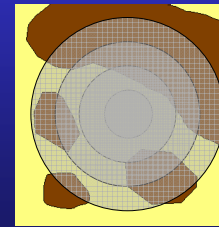
Water depth- changing water depth will change the footprint size. This will have impacts on the discrimination ability of the acoustics

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Footprint size

Acoustic footprint size varies with depth

As depth changes the same habitat structure will give a different acoustic response



30m

10m

20m

30m

40m

7m

Dominant Algal Species

Use acoustics and video to map algal species

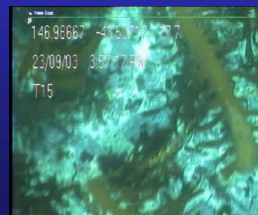
Towed video to record dominant canopy algal species

Overlay depth and position to video

Video and acoustic data collected on the same transects can be used to examine whether acoustics can discriminate the presence of different dominant algal species



Towed video



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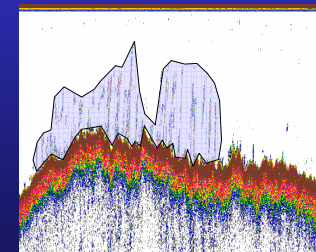
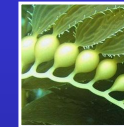
Macrocystis detection

Surface canopy detectable from aerial remote sensing

Often majority of kelp canopy is sub surface

Acoustics can detect kelp due to gas filled floats

Is it possible to quantify the amount of kelp being acoustically detected?



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Conclusions

Single beam acoustics have potential to classify the area and structure of reef habitat for fisheries management and assessment

Effects of ping rate, power output, pulse length need to be tested

Need to test measures of profile and rugosity against ground truth data

Examine the ability of acoustics to detect dominant algal species

Need to assess the error and accuracy of maps produced by this method