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North West Shoals to Shore Research Program

Understanding the isolated coral atolls of the north west shelf: The past, present and future of Rowley Shoals

James Gilmour

September 2020

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NWSS Theme 4

Understanding the isolated coral atolls of the north west shelf: The past, present and future of Rowley Shoals

AIMS: Australia's tropical marine research agency.

ACKNOWLEDGEMENTS

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Theme 4 would also like to acknowledge:

- **Woodside Energy Ltd** on behalf of the Browse Joint Venture
- **University of Western Australia**
- **Curtin University**
- **Western Australia Museum**
- **Dept of Biodiversity Conservation Attractions (DBCA)**
- **Dept of Primary Industries + Regional Development (DPIRD)**
- **Integrated Marine Observing Systems (IMOS)**

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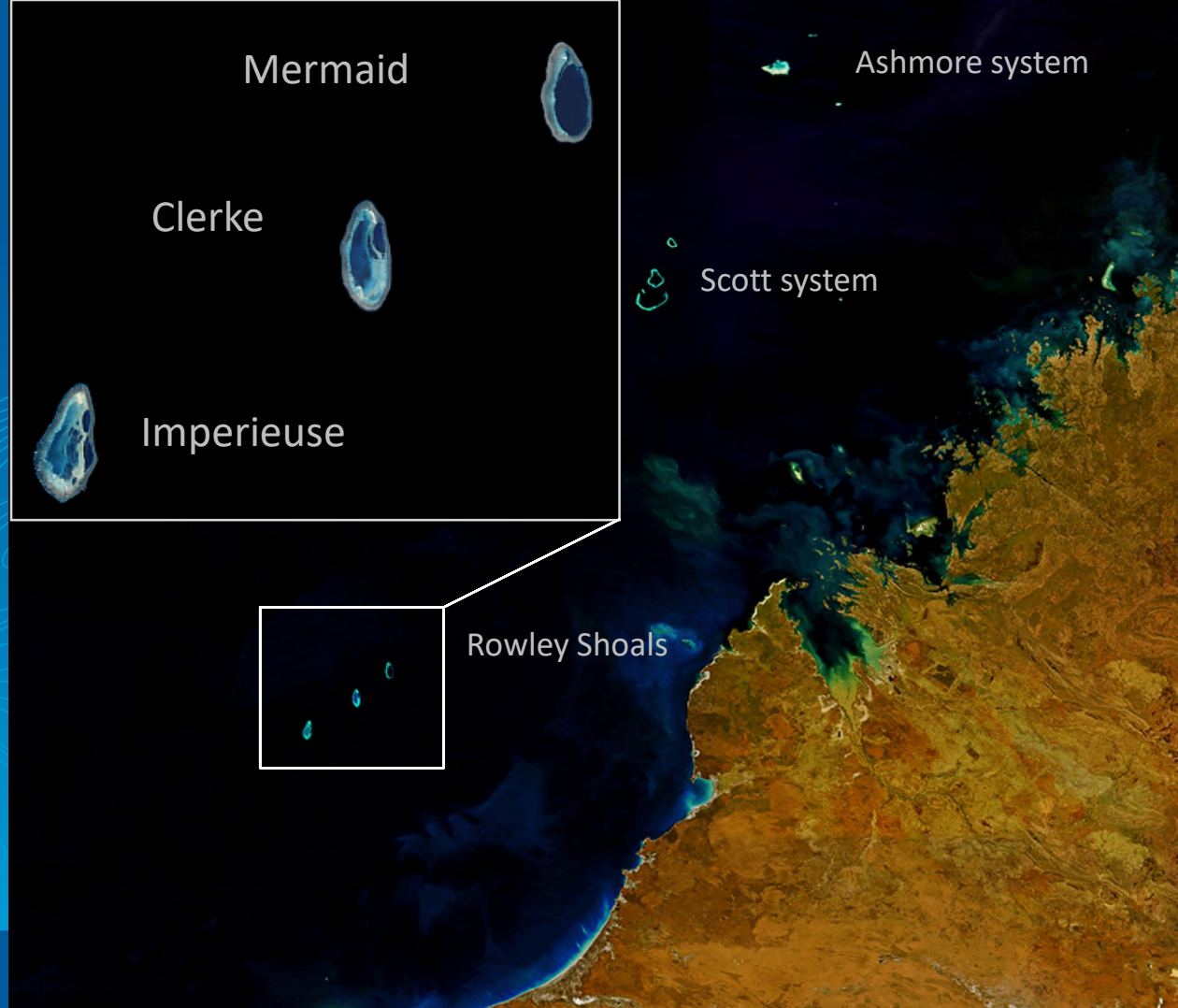
NWSS Theme 4

Understanding the isolated coral atolls of the north west shelf: The past, present and future of Rowley Shoals



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Understanding the isolated coral atolls of the north west shelf: The past, present and future of Rowley Shoals

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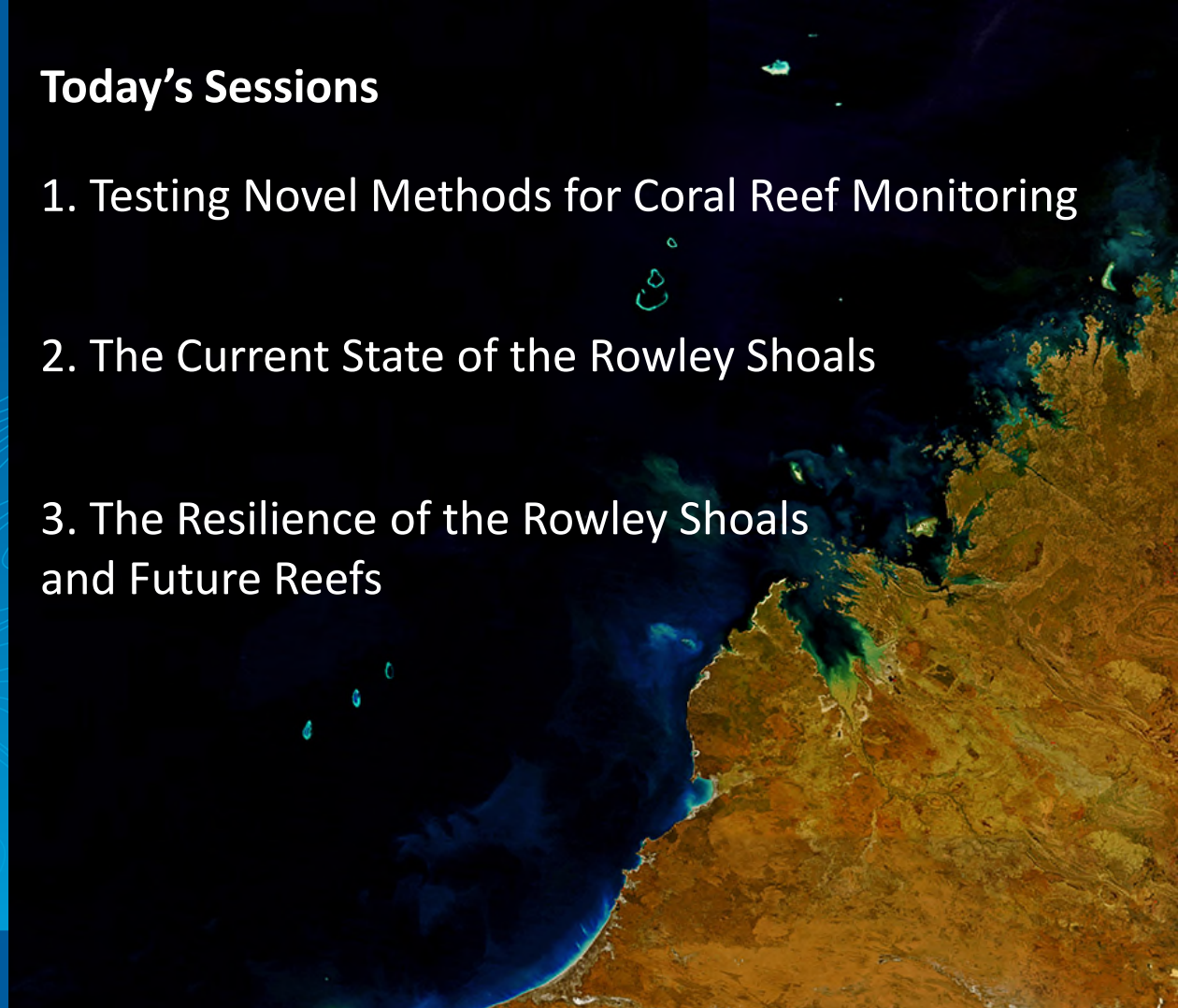
Today's Sessions

1. Testing Novel Methods for Coral Reef Monitoring

2. The Current State of the Rowley Shoals

3. The Resilience of the Rowley Shoals and Future Reefs



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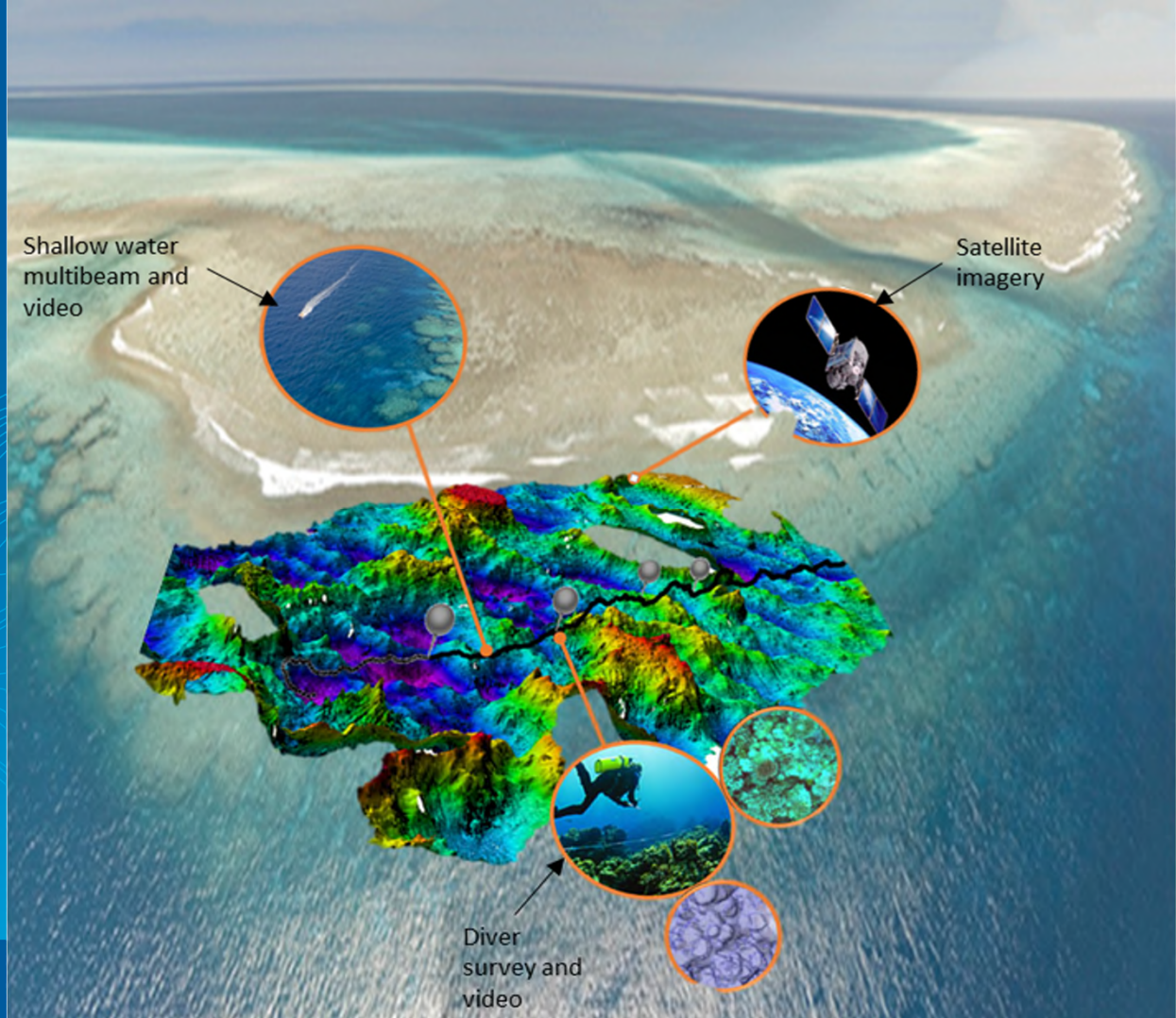
1. Testing Novel Methods for Coral Reef Monitoring

a) 3D mapping + monitoring

b) eDNA mapping + monitoring

c) Tow-camera + monitoring

d) Autoclassification of images



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Testing novel methods for coral reef monitoring

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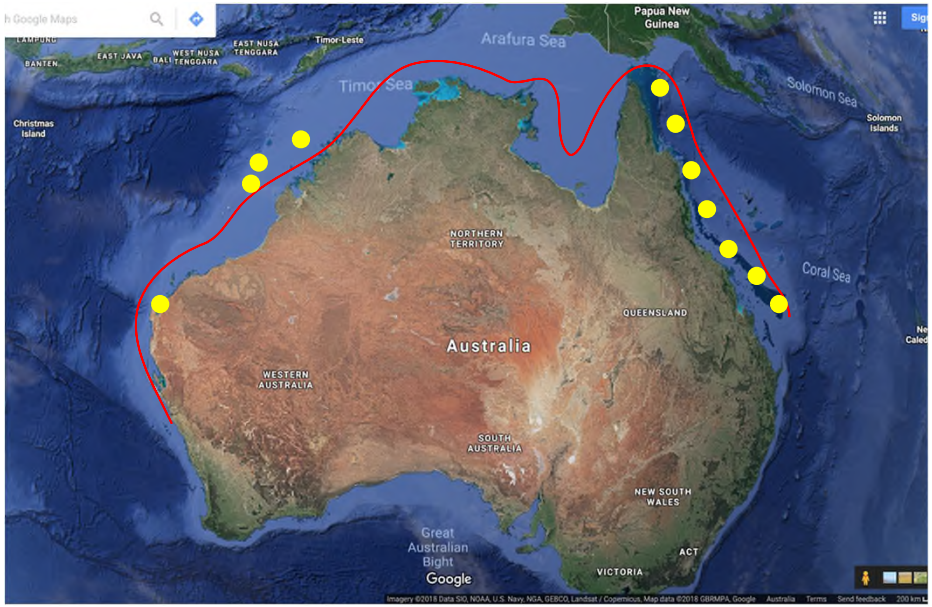
Mapping coral reef habitats at multiple scales using structural metrics

Ben Radford, Sharyn Hickey, Mark Case, Mary Wakeford, Simon Harries, Andrew Heyward, James Gilmour

Motivation



- Vast marine area with remote reefs to map, monitor and assess for impacts.
- Most reefs are not regularly monitored and their condition and response to impacts are unknown.
- Capitalize on new remote sensing data, cheaper data and online process capacity.
- Develop robust, scalable applications that increase our knowledge of changing environment
- Leads to better decision support

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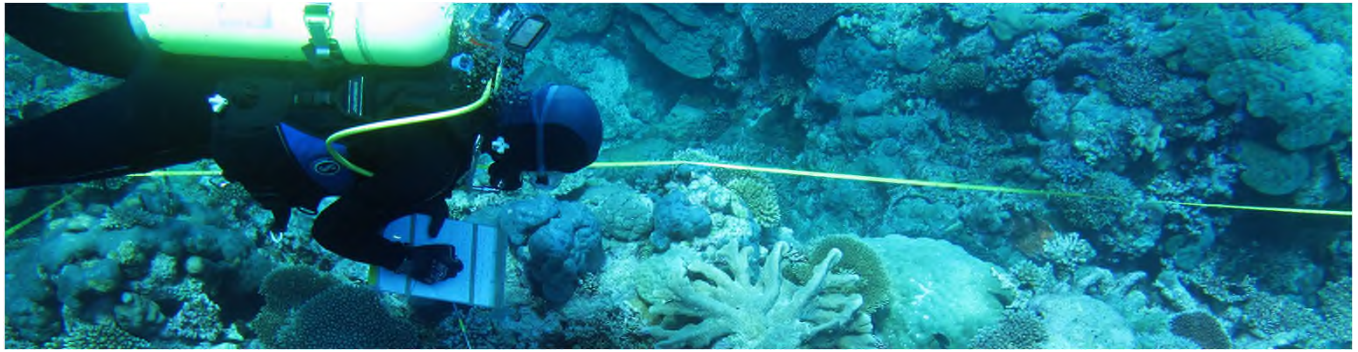
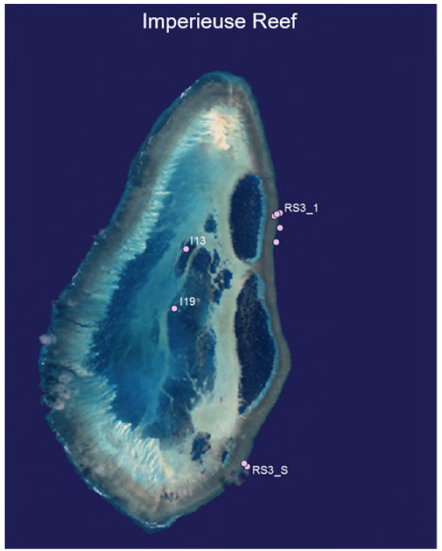
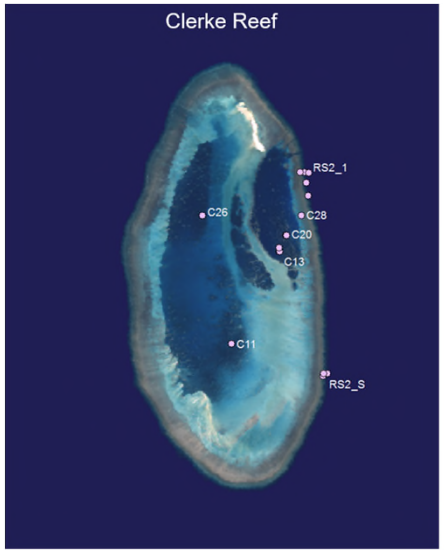
Objectives

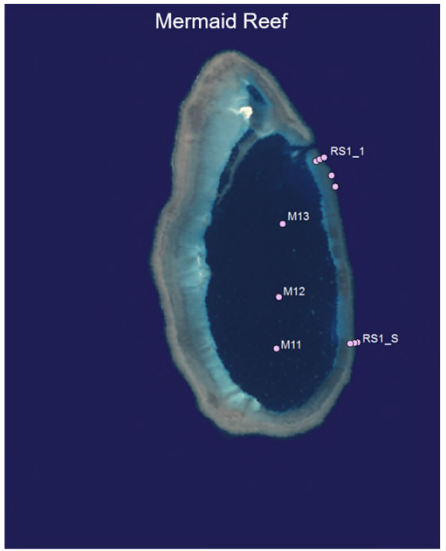
- Map habitats identify where we do and don’t monitor
- Develop smart methods to monitor gaps.
- Building on LTM by incorporating new multiscale and scalable remote sensing data and methods
- Calibrate methods against natural turnover and disturbances
- Work towards adaptive monitoring and disturbances triggering monitoring on-demand

Current location of monitoring sites









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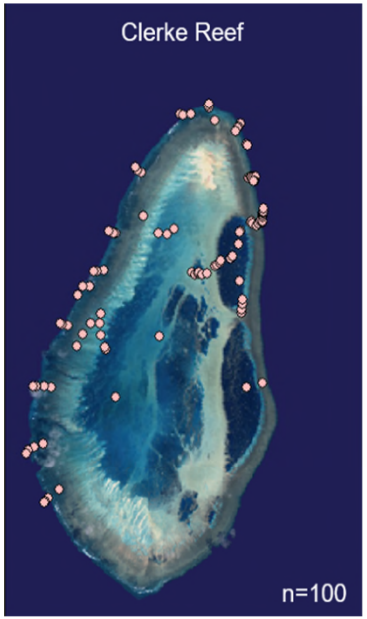
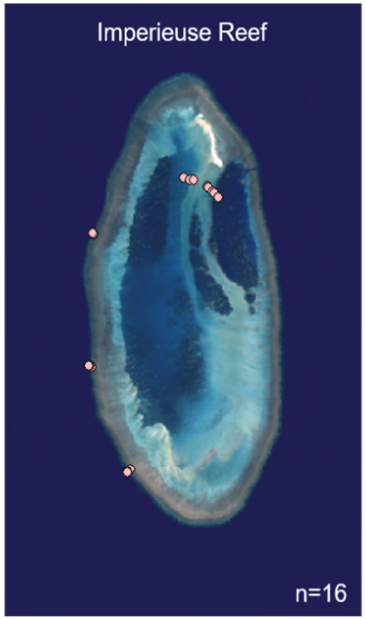
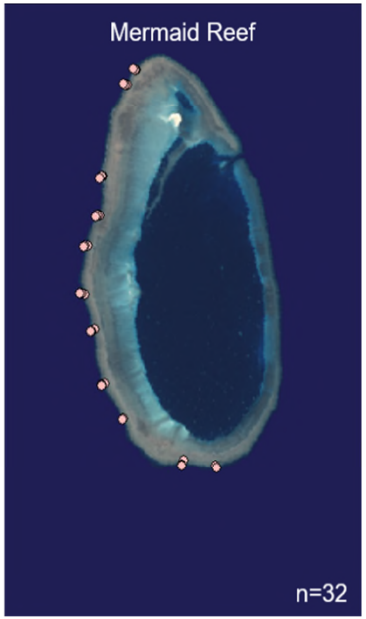
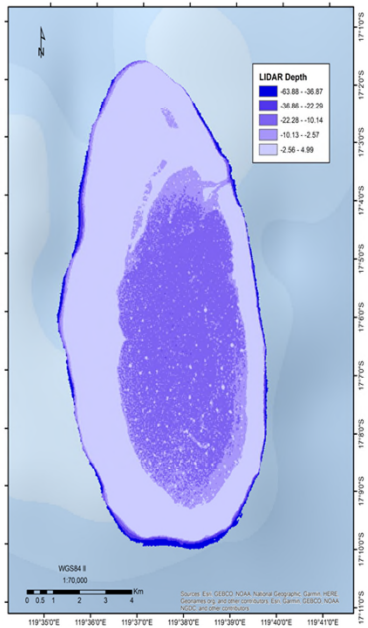
Smart methods: Repurposing existing data LADS Lidar

Trip 6854 March 2018 Rowley Shoals Habitat Assessment Points









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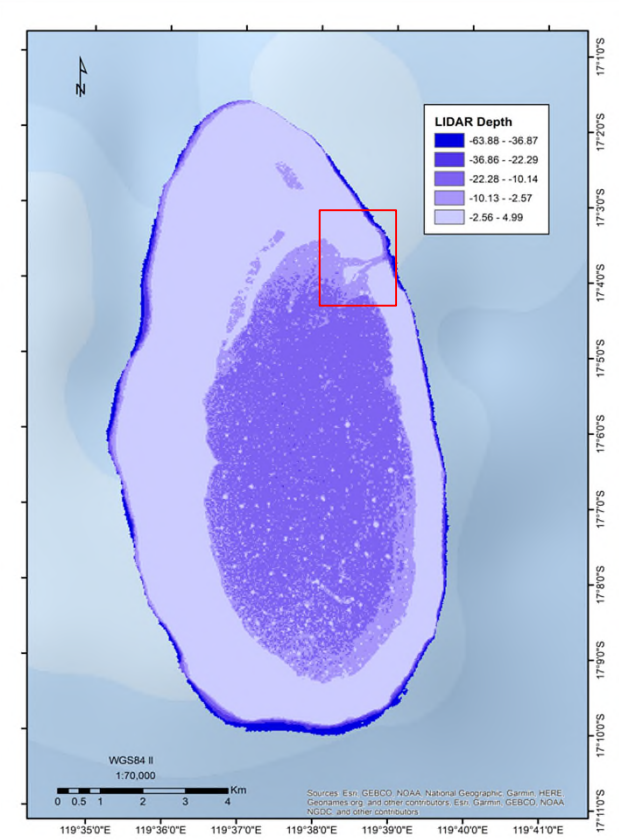
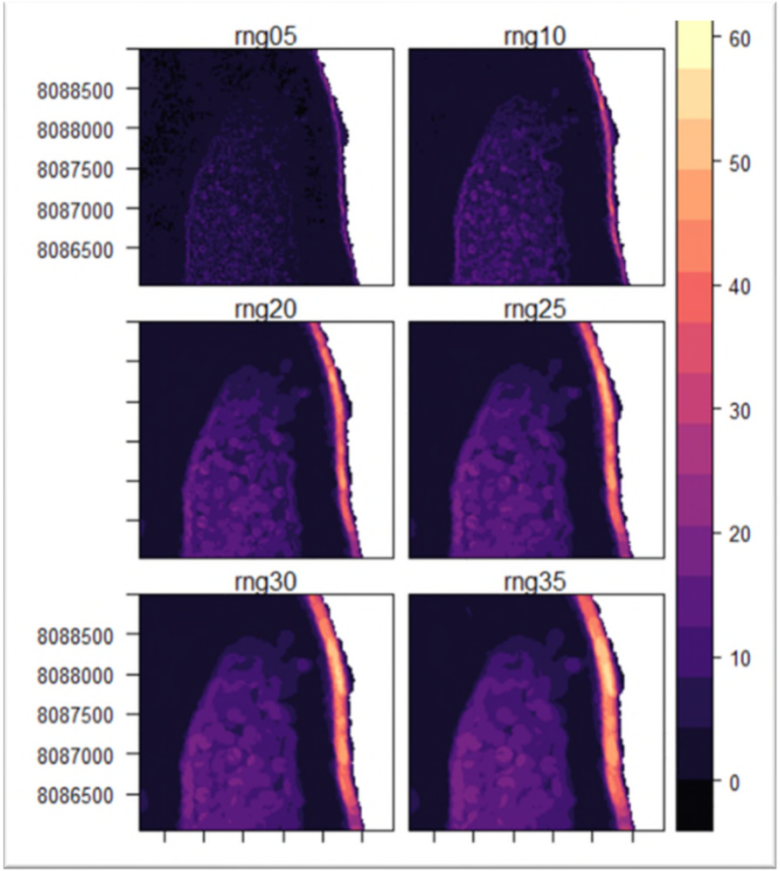
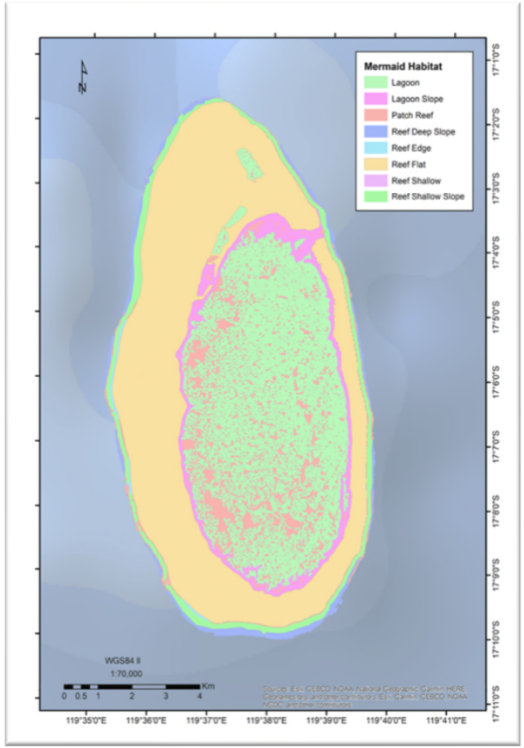
3D metrics = rugosity kernels

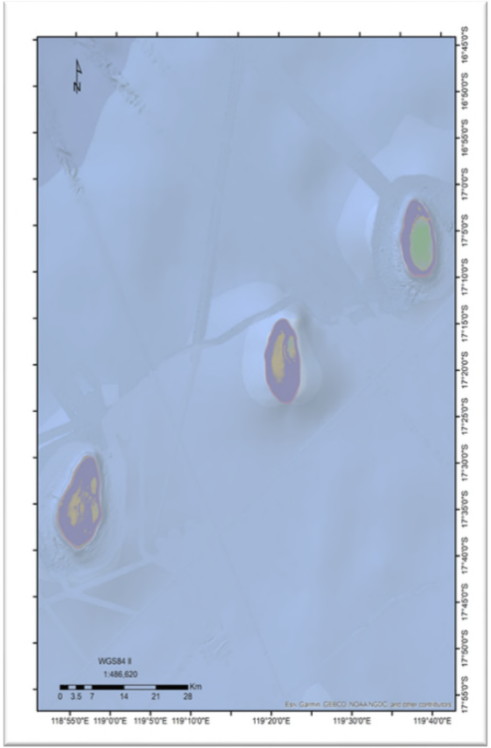




Outcomes

- Repurposed an existing dataset, could have other such applications
- Models with Kappa values of 0.8 with blind validation data
- 8 habitats mapped, currently monitoring in **3**
- Largest area reef flat, deeper and exposed reef, harder to get to with no monitoring
- Potentially important habitat (diverse, temperature resistant)
- Assess new remote sensing data, cheaper data, analysis methods to solve this problem





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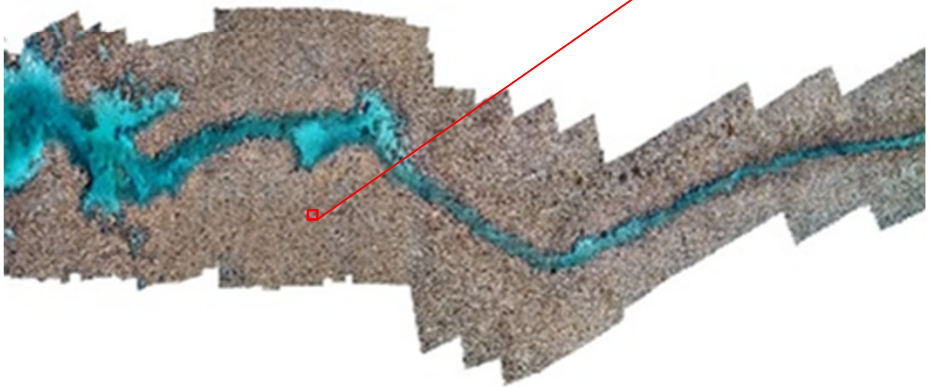
Objectives

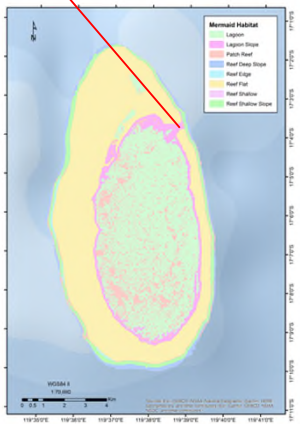
- Map habitats identify where we do and don’t monitor
- Develop smart methods to monitor gaps (S Hickey)
- Building on LTM by incorporating new multiscale and scalable remote sensing data and methods

Smart methods: Drone surveys to estimate cover of intertidal coral using rugosity

6mm*
6mm pixel
- tasked

20m
altitude





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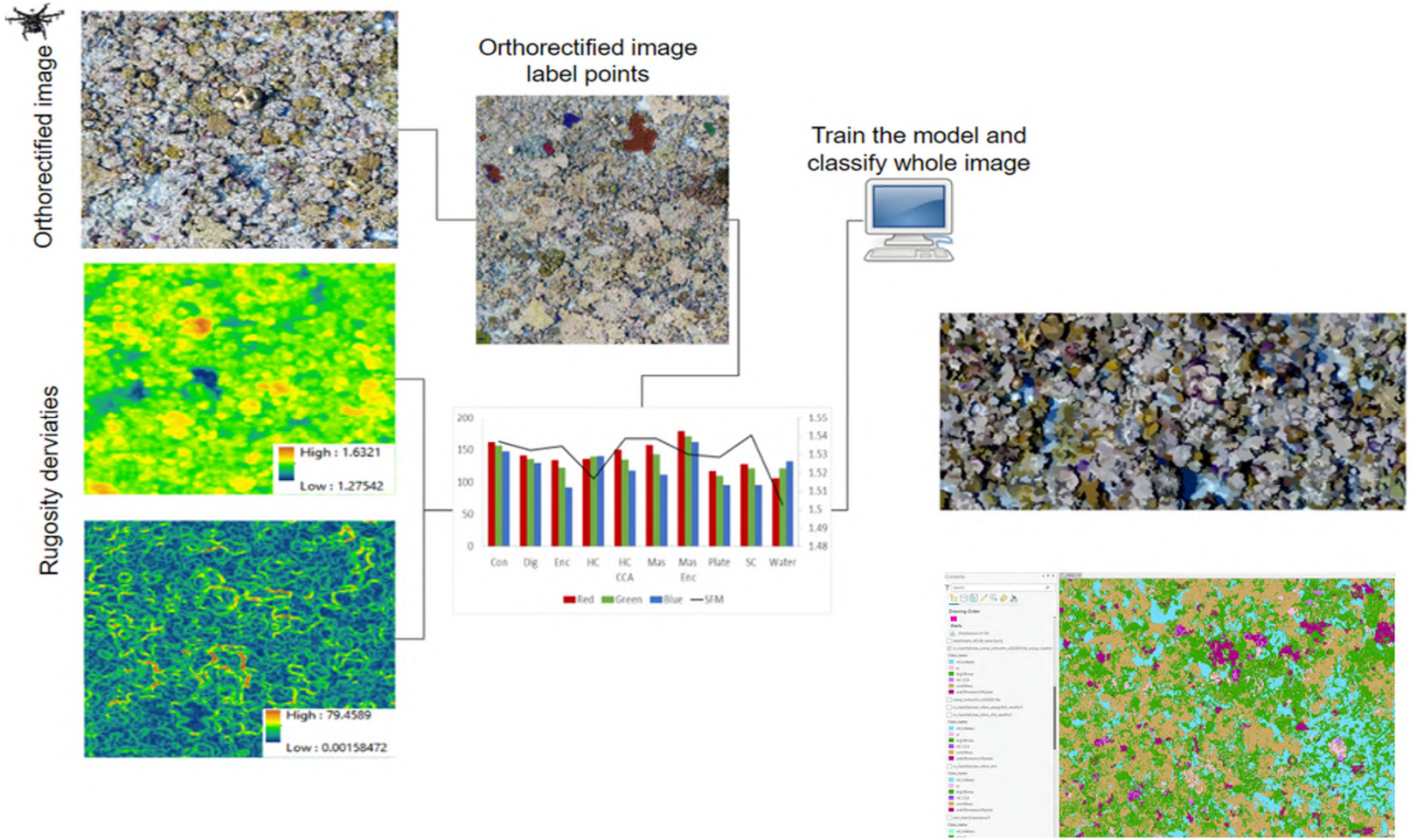
Smart methods: Drone surveys to estimate cover of intertidal coral using rugosity



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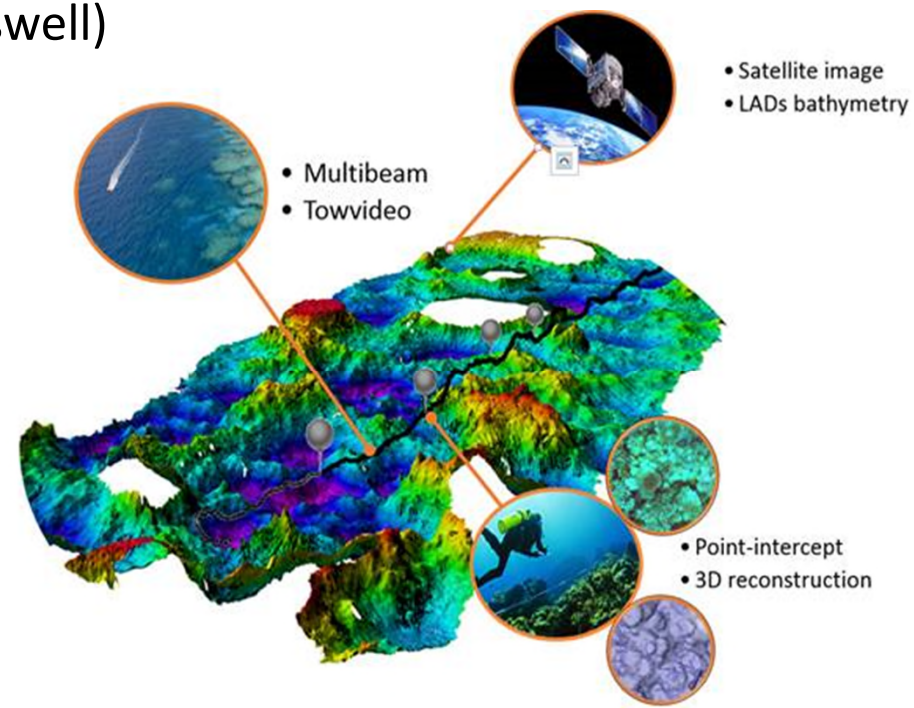
Objectives

- Map habitats identify where we do and don't monitor
- Develop smart methods to monitor gaps (M Wyatt)
- Building on LTM by incorporating new multiscale and scalable remote sensing data and methods (A Crewswell)



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Testing novel methods for coral reef monitoring

AIMS: Australia's tropical marine research agency.

Coral monitoring in northwest Australia with environmental DNA metabarcoding

Laurence Dugal, Luke Thomas, Shaun Wilkinson, Zoe Richards, Jason Alexander, Arne Adam, Jason Kennington, Simon Jarman, Nicole Ryan, Michael Bunce & James Gilmour

Submitted: Molecular Ecology Resources

Aims and Methods

Can eDNA be used to reliably map and monitor corals communities?

Organisms continuously expel DNA

DNA can be sampled, extracted and analyzed

Sequences cross-referenced to databases

Coral-specific DNA magnets

To tease apart taxa of interest from all DNA noise in seawater

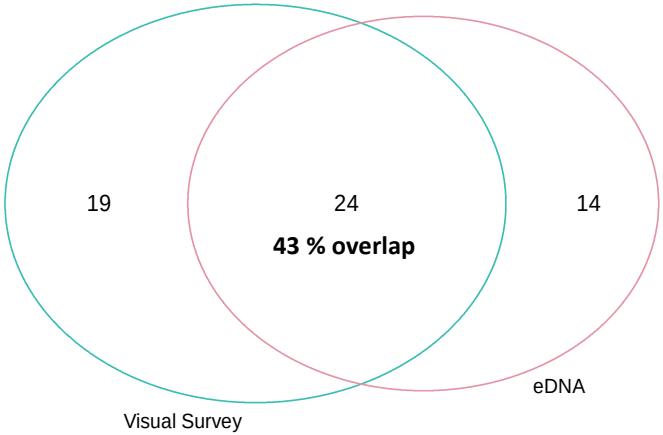
1) Genus-level detections and overlap between methods

eDNA: 38 genera

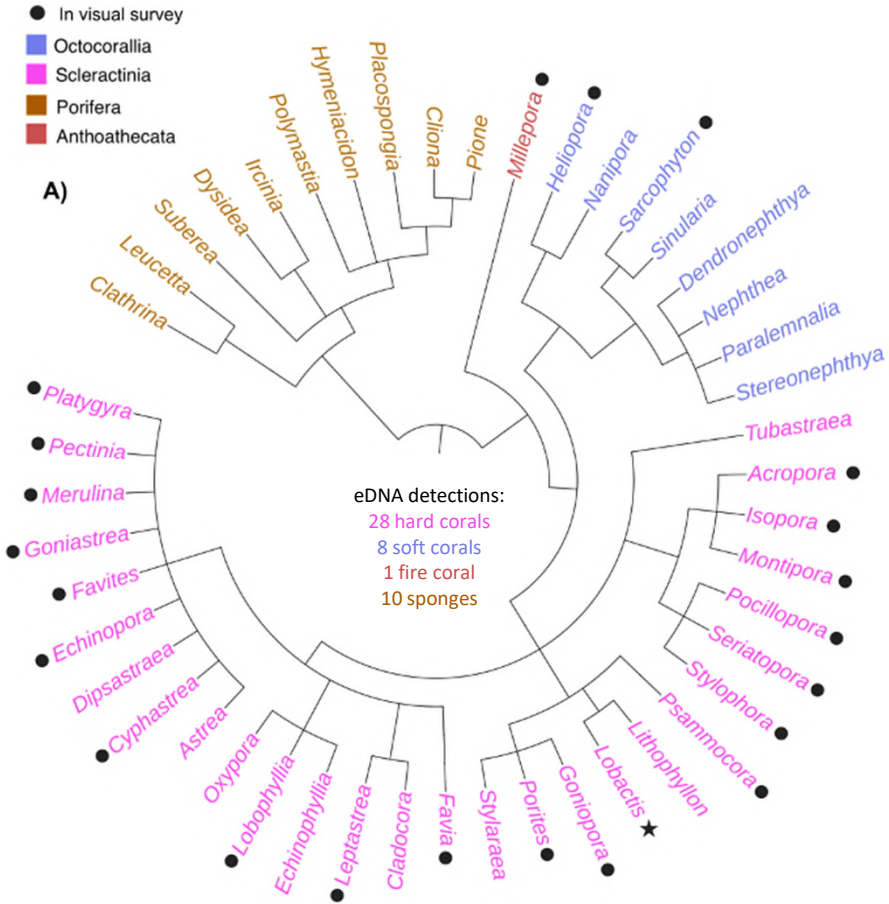
Visual: 43 genera

Total:

56 genera



Initial evidence of a relationship between coral cover and eDNA reads

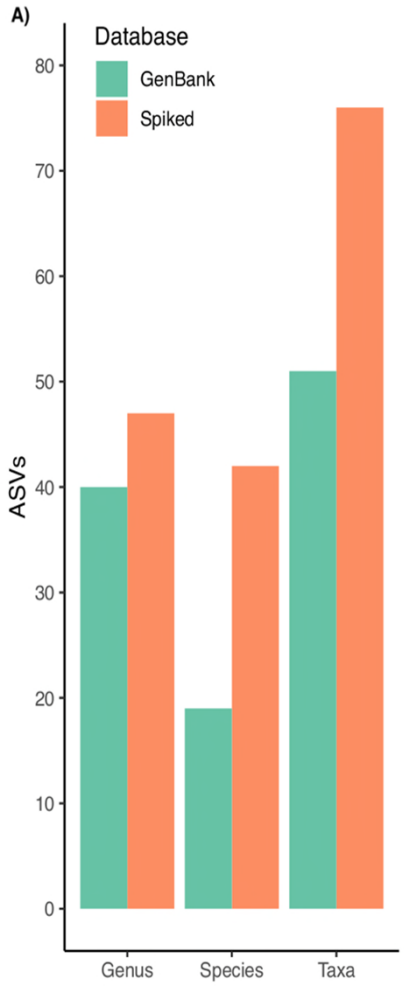


2) Species-level resolution

Useful for taxonomic groups where morpho-IDs are difficult

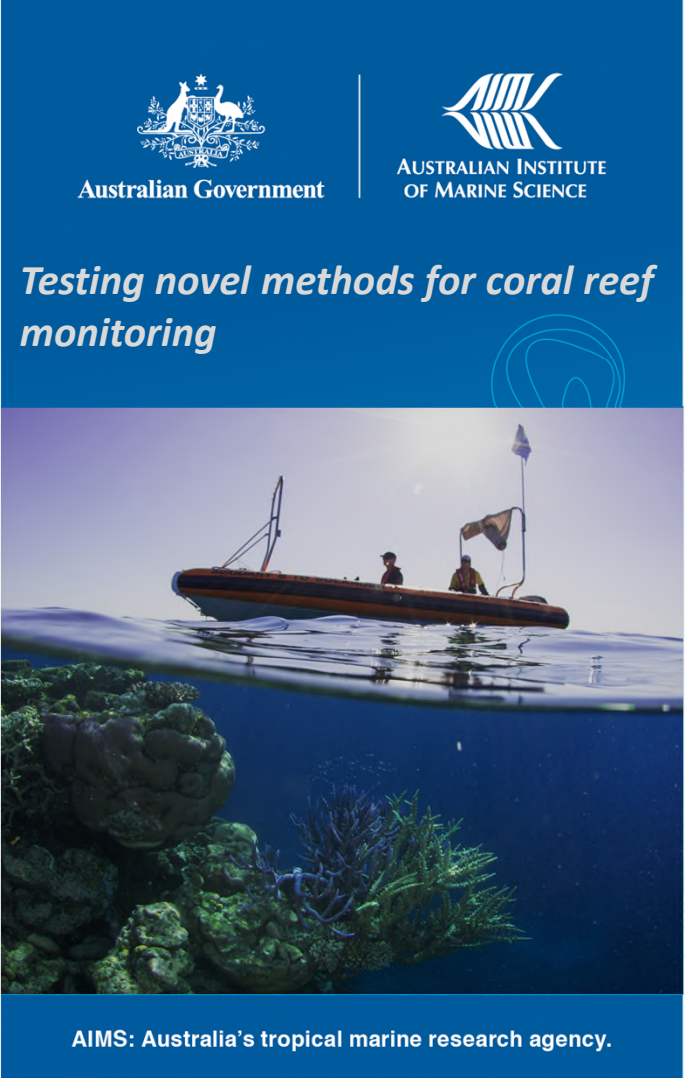
Dependant on the databases available

Developing a local reference database using 94 coral species allowed for 2x more species detected



Conclusions

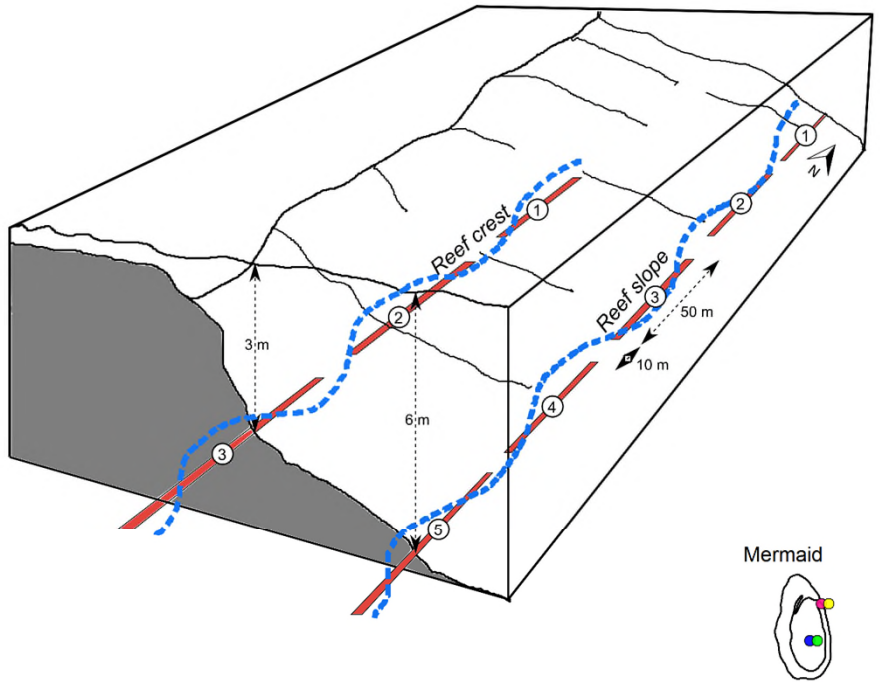
- eDNA as an emerging tool for coral monitoring
- Enhanced potential to detect cryptic and inconspicuous taxa
- Ongoing use of the same set of samples
- Continuous advancements and optimization
- Very transferable

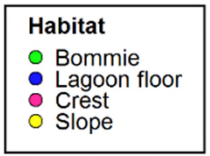


A quantitative comparison of tow-camera and diver transects for monitoring coral reefs

Anna K. Cresswell, Nicole M. Ryan, Mark Case, Andrew J. Heyward, Adam N.H. Smith, Jamie Colquhoun, Paul Costello, Matthew J. Birt, Mark Chinkin, Mat Wyatt, James P. Gilmour

Methods





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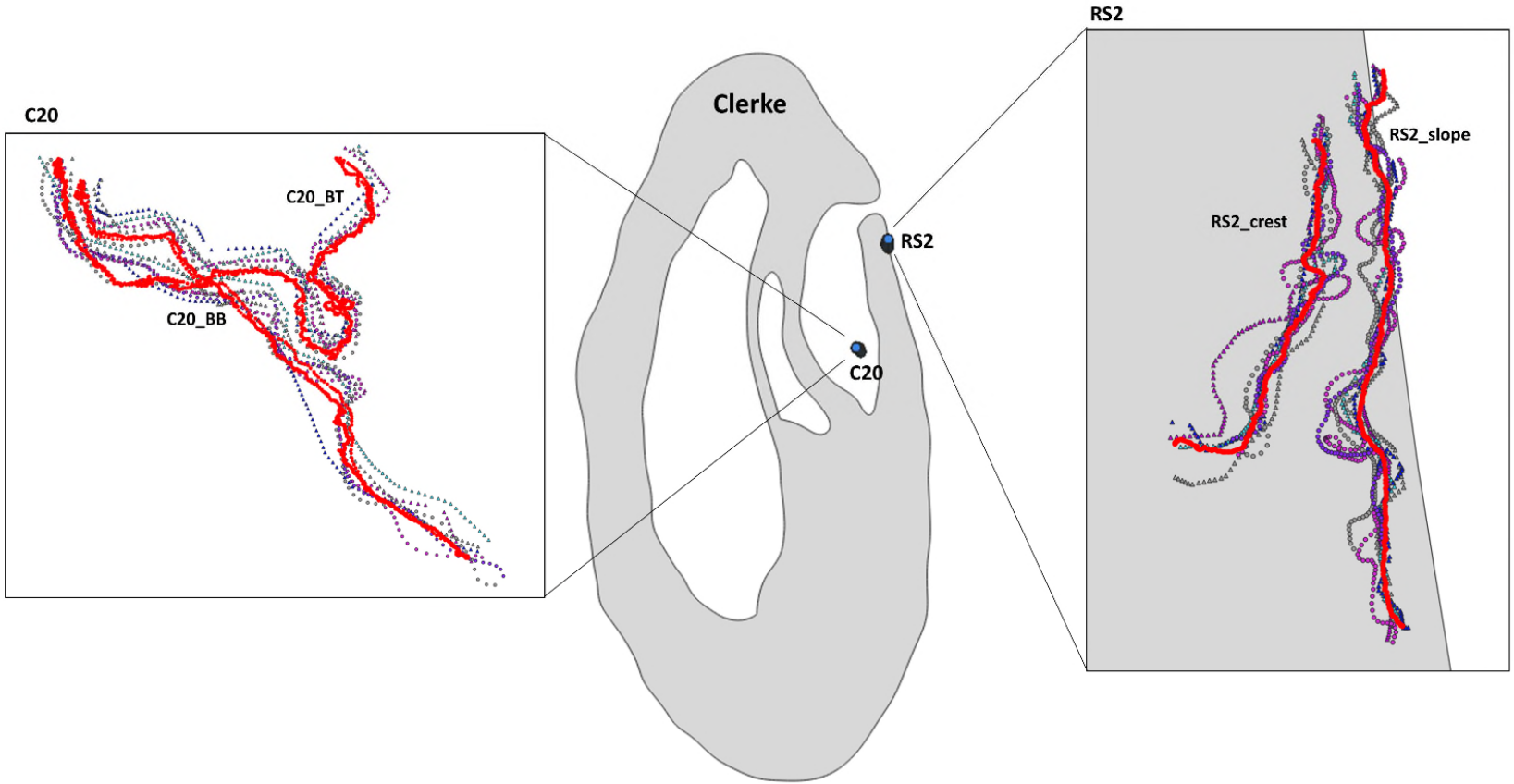
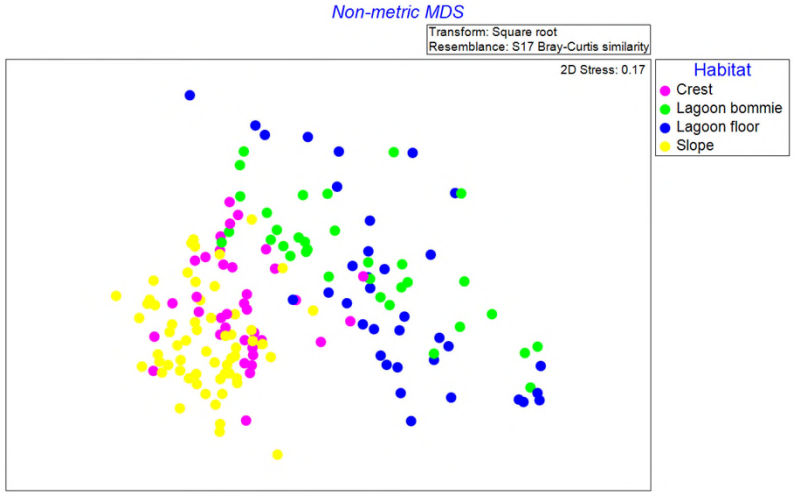
Spatial precision and accuracy

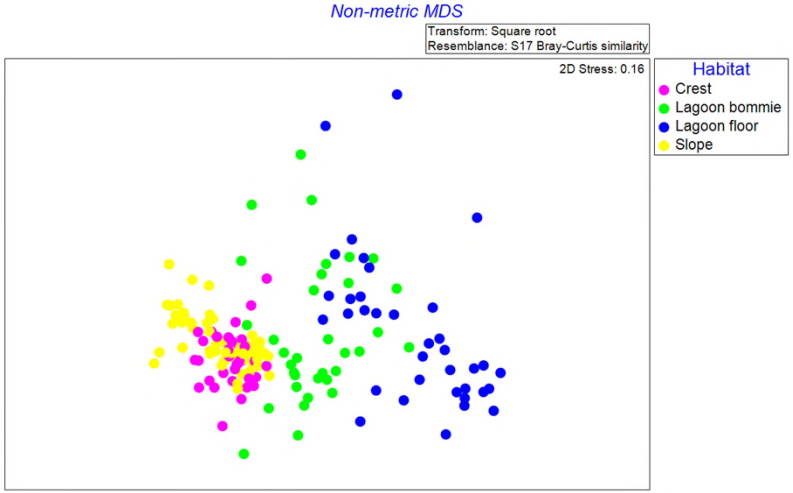


Community assemblages

Benthic community

Coral community





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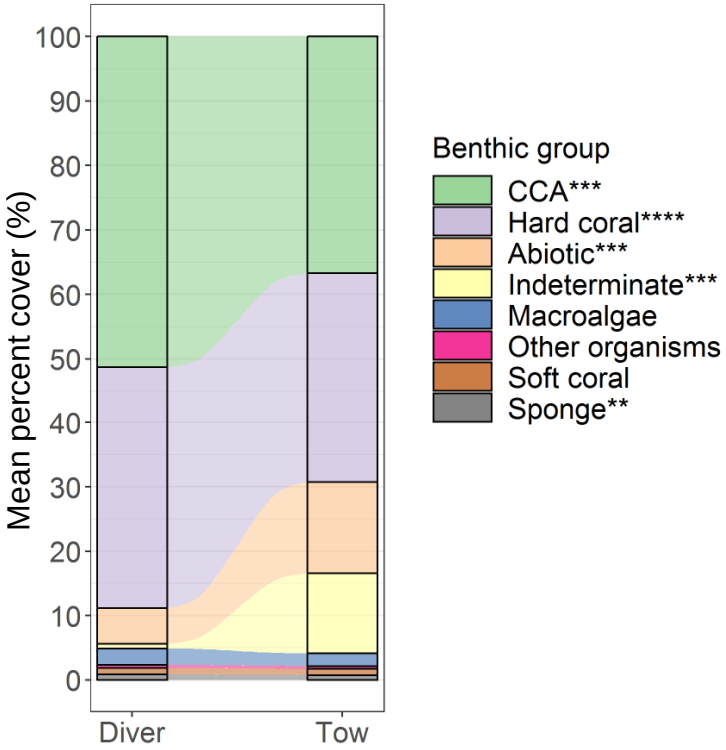
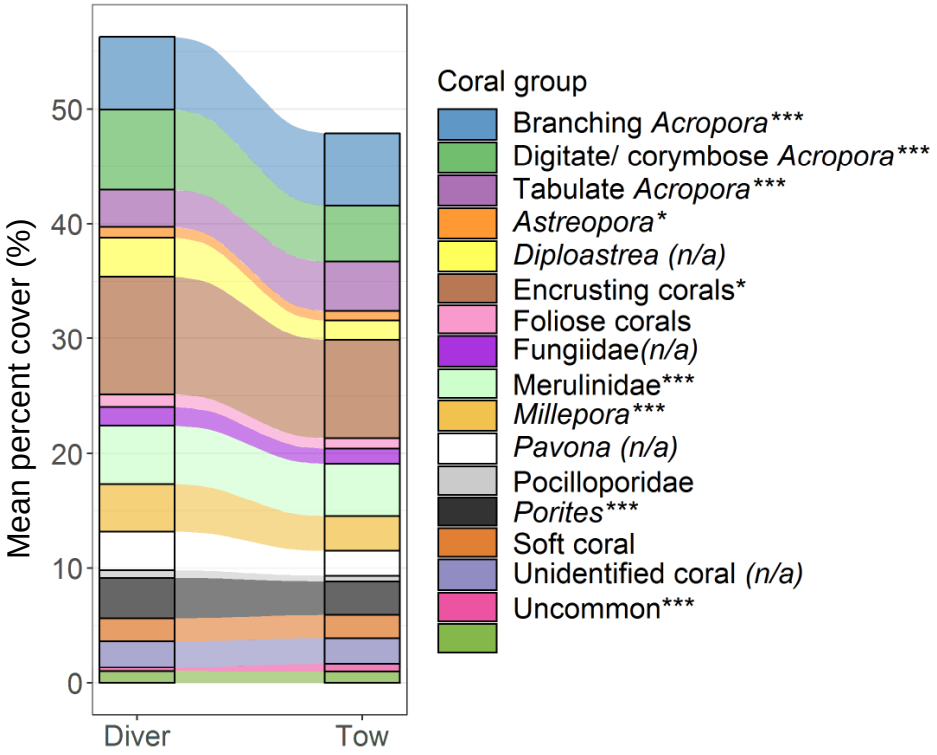
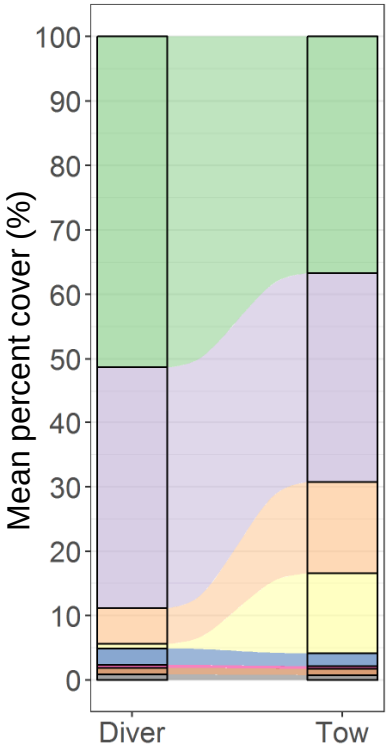
Differences in percent cover





Covariates

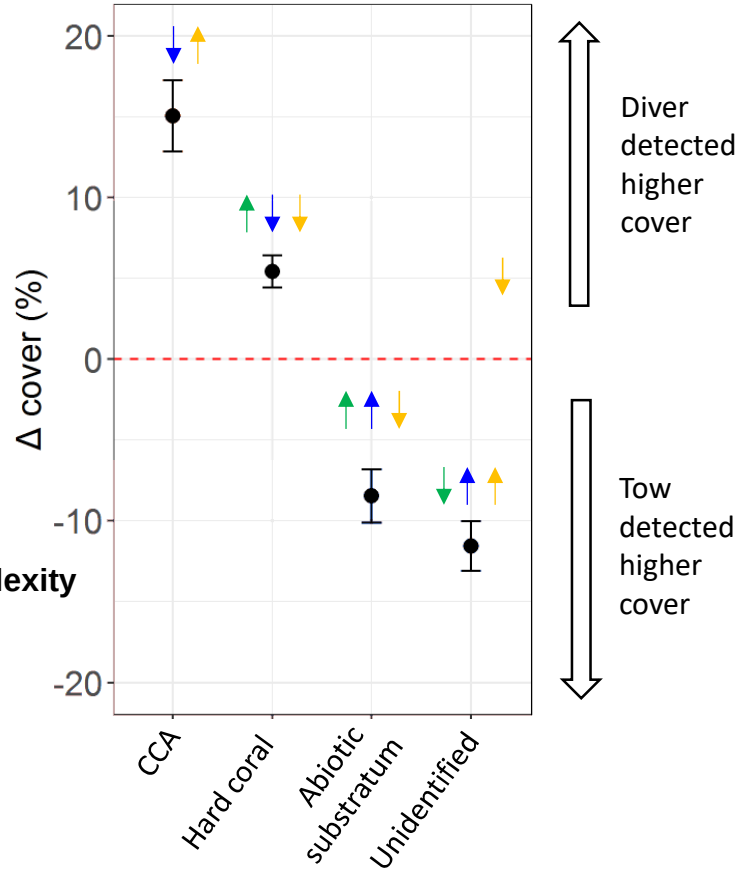


Benthic group

- CCA***
- Hard coral****
- Abiotic***
- Indeterminate***
- Macroalgae
- Other organisms
- Soft coral
- Sponge**

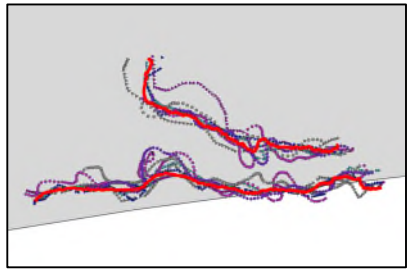
Covariate influence

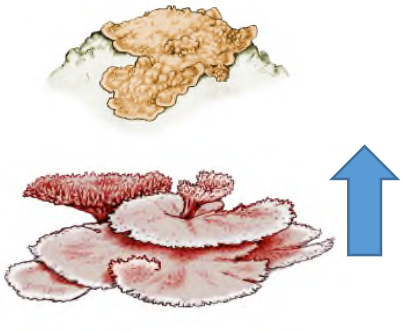
- **Slope/ structural complexity**
- **Number of images**
- **Depth**



Key findings

- Following a transect line is challenging, transect belts or areas more feasible?
- Structurally simple benthic and coral groups more difficult to distinguish in the tow-camera
- Tow-camera obtained higher percent cover of overtopping *Acropora* morphologies
- Situation dependent: slope, structural complexity, depth, environmental conditions
- Increasing the number of images may increase comparability of tow-camera data





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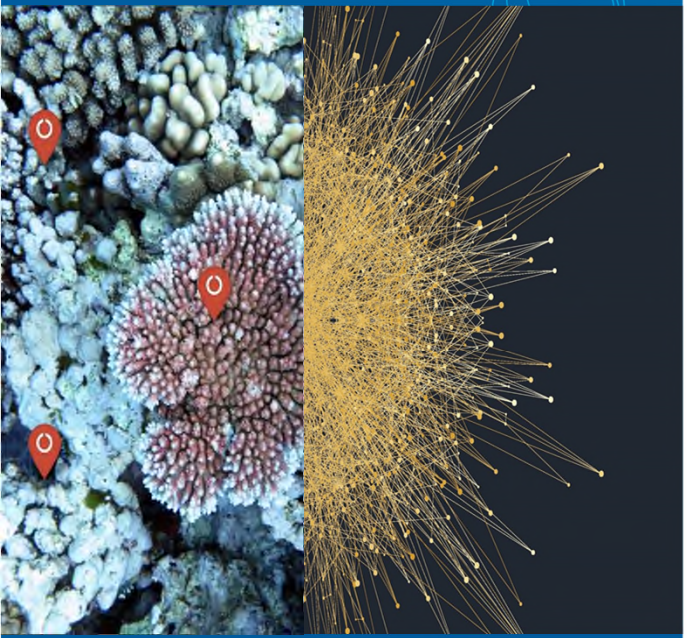
Testing novel methods for coral reef monitoring



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Ecology at Scale: Applications of deep learning for monitoring of benthic habitats

Mathew Wyatt, Ben Radford, Mark Case, Nader Boutros, Nick Middleton, Anna Creswell, Manuel Gonzalez-Rivero

Motivations

Minimising cost & increasing coverage!

- Does AI work for coral classification in imagery?
- Can we automate coral classification at manta tow scale given imagery from towed platforms?
- How does this compare to accuracy achieved on LTM level classification?
- Can we push the boundaries of AI, and use models learned from one platform on another?

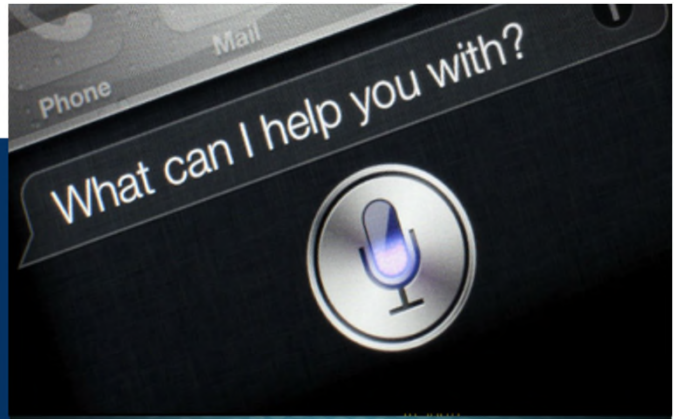
Deep Learning

'AI IS THE NEW ELECTRICITY'

"Just as electricity transformed almost everything 100 years ago, today I actually have a hard time thinking of an industry that I don't think AI will transform in the next several years."

Andrew Ng

Former chief scientist at Baidu, Co-founder at Coursera



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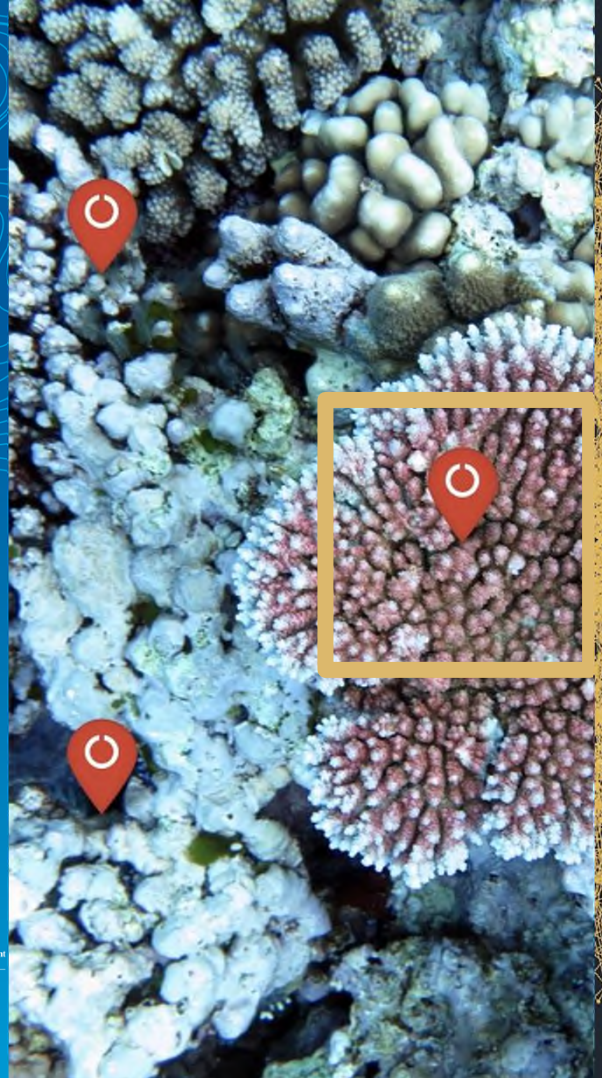
Deep learning for corals



Acropora Digitate

Branching Acropora

Porites

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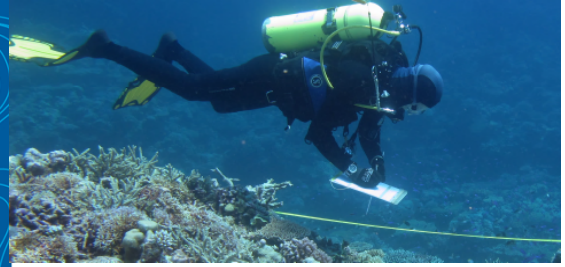
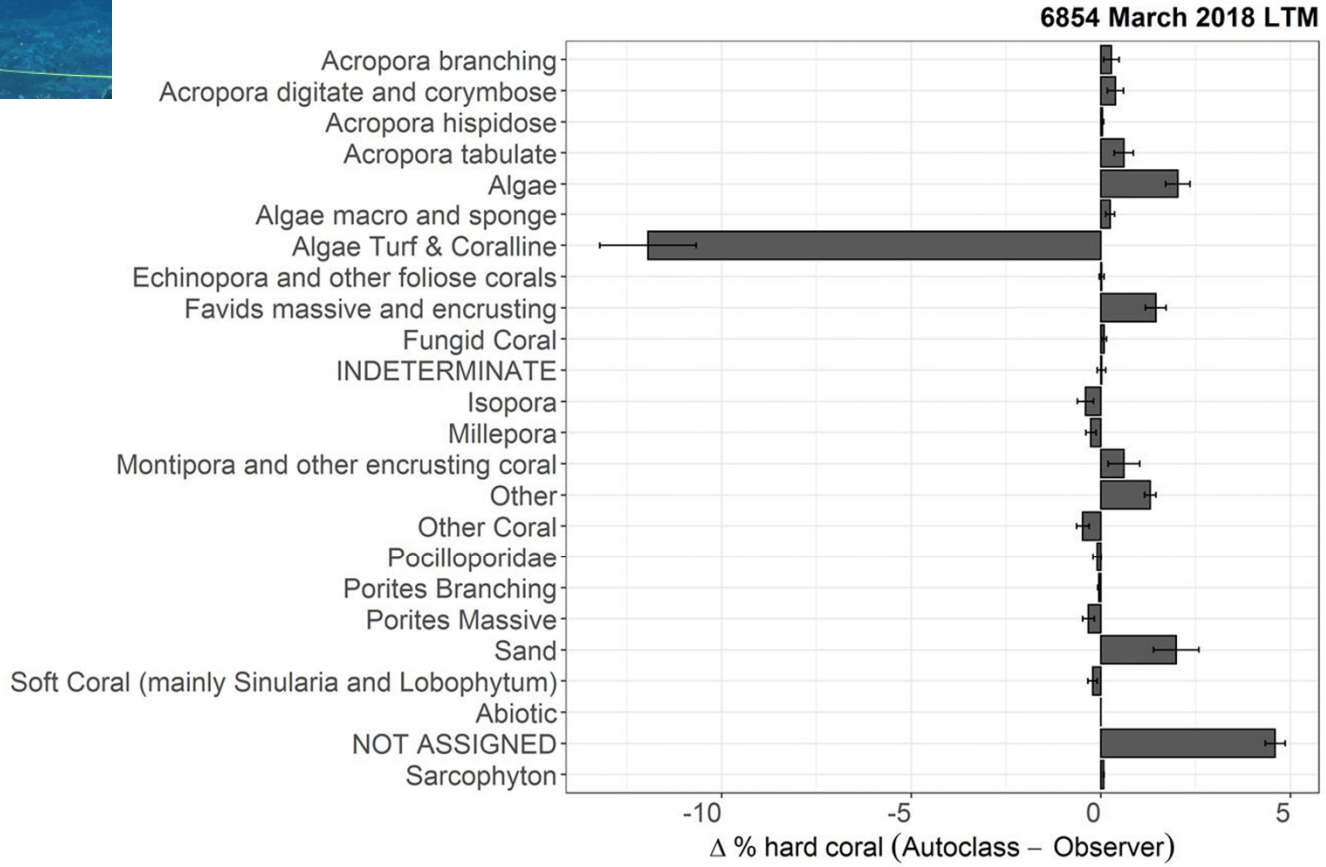


Autoclassification: Diver LTM



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Autoclassification: Tow-camera

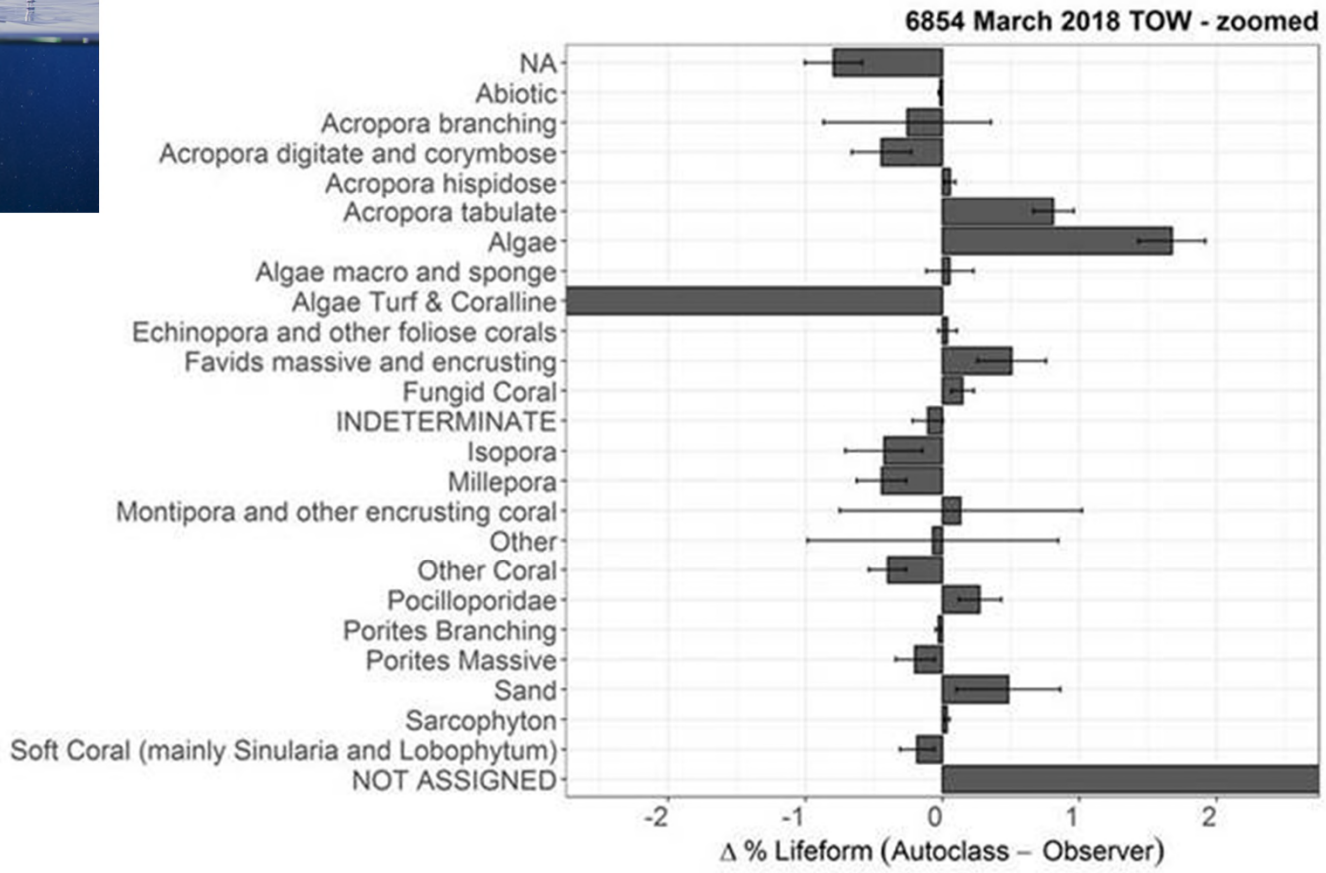

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Image quality and overfitting

Image correction

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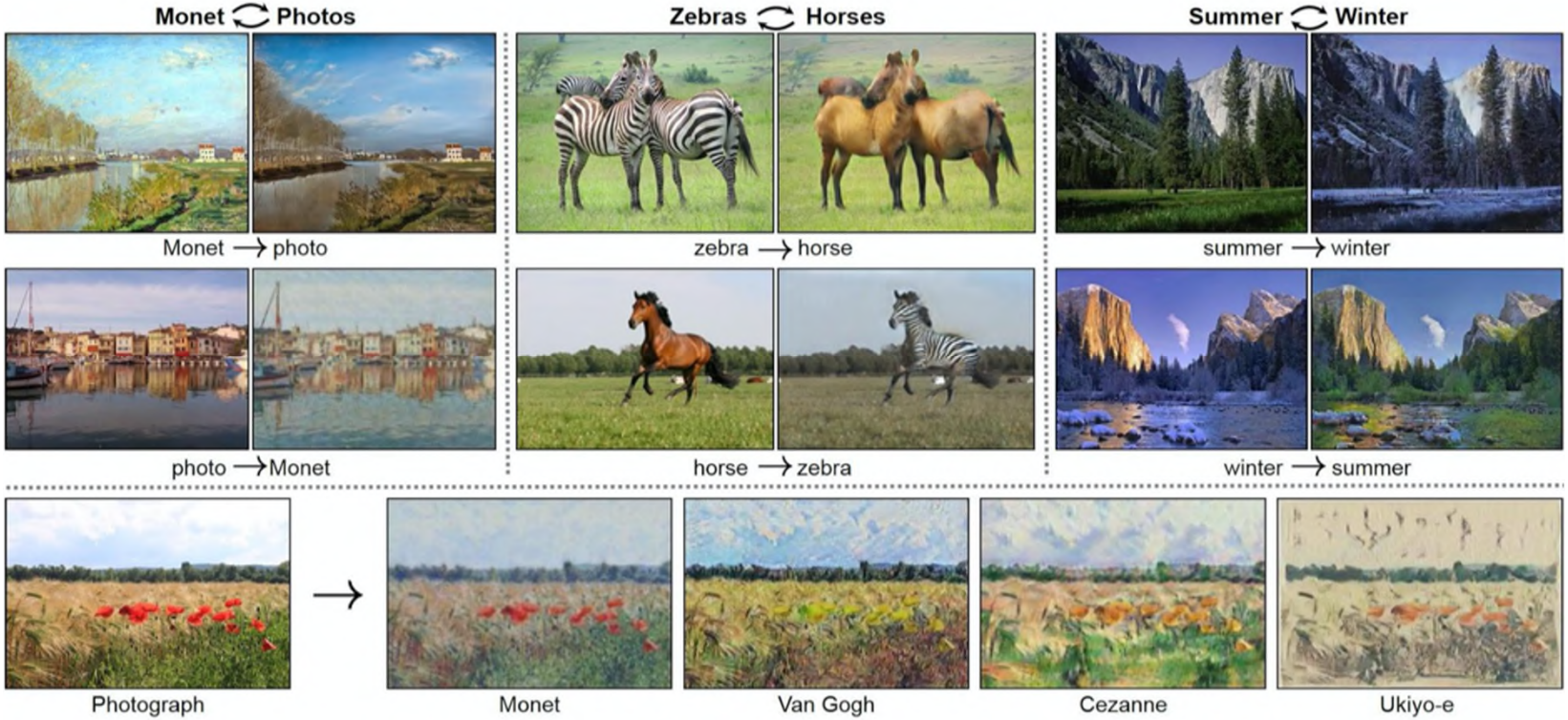
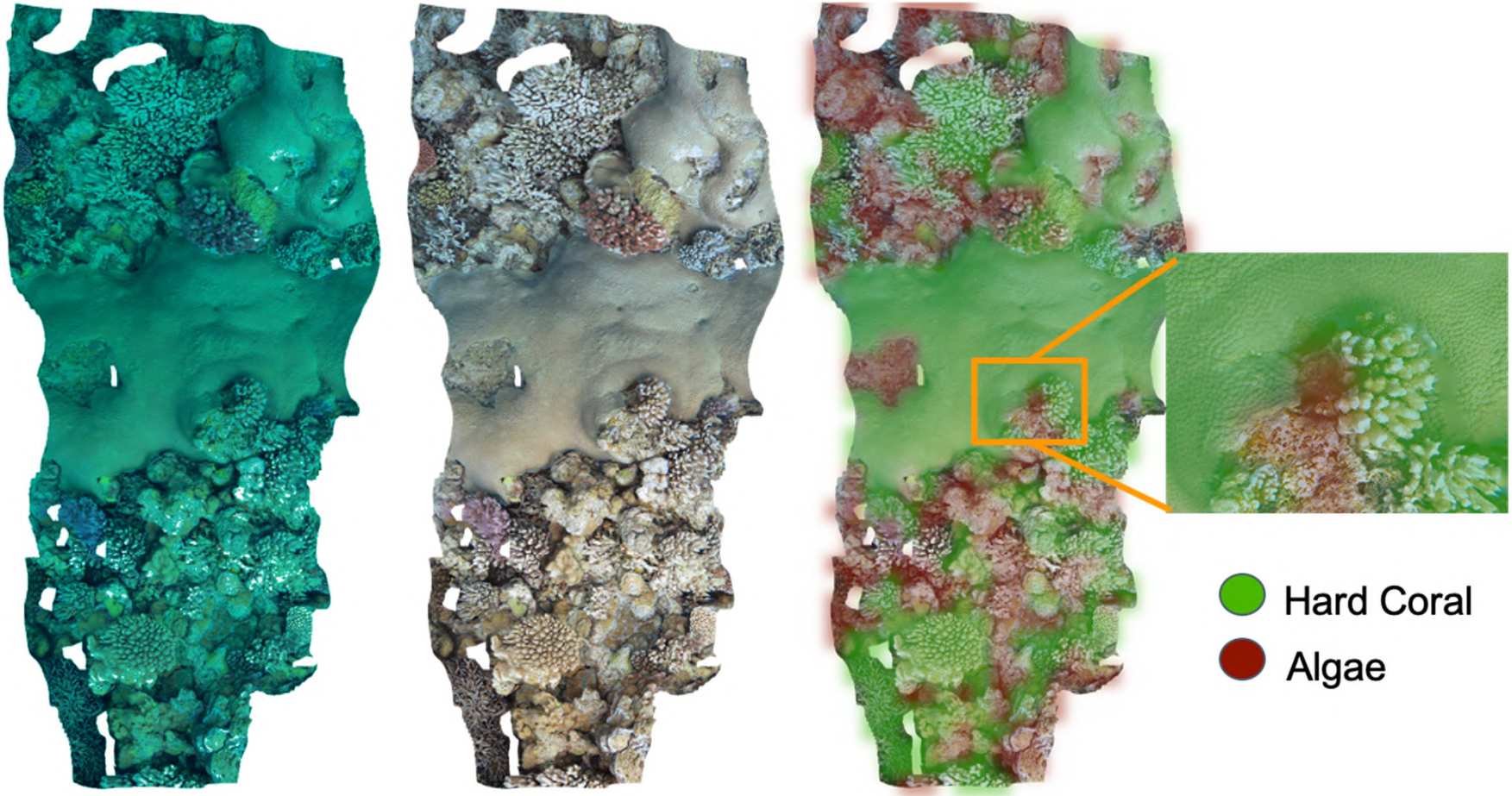
Generative Adversarial Networks



Mosaic classification



Conclusions

Semi-automating shallow water transects is achievable and within human error at broad taxonomic groups

GANs offer a path for domain adaptation, increasing the scale with which we can automate

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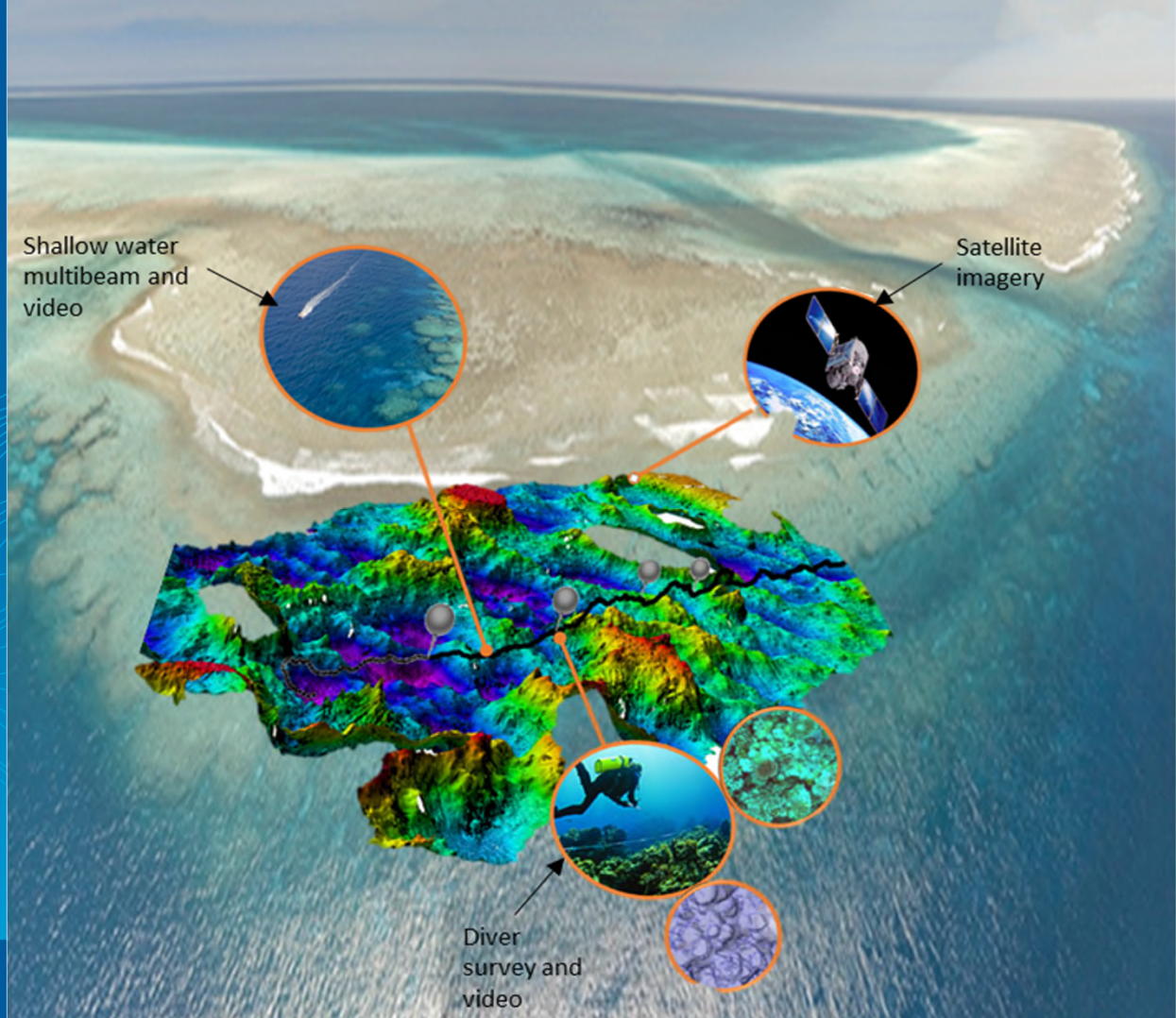
1. Testing Novel Methods for Coral Reef Monitoring

QUESTIONS?



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