Technology and science for marine protected area management

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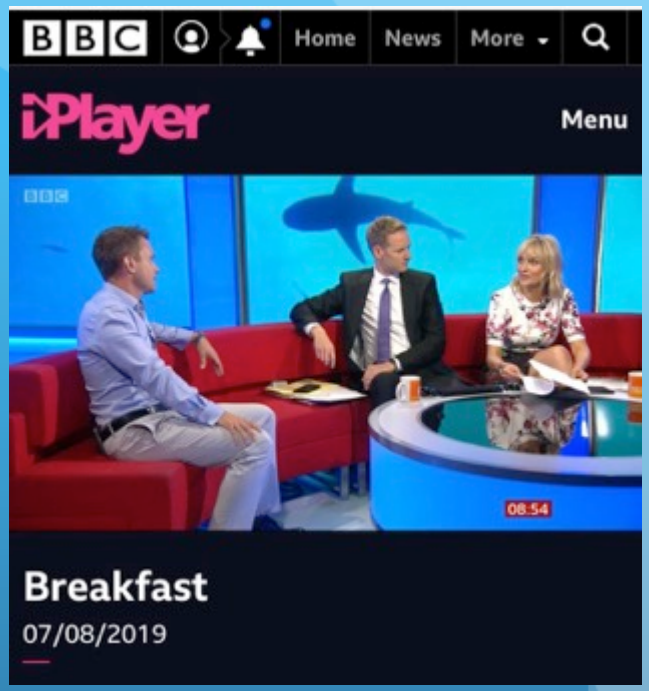
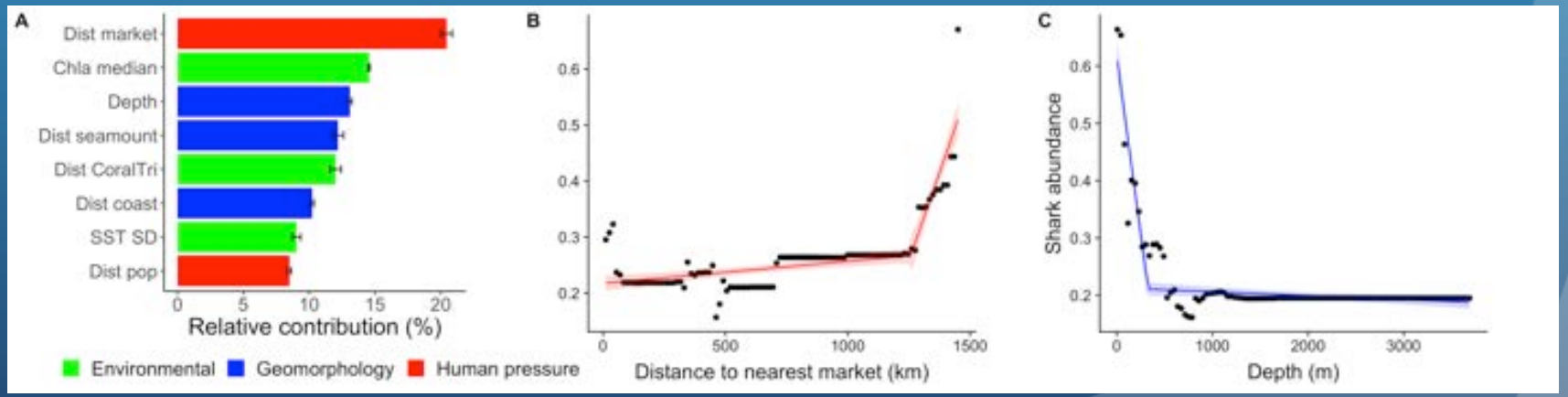
Overview

- Marine protected areas and illegal fisheries
  - Why we should care
  - Social dimensions
- Research and surveillance
  - Hydrophone and biological indices
  - Drone monitoring
  - Habitat mapping and megafauna
  - Random Encounter Models
- Patrol-based monitoring
  - Challenges and opportunities

Letessier T, Mouillot D (and others), Meeuwig J (2019). *PLoS Biology*, *17*(8), e3000366.

- Human pressure is now the biggest driver of shark distribution
- Refuges
- Hotspots underrepresented within MPAs
- Elevated shark levels is due to remoteness, NOT MPA status
- A need for better IUU enforcement.





Driving decision to fish shark

600-700kg for shark vs. 300-400kg for tuna (high value of fins **and** shark meat) (Feb-July, 2019, SL)

Suited for multi-day vessel equipment…*"tuna needs 2x ice and shark decomposes slower". "Quality is less important* (for sharks)".

Conservation awareness…*"the ocean is so big, sharks can't go extinct"…"*

Poor compliance with national regulations, e.g. fin bans…*"there are no regulations that impact on our lives"… officers do not tell us exact reasons why they put such bans on fish and since people do not know, they are trying to catch those species illegally because for us fish is our income"*

Guaranteed catch..."*when we go to those areas we know sharks are there in high volumes*"

Higher socio-economic status from dangerous fishing of large sharks in illegal areas

Driving decision to on where to fish or fish illegally

Ecological declines… *"fish in Sri Lankan waters and even in international waters are very less now. So to catch fish they go to those areas"*

Over-capacity…from "*450 vessels...now 1000…so trend is now towards High Seas".*

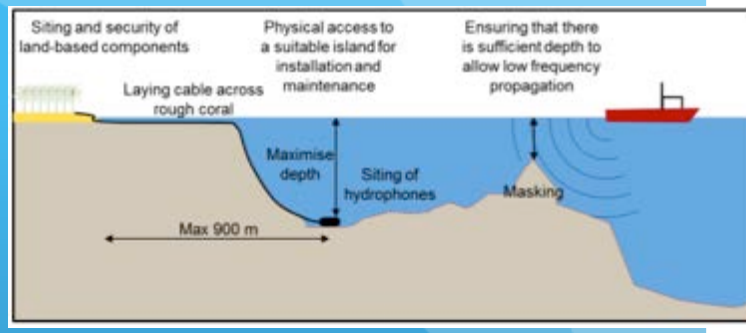
Perception of legitimacy of closed areas.. *"I am Indian, this is the Indian Ocean"*

Perception of risk ~ 5-10%. *"Very dangerous to go in those areas…but not all fishes get caught like only 5 % get caught from all who cross borders".* Fishers all have good knowledge of sanctions, BIOT seen as lower risk due to less severe penalties than areas such as the Maldives

"*the vessels which are not equipped with VMS always fish in other territories…*"

Passive acoustic monitoring

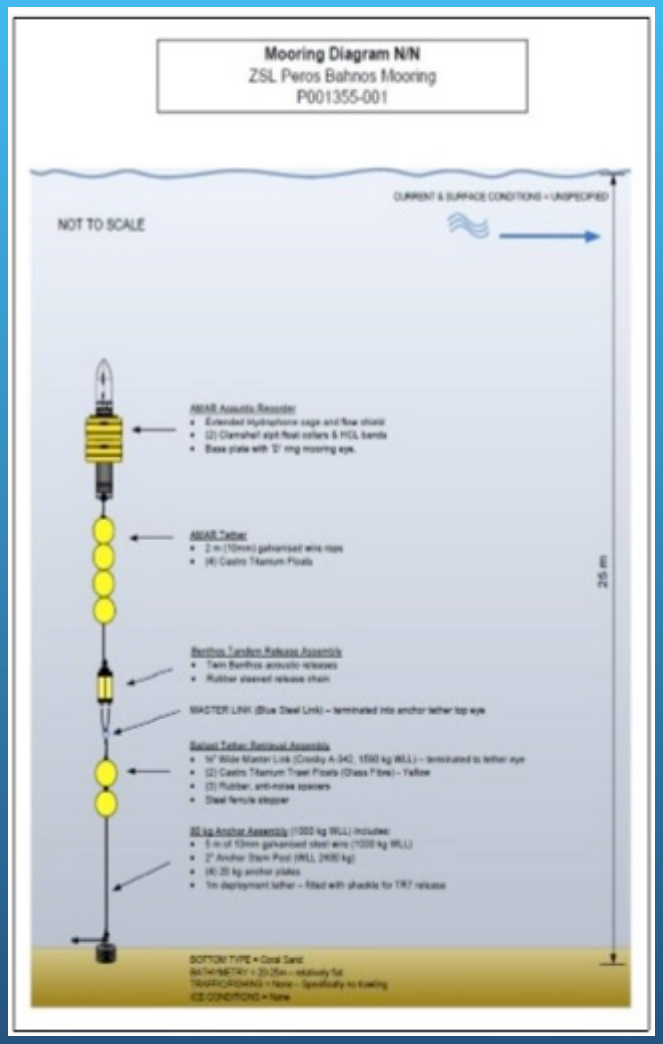
- Hydrophone deployed on the seabed
- Can yield instantaneous vessel detections
- Can monitor biological activity that produces noise

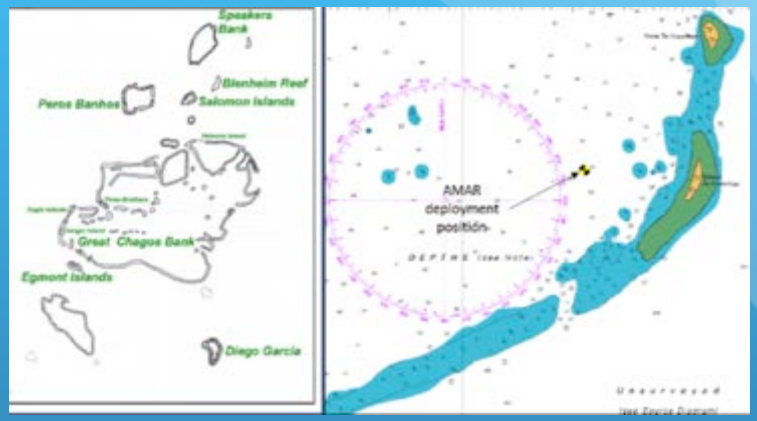


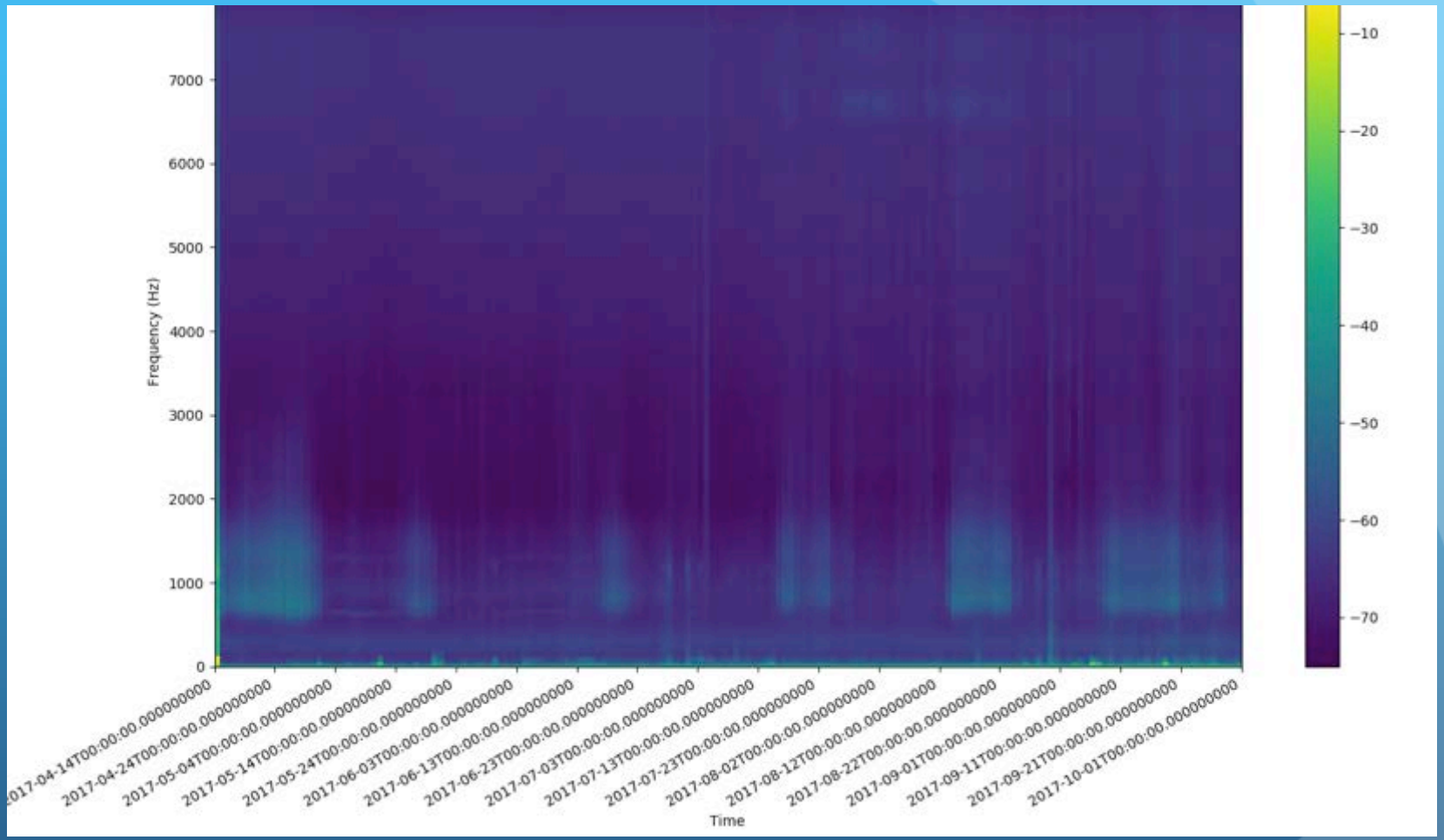
Drones

- Comes in range and sizes
- Cost from £100 to 100,000,-
- Larger drones require a pilot team
- Smaller drones are not outside the technical ability of most fisheries patrol or MPA ranger
- Requires a lot of training
- Regulations are catching up

Vessel detection



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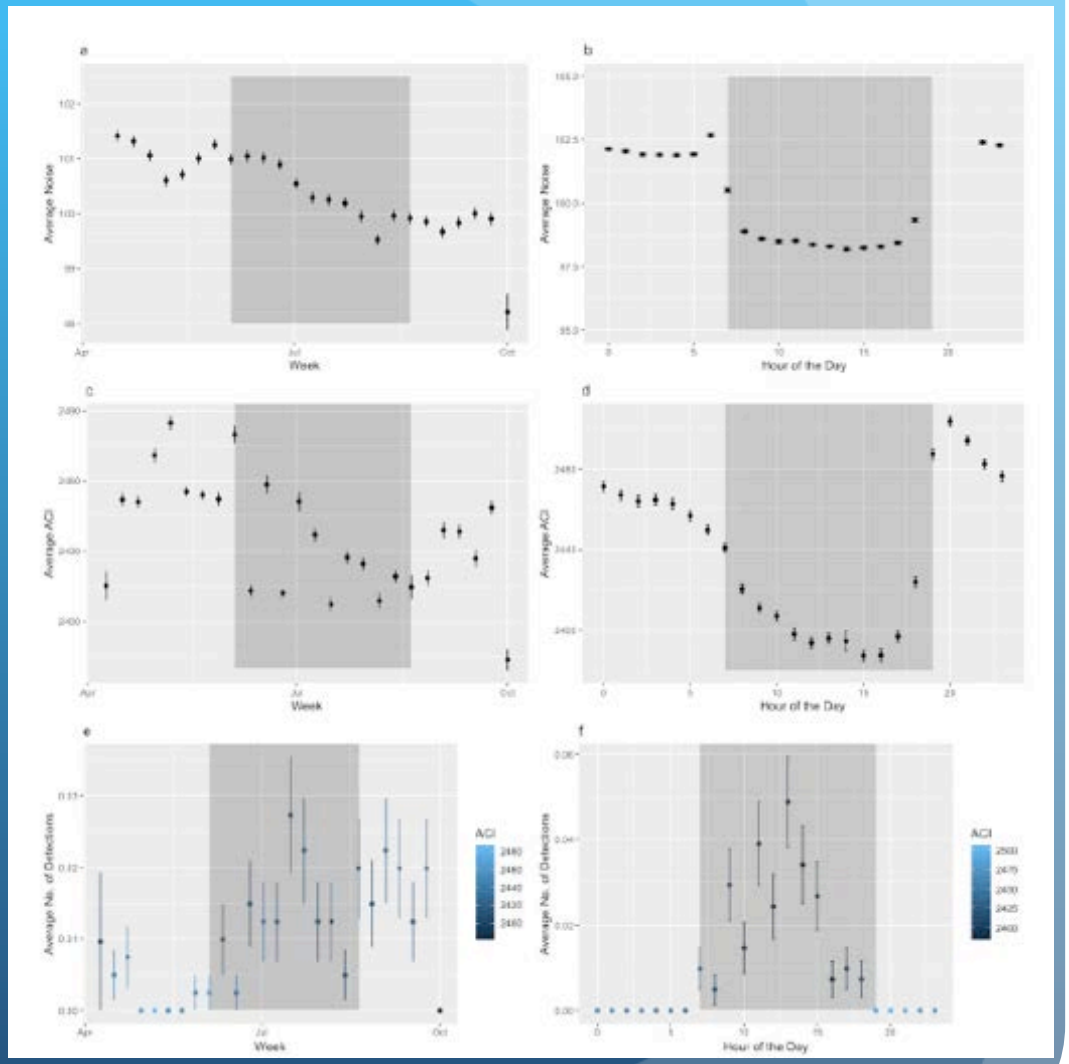
Time

Biological Indices

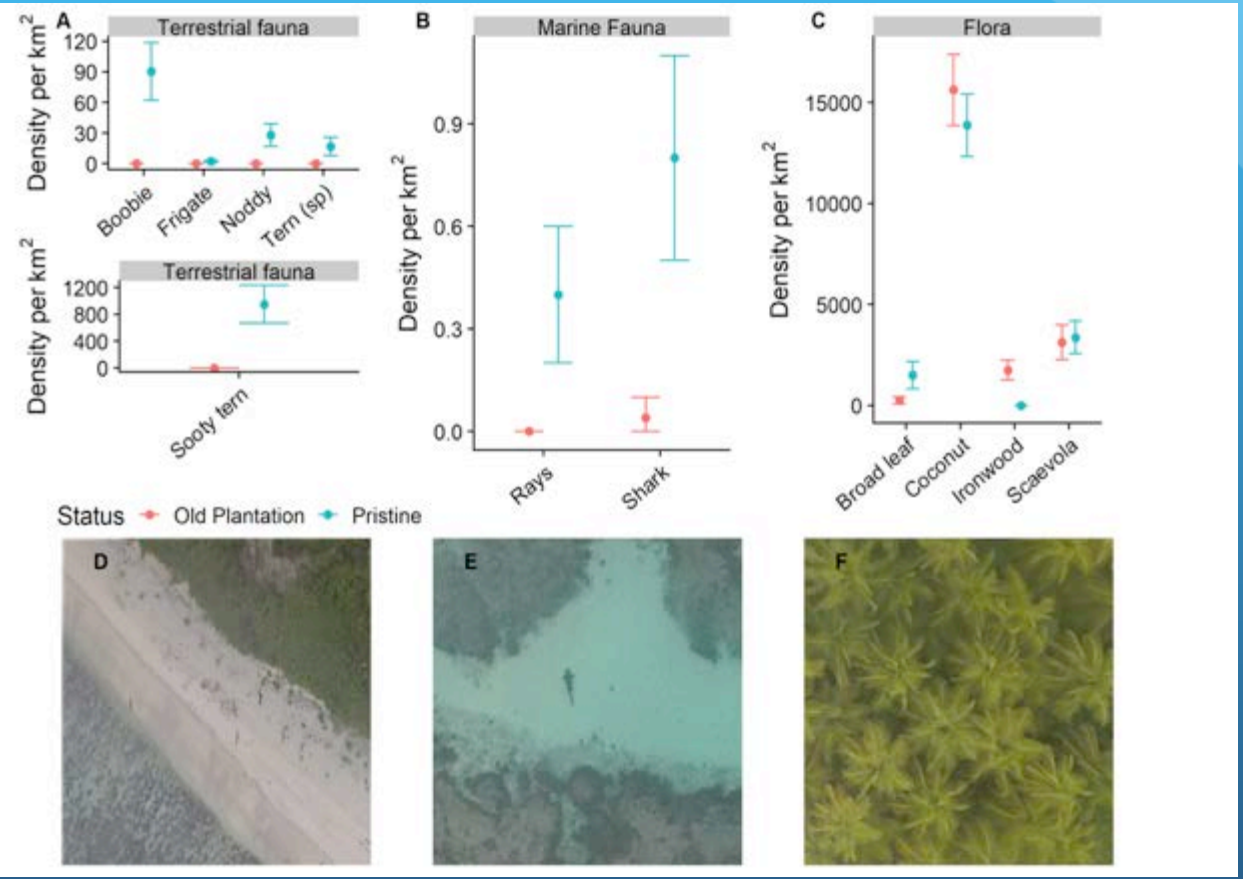
- Mean noise values, Acoustic Complexity, and dolphin whistle detections
- Strong seasonality, and diel pattern
- No dolphin detections during the night – evidence of migration off-shore?



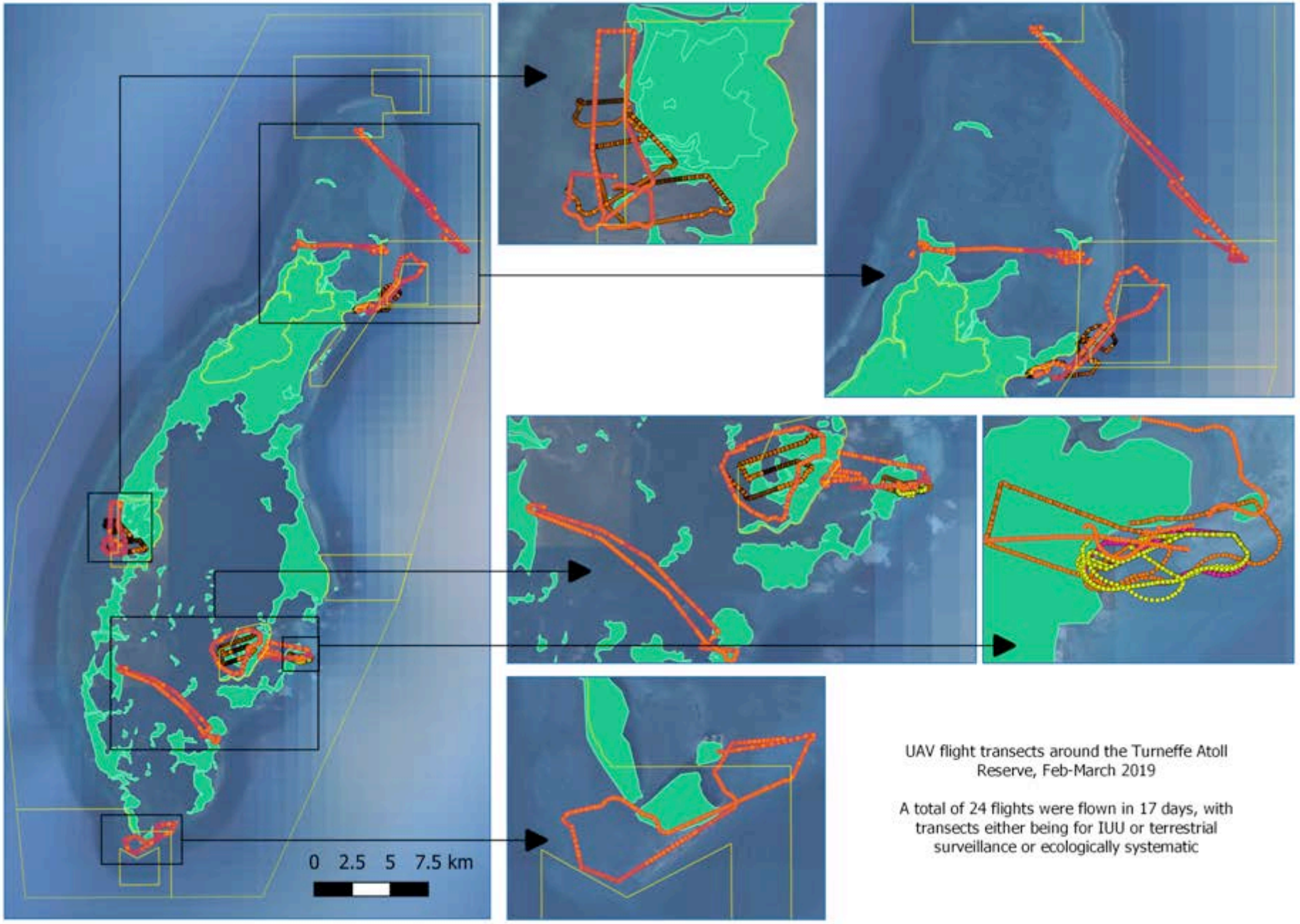
Development of a fixed-wing waterlanding drone

- Trials in BIOT and in Belize
- Surveyed pristine islands and rat infested islands (old coconut plantations)
- Integrate drone with patrol-based monitoring

Patterns in fauna and flora related to bird colonies



Schiele et al Conservation Biology (Submitted)

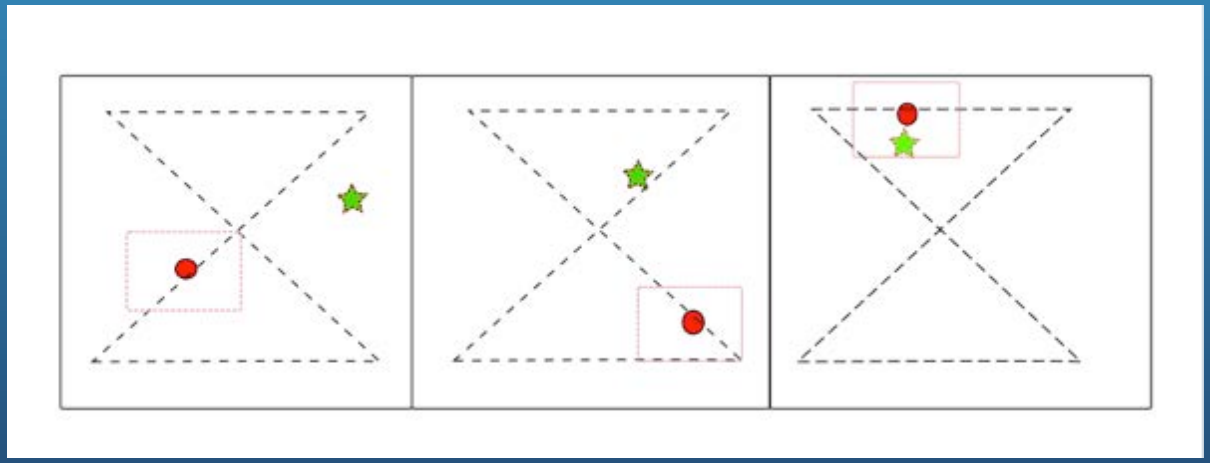


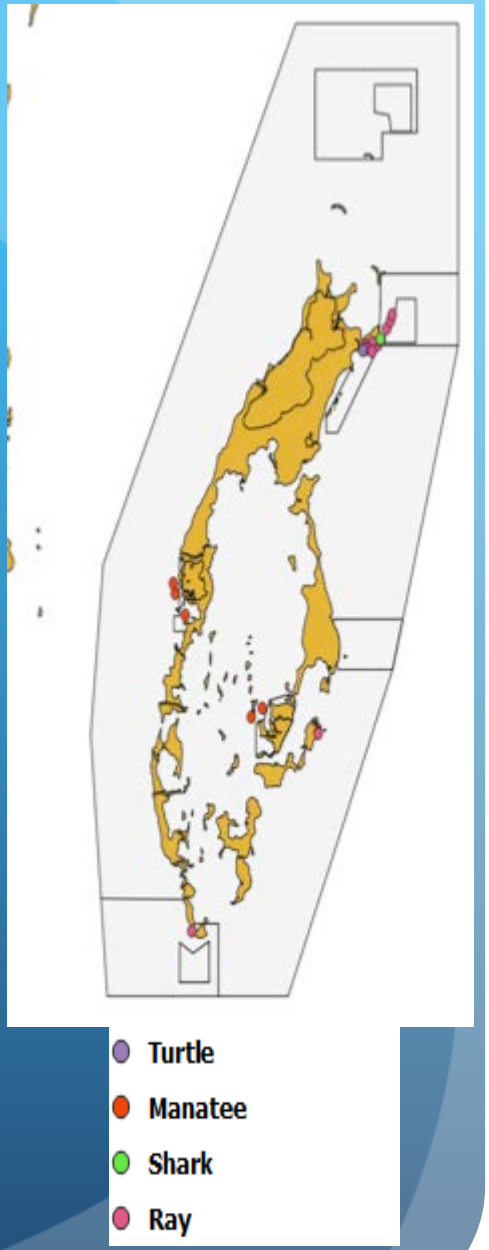
UAV flight transects around the Turneffe Atoll Reserve, Feb-March 2019

A total of 24 flights were flown in 17 days, with transects either being for IUU or terrestrial surveillance or ecologically systematic

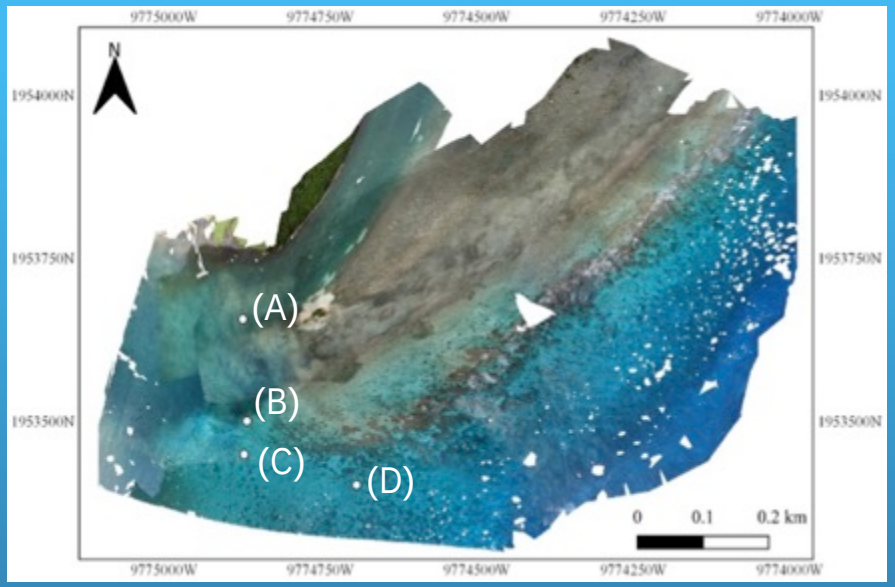
Analysis

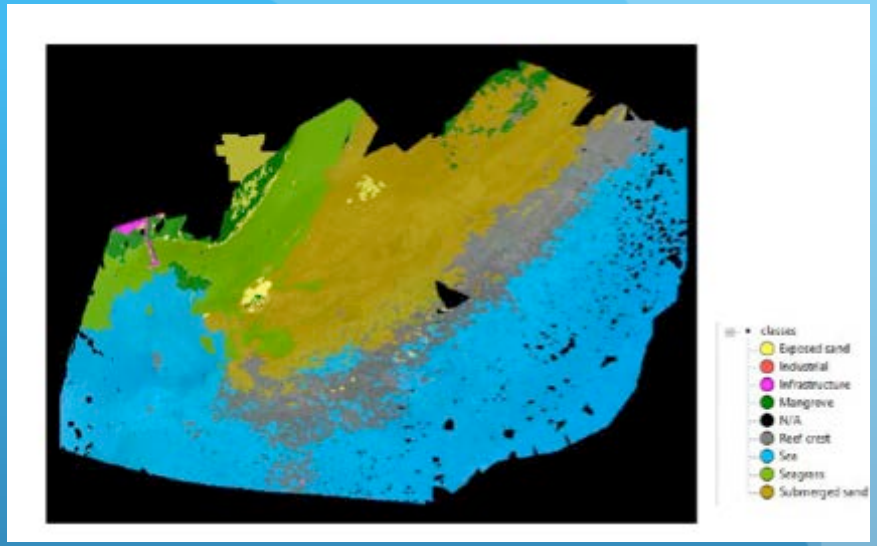
- Megafauna identified from images in Turneffe. 42,915 images, 264 km of areal transects
- Develop Random Encounter Model, to generate density from the megafauna count.

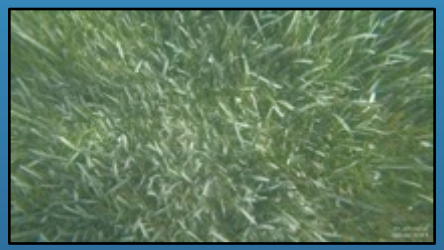


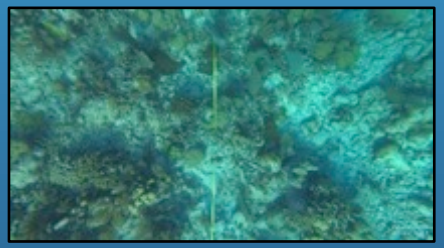


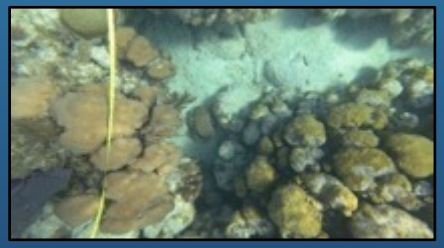
Habitat classification











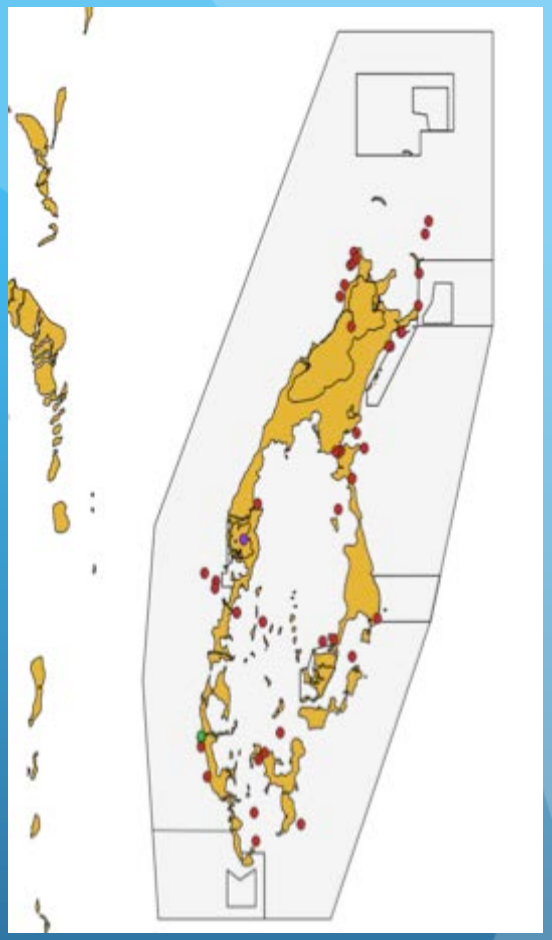
- Explore the effect of different heights (75, 85, 110 m) on habitat classification

Latest steps in drone development…

- Further vessel trials in Lake Victoria (Oct 19) and BIOT (Feb 20).
- Improve calibration whilst on a moving vessel
- Dynamic Home Position - In case both drone and vessel are moving
- AI on ‘the-fly’ to detect animals or vessels on the live camera stream.
- Integrate drone as part of patrol-based monitoring protocols

Opportunities in patrol-based monitoring

- SMART Tool, a platform for patrol logging and ecological monitoring
- Enables to evaluate the effectiveness of patrol efforts, and record megafauna
- SMART logging patrol logging is currently used globally and sustained by 9 conservation agencies, of which ZSL is a partner
- Training for fisheries officers and rangers is available



SMART

WWF

PEACE PARKS FOUNDATION · THE GLOBAL SOLUTION

WCS

WILDLIFE PROTECTION SOLUTIONS

FRANKFURT ZOOLOGICAL SOCIETY

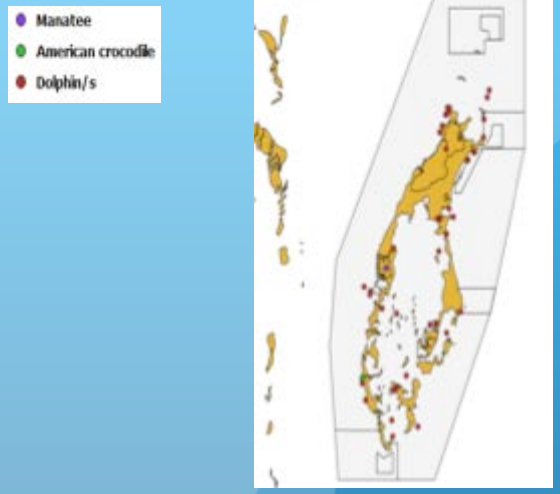
ZSL LET'S WORK FOR WILDLIFE

North Carolina ZOO

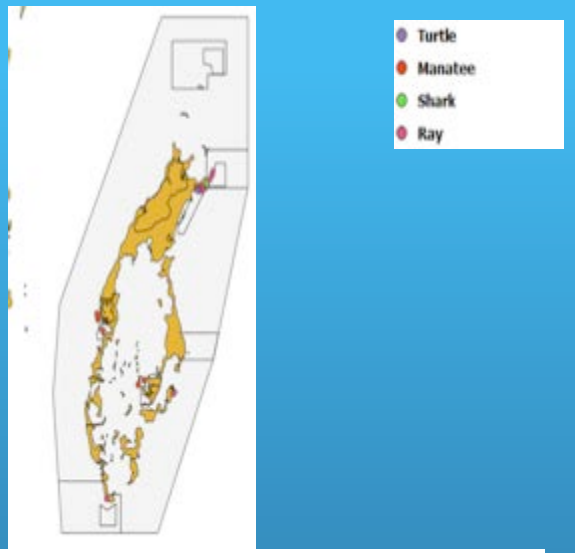
PANTHERA

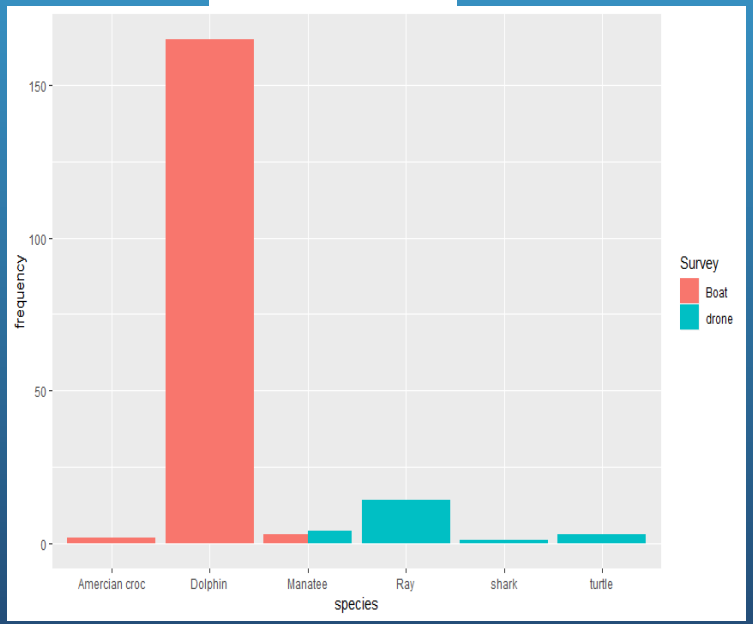
GLOBAL WILDLIFE CONSERVATION

Megafauna from patrols

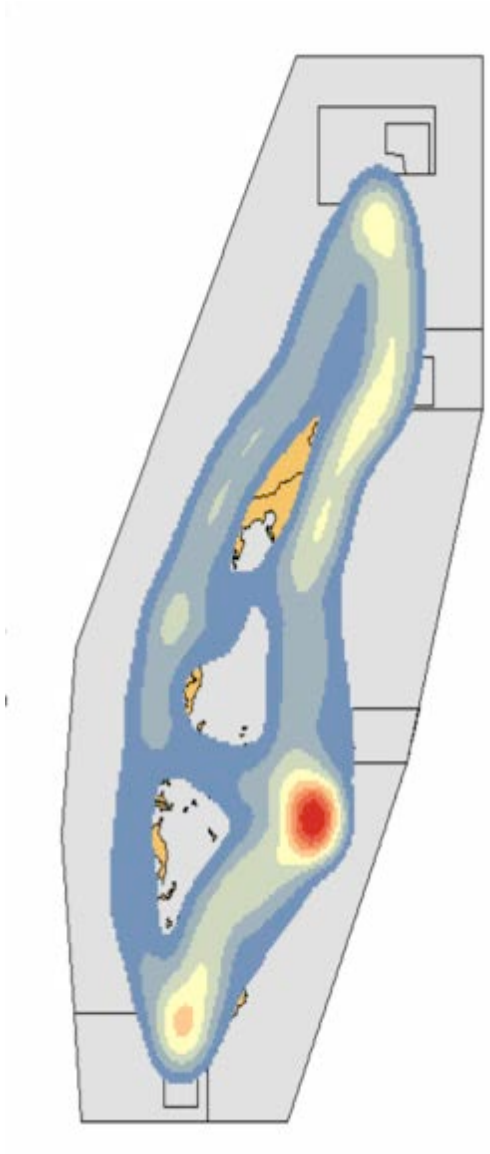


Megafauna from drones

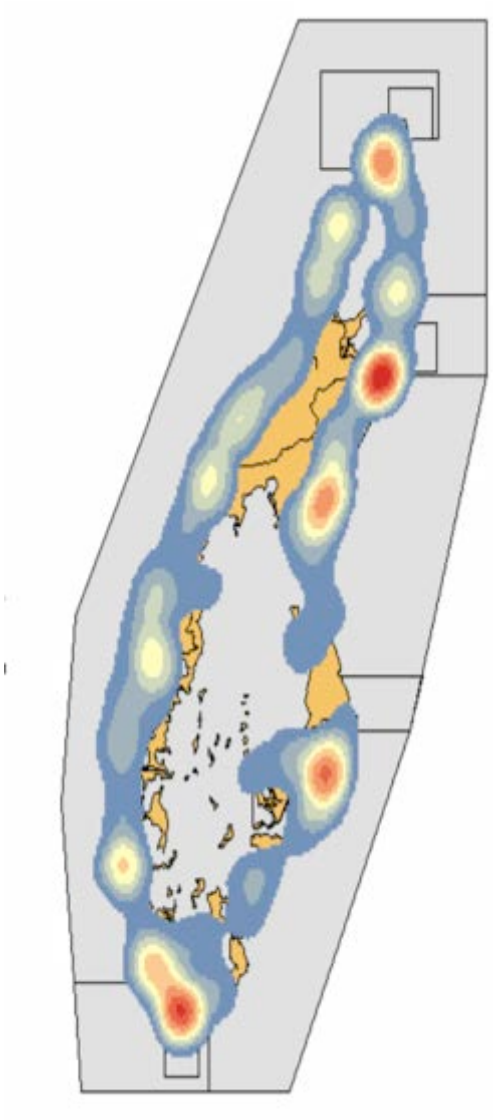


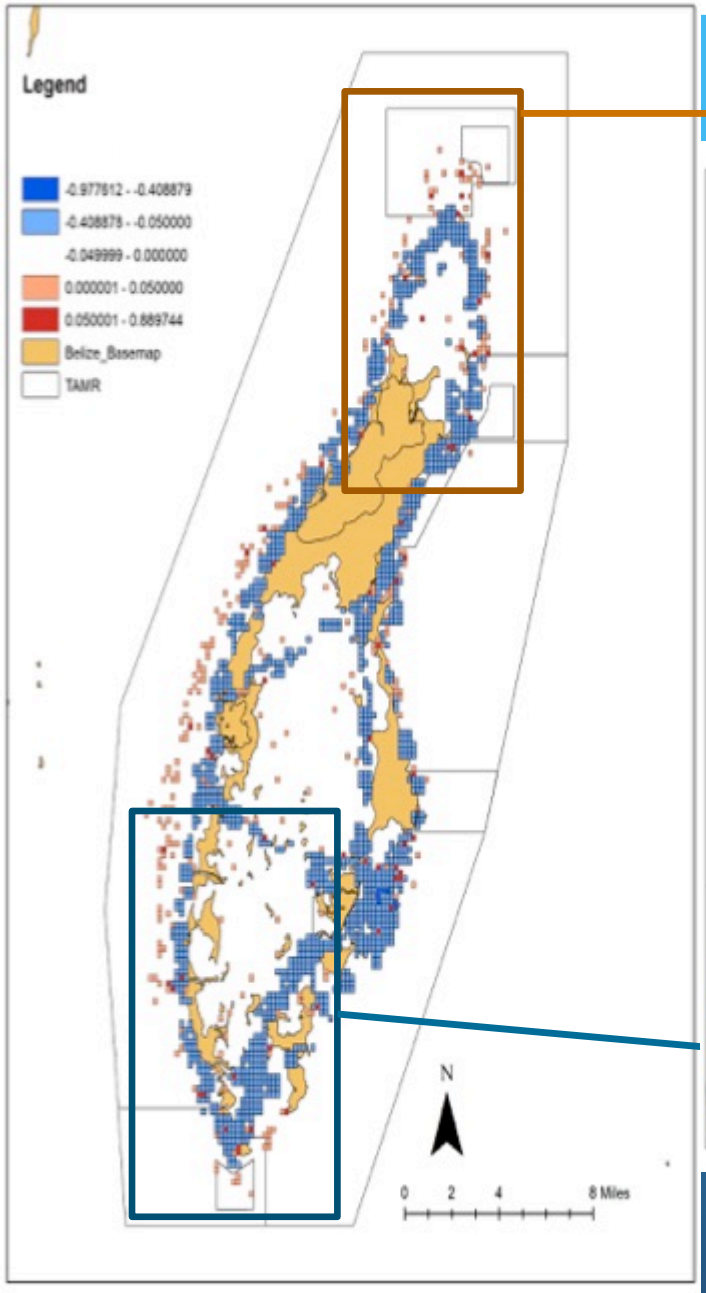


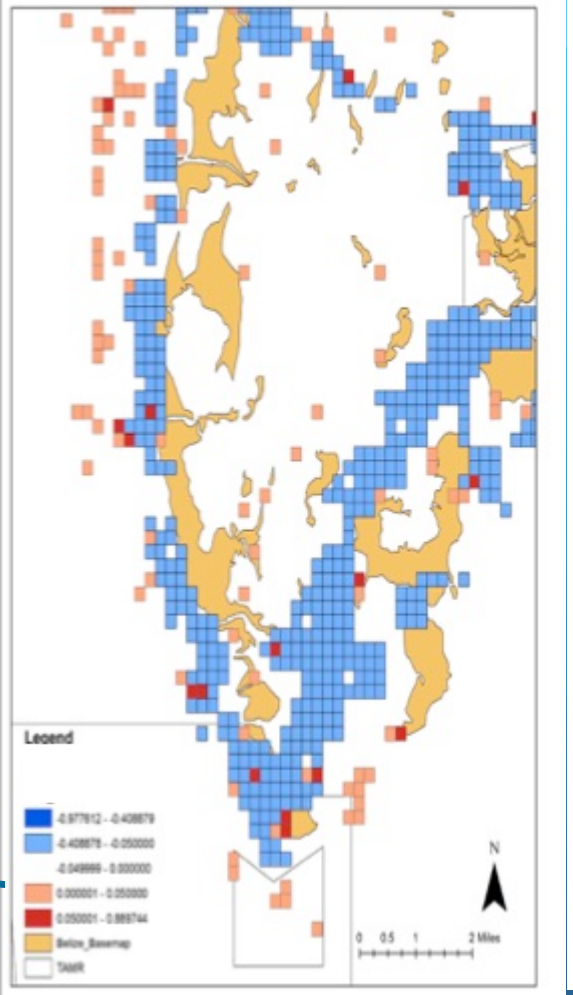
Patrols

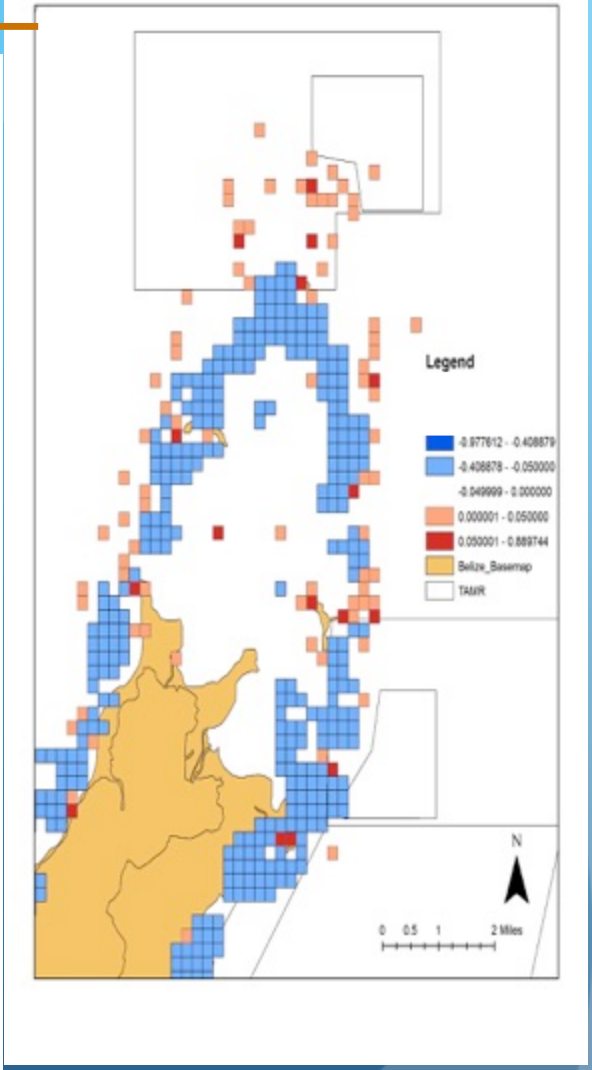


Fishing pressure









Red = high fishing pressure per patrol effort
Blue = low fishing pressure per patrol effort

Conclusion

- MPA only as good as their enforcement
- Socio-economic drivers are complex and dynamic
- Surveillance technology offer opportunities for ecological monitoring
- Patrol-based monitoring – need for research to identify limitations and biases

Students

- Claire Collins, PhD student (University of Exeter)
- Melissa Schiele, PhD student (Loughborough University)
- James Johnston, MSc student (University College London)
- Eva Linehan, MSc student (Imperial College London)
- Sophia Ellis, MSc student (University of Essex)
- Abbie Montgomery , MSc student (Imperial College London)

Collaborators/Funders

- BIOT Administration and UK Foreign Office
- Ana Nuno (University of Exeter)
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- Robin Burns (JASCO)
- Olivier Adams (University Paris Sud)
- Dorian Cazau (Pierre and Marie Curie University)
- James MacAuley (University of St-Andrews)
- Sarah Keynes (Marine Management Organisation)
- Kate Moses (ZSL conservation tech unit)
- Marcus Rowcliffe (ZSL, Institute of Zoology)
- Jessica Meeuwig (UWA)
- Bertarelli Foundation
- National Geographic Pristine Seas
- Ascension Island Fisheries Association
- Darwin Initiative