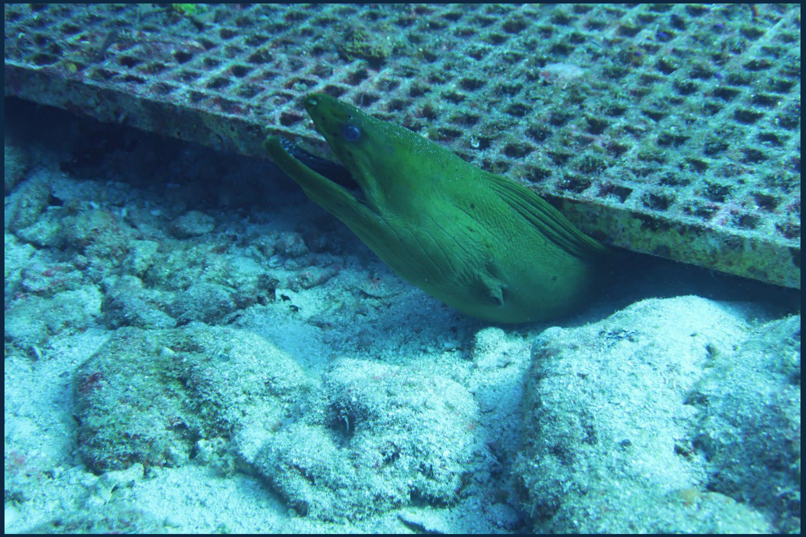
The Influence of Structural Complexity on the Fine-Scale Diurnal Space Use of Reef Fishes



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FIU Institute of Environment

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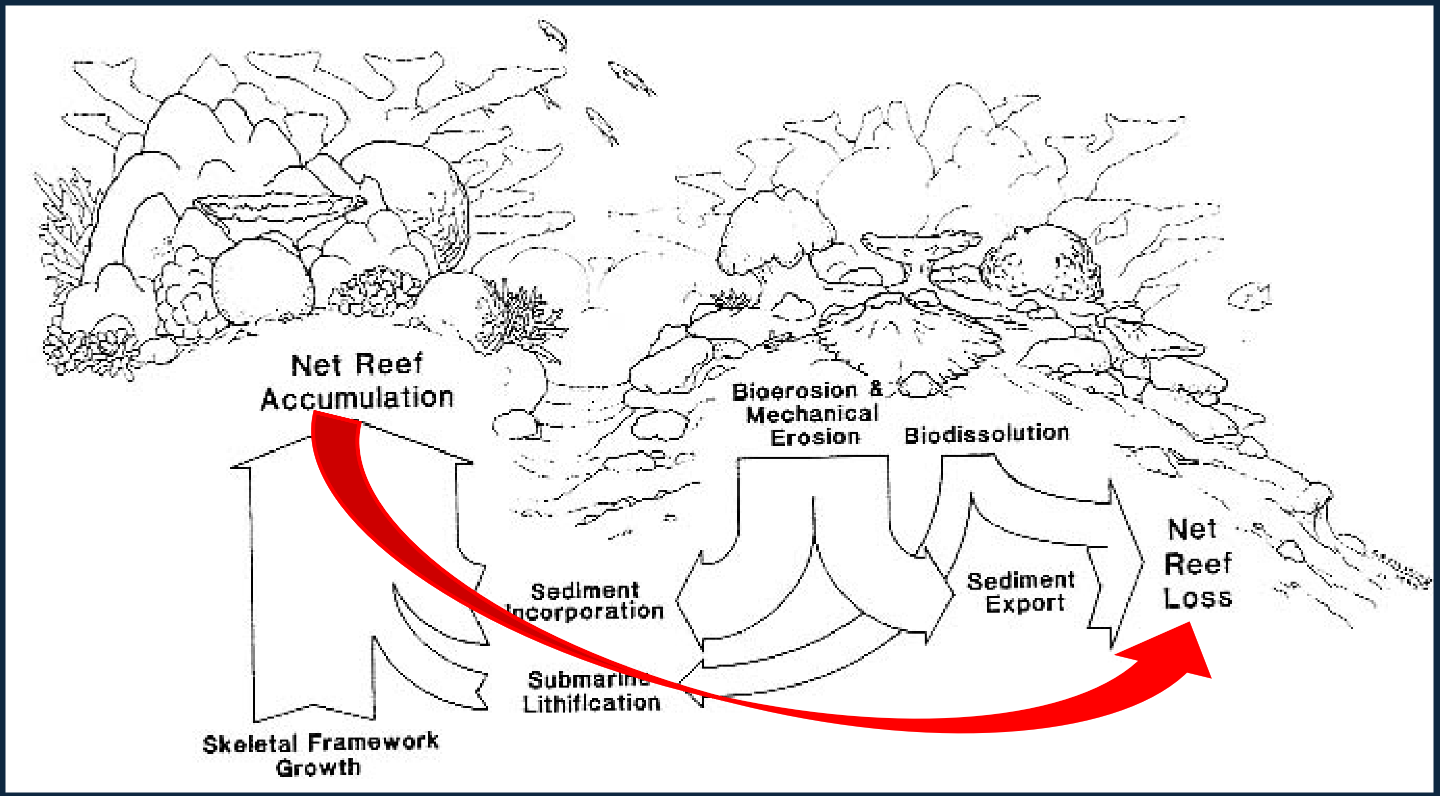
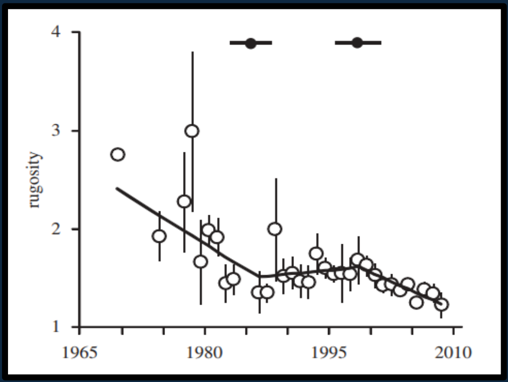
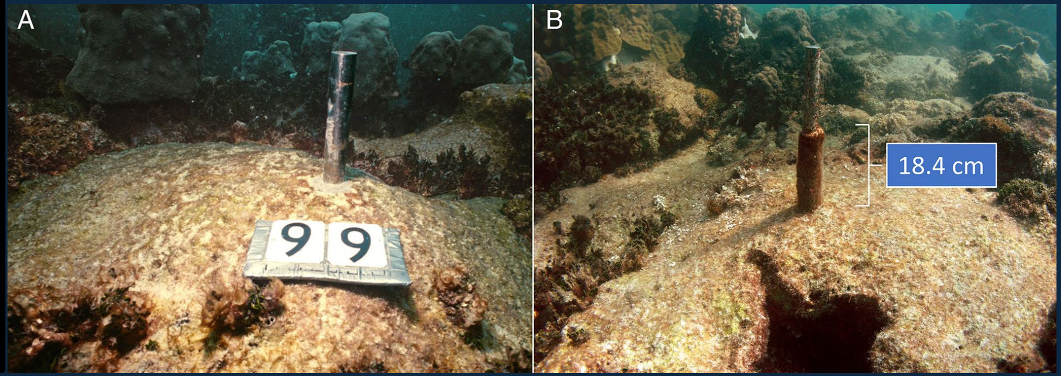
Loss of coral linked to loss of structure





Alvarez-Filip et al. (2009)



Change over 17 years. -5.5 mm yr^{-1} or −6.6 kg m^{-2} yr^{-1} Kuffner et al. (2019)

Complexity is critical for fishes

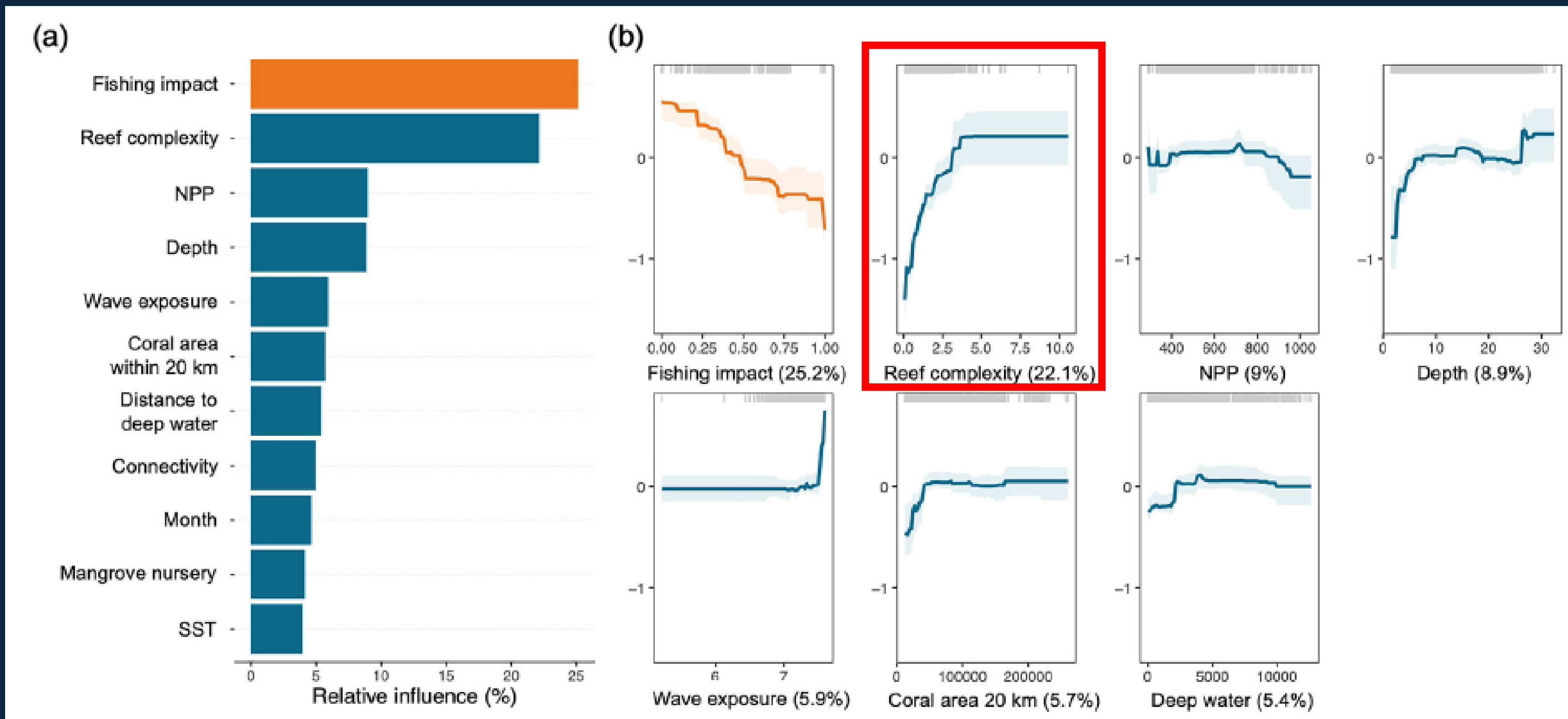
- Link between complexity and fish abundance and diversity well established
- Important for refuges, spawning, nesting, foraging, energetics in strong currents
- Need to move towards an understanding of when, where, and why complexity is particularly beneficial
- Understand the full implications of habitat degradation and conservation options

Link to snapper-grouper biomass (RVC data)

High

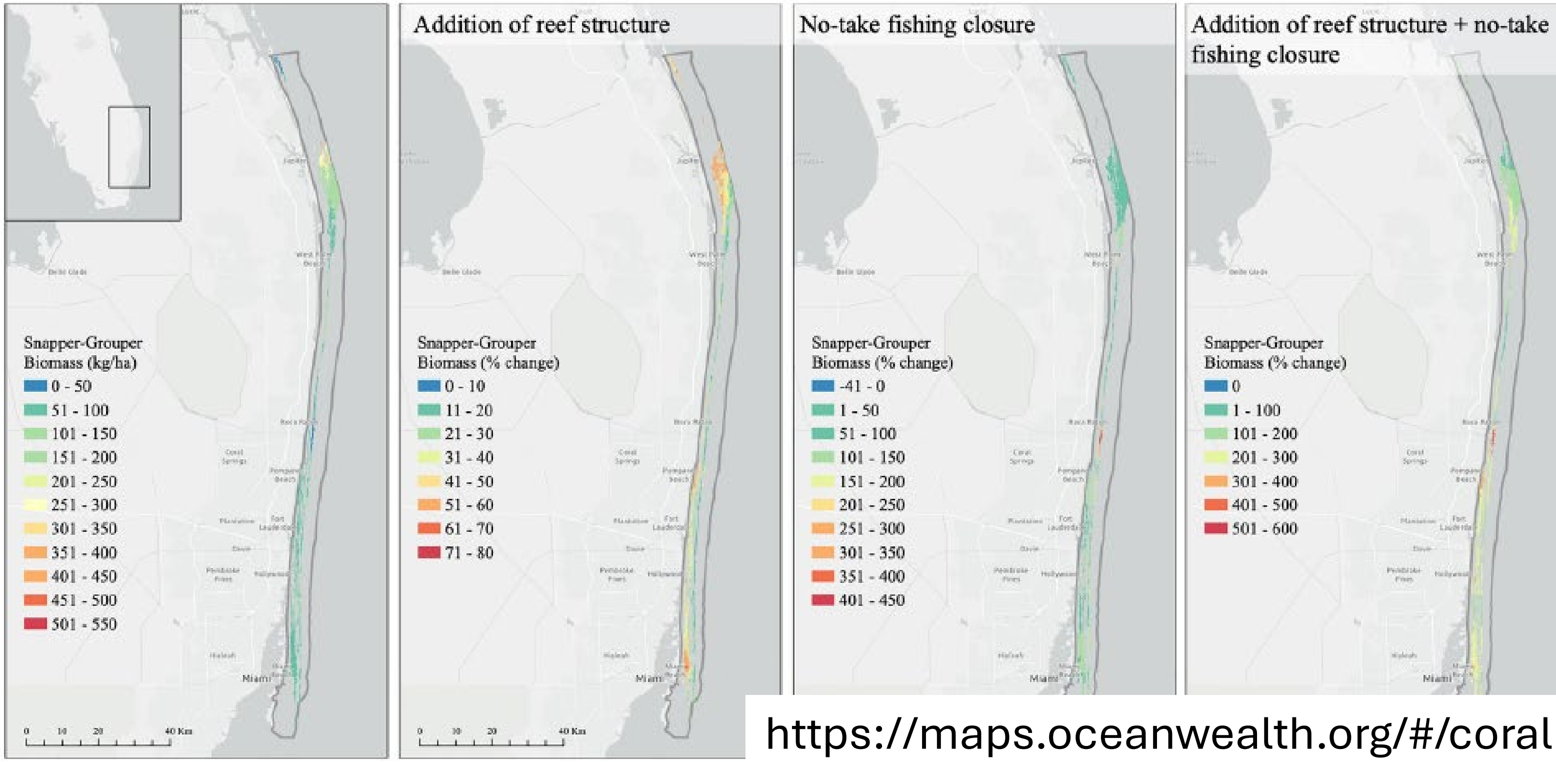
Fish Biomass

Low



Zuercher *et al*. 2023. *Aquatic Conservation-Marine and Freshwater Ecosystems* 33, 246-263
Zuercher *et al*. 2023. *Journal of Fish Biology* 103, 1526-1537

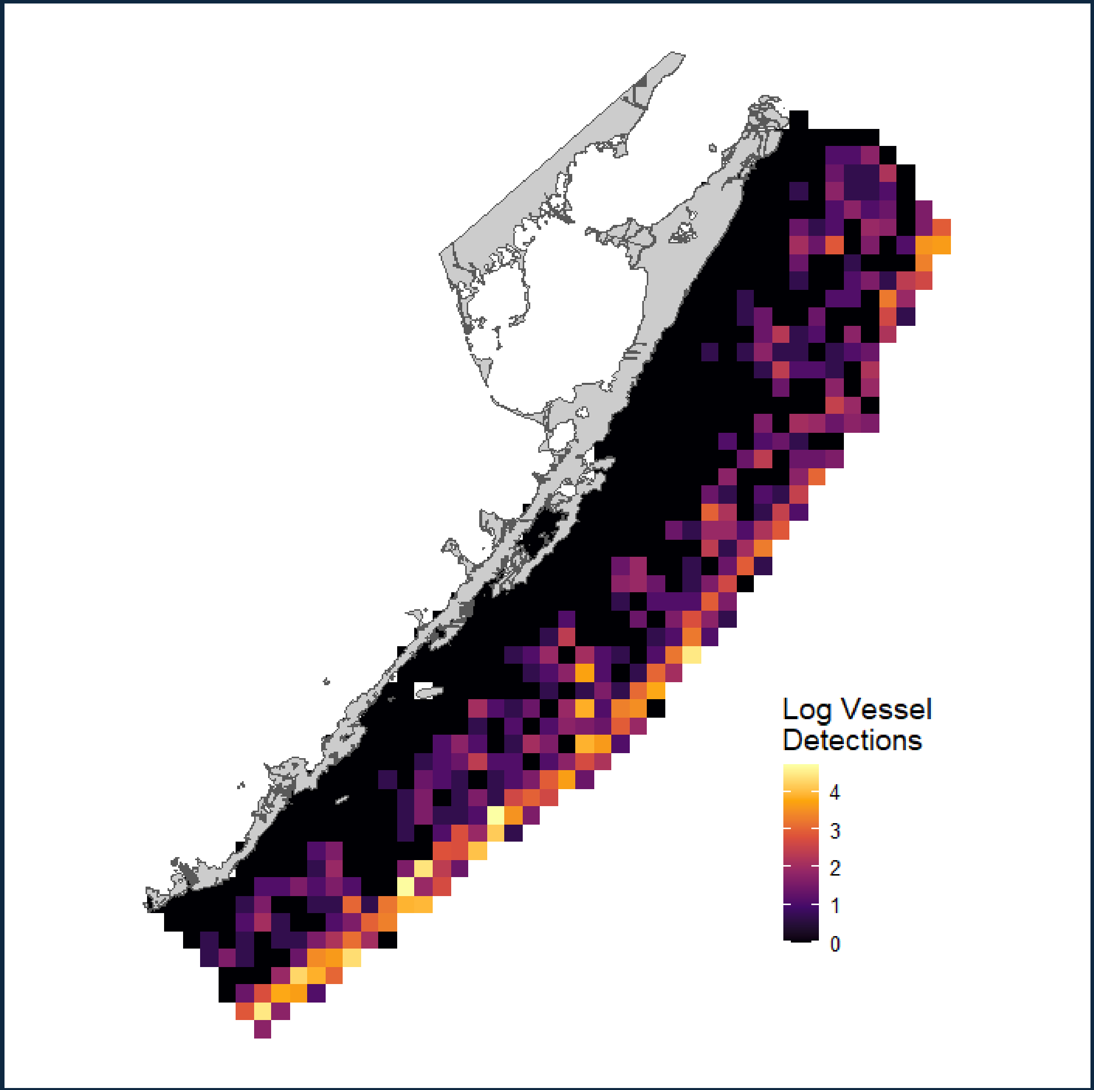
Scenario testing (snapper-grouper)

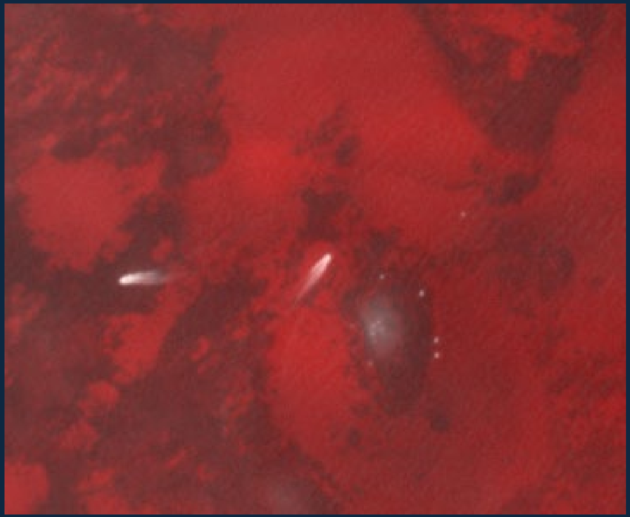


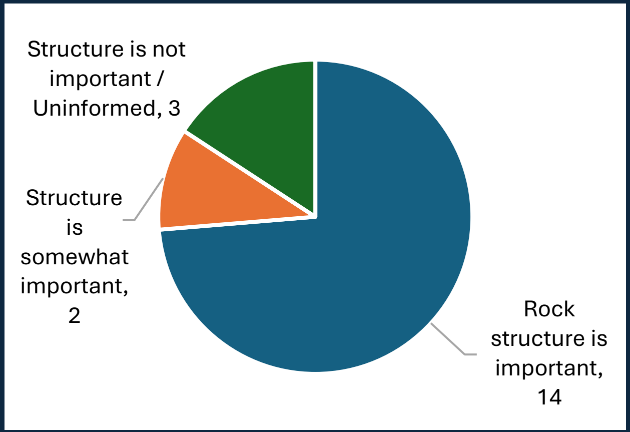
https://maps.oceanwealth.org/#/coral

	All species		Snapper–grouper		Grazing species		Aquarium species	
Management scenario	kg ha^{-1} (SD)	%Δ	kg ha^{-1} (SD)	%Δ	kg ha^{-1} (SD)	%Δ	kg ha^{-1} (SD)	%Δ
Current	657 (252)	–	218 (137)	–	98 (35)	–	189 (52)	–
I: Reef restoration – phase 1a	689 (242)	5%	237 (159)	8%	94 (33)	-4%	198 (52)	5%
II: Reef restoration – phase 2	996 (508)	52%	285 (191)	31%	103 (41)	5%	225 (69)	19%
III: Artificial structure	1,132 (482)	72%	314 (208)	44%	121 (42)	23%	258 (70)	37%
IV: Fishing closure	698 (204)	6%	269 (110)	23%	112 (42)	14%	201 (52)	6%
V: Reef restoration + fishing closure	1,094 (520)	67%	369 (150)	69%	117 (48)	19%	240 (72)	27%
VI: Artificial structure + fishing closure	1,241 (477)	89%	411 (160)	89%	136 (49)	39%	274 (73)	45%

Distribution of anchored recreational vessels 2021-23







Marrero *et al*. In prep.

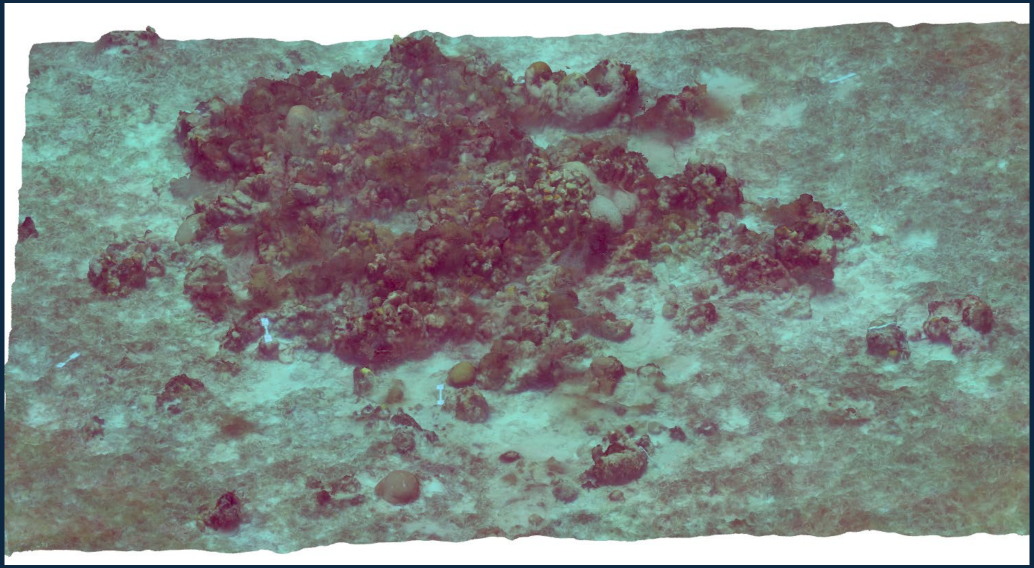
Traits can be used to predict reef fish responses

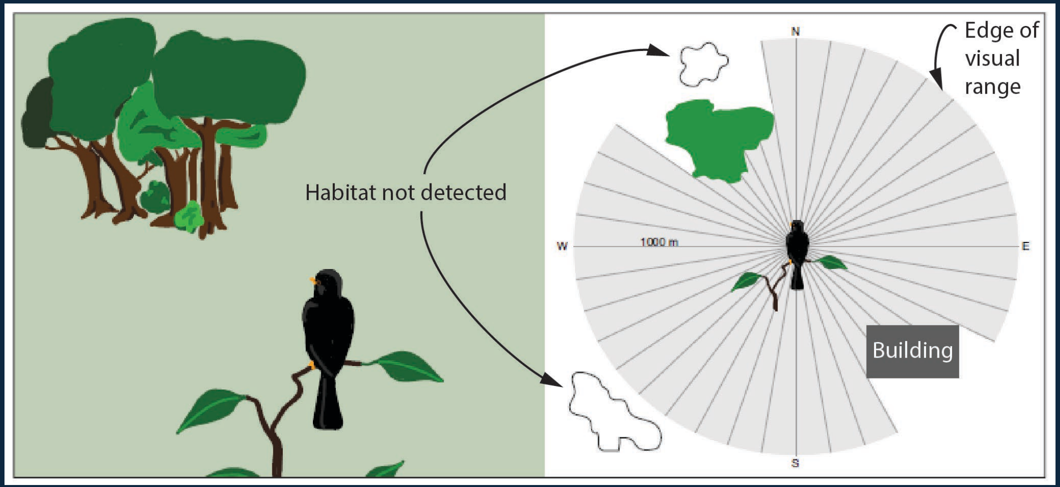
- Rounded body, specific aspect ratio of caudal fin, large, high trophic level…

- More than half of common species likely to decline with flattening
- Coral cover less important to driving fish assemblages
- Important fisheries species will decline with flattening
- What are the mechanisms?

Kochan *et al*. 2023. *Oikos*, e10011

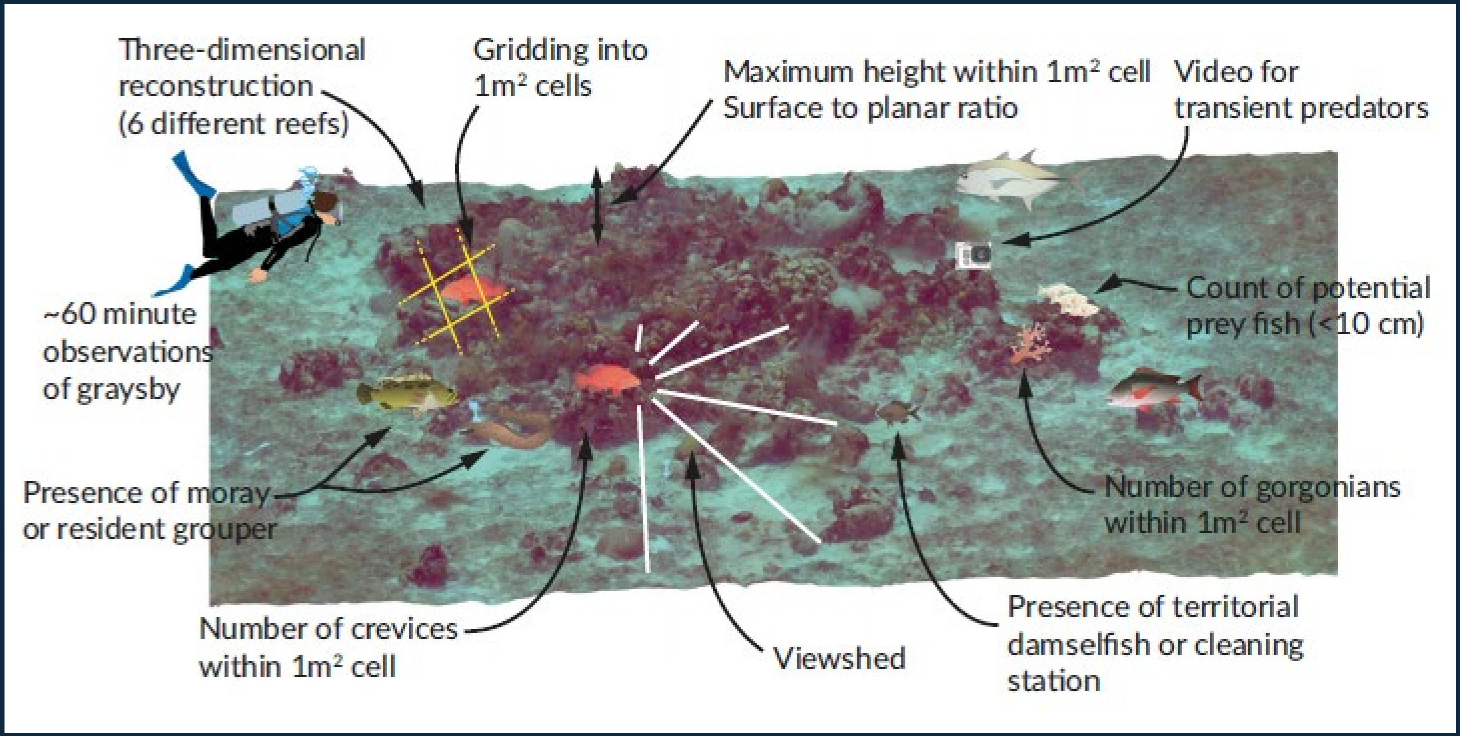
What aspects of complexity are particularly important to a ‘loser’?

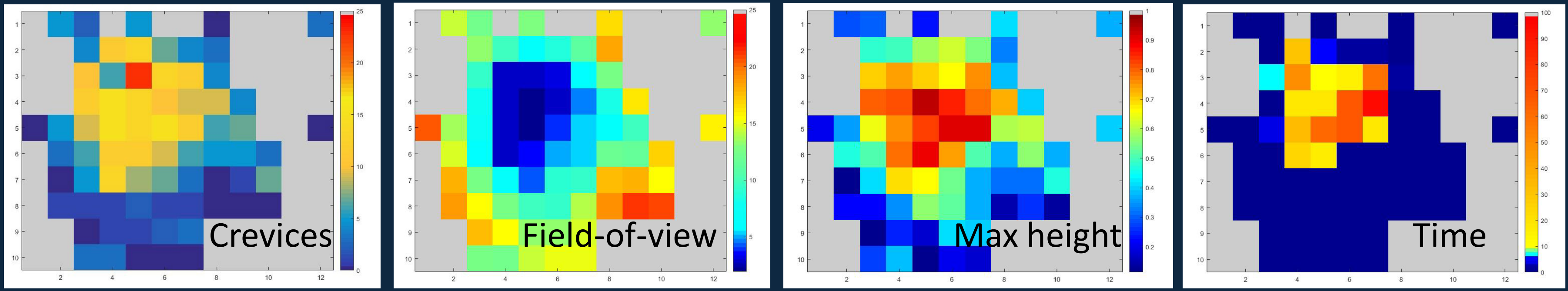




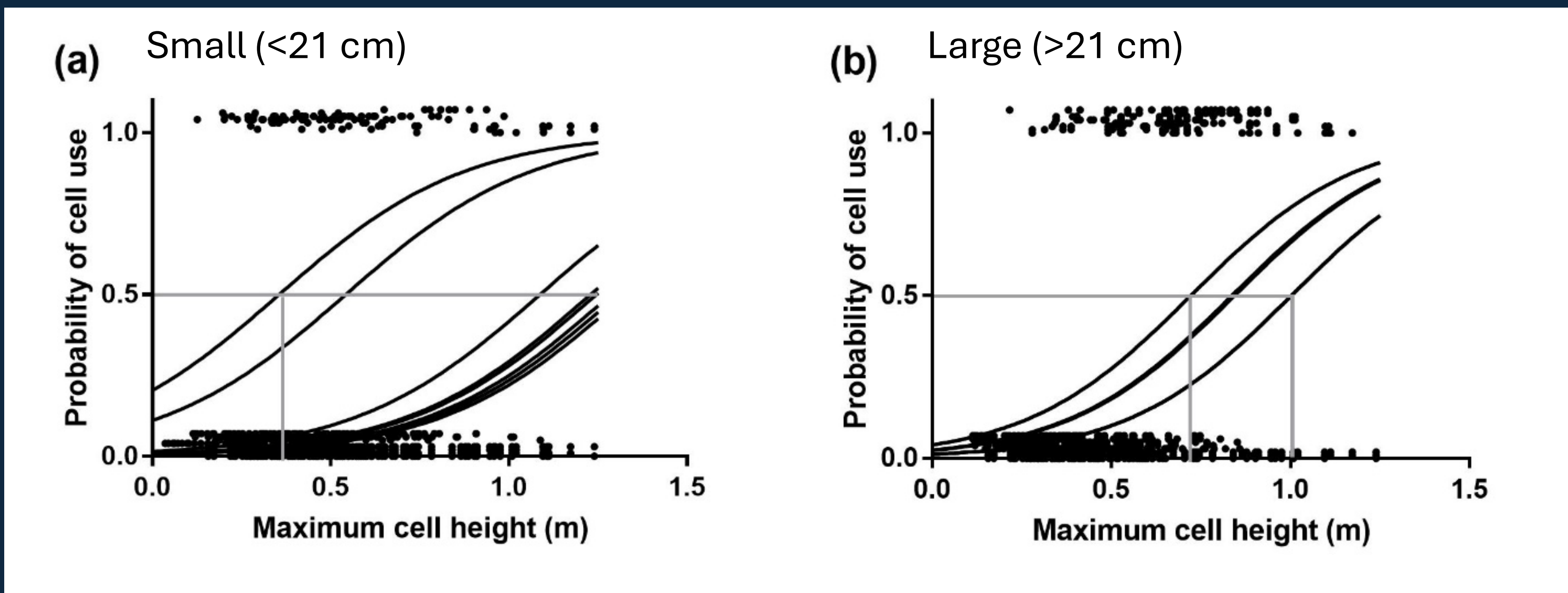
Harborne *et al*. 2022. *J. Fish Biology* 10, 1009-1024

Effects of loss of complexity on fish behavior – patch reef movement





- 16 individual graysby across 6 patch reefs
- Model including multiple complexity metrics and other factors
- Maximum height was key factor (space underneath for ambush / refuge)



Remarks.—A bold little grouper, the graysby will approach a diver closely and may even take food from his hand. It is frequently observed in caves on reefs.

What about grazers?

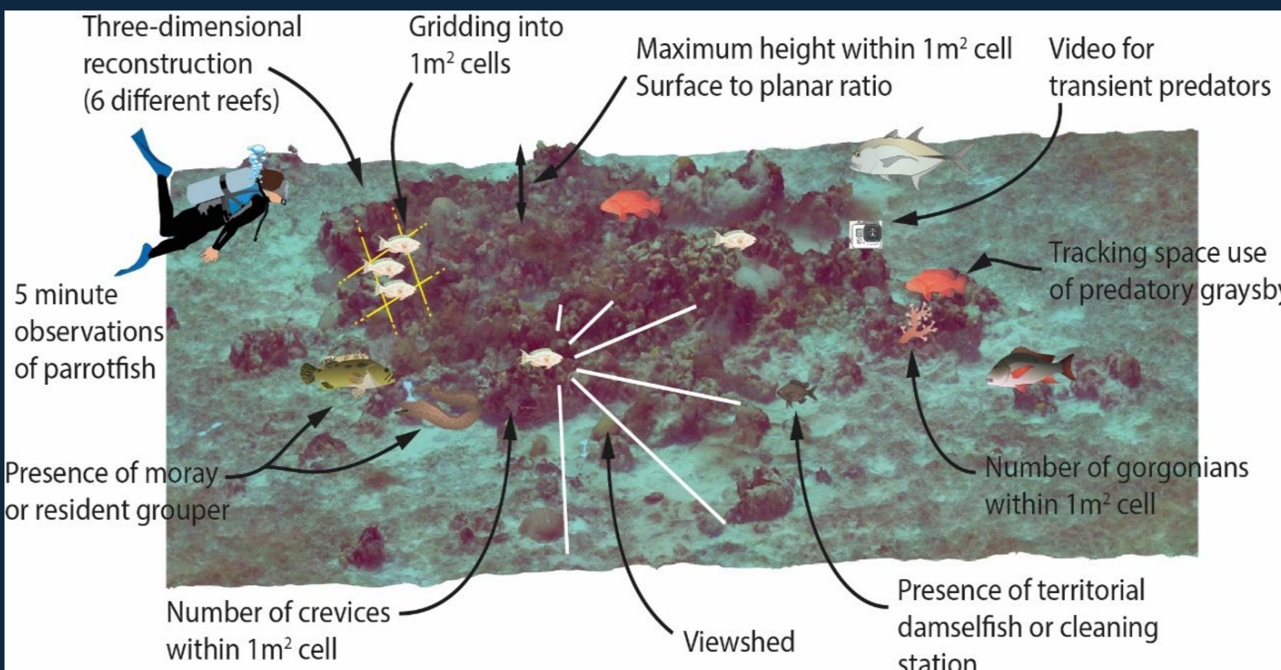
RESEARCH ARTICLE

Functional Ecology

Patchy delivery of functions undermines functional redundancy in a high diversity system

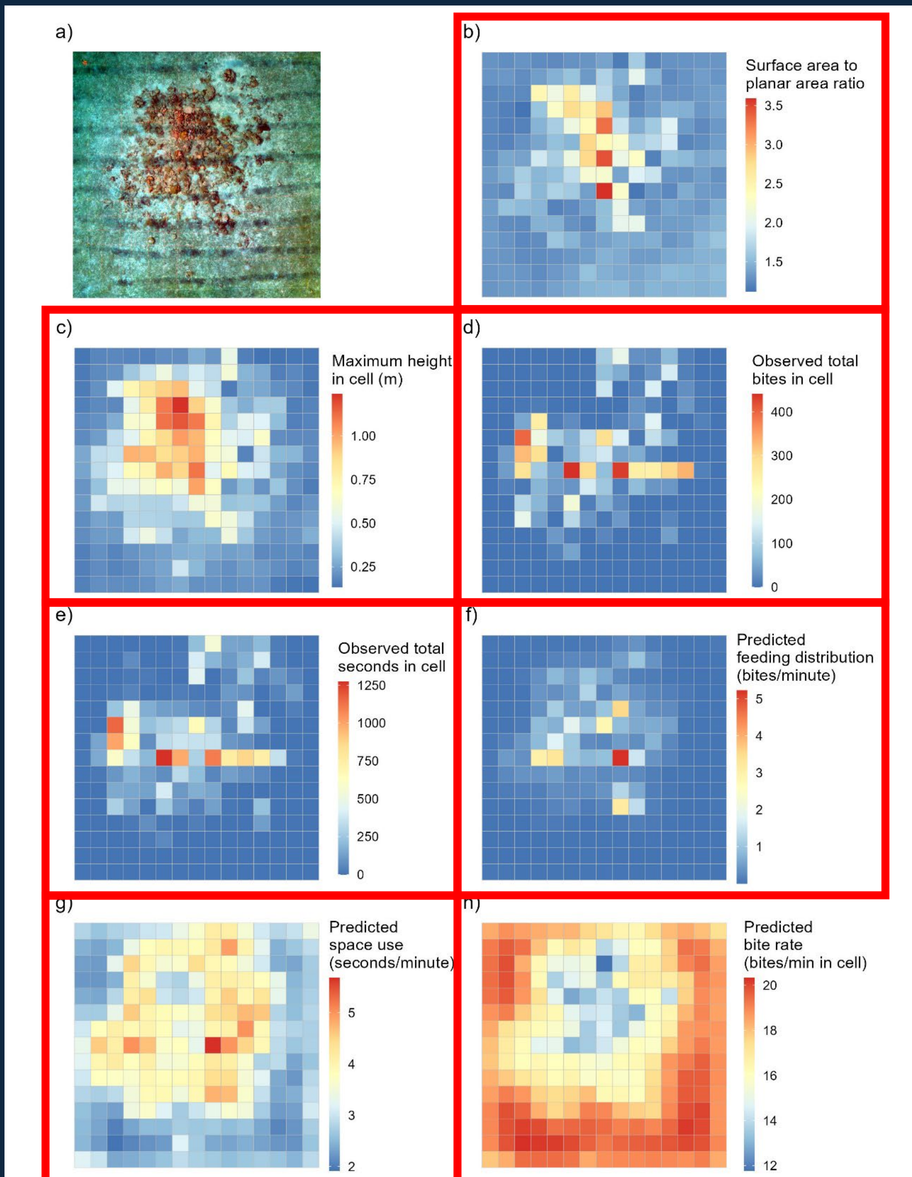
Robert P. Streit[1,2] | Graeme S. Cumming[1] | David R. Bellwood[1,2]

ferent functional groups. Core feeding areas were highly concentrated and consistently covered just 14% of available reef space. Overlap across functional

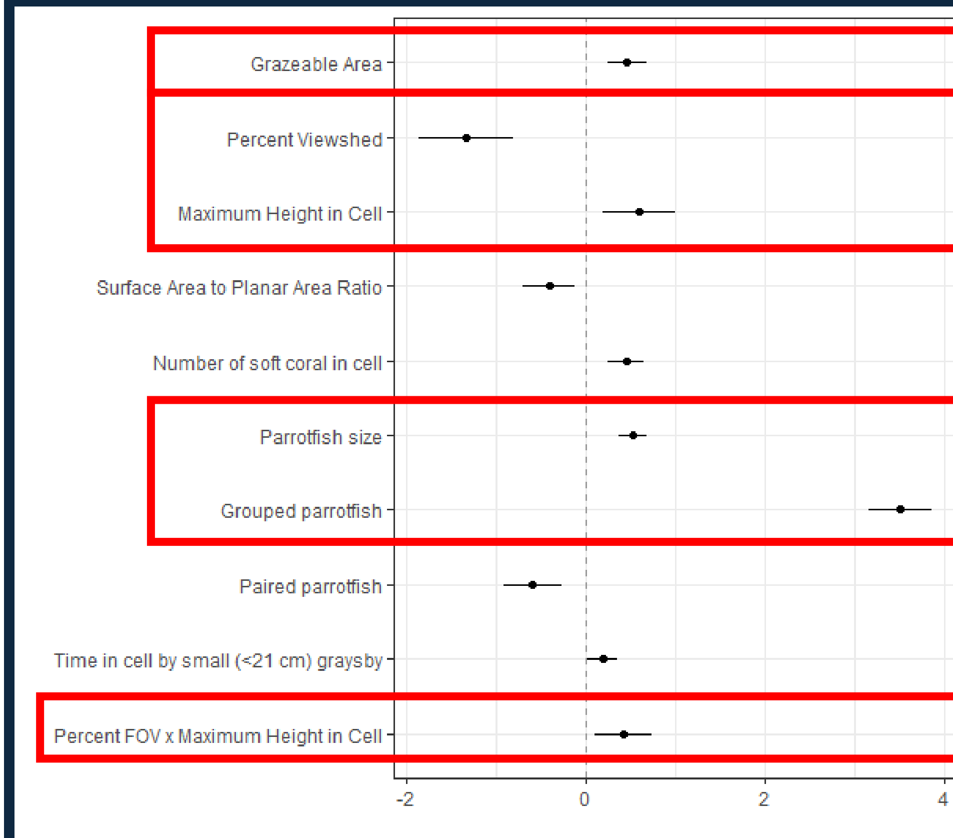


Kochan *et al*. *In prep*.

Feeding is highly heterogeneous



- Model of feeding distribution



- Few hotspots of feeding distribution
- Generally associated with high-relief structures along reef edges

Conclusions

- Complexity is important, but many nuances for abundance and behavior
- May change fish behavior (spatial and temporal)
- Flattening will affects fine-scale patterns of ecological processes such as predation and grazing (and potentially algal patchiness?)
- Three-dimensional modeling provides opportunities to explore different metrics

Acknowledgements

Identifying correlates of coral-reef fish biomass on Florida's Coral Reef to assess potential management actions

Rachel Zuercher[1] | David P. Kochan[1] | Robert D. Brumbaugh[2] | Kathleen Freeman[2] | Rachel Layko[2] | Alastair R. Harborne[1]

Factors influencing the biomass of large-bodied parrotfish species in the absence of fishing on coral reefs in Florida, USA

Rachel Zuercher | David Kochan | Alastair R. Harborne

Winners and losers of reef flattening: an assessment of coral reef fish species and traits

David P. Kochan[1], Matthew D. Mitchell[1,2], Rachel Zuercher[1] and Alastair R. Harborne[1]

Drivers of fine-scale diurnal space use by a coral-reef mesopredatory fish

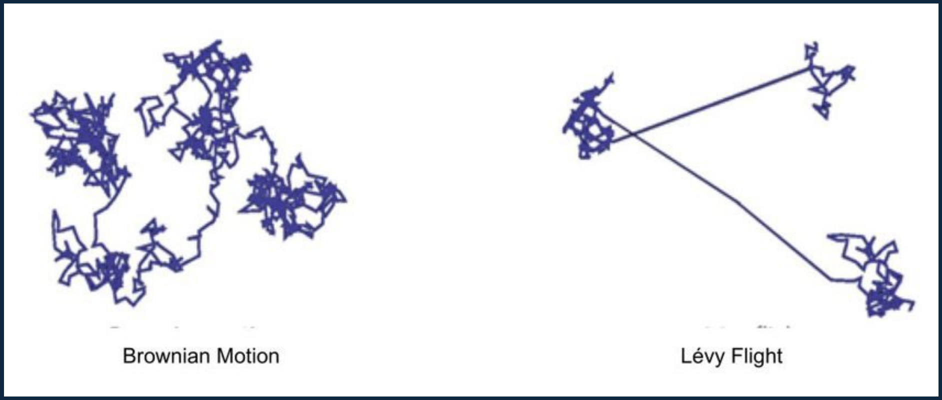
Alastair R. Harborne[1] | David P. Kochan[1] | Melanie M. Esch[1] | Robert Y. Fidler[1] | Matthew D. Mitchell[1,2] | Drew W. Butkowski[1] | Manuel González-Rivero[3]

Sea Grant Florida

The Nature Conservancy

FIU FLORIDA INTERNATIONAL UNIVERSITY

Distribution of waiting times in each cell

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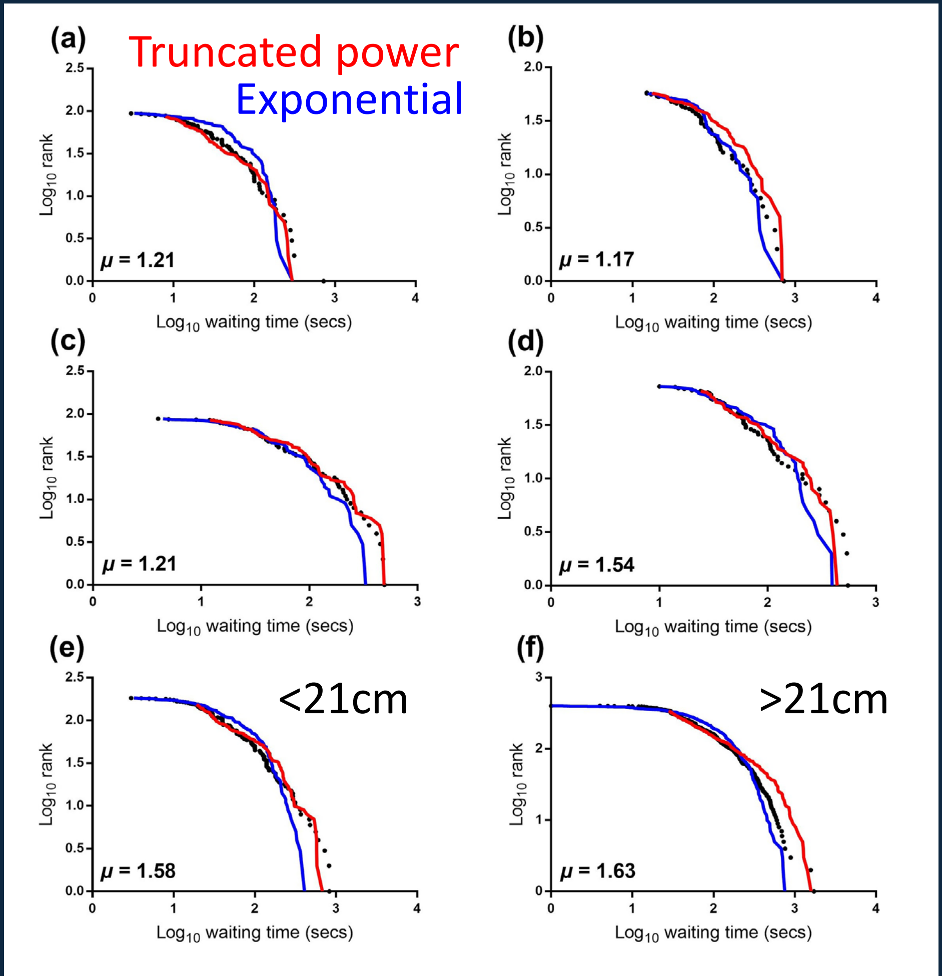
rspb.royalsocietypublishing.org

Scaling laws of ambush predator 'waiting' behaviour are tuned to a common ecology

Victoria J. Wearmouth[1], Matthew J. McHugh[1], Nicolas E. Humphries[1], Aurore Naegelen[1,2], Mohammed Z. Ahmed[3], Emily J. Southall[1], Andrew M. Reynolds[4] and David W. Sims[1,5,6]

- Time distributed roughly equally (exponential) or 'bursty' (truncated power)?
- Bursty pattern typical of reef ambush predators (like grouper)?



- Extend this move-wait behaviour, which may optimize foraging success, to a reef fish