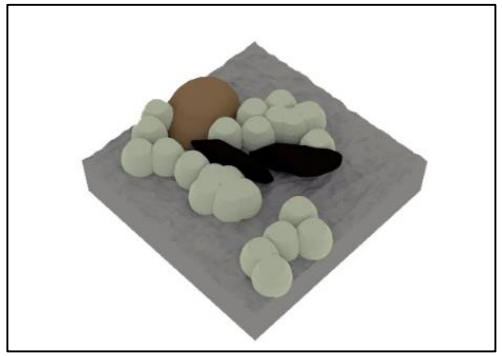
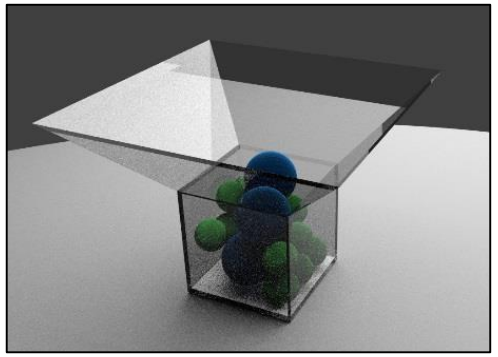
Sequential invasions on rocky shores:

Implications for structural complexity, community structure and ecosystem functioning






Saachi Sadchatheeswaran

Supervisors:

Coleen Moloney, George Branch, Tammy Robinson, Lynne Shannon

Nina Dreyer & Jim Hensley
Summer Food by Paul Lowe

Sequential Alien Invasion

Mytilus galloprovincialis

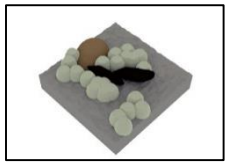
Balanus glandula

Semimytilus algosus

Marcus Island, Saldanha Bay

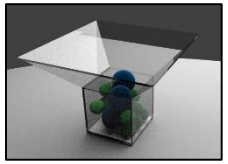
Project Aims

Chapter 1 – Introduction, Literature Review



Chapter 2 - How did past sequential invasions affect complexity and, in turn, biodiversity?

Chapter 3 - What's happening to Marcus Island now?



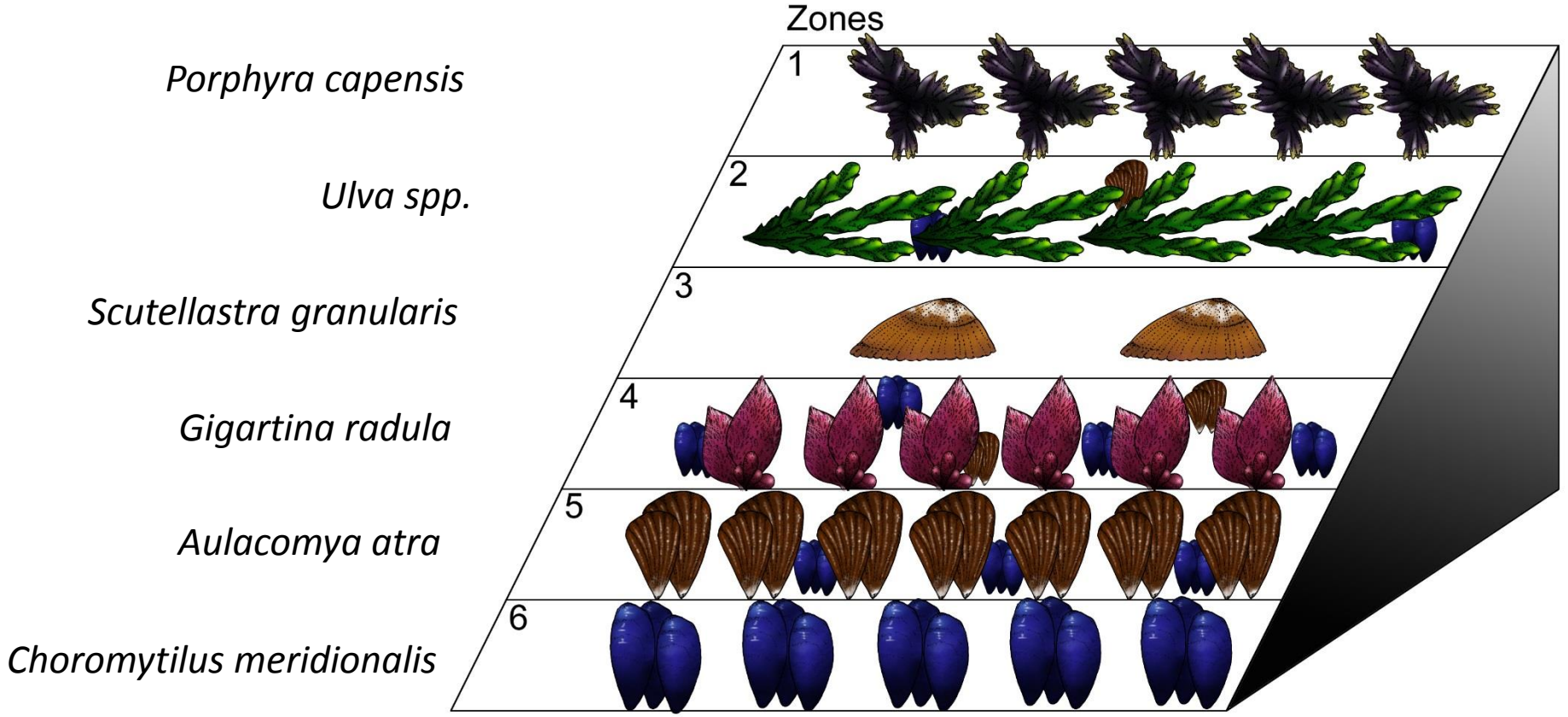
Chapter 4 - What's the best way to measure complexity?

Chapter 5 - Is it possible to model the future of Marcus Island?

Chapter 6 – Conclusion and Appendices

Chapter 2

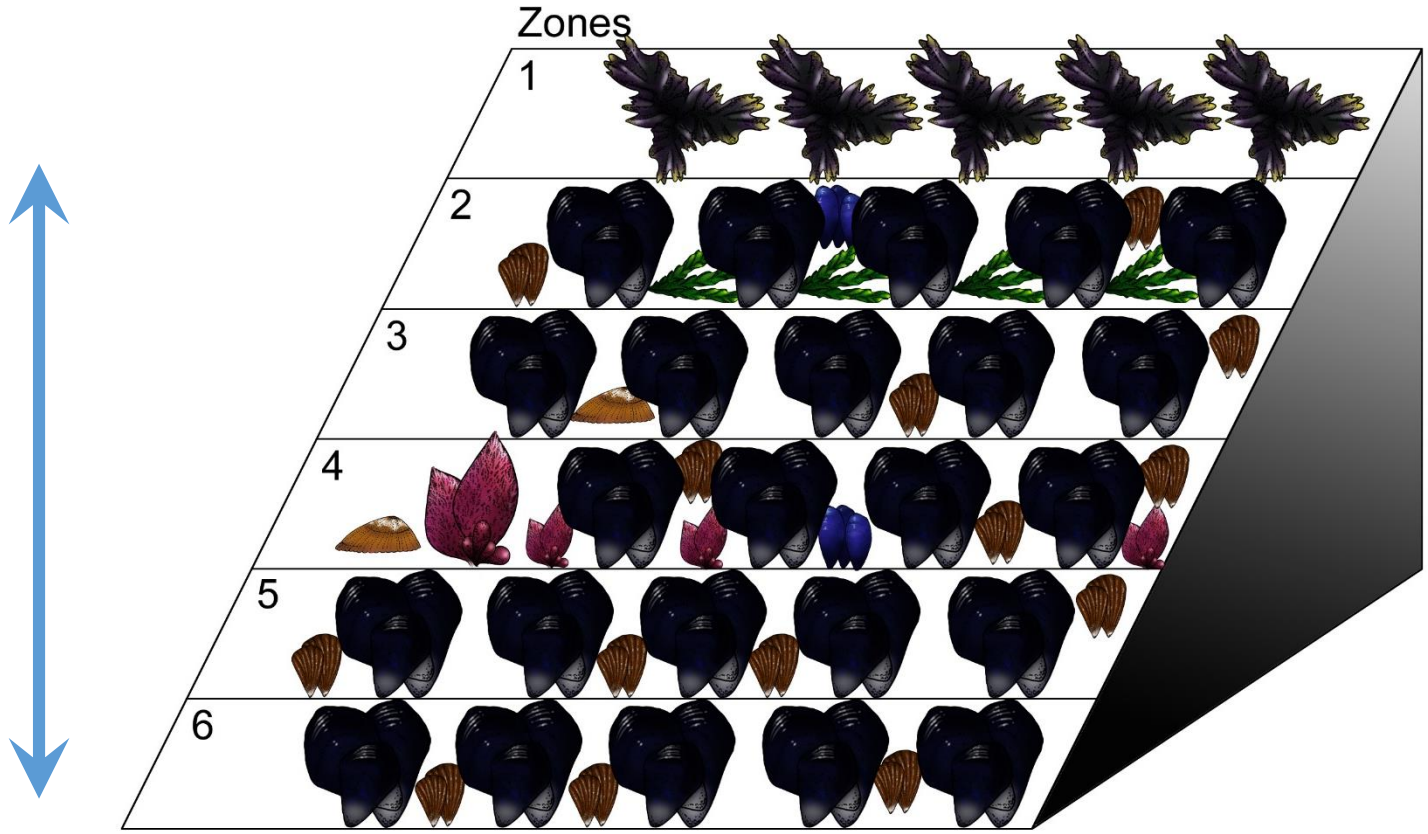
How did past sequential invasions affect complexity and, in turn, biodiversity?



1980

Chapter 2

Mytilus galloprovincialis domination

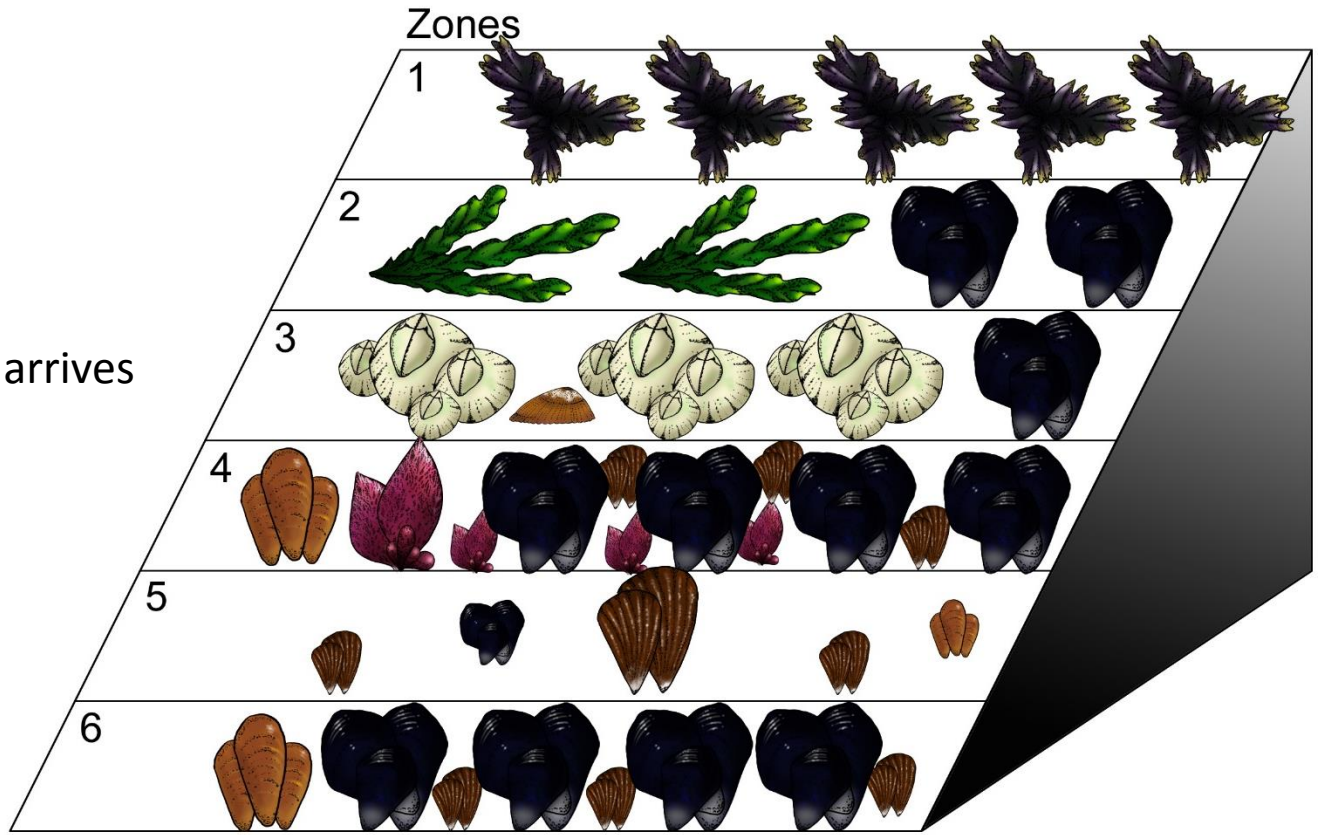


2001

Chapter 2

Mytilus diminishes, *Balanus* arrives

Semimytilus algosus arrival

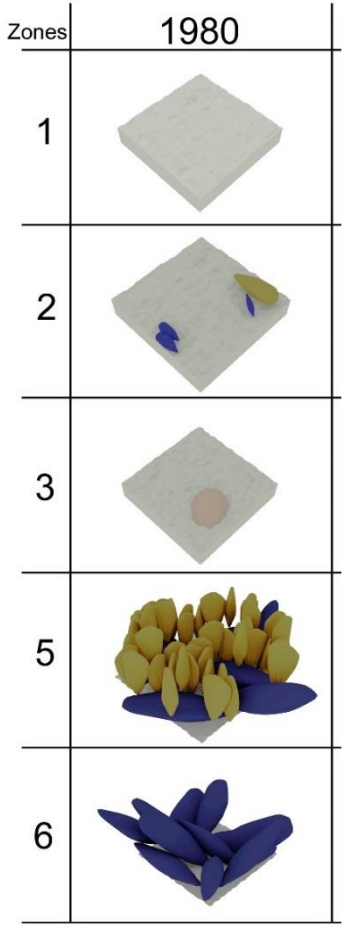


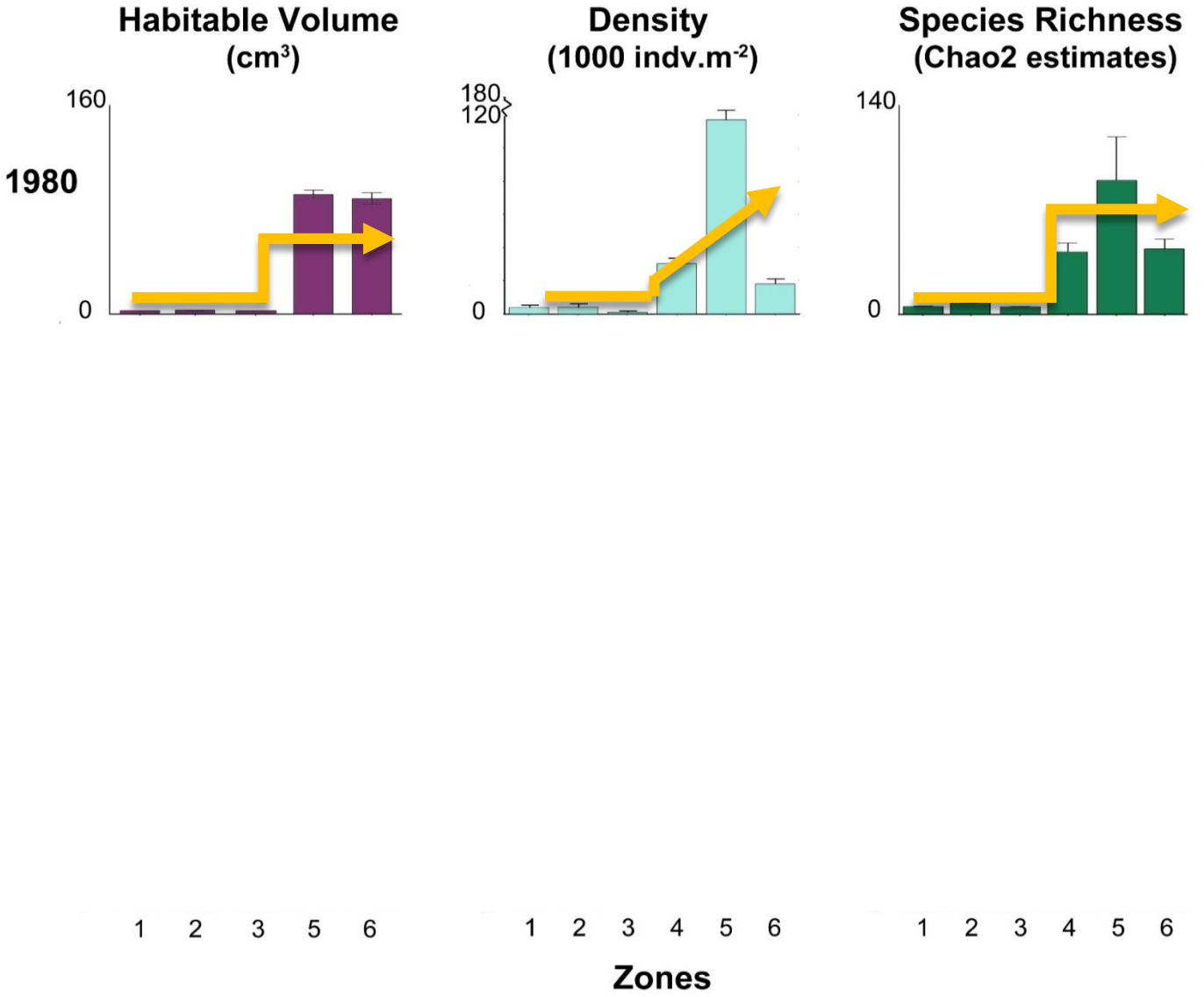
2012

Chapter 2

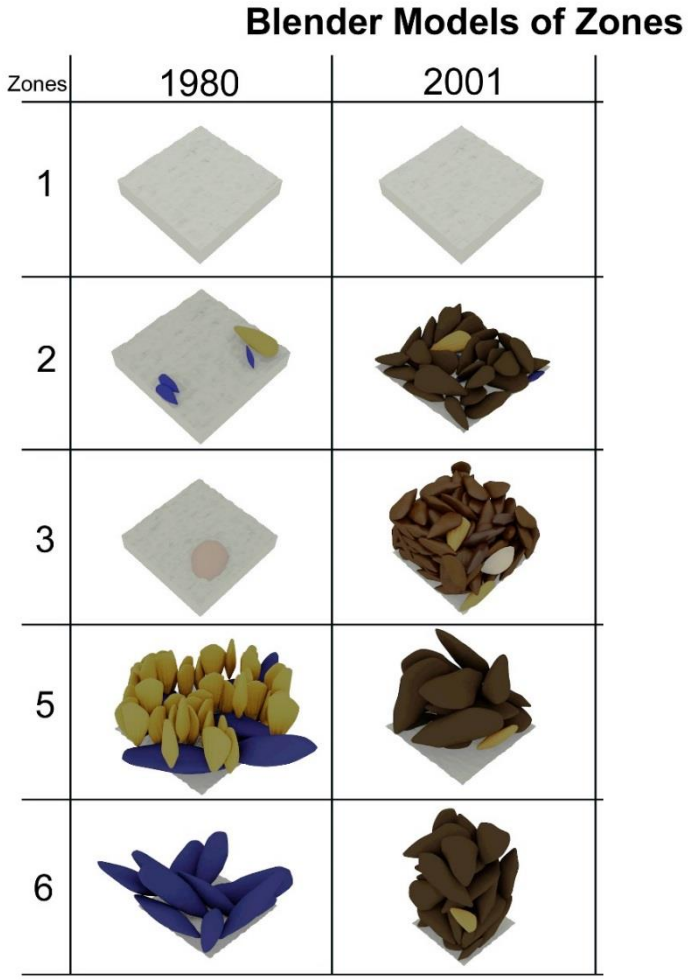
Complexity vs. Density and Species Richness

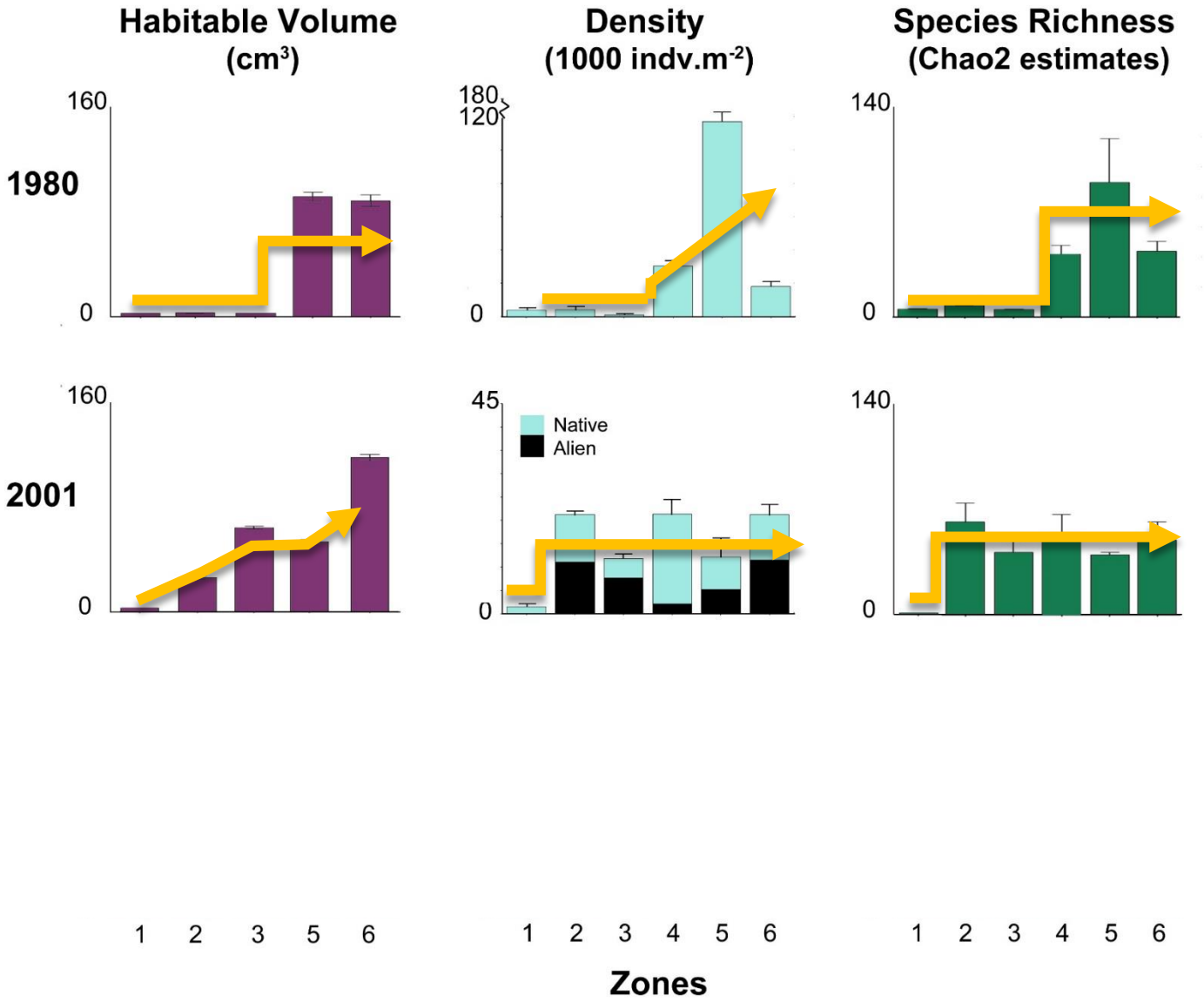
Blender Models of Zones



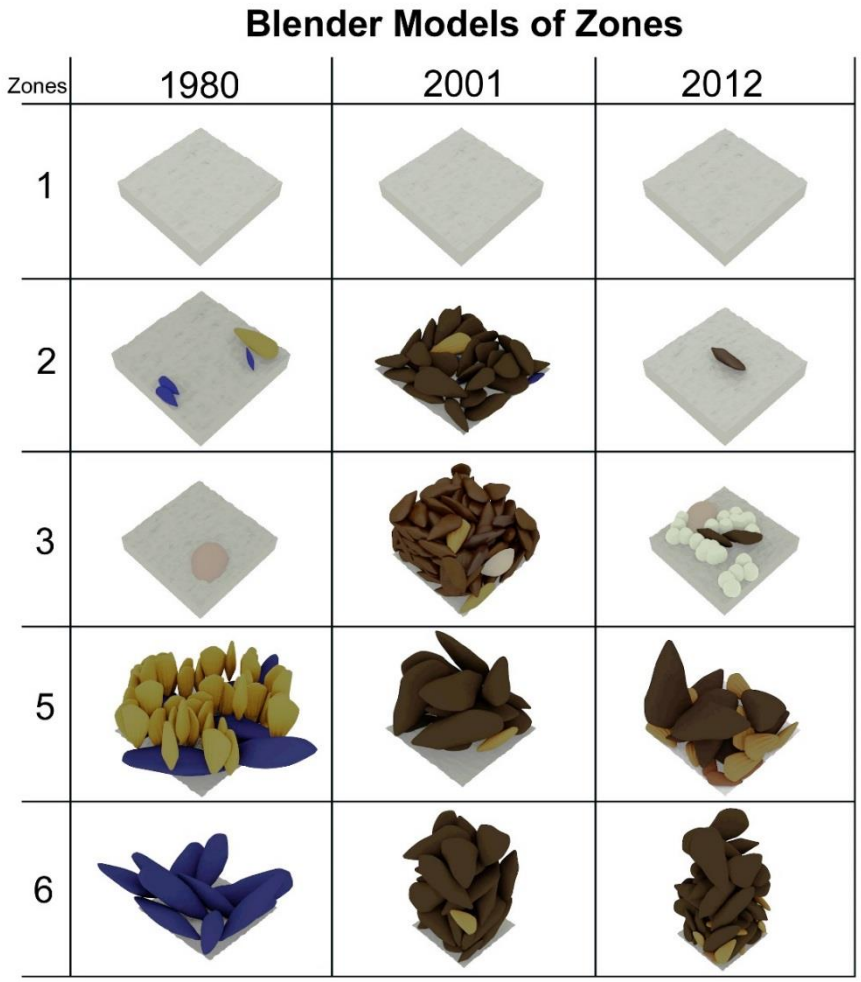


Chapter 2


Blender Models of Zones
Zones
1980
2001
1
2
3
5
6


Habitable Volume
(cm³)
Density
(1000 indv.m⁻²)
Species Richness
(Chao2 estimates)
1980
2001
160
180
120
140
0
45
Native
Alien
1 2 3 5 6
1 2 3 4 5 6
1 2 3 4 5 6
Zones

Chapter 2


Blender Models of Zones
Zones
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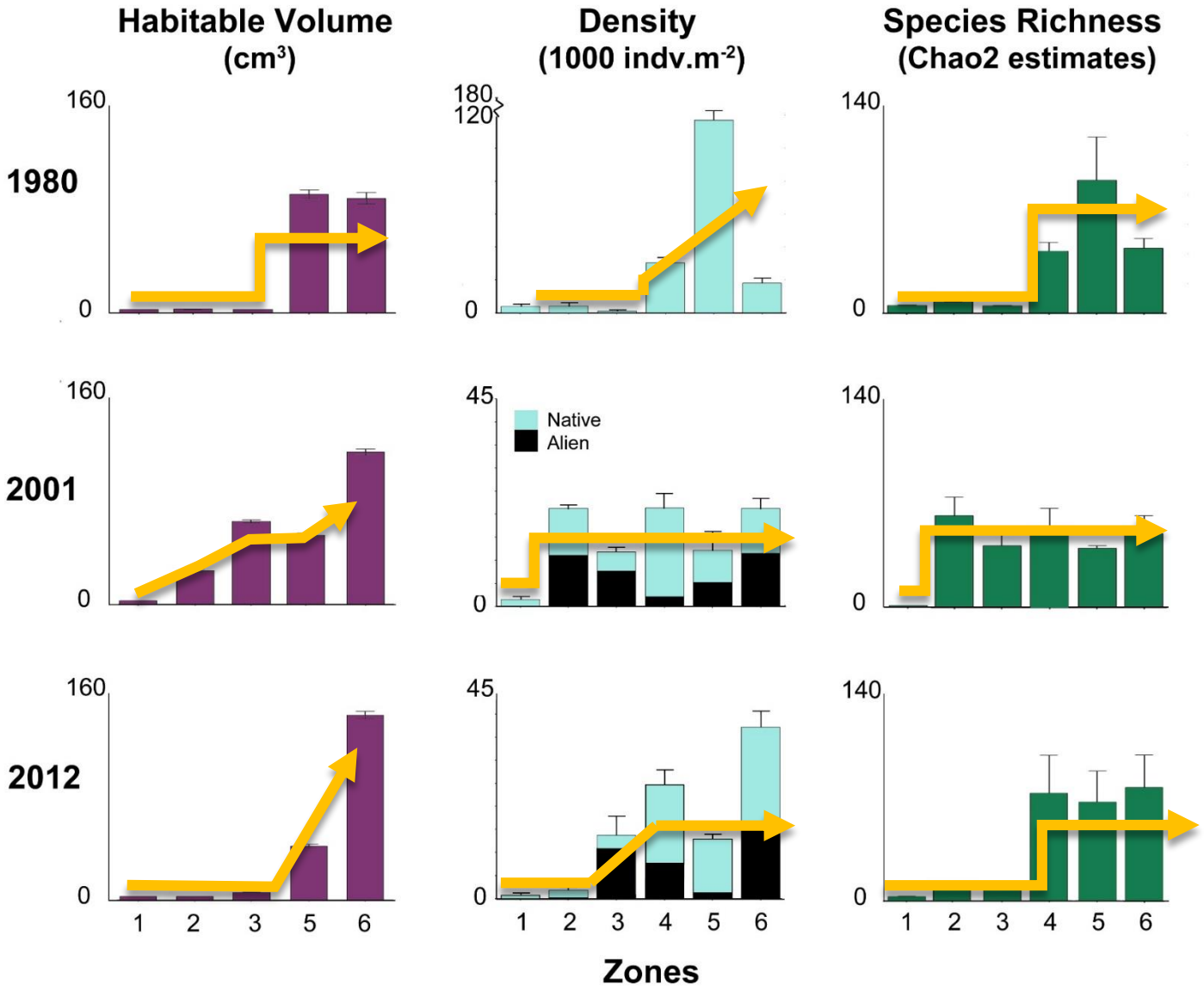
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1980
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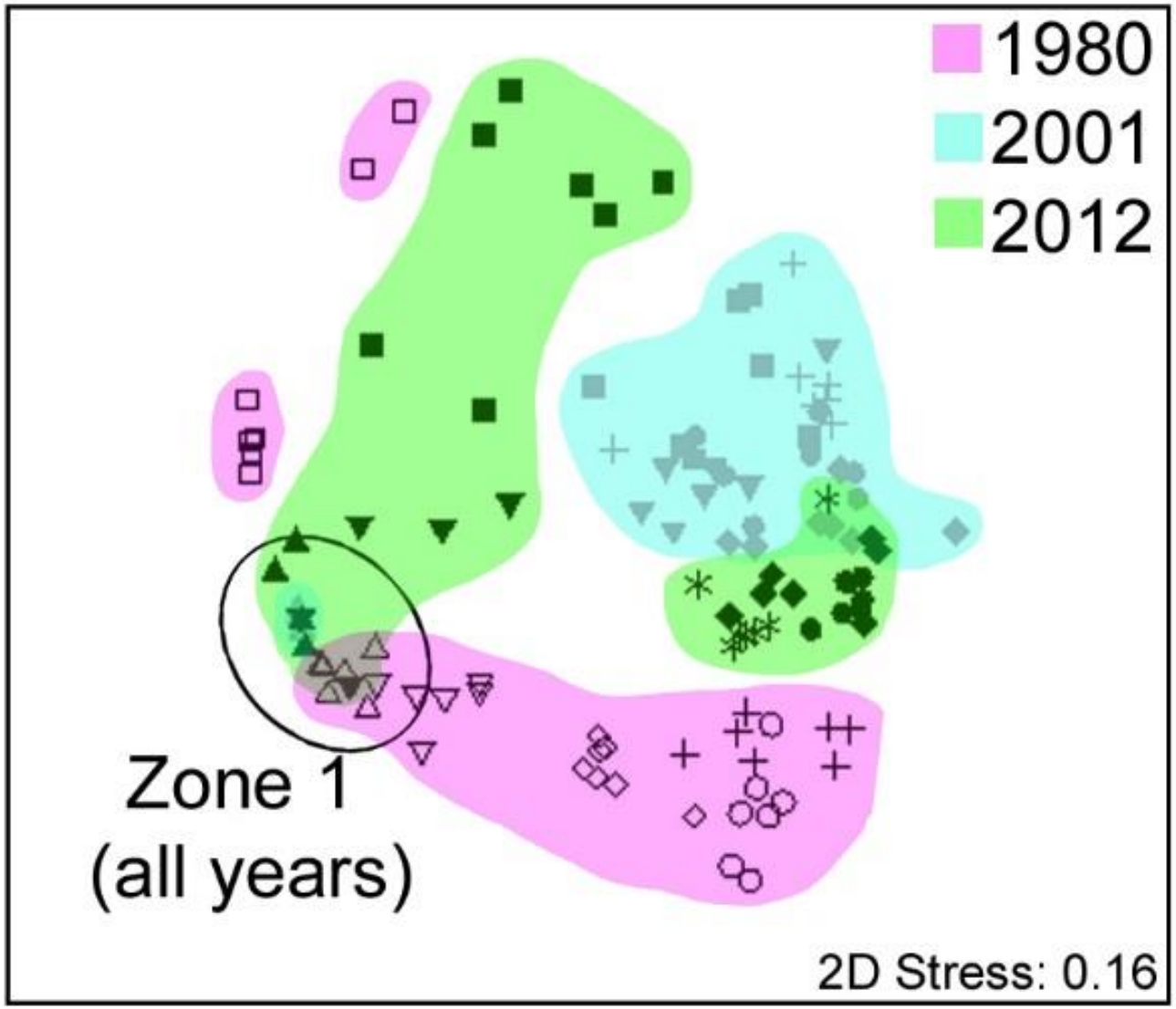
2012
160
180
120
140
0
45
Native
Alien
1 2 3 5 6
1 2 3 4 5 6
Zones

Chapter 2

Community Composition

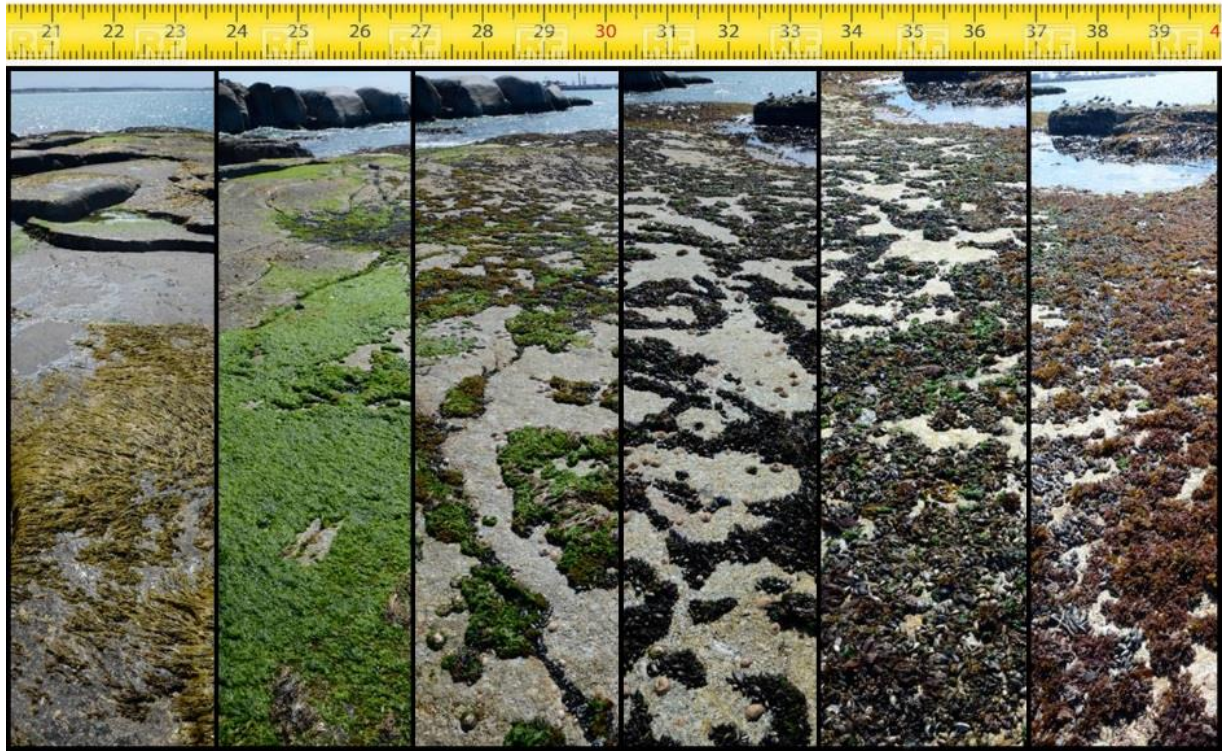


Chapter 3

What's happening to Marcus Island now?

Objectives

- Quarterly monitoring of Marcus Island to explore seasonality

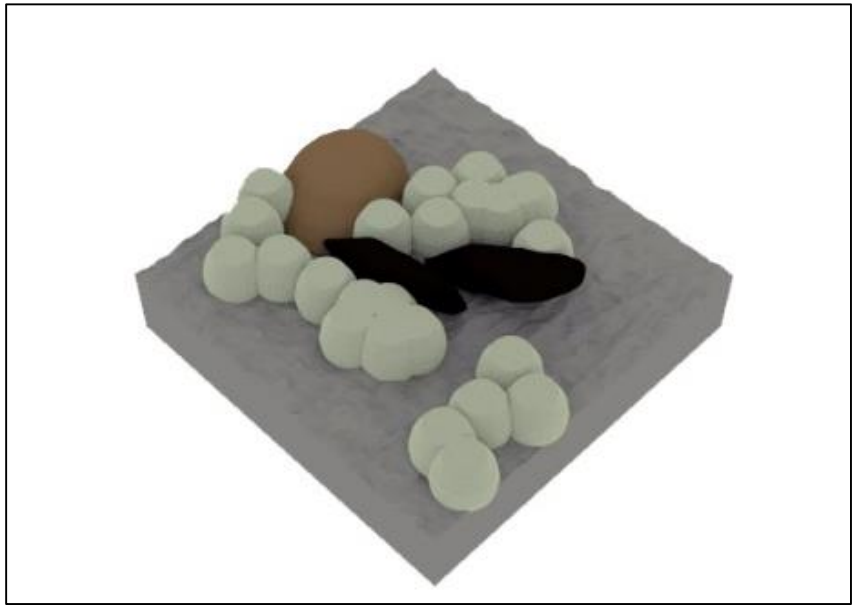


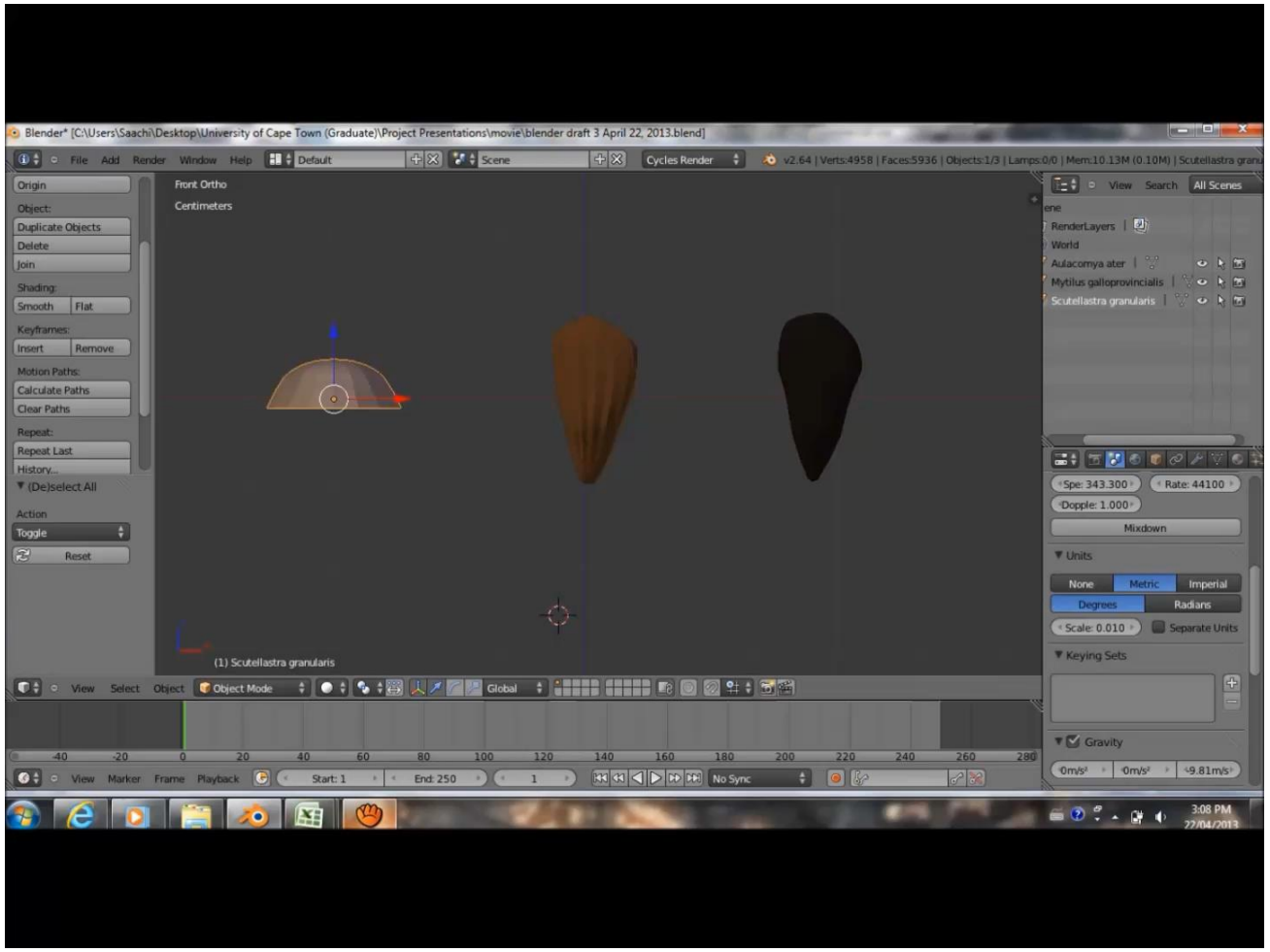
Chapter 4

What's the best way to measure complexity?

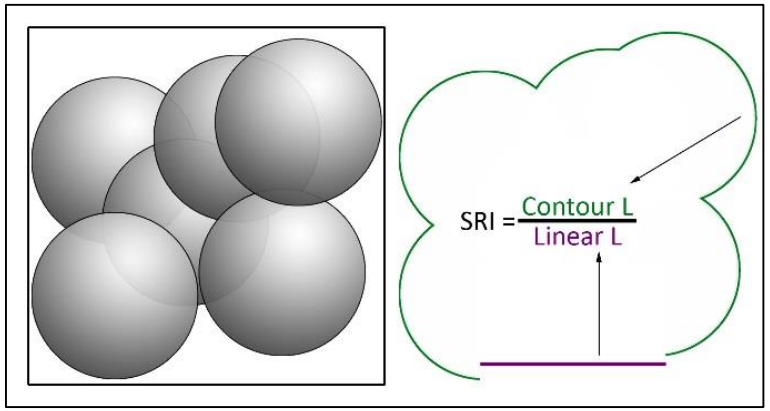
Objectives

- Compare methods to each other and control calculations

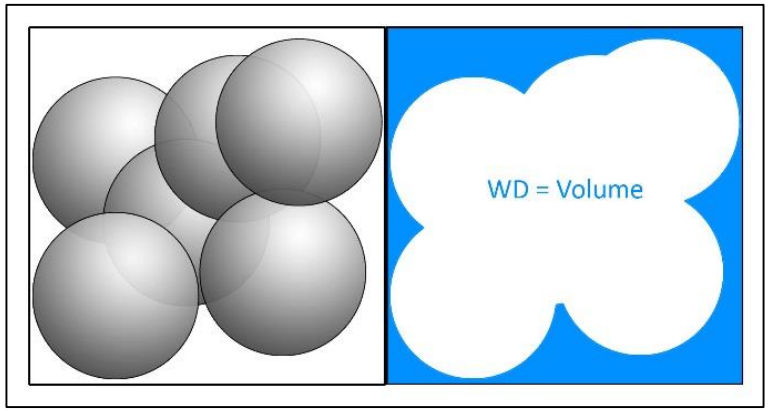




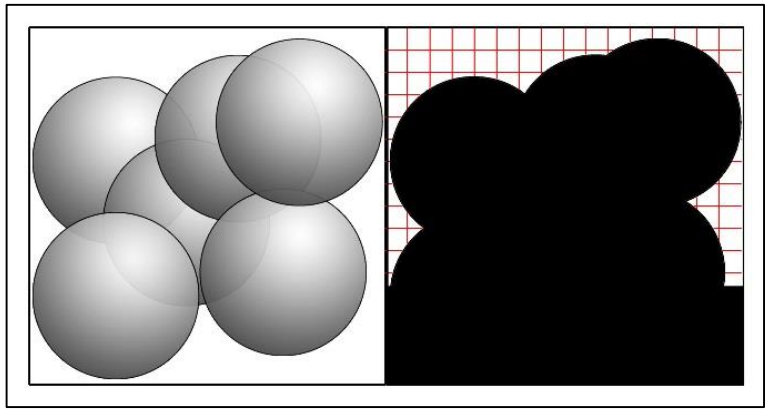
Chapter 4 – Methods to Test



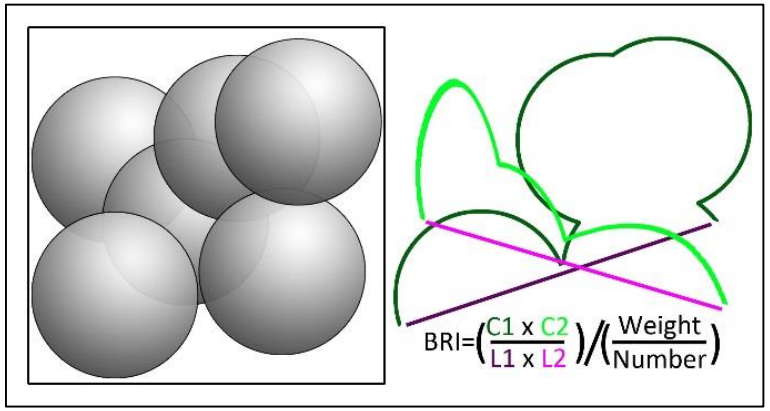
substrate rugosity index
(Risk 1972)



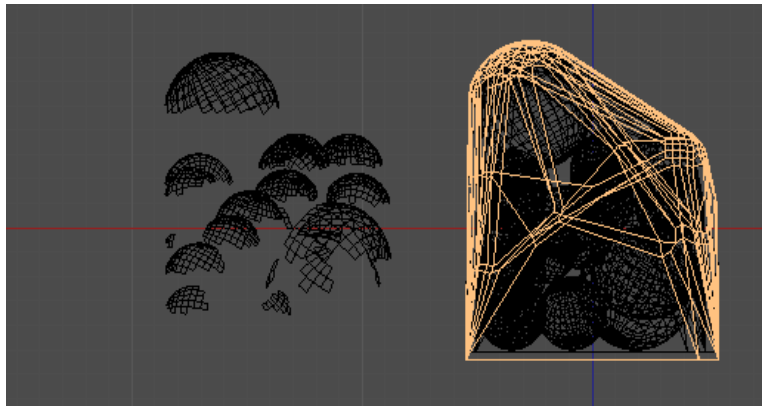
water displacement
(Tsuchiya and Nishihira 1985)



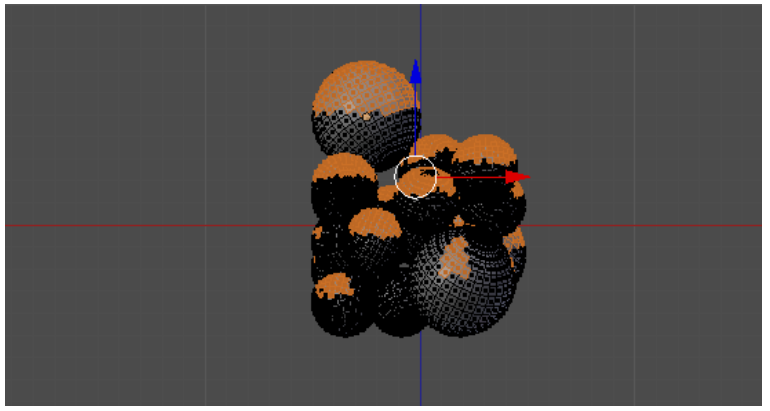
fractal analysis
(Commito and Rusignuolo 2000)



bidimensional rugosity index
(Gestoso et al. 2013)



Blender volumetrics
(Sadchatheewaran et al. in press)



Blender surface area
(Sadchatheewaran et al. unpublished)

Chapter 5

Is it possible to model the future of Marcus Island?

Objectives

- Explore relationships between native limpet and aliens
- Future trajectories of the limpet
- Determine *Ecopath with Ecosim* capabilities

Ecopath

- Model input/output
- Trophic functioning

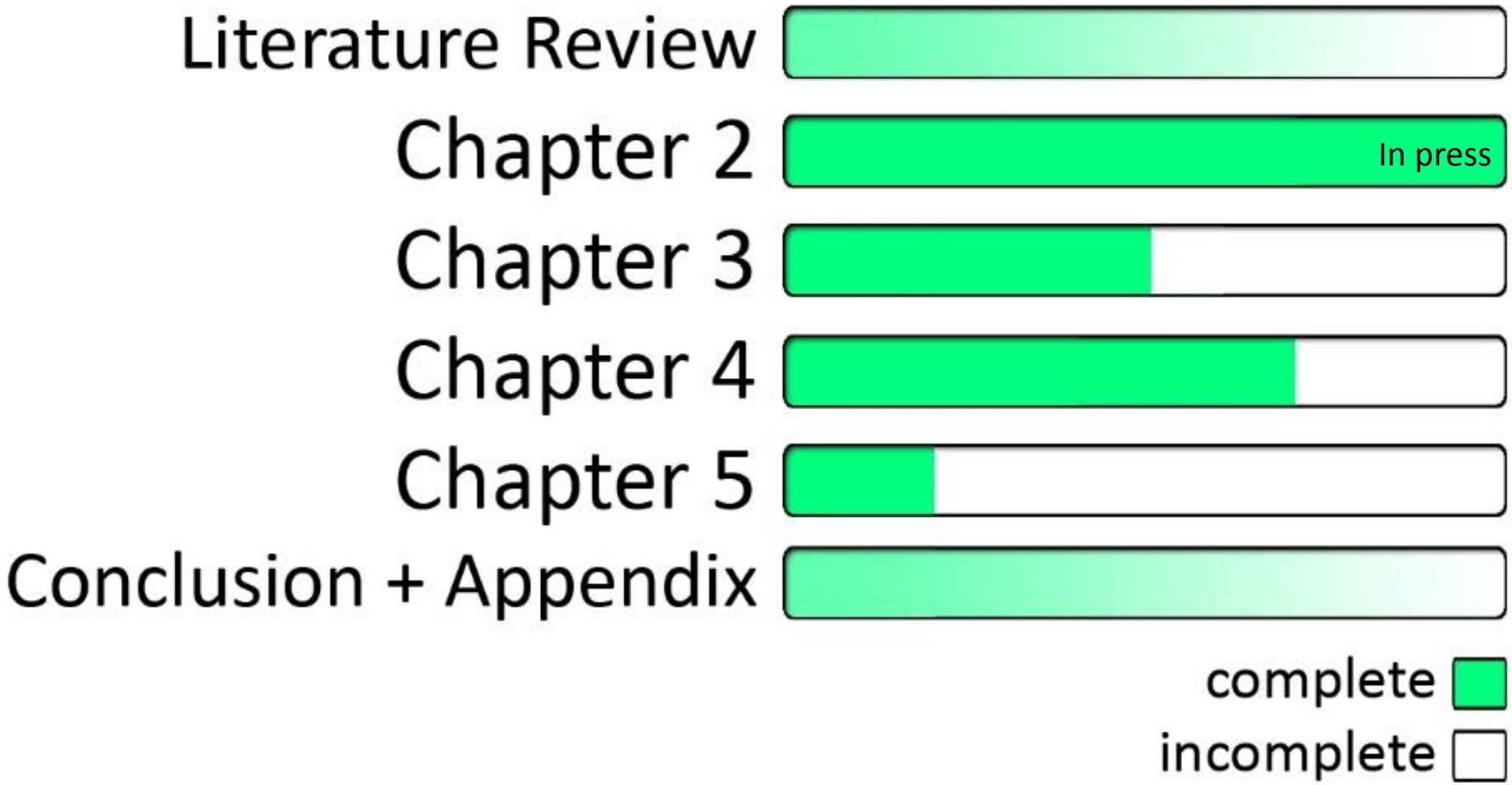
Ecosim

- Time dynamic
- Mediation function

Ecospace

- Space dynamic
- Explore functional process

Thesis Progress



Acknowledgements

Special thanks to:

- My supervisors: Coleen Moloney, Tammy Robinson, Lynne Shannon, George Branch
- Many field assistants, etc.: Brendan Havenga, Haley Pope, Ben Brooker, Cher Swart, Mhairi Alexander, Hannah Raven, Robyn Adams, Zanne Zeeman, Charine Collins, Grea Groeneweld, Koebraa Peters, Stewart Norman, Martin Emmanuel
- SANParks for access to Marcus Island.

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- The Centre for Invasion Biology – a joint venture of NRF and DST
- MA-RE BASICS project (UCT Vice Chancellor's Strategic Initiative).
- UCT Faculty of Science PhD Fellowship
- UCT International and Refugee Scholarship Bursary
- Andrew Mellon Foundation

Thank you!

Alien species
on Marcus Island's rocky shores

Mytilus galloprovincialis

invaded the shores of Marcus Island around 1979.

Balanus glandula

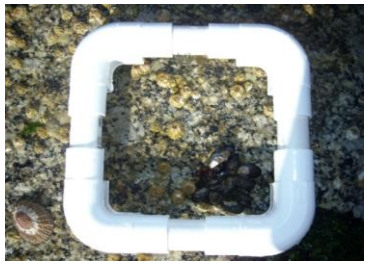
was first recorded in Saldanha Bay in 2007; the most abundant intertidal barnacle at time.

Semimytilus algosus

invasion recognised in South Africa in 2009; recorded in Saldanha Bay in 2012.

Chapter 2
Methods

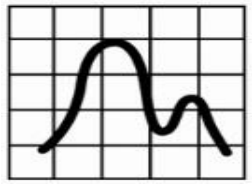
Study site: Marcus Island, Saldanha Bay



Seven 10x10 cm^2 samples were collected from visible six zones

Sorted and quantified all marine invertebrates over 5mm

Novel and unique measurement of habitat complexity was made with Blender 2.64



Univariate statistics performed in Statistica (Ver. 10, 11); α set to 0.05

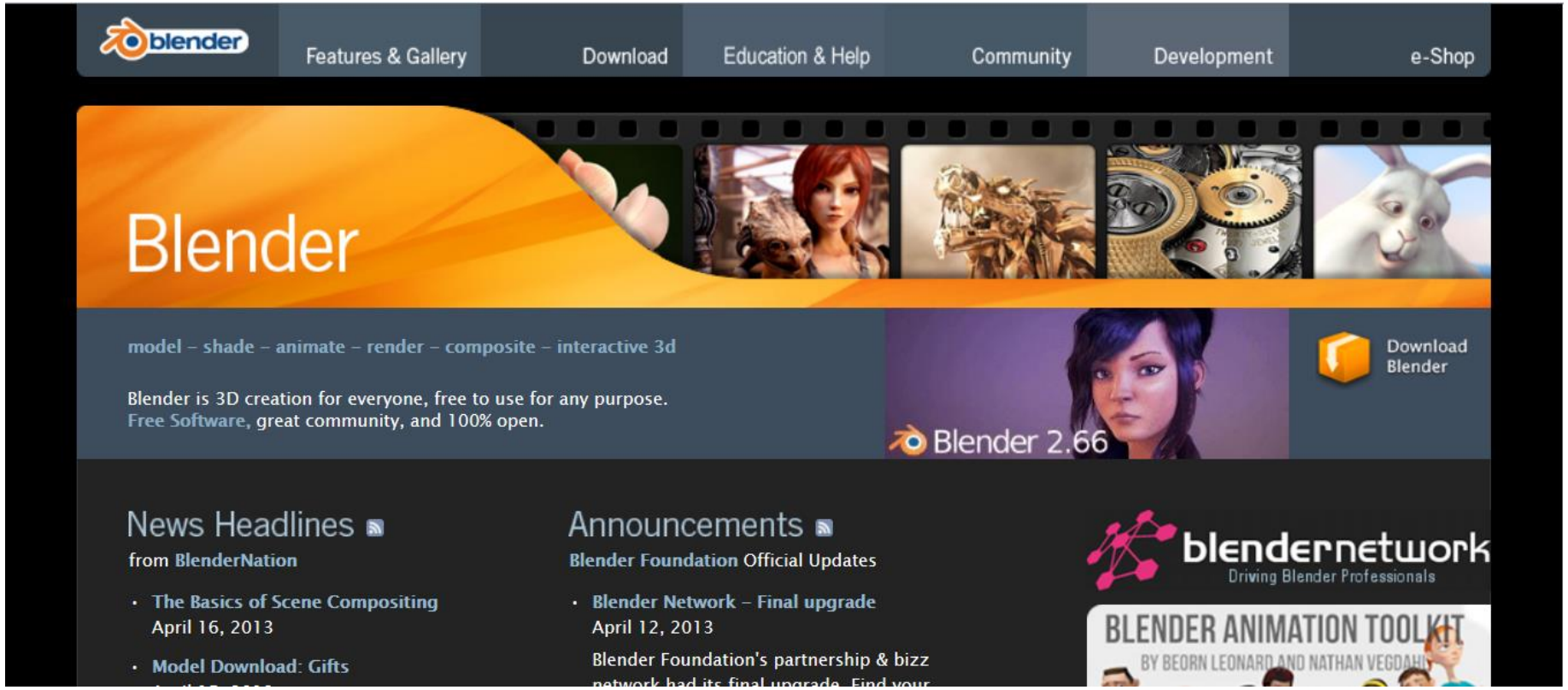
Multivariate statistics performed in PRIMER + PERMANOVA

Ecological Engineers

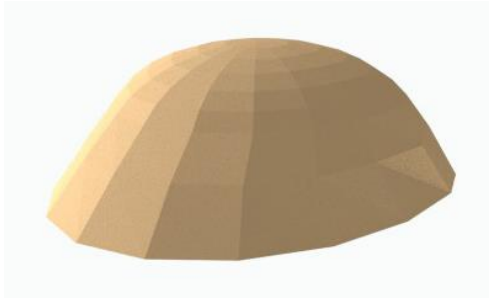
Allogenic

Autogenic

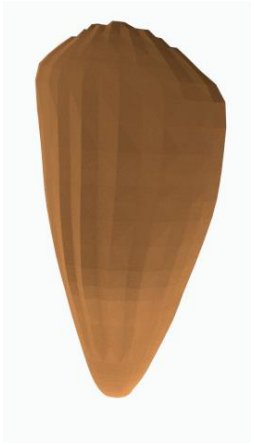
Habitat Complexity



Habitat Complexity - Models



Scutellastra granularis



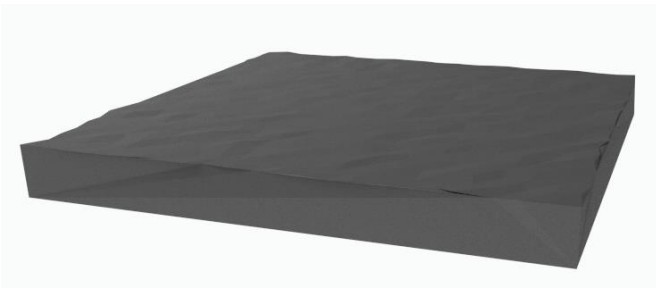
Aulacomya ater

Choromytilus meridionalis

Mytilus galloprovincialis

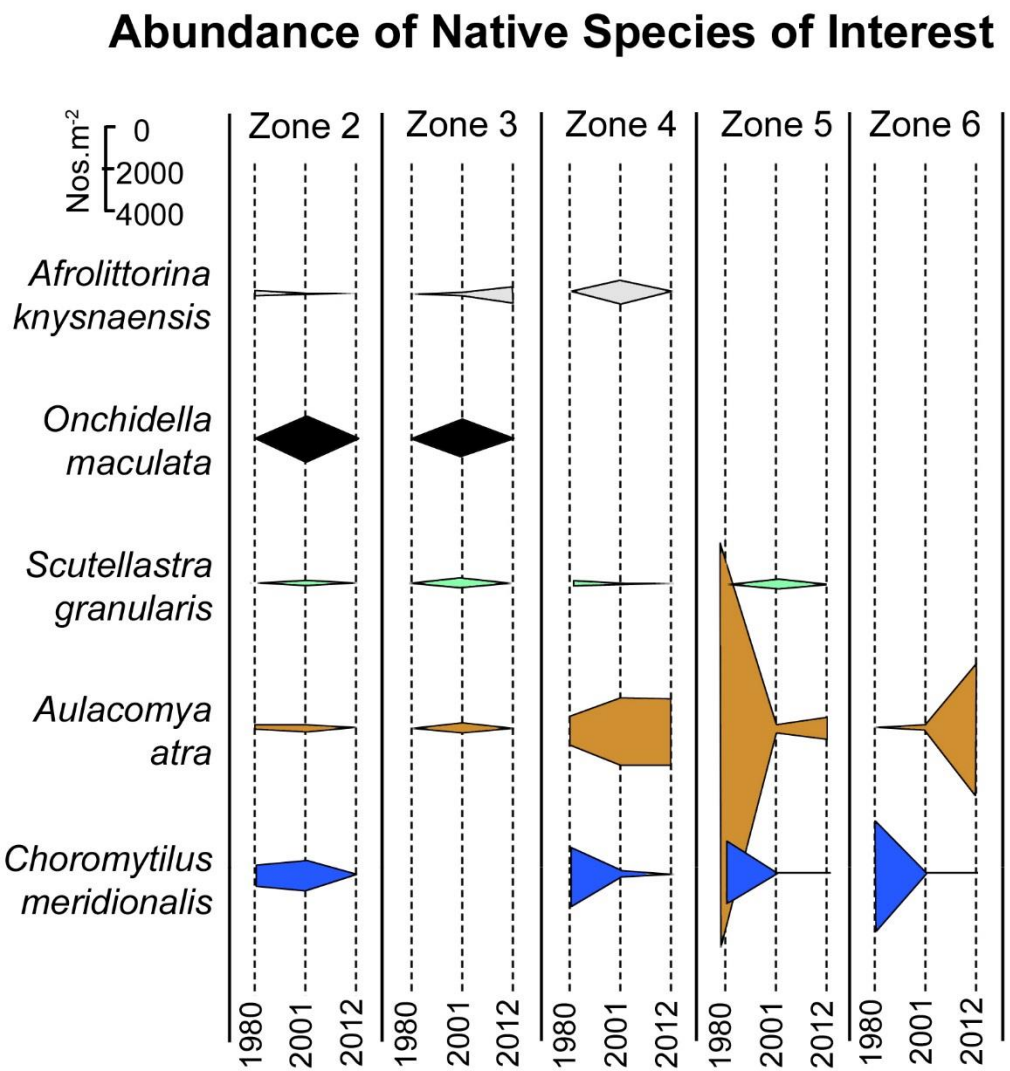
Balanus glandula

Semimytilus algosus

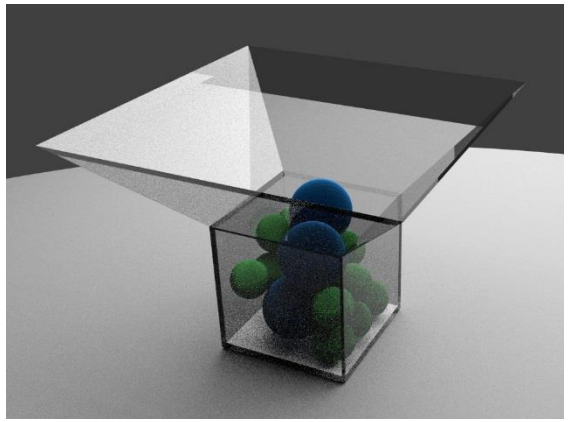


bare rock

Chapter 2
Results

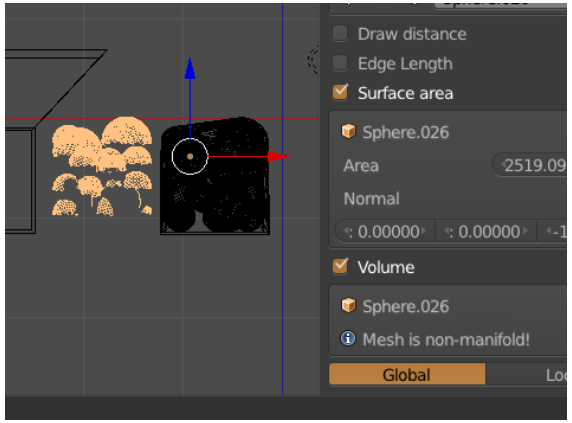


Chapter 4
Methods



Setup Experiment

- 10 cm^3 box
- 15 runs each
  - 6 large spheres (diameter = 5 cm)
  - 25 small spheres (diameter = 3 cm)
  - 3 large, 15 small



Measure Complexity

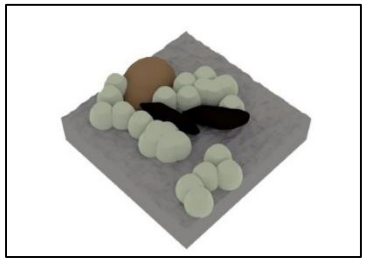
Run 8 methods on regular sphere matrices

- Control method (1)
- Known methods (4)
- Novel methods (2)

Statistical analysis performed in R

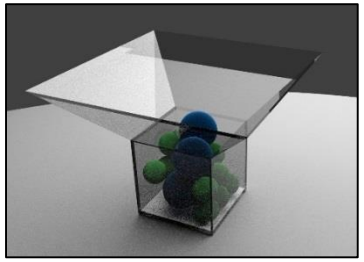
- Compare methods
- Run and compare best methods in field

Telling a Story



Snapshots of the past

Careful eye on the present



Examine method and reason

Explore possible futures