



Biophysical interactions, economies, ontologies and decision support models: Examples from temperate and tropical reefs



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Characteristics of reef ecosystems

- High ecological value
 - high biodiversity
 - high production
- High economic value
 - high fisheries yield (seaweeds, invertebrates, teleosts)
 - high bio-prospecting (bioactives, nutriceuticals etc.)
 - tourism
 - ecosystem services, e.g. coastal protection, nutrient uptake



Characteristics of reef ecosystems

- Relatively few key interactions driving ecosystem dynamics
- Nature of these interactions are similar across different systems
- Accessible by diving
 - ∴ amenable to experiments
 - ∴ solid basis for modelling

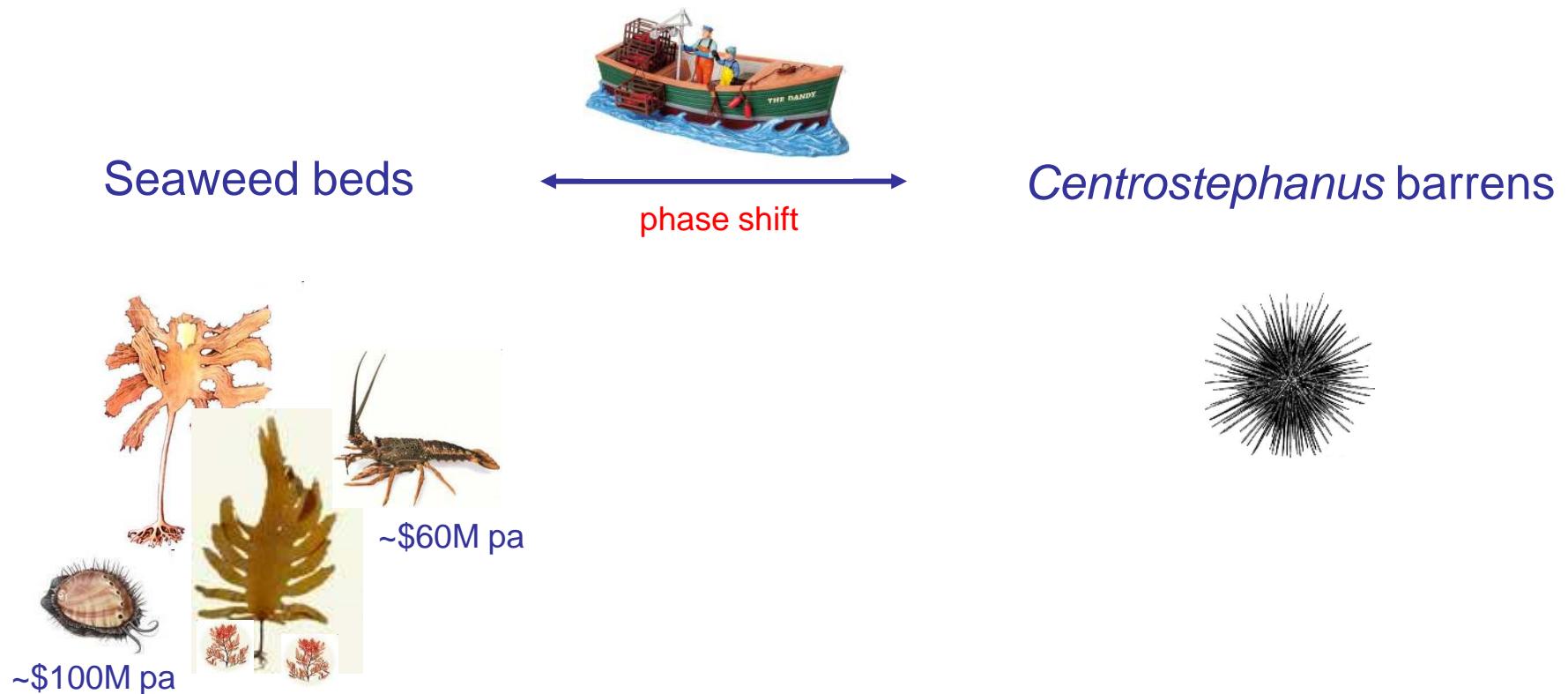
A Bold Claim (!): possible to develop generic models for temperate and tropical reefs that are both ‘portable’ and useful



Dynamics of reefs in eastern Tasmania

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- Johnson, C., Ling, S., Ross, J., Shepherd, S., Miller, K. (2005). FRDC Final Report, 2001/044, 79 pp.
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Dynamics of reefs in eastern Tasmania: Open coast

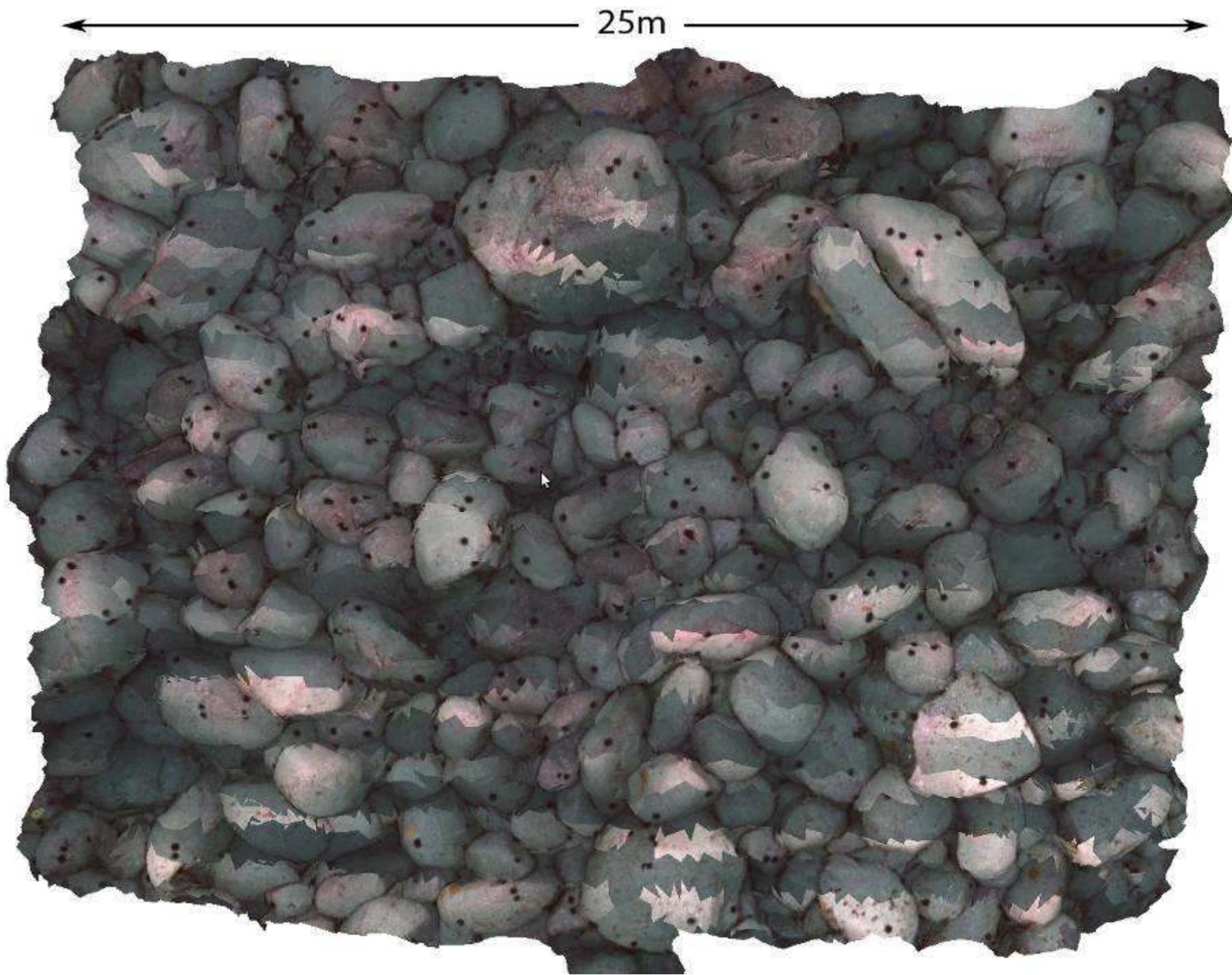


Why is this an issue?

- loss of biodiversity (seaweeds / invertebrates)
- loss of production
- local collapse of key fisheries
 - abalone (~\$100 M pa)
 - rock lobster (~\$60 M pa)
- difficult to reverse – what are the management options?



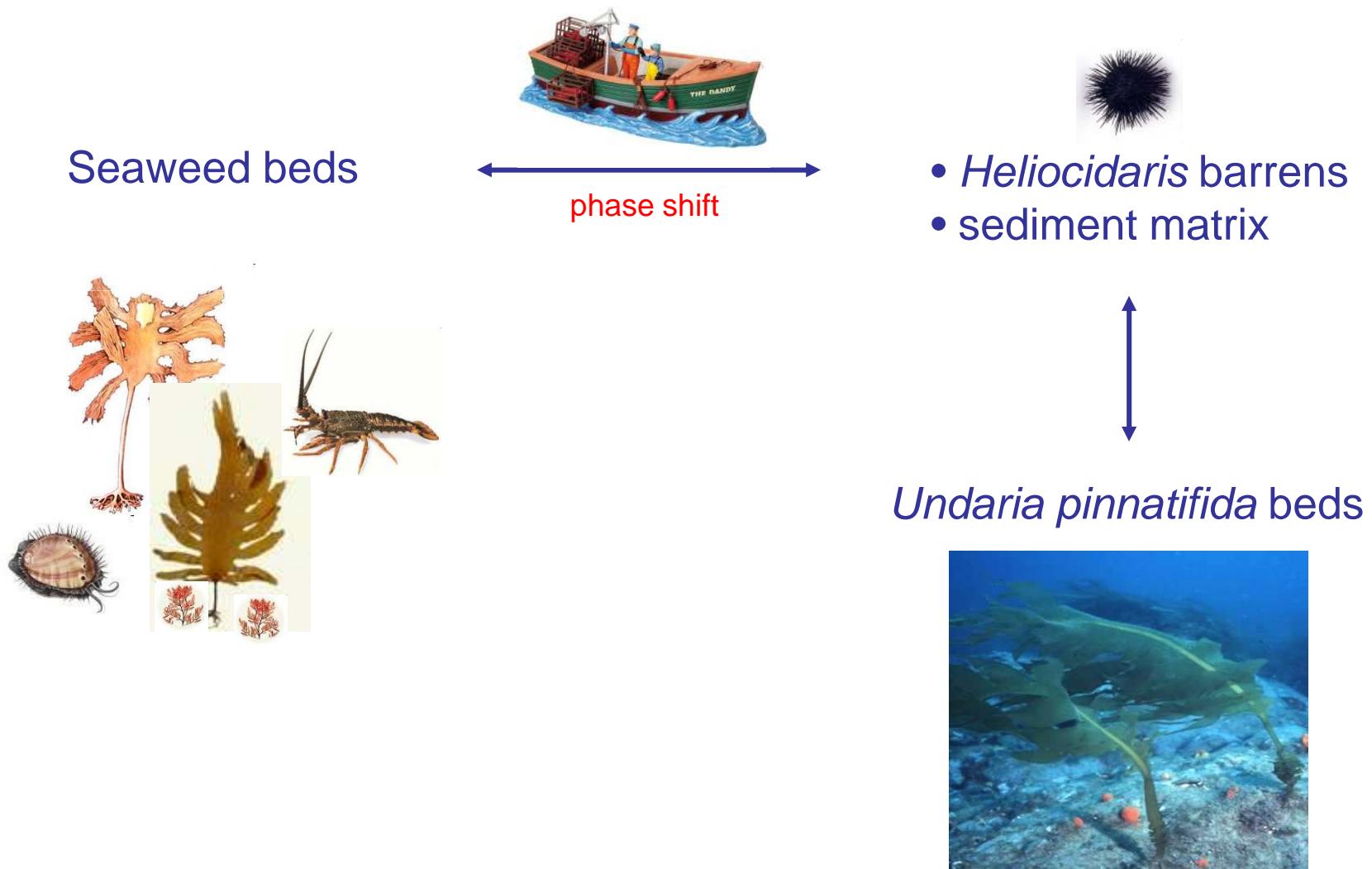
Johnson CR et al. 2005. FRDC Report; Ling S. 2008. *Oecologia* 156: 883-894



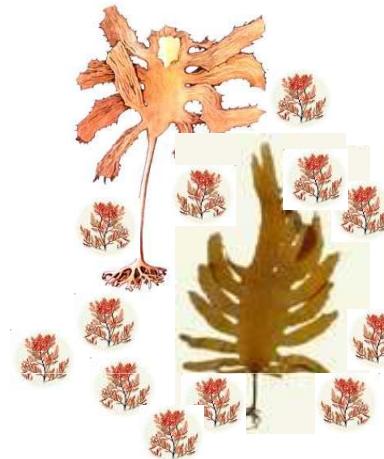
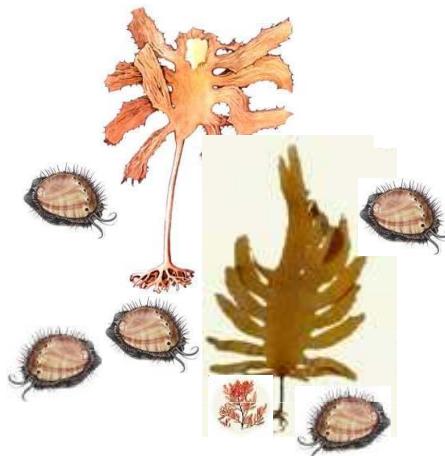
~900 large lobsters
translocated to closed area



Dynamics of reefs in eastern Tasmania: Sheltered coast



Dynamics of reefs in eastern Tasmania: Understorey (basal layer)



Seaweed beds with
encrusting algae
= 'pink bottom'

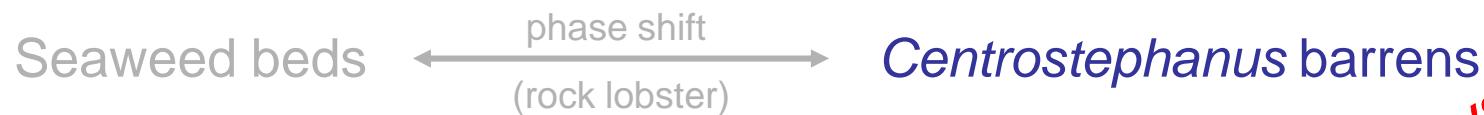
Seaweed beds with:

- sessile invertebrates
- foliose / filamentous algae
- sediment matrix

= 'brown bottom'

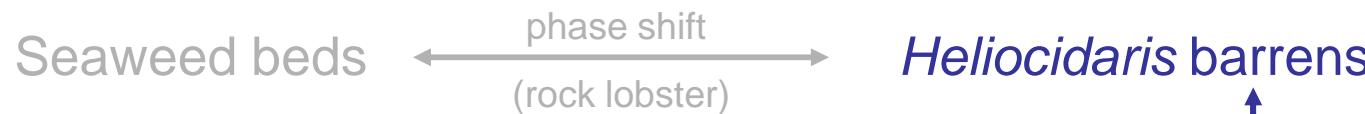
Dynamics of reefs in eastern Tasmania

(i) Open coast:



= hysteresis!

(ii) Sheltered bays:



Undaria pinnatifida beds

= hysteresis!

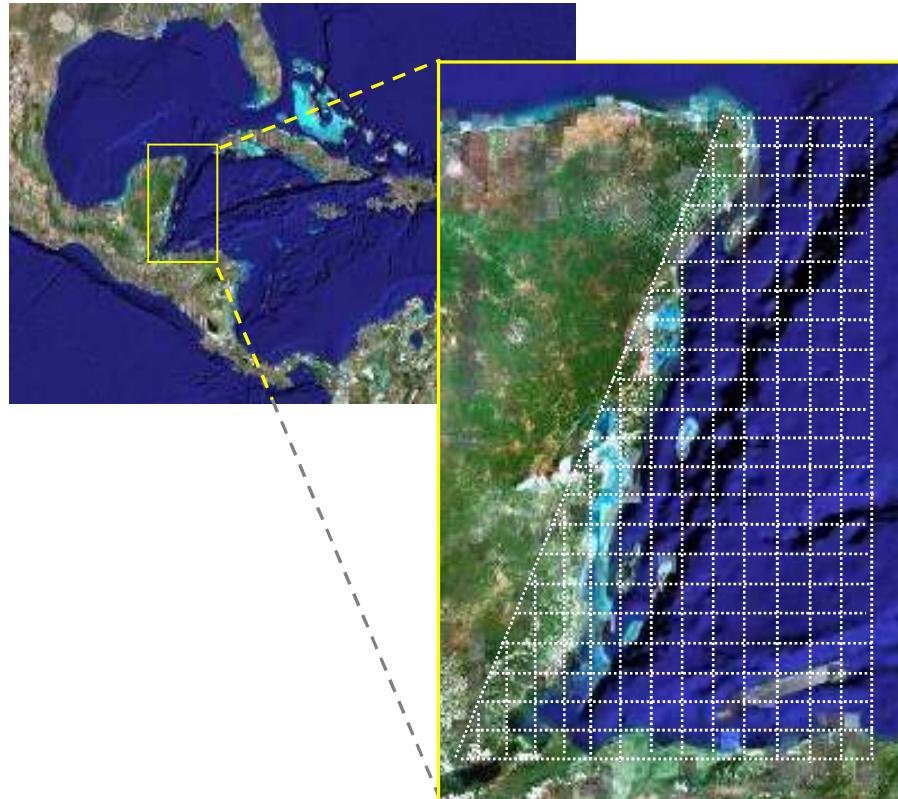
(iii) Understorey / basal layer:



= hysteresis!

Dynamics of coral reefs

- World Bank funded project (last 5 years)
- Aim is to build multiscale models of coral reef systems as decision support systems for managers – coupled biophysical / socioeconomic



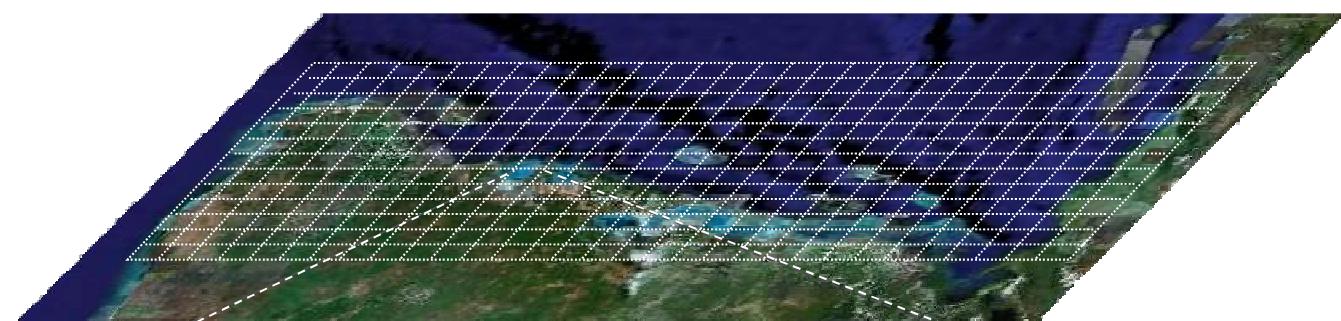
- Tak Fung (UC London)
- Jessica Melbourne-Thomas (Univ Tas)

Dynamics of coral reefs





Over one-half
of the world's population lives
within **100 kilometres
of the sea.**



Benthos

'empty' space

macroturf

macroalgae

spawning
corals

brooding
corals

Consumers

herbivores

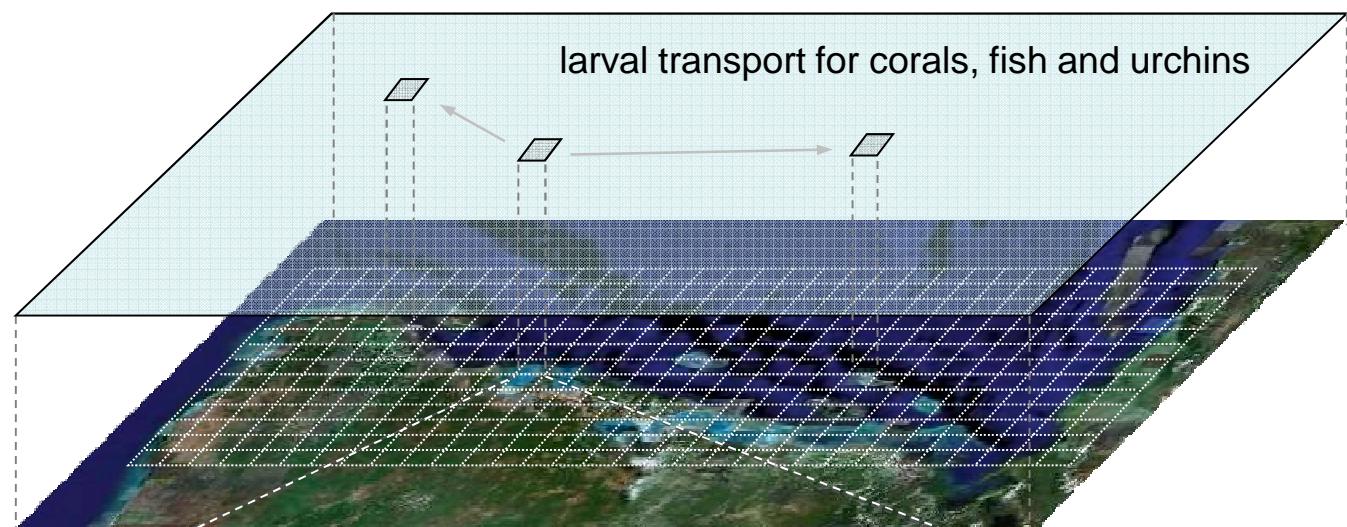
small
piscivores

large
piscivores

urchins



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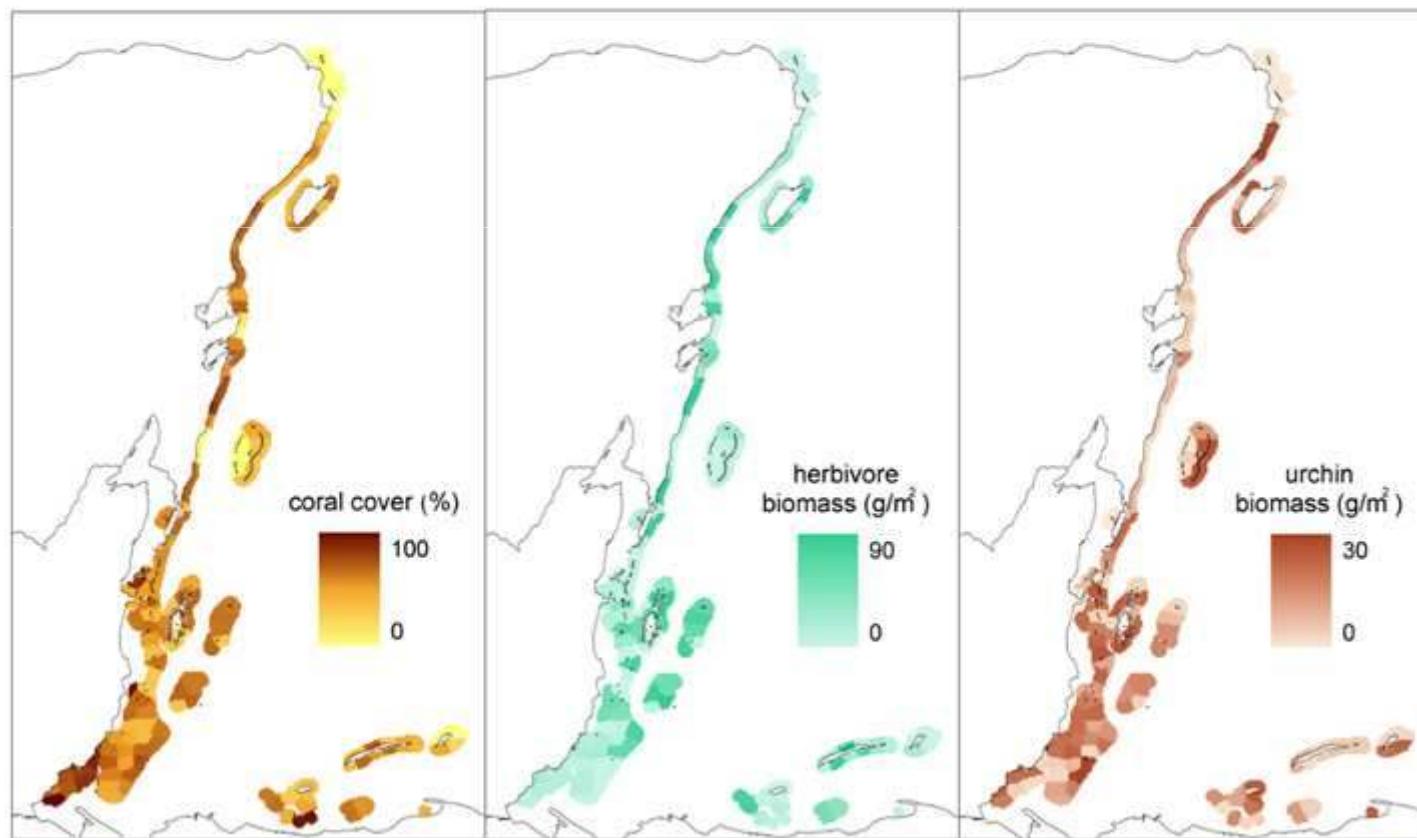
urchins



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Calibrated / validated for Meso-American Barrier Reef System

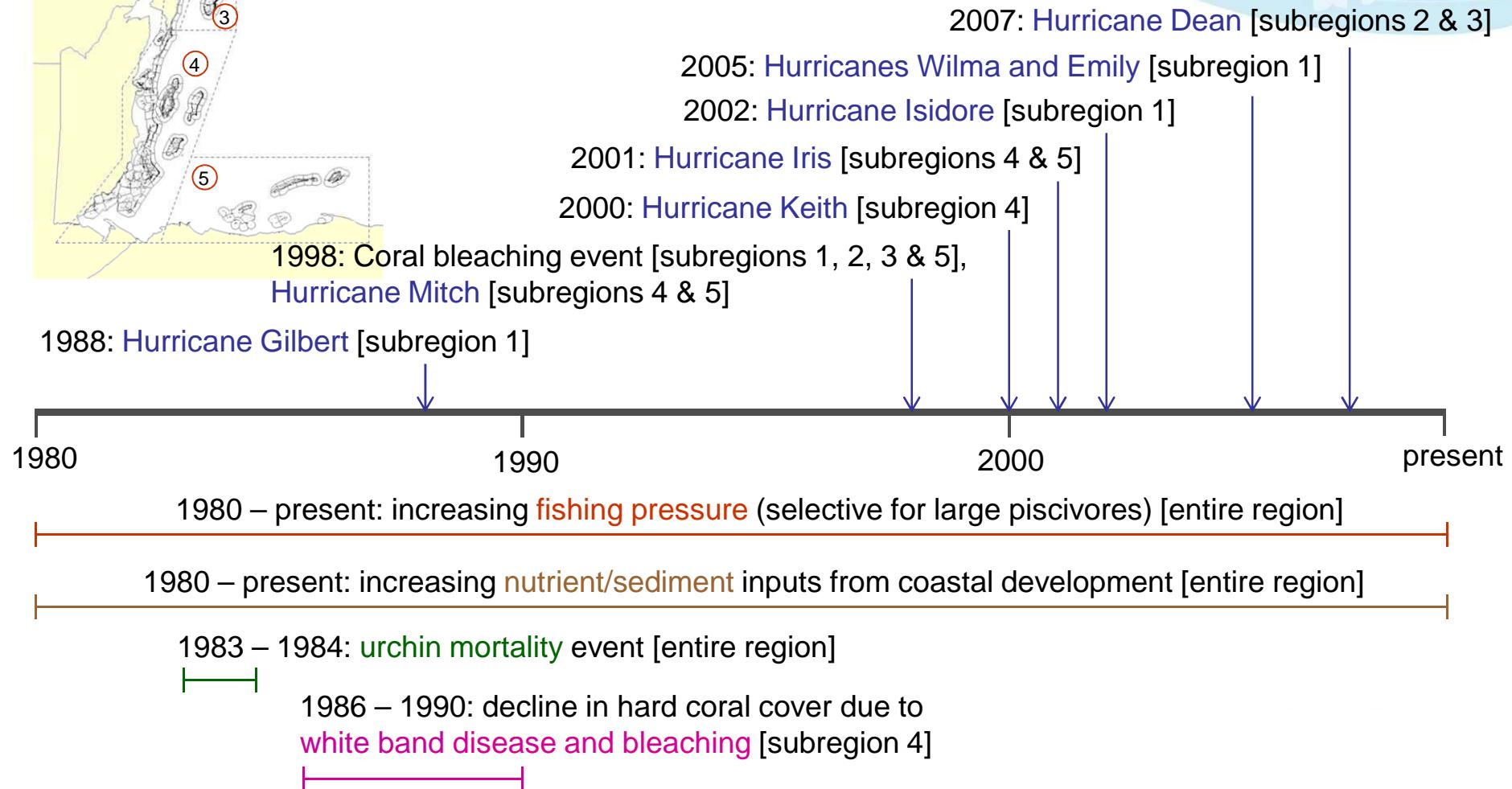


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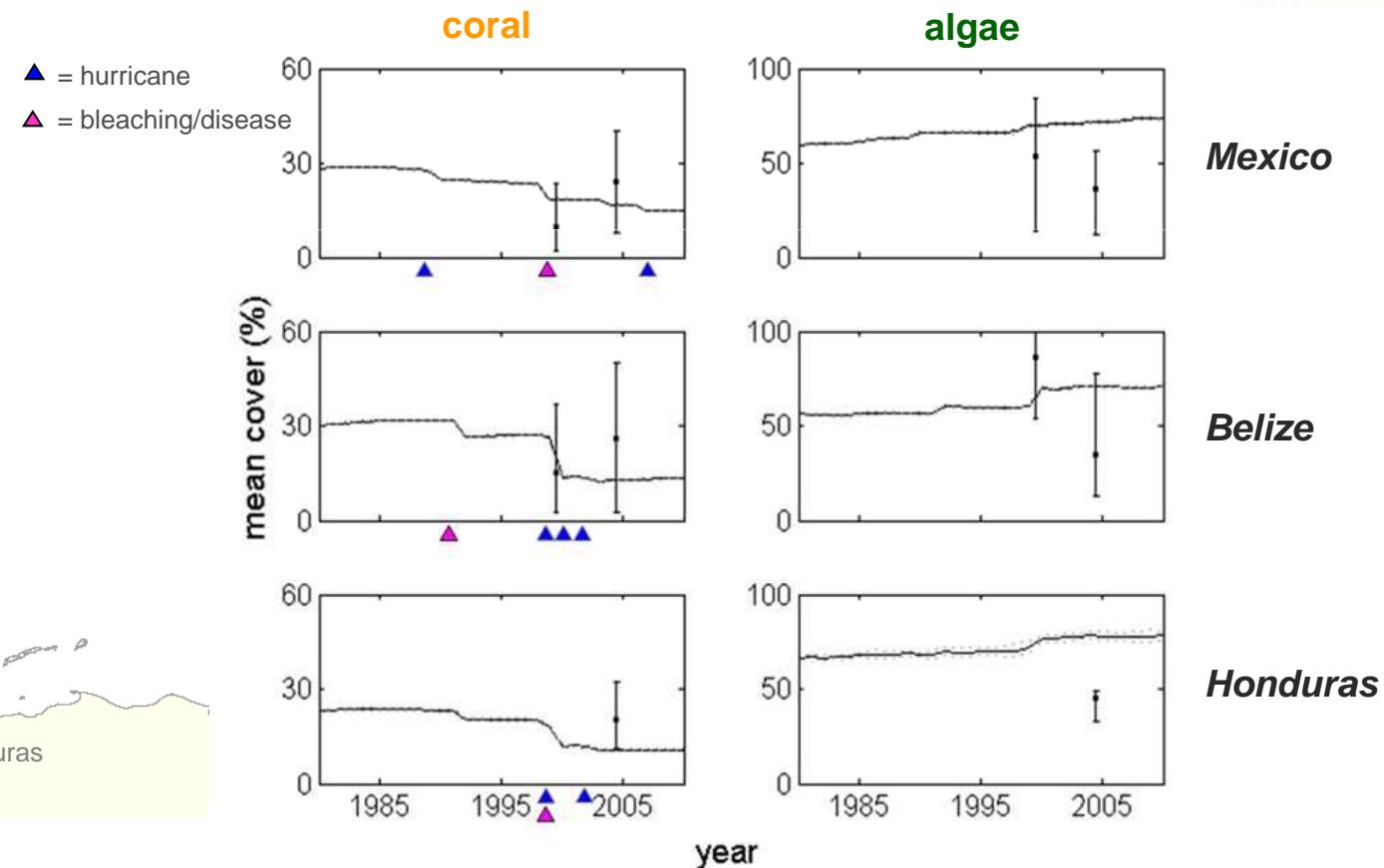
Timeline for the MAR:

1980 – present

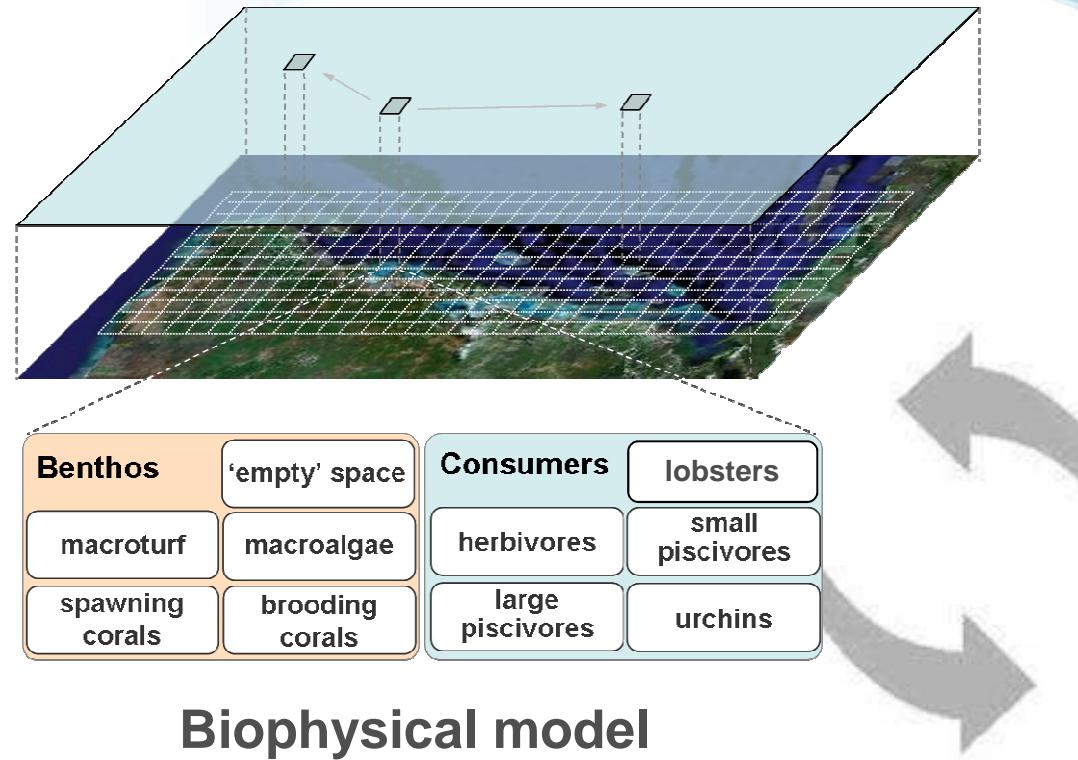




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Coupled models

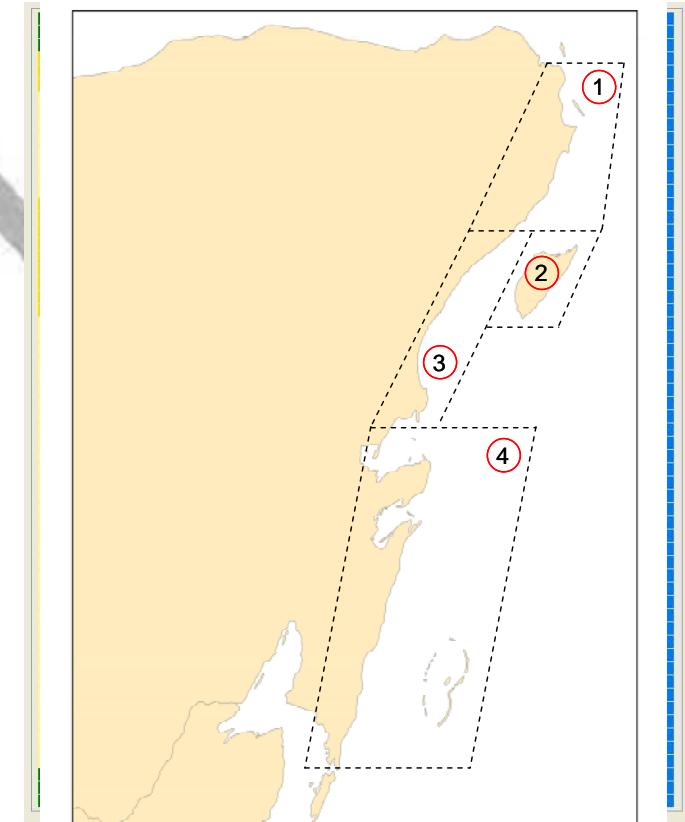


Information exchanges:

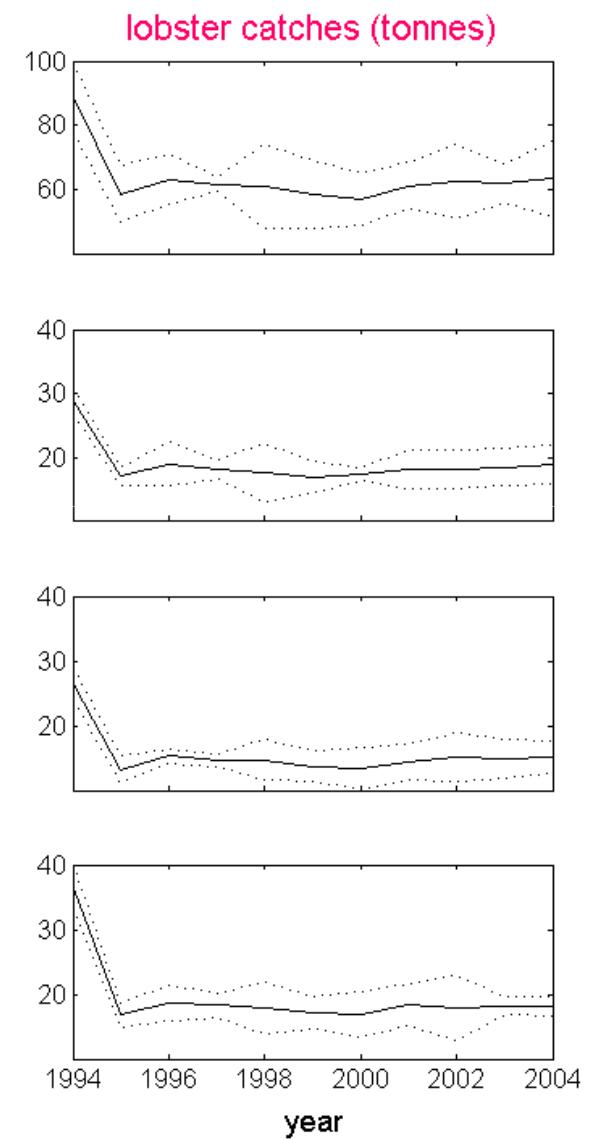
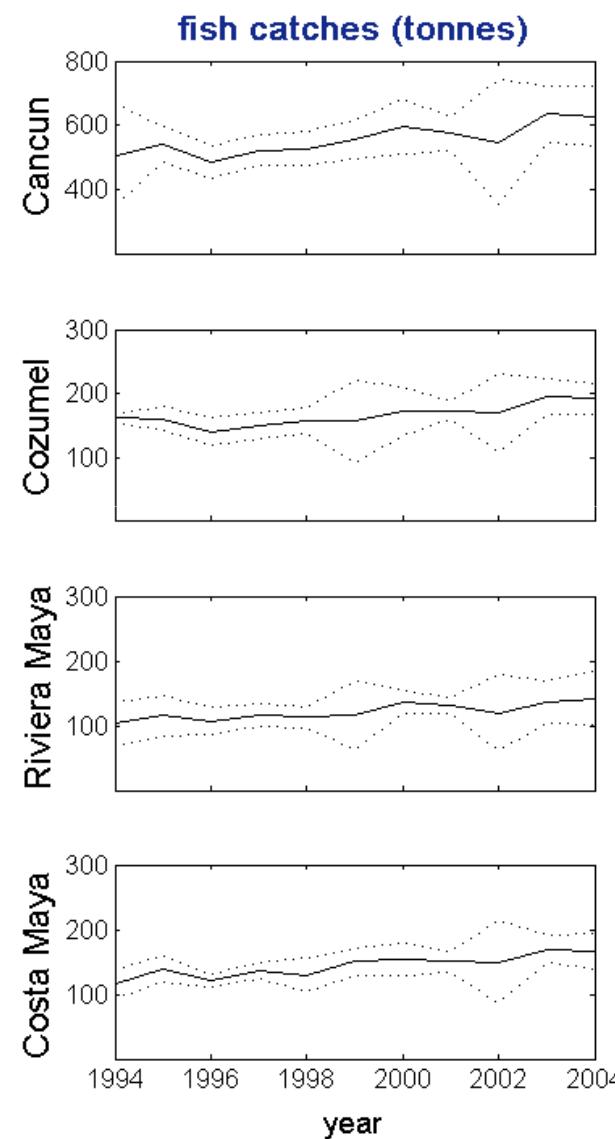
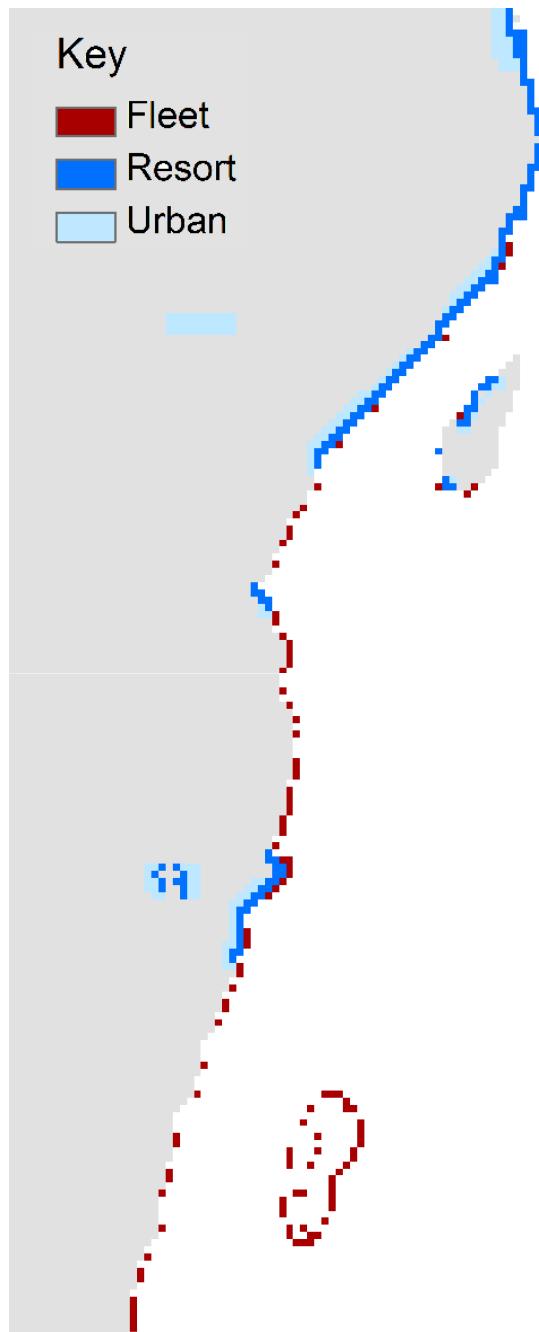
- **Fishing (fish and lobsters)**
- **Pollution (from urban development and tourism)**

Over one-half of the world's population lives within **100 kilometres of the sea.**

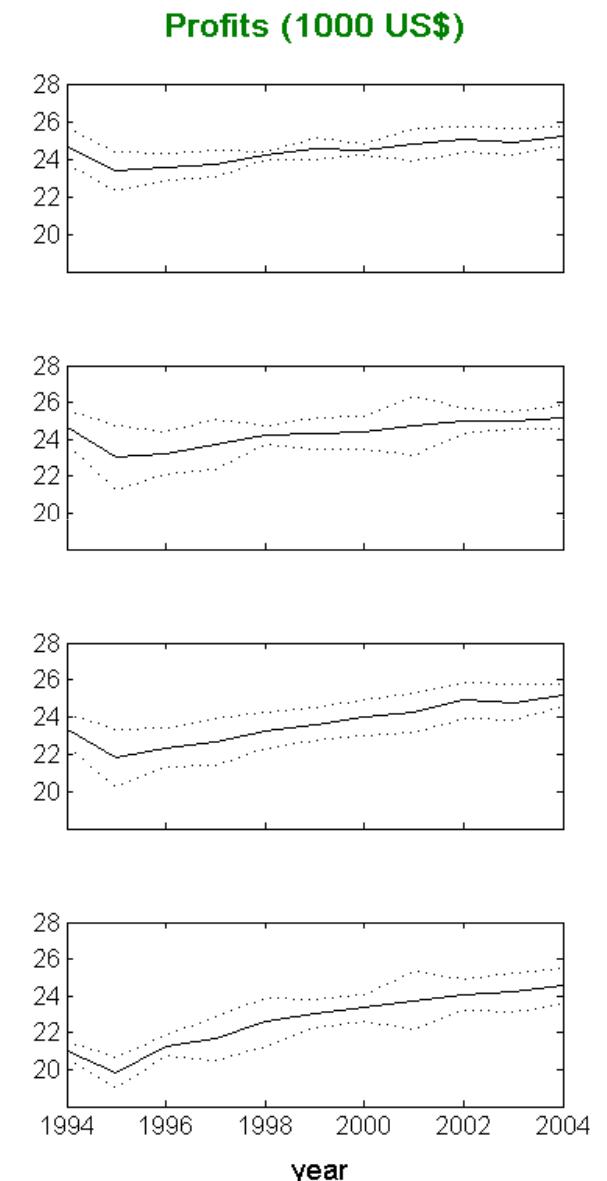
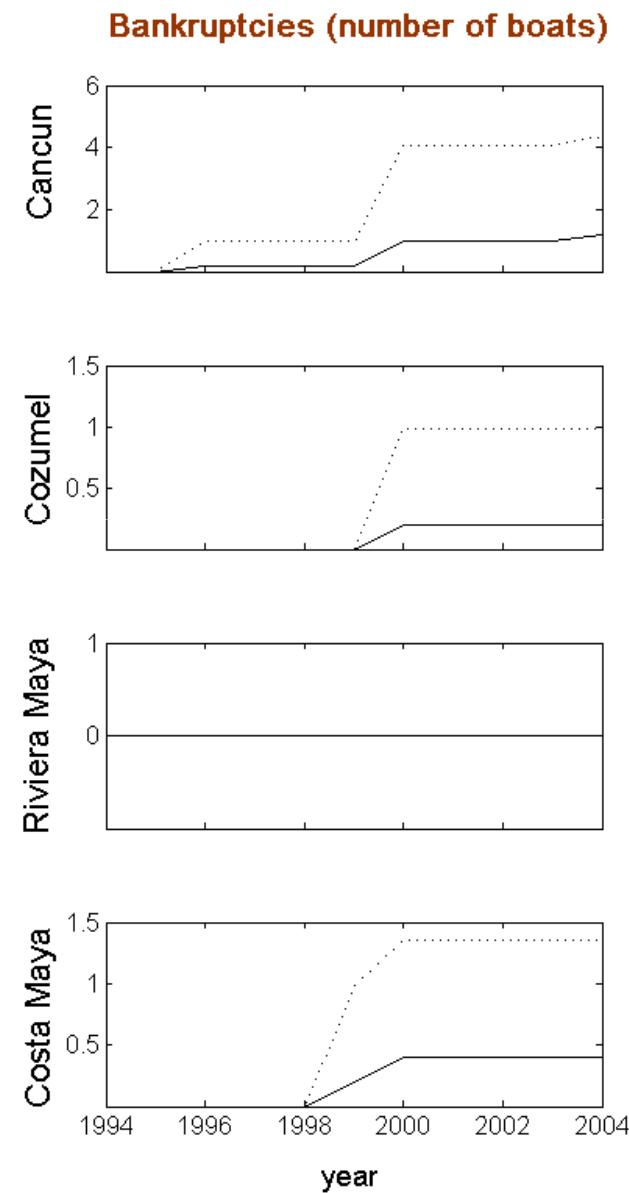
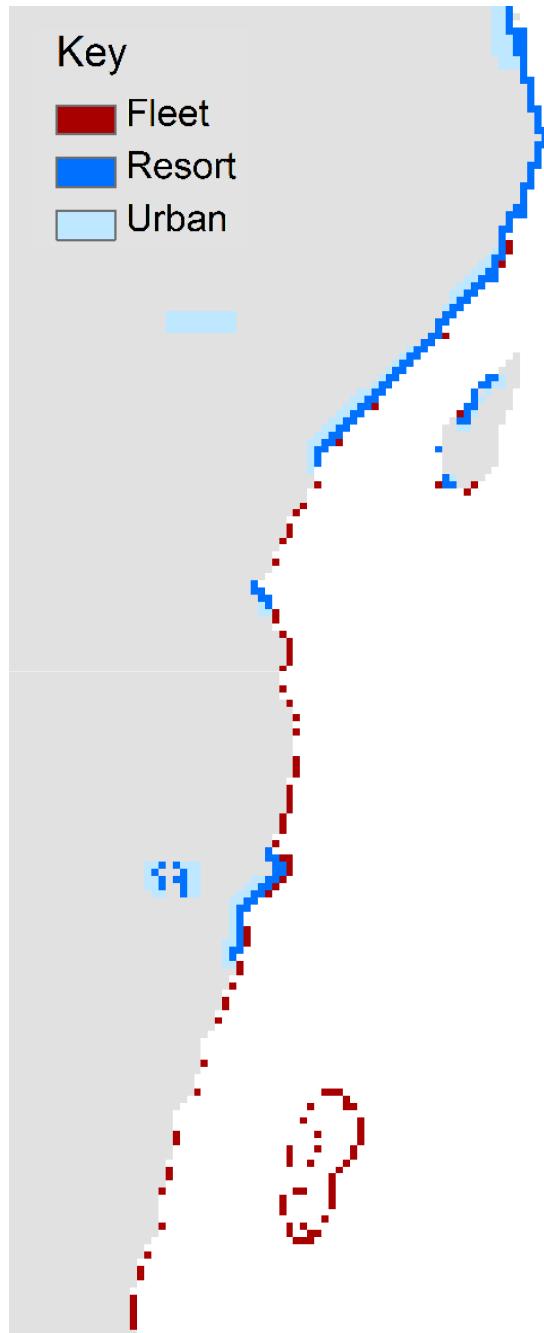
Socio-economic model



Coupled model output

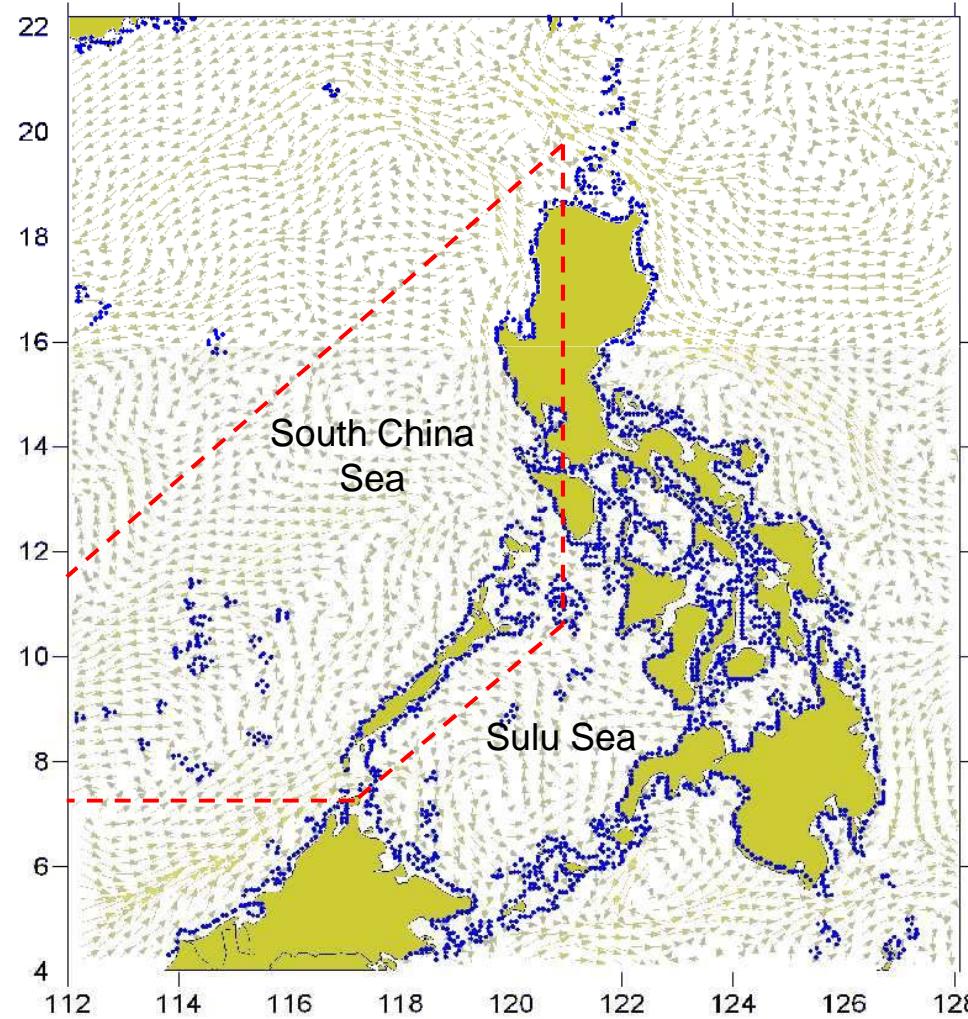


Coupled model output



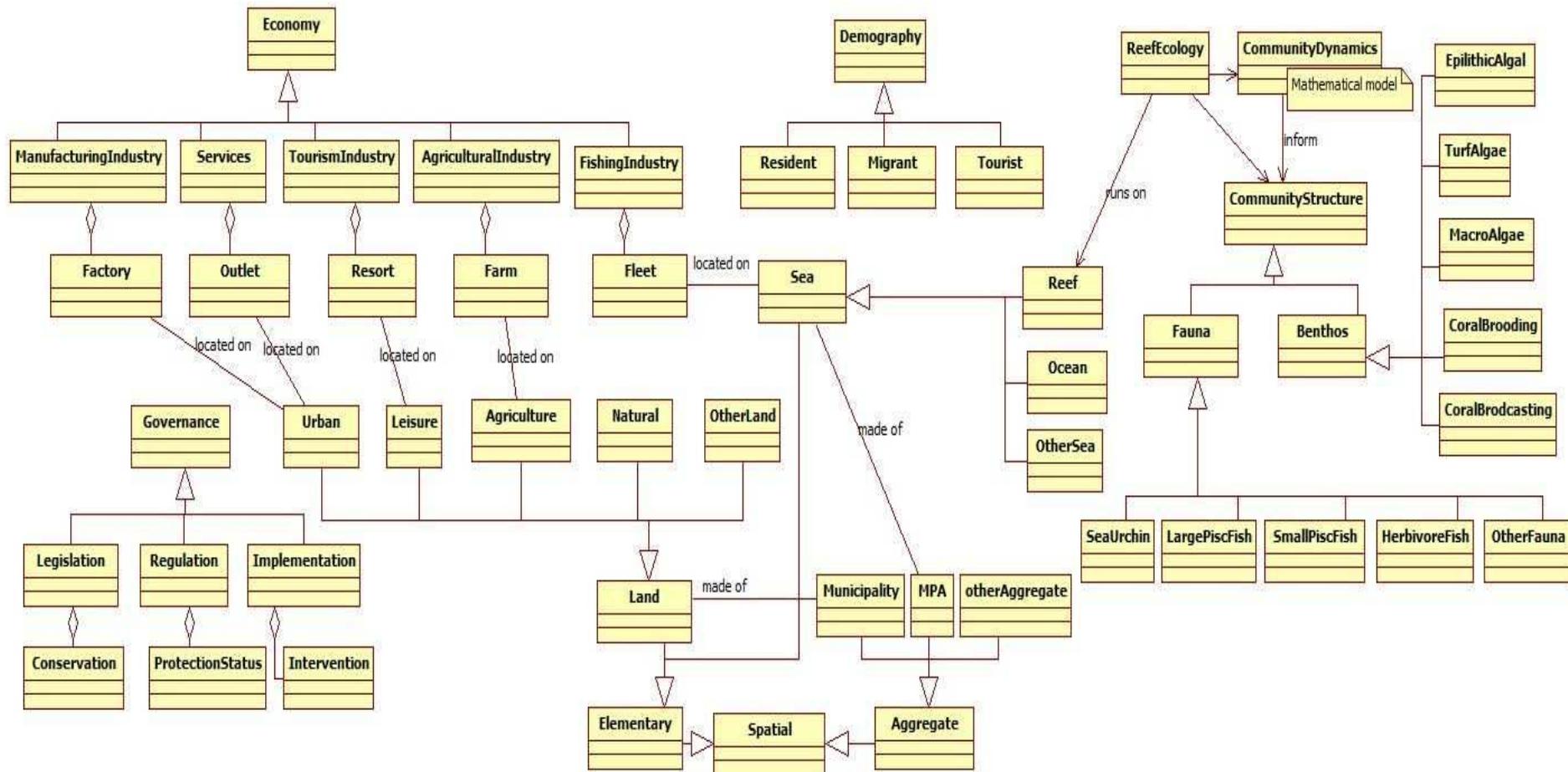


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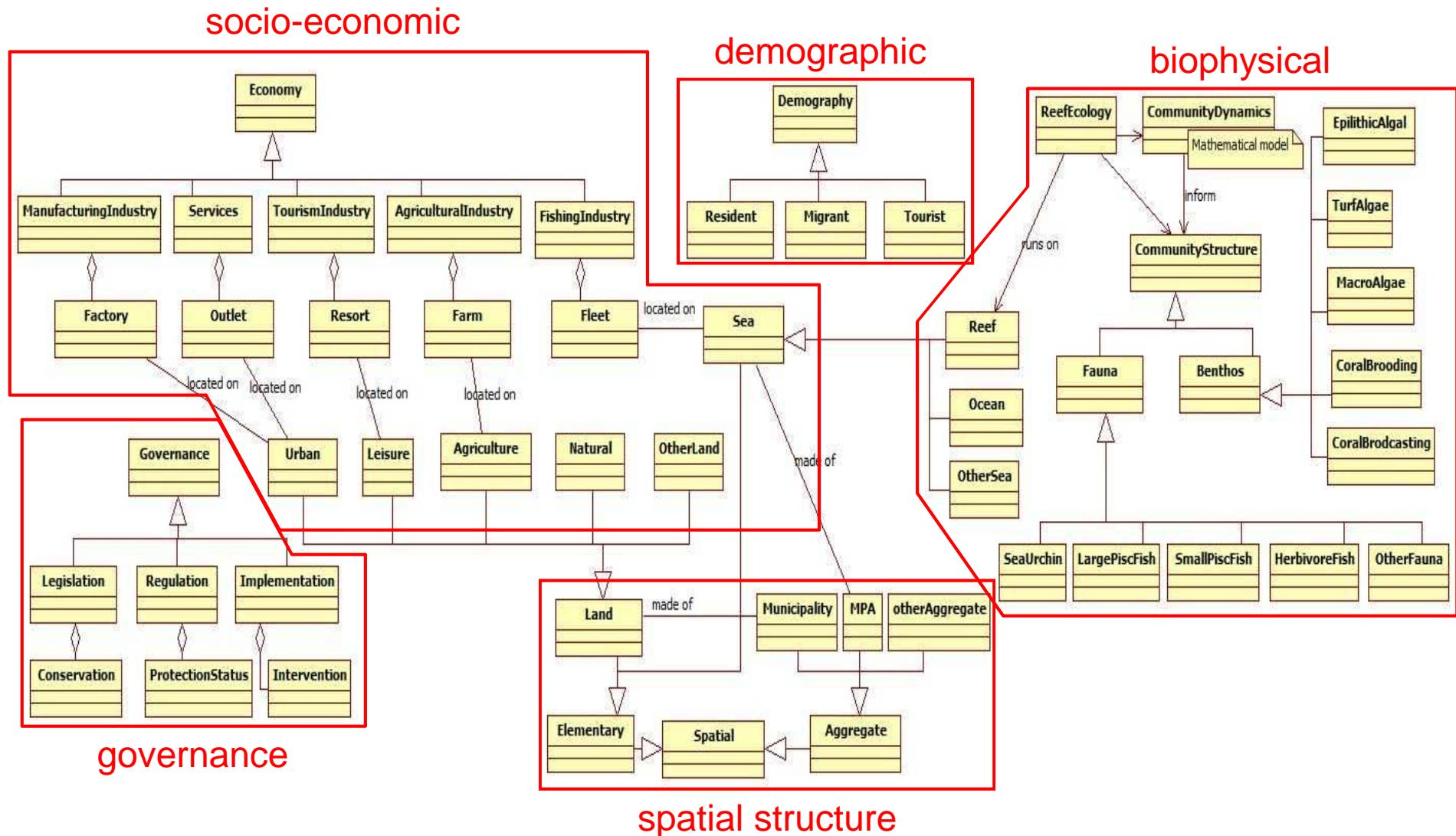


Now instantiated for the South
China Sea (Philippines)

Dynamics of coral reefs – a generic ontology



Dynamics of coral reefs – a generic ontology



And finally – back to temperate reefs ...

Arguably ...

- sufficient knowledge to attempt a similar model for eastern Tasmania
- a portable generic DSS for temperate reef systems?