Modelling the disappearance of floating algal wrack and its impact on marine invertebrate biodiversity in a future ocean

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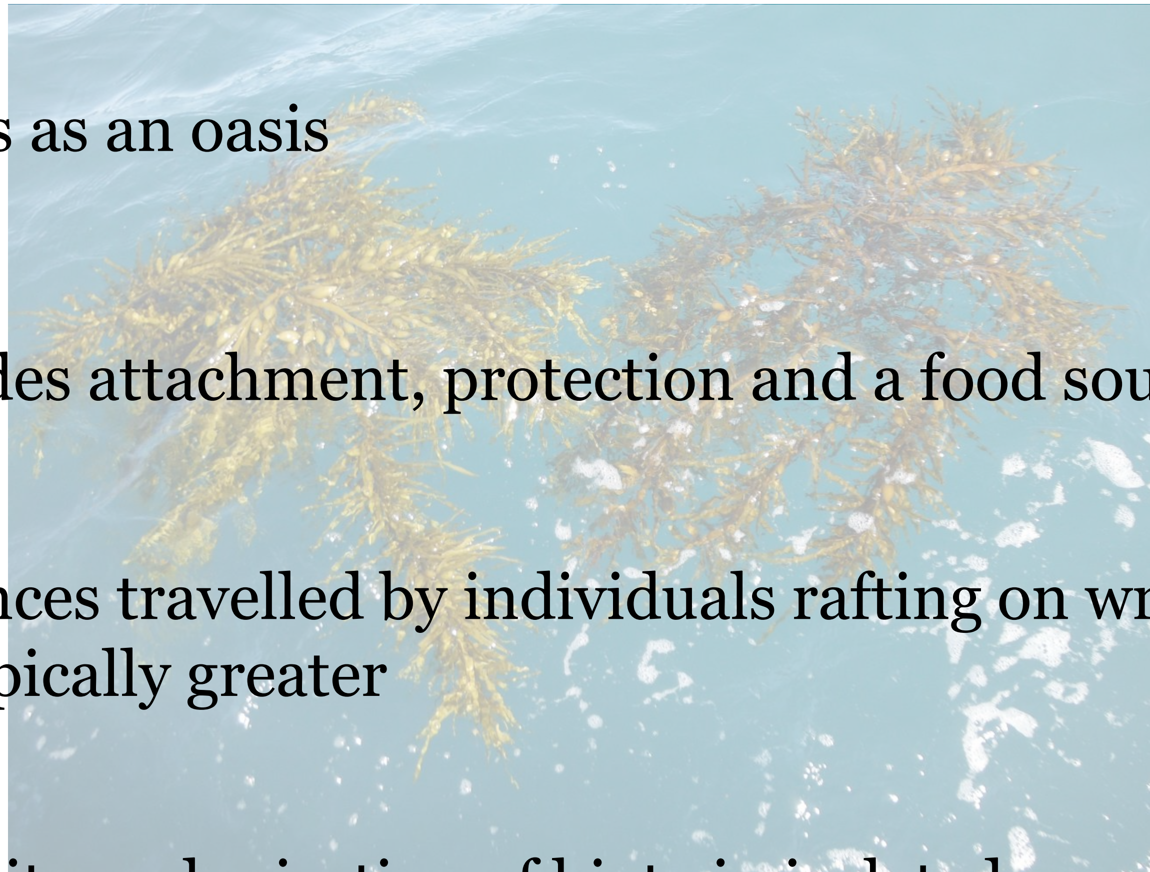
What is "wrack"?

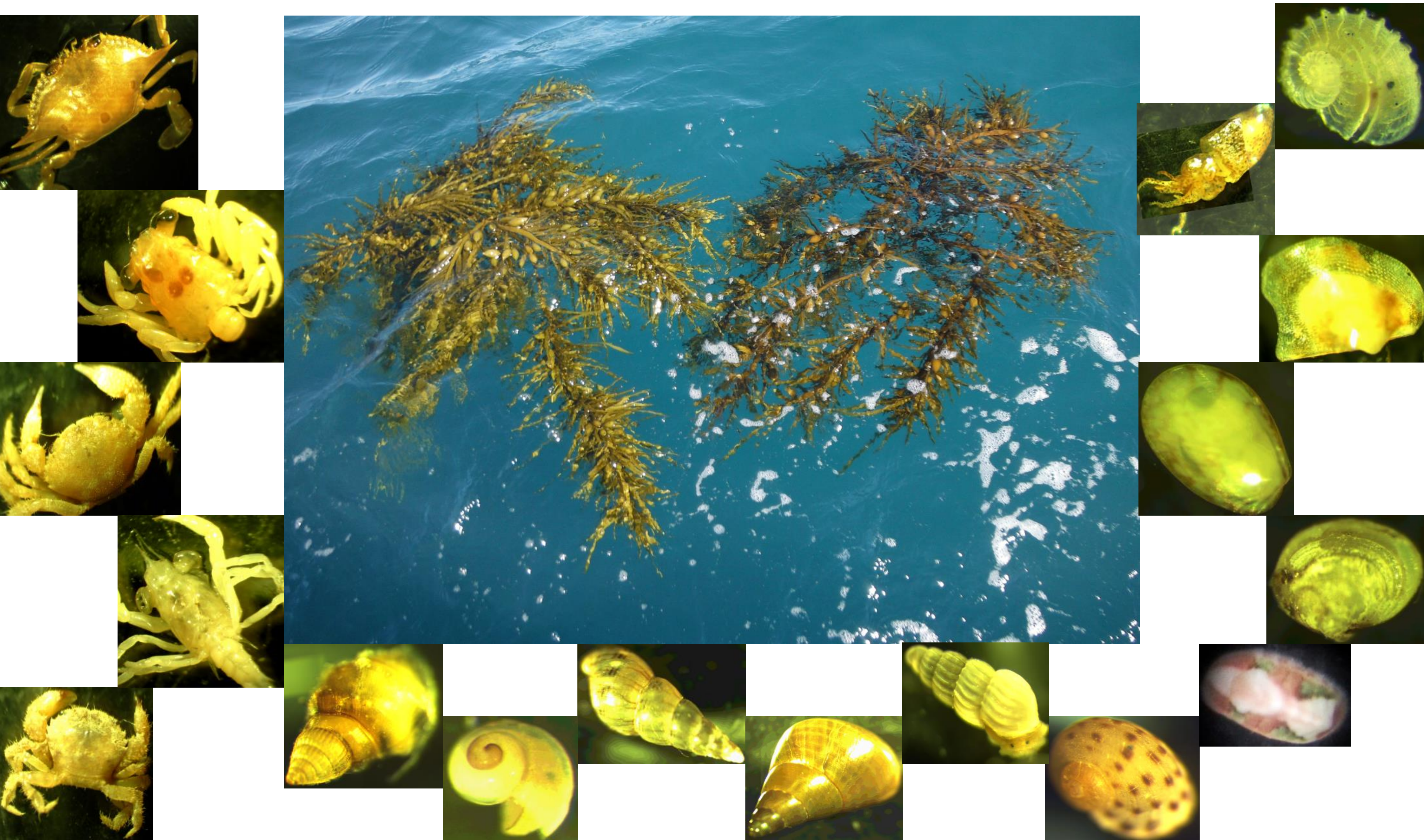
A fragment of seaweed that has become detached from its location and is free-floating on the surface of the ocean

Wrack plays multiple key roles for a wide variety of species

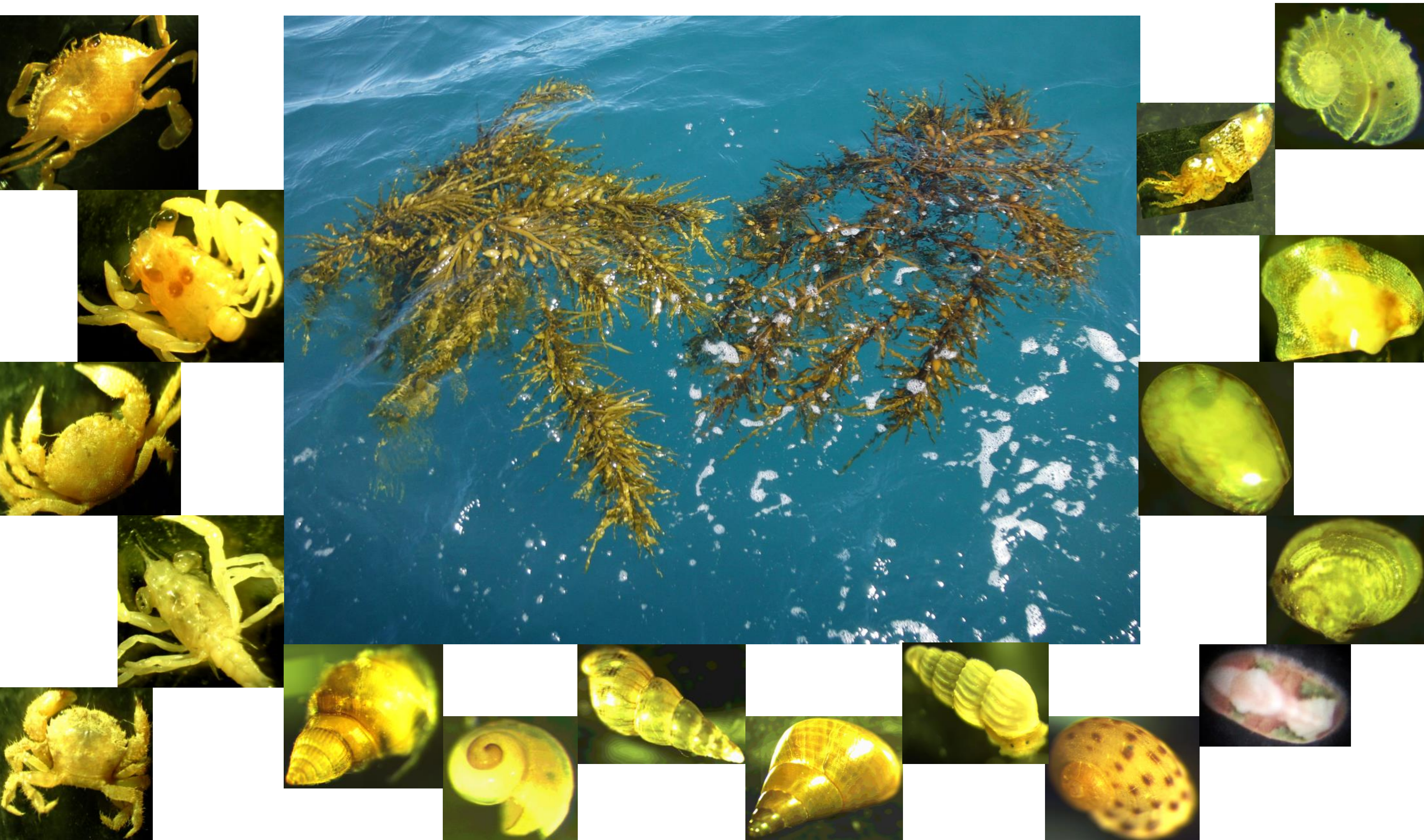


- Serves as an oasis
- Provides attachment, protection and a food source
- Distances travelled by individuals rafting on wrack are typically greater
- Expedites colonization of biota in isolated areas

A wide variety of species call wrack home



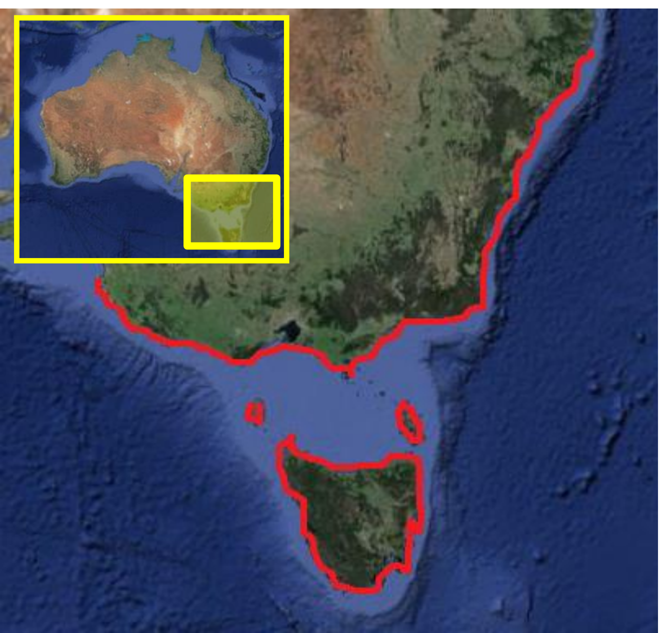
What if wrack abundance were to decrease?



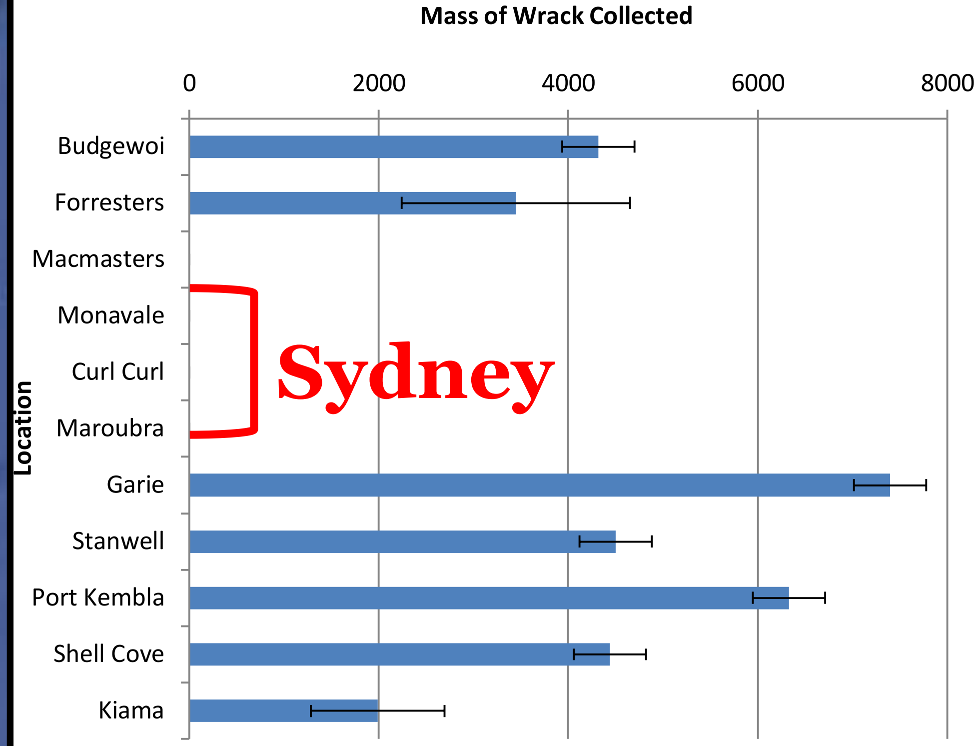
Phyllospora comosa

Has already disappeared from more than 70 kilometres of New South Wales Coastline

Phyllospora comosa



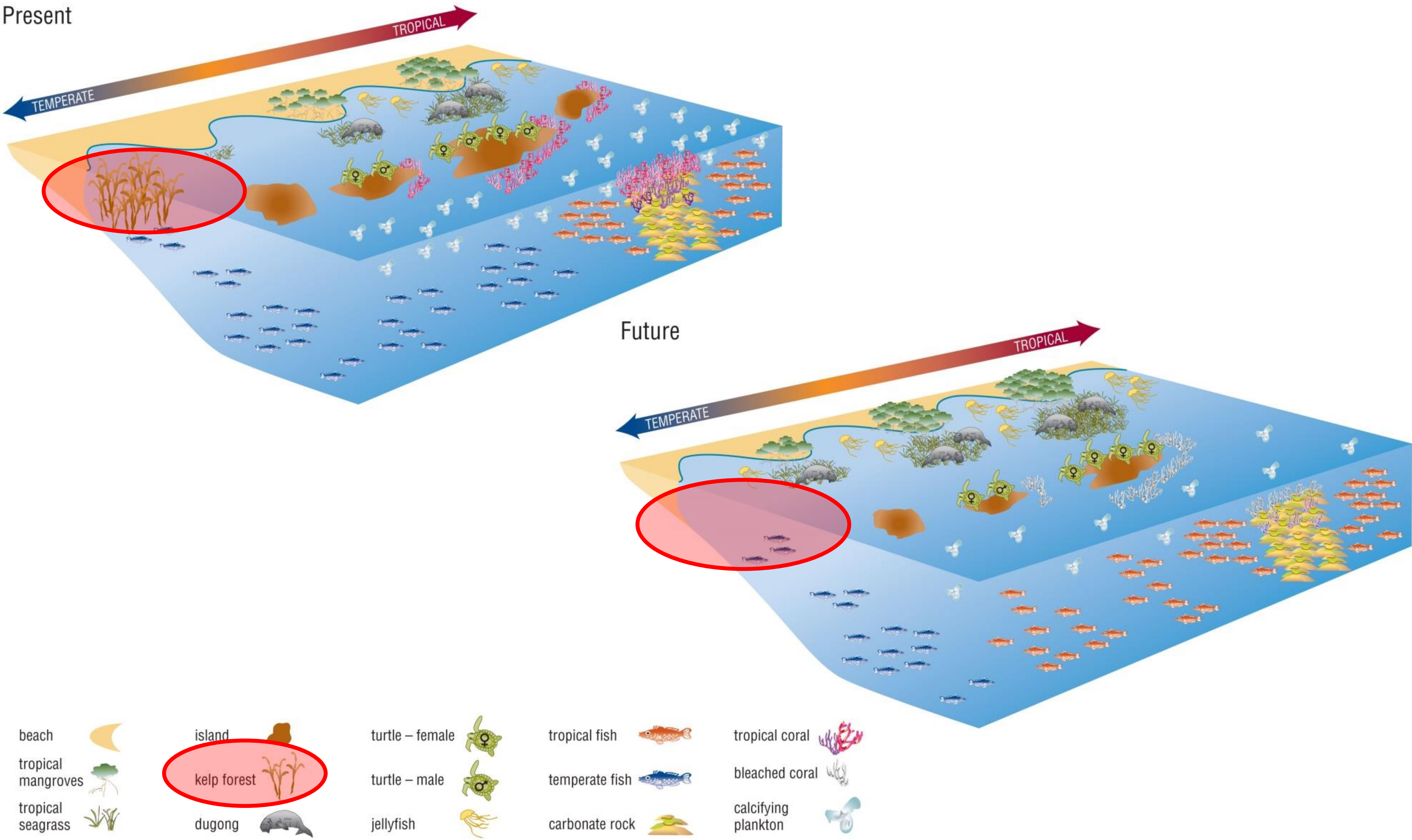
- Important habitat-forming macroalga
- Endemic to eastern Australia and Tasmania's subtidal reefs
- Ranges from extremely patchy to 100% cover
- Gas-filled bladders aid in floatation, allowing for long distance dispersal



High susceptibility to anthropogenic factors

Urbanization and climate change could continue to decrease the amount of *Phyllospora* and associated wrack

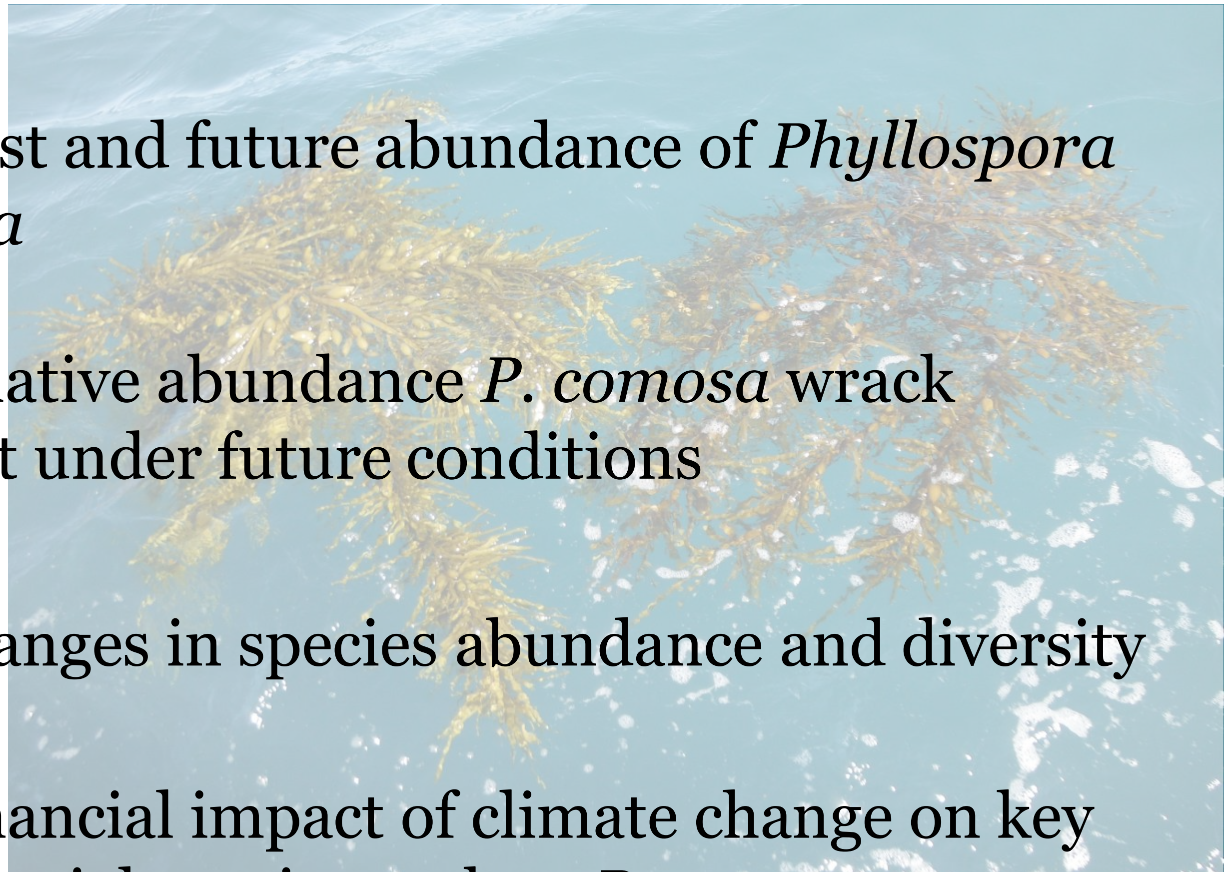
Climate impact on the marine environment



Poloczanska, E. S., R. C. Babcock, A. Butler, A. J. Hobday, O. Hoegh-Guldberg, T. J. Kunz, R. Matear, D. Milton, T. A. Okey and A. J. Richardson (2007). Climate Change And Australian Marine Life. *Oceanography and Marine Biology Annual Review* 45: 409-480.

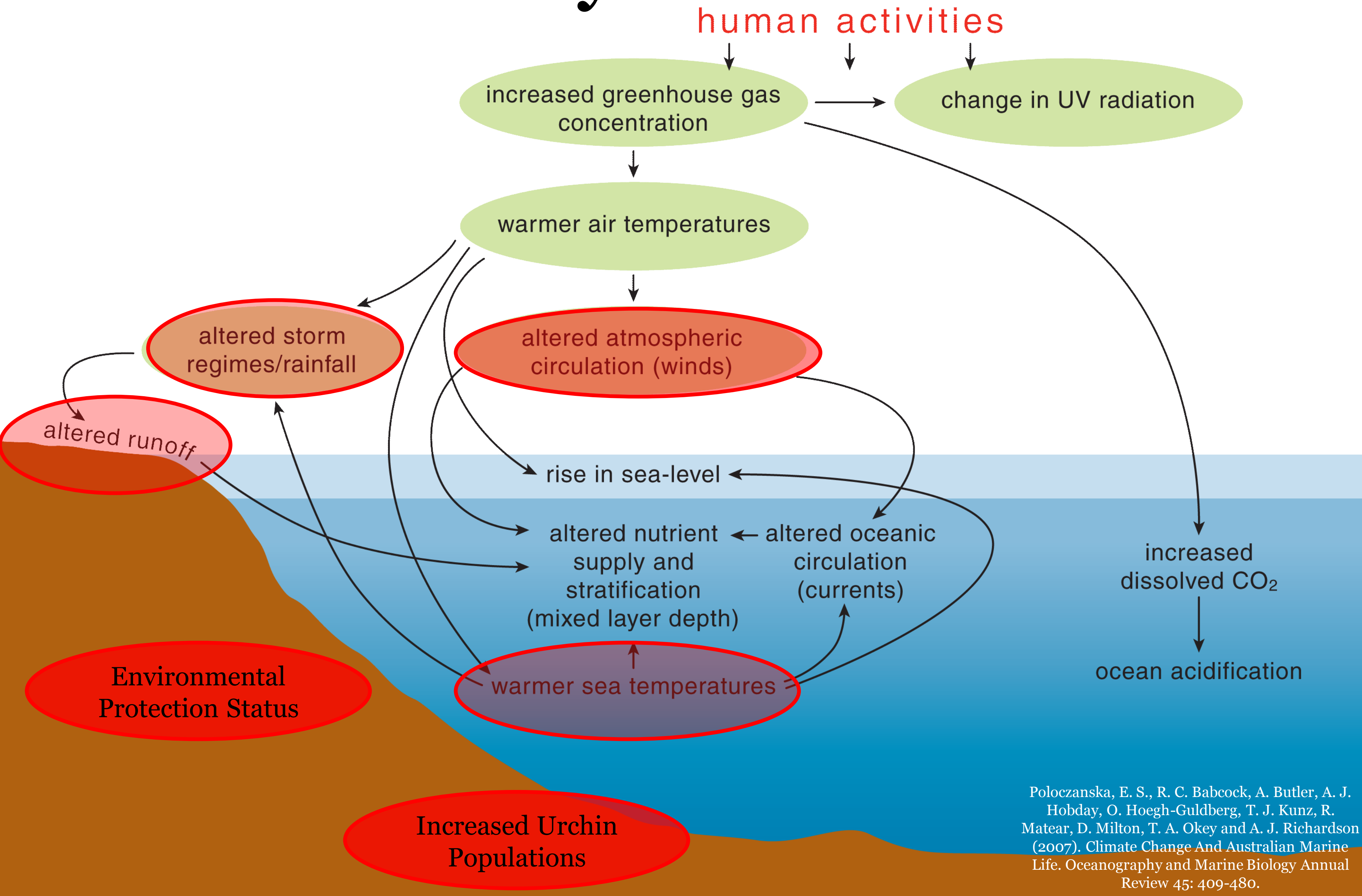
Aims of my Bayes Net

Use field data and climate change predictions to model:



- The past and future abundance of *Phyllospora comosa*
- The relative abundance *P. comosa* wrack present under future conditions
- The changes in species abundance and diversity
- The financial impact of climate change on key commercial species such as *Portunus spp*.

Human activities' impact on marine systems



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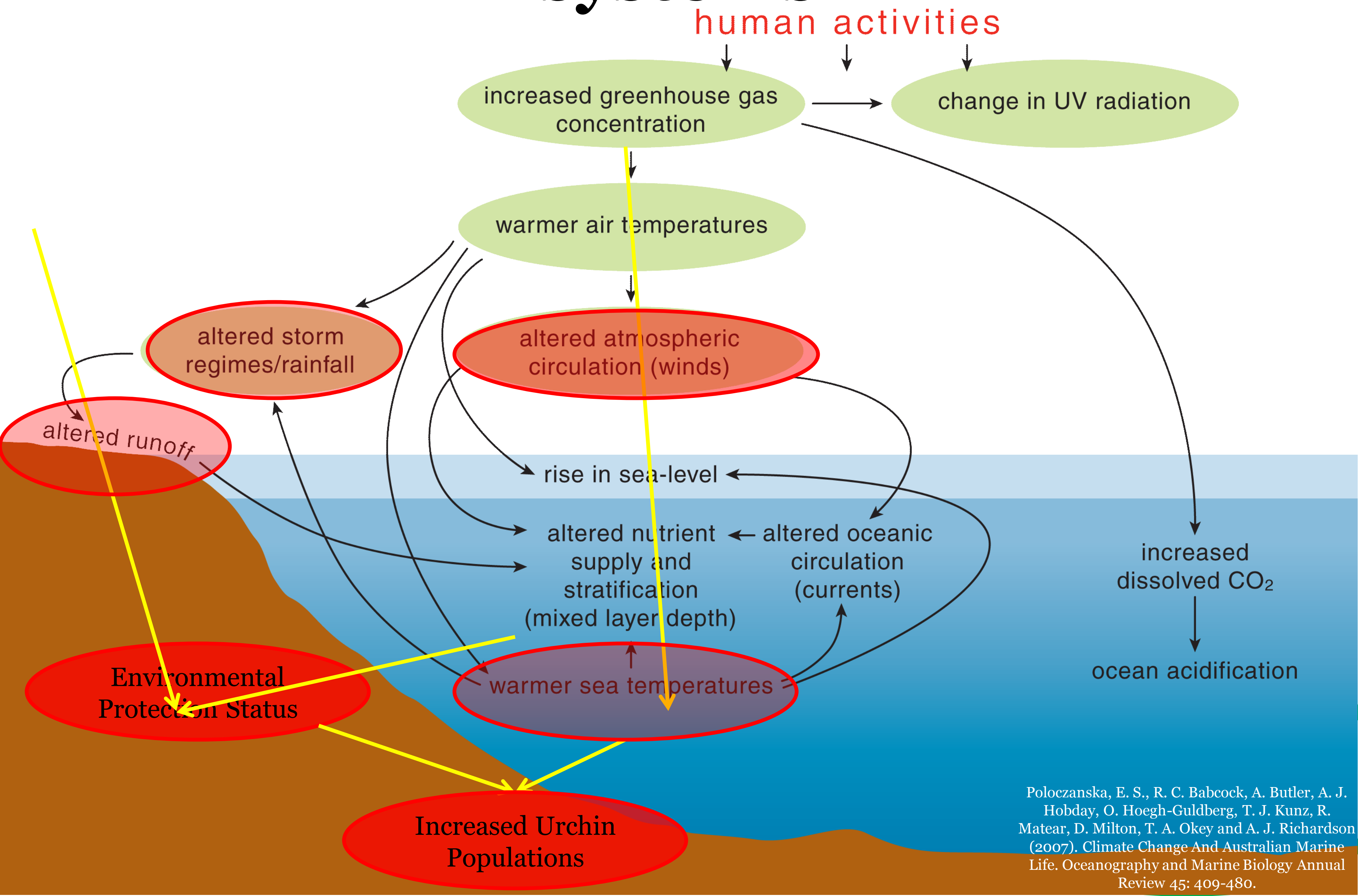

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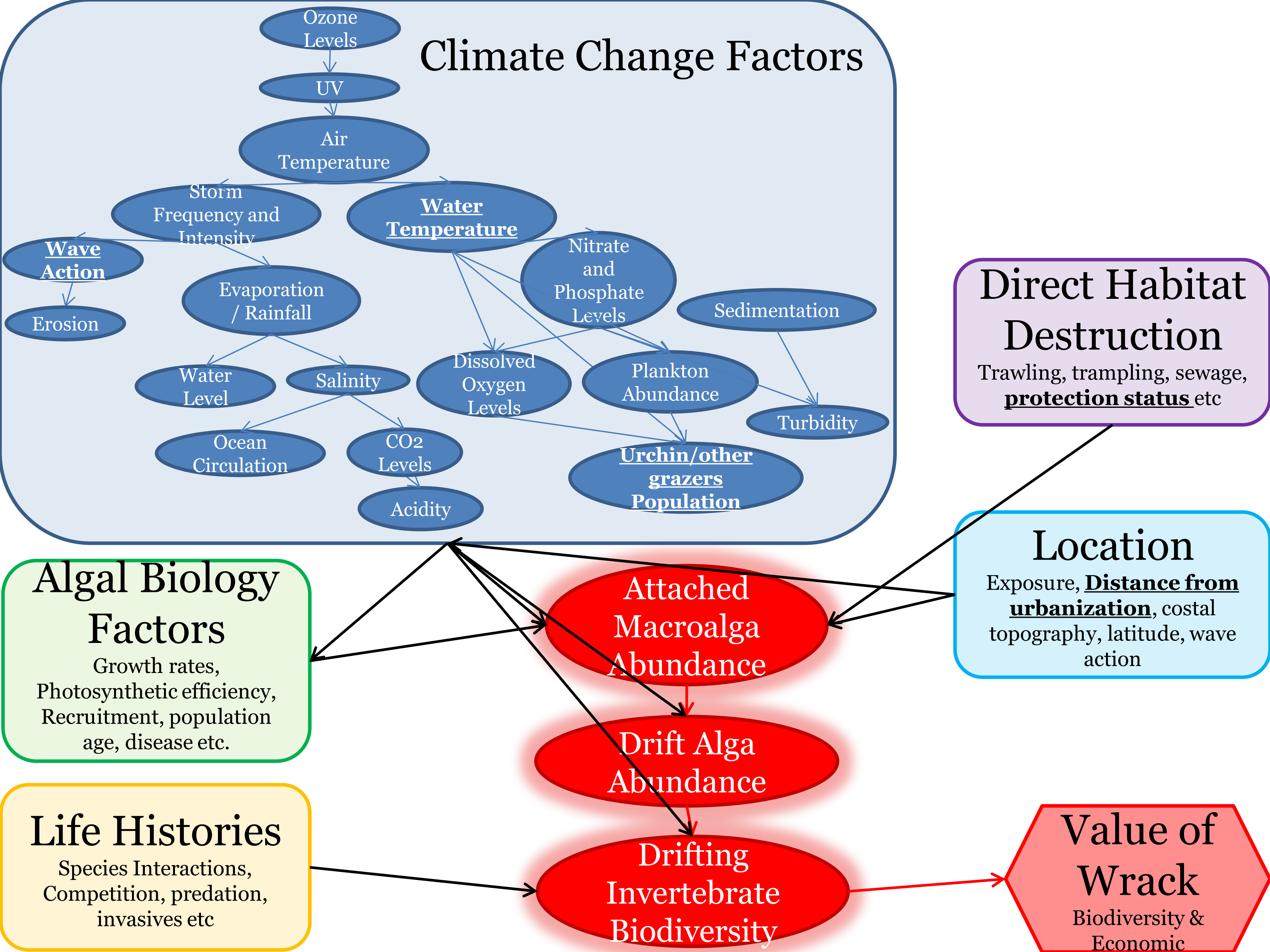
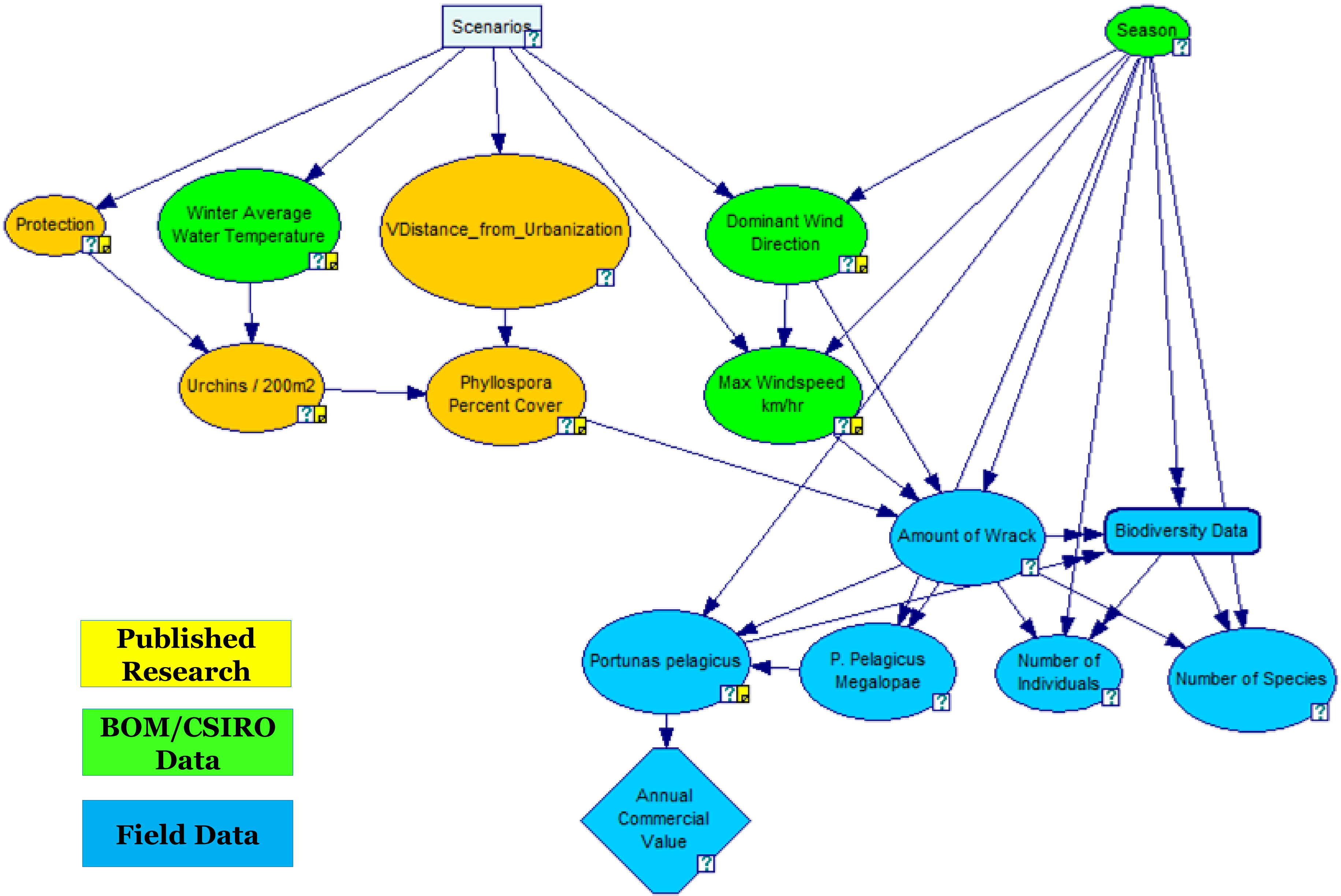


Climate Change Factors
Ozone Levels
UV
Air Temperature
Storm Frequency and Intensity
Water Temperature
Wave Action
Erosion
Evaporation / Rainfall
Nitrate and Phosphate Levels
Sedimentation
Water Level
Salinity
Dissolved Oxygen Levels
Plankton Abundance
Turbidity
Ocean Circulation
CO2 Levels
Acidity
Urchin/other grazers Population
Direct Habitat Destruction
Trawling, trampling, sewage, protection status etc
Location
Exposure, Distance from urbanization, costal topography, latitude, wave action
Algal Biology Factors
Growth rates, Photosynthetic efficiency, Recruitment, population age, disease etc.
Attached Macroalga Abundance
Drift Alga Abundance
Life Histories
Species Interactions, Competition, predation, invasives etc
Drifting Invertebrate Biodiversity
Value of Wrack
Biodiversity & Economic

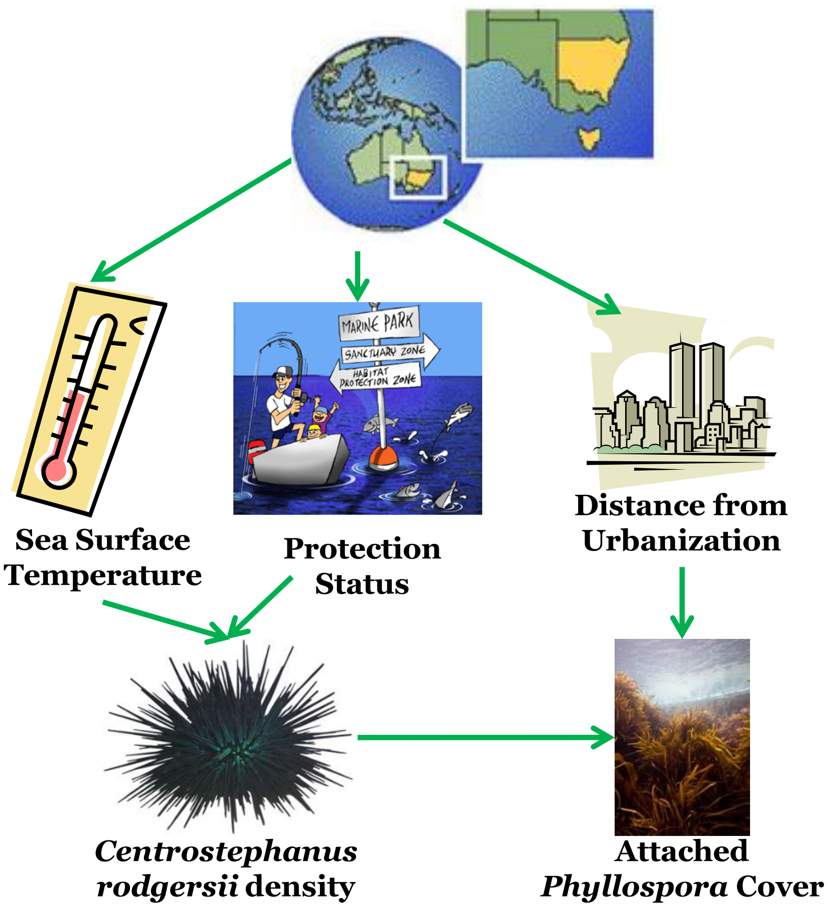
My Model



Scenarios
Season
Protection
Winter Average Water Temperature
VDistance_from_Urbanization
Dominant Wind Direction
Urchins / 200m2
Phyllospora Percent Cover
Max Windspeed km/hr
Amount of Wrack
Biodiversity Data
Portunas pelagicus
P. Pelagicus Megalopae
Number of Individuals
Number of Species
Annual Commercial Value
Published Research
BOM/CSIRO Data
Field Data

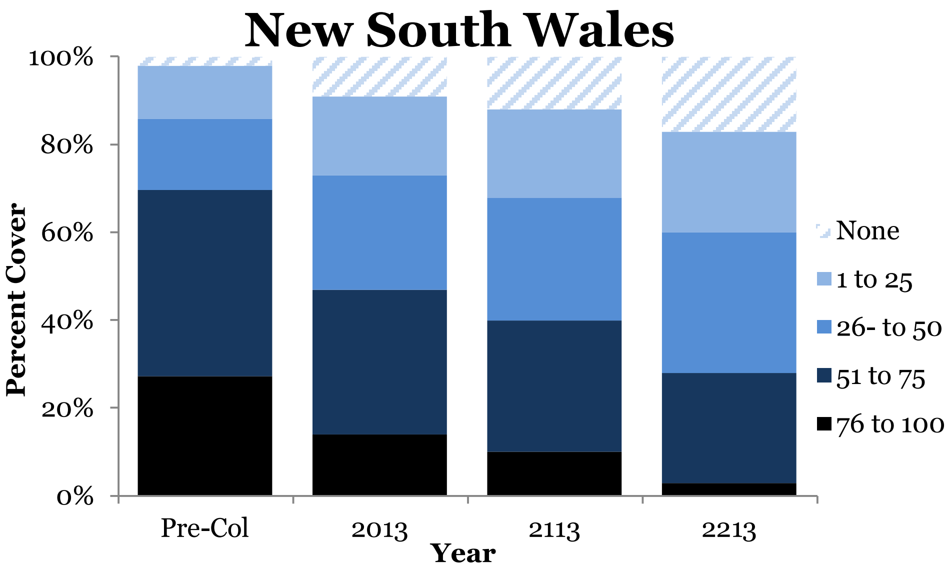
Human activities' impact on marine systems

Predictions for New South Wales and Tasmania

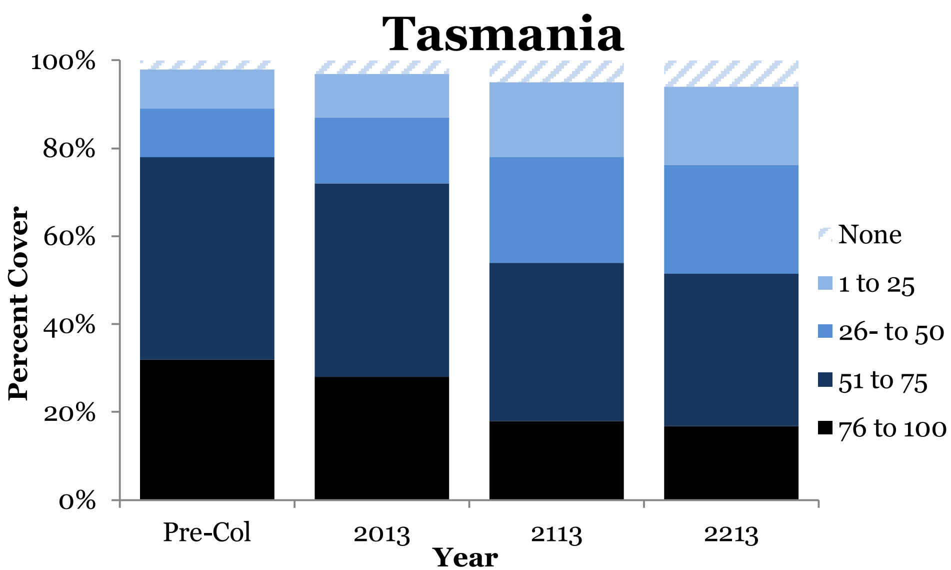


- Southern advance of the EAC results in higher sea surface temperatures
- Struggle to enact policy to protect vulnerable marine habitats
- Increased reproductive success for aggressive herbivores *like C. rodgersii*
- Decreased macroalgal growth rates and more frequent dieback events

Attached *Phyllospora* cover

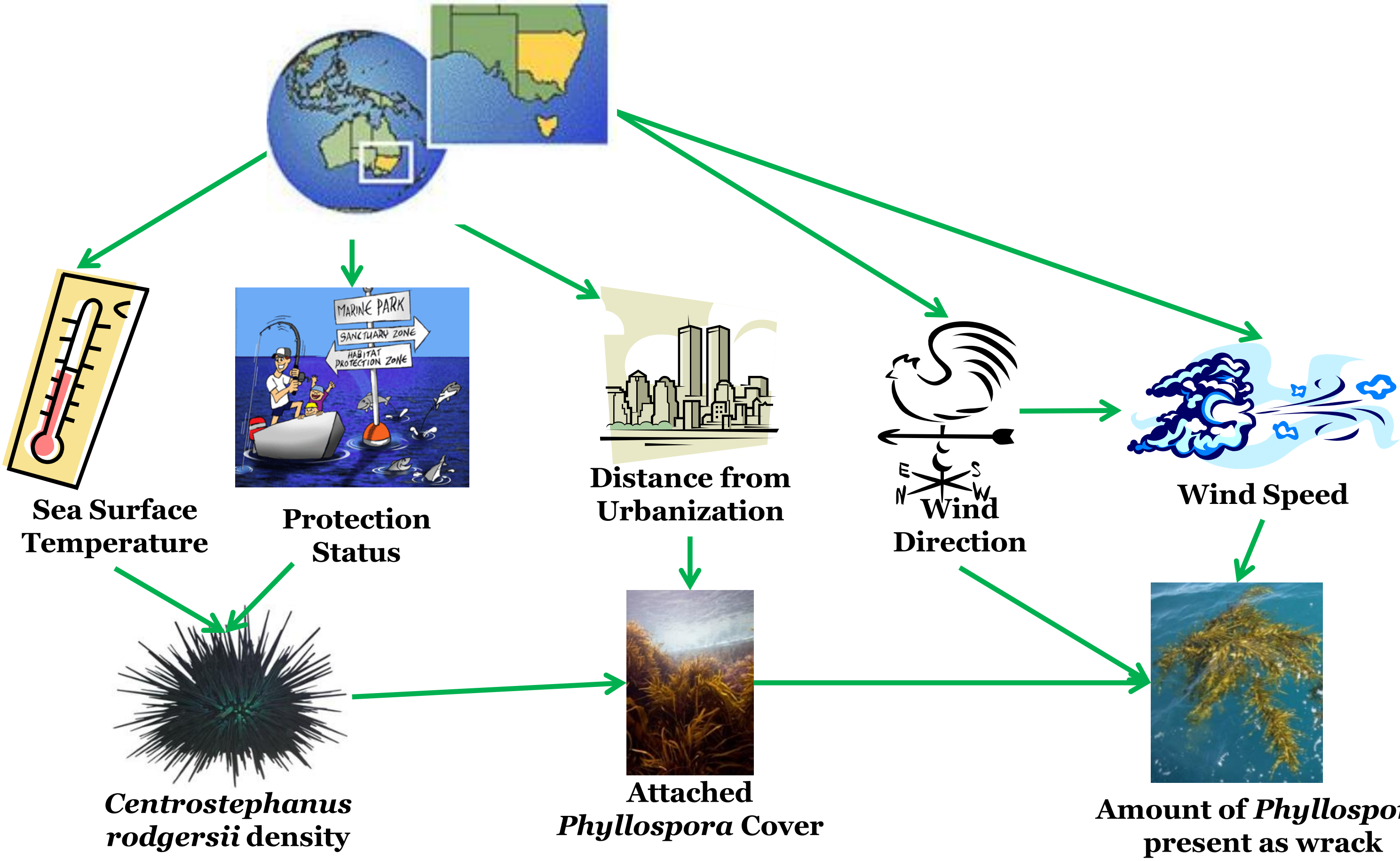


Influenced by increasing urbanization

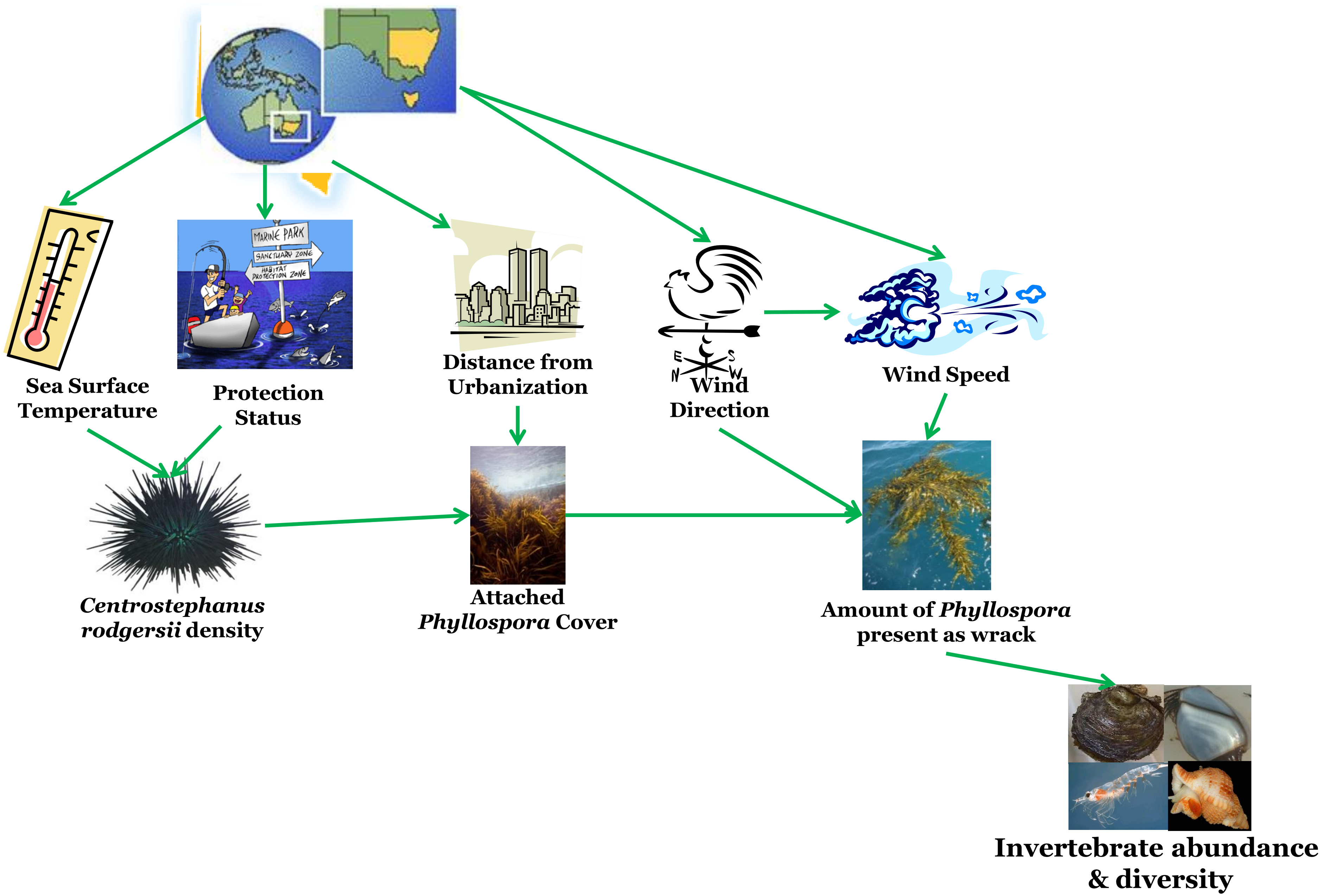


Influenced by increased urchin grazing

Phyllospora as Wrack



Invertebrate Abundance & Diversity



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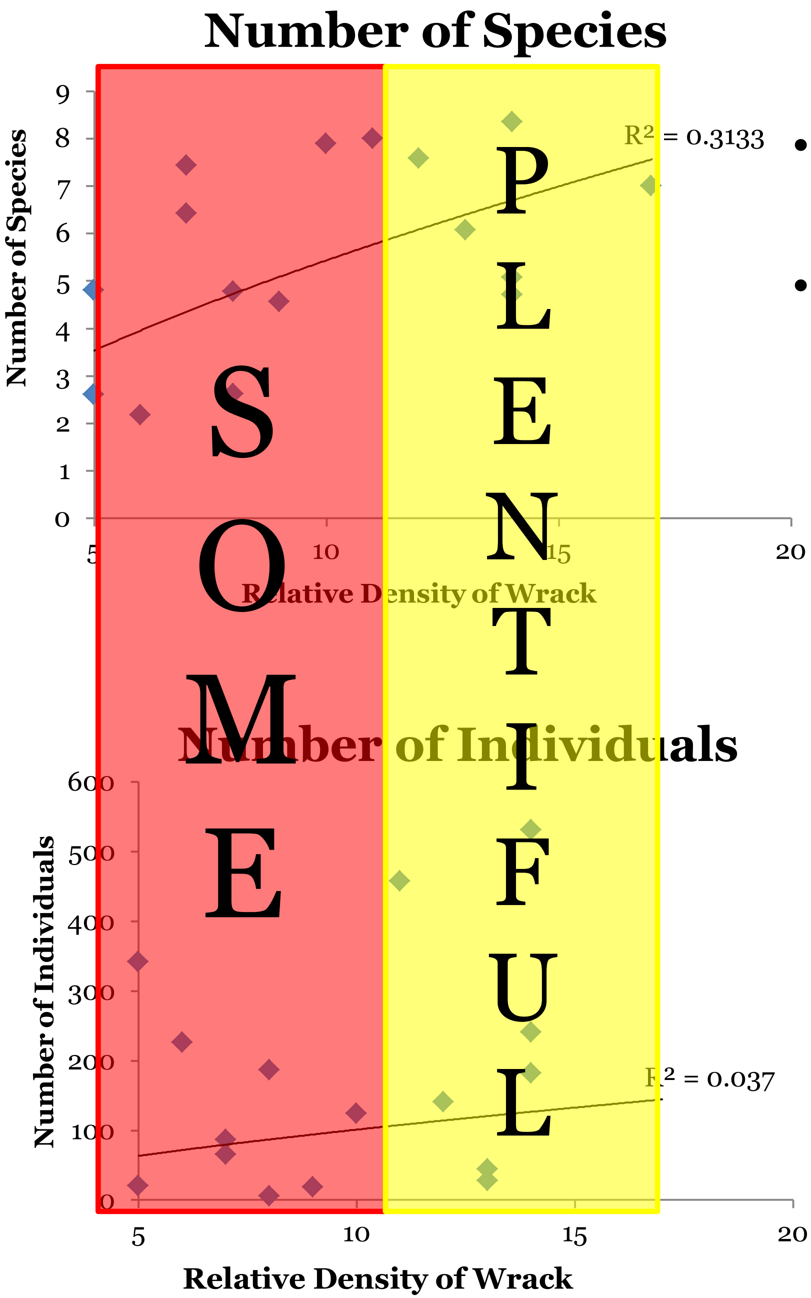
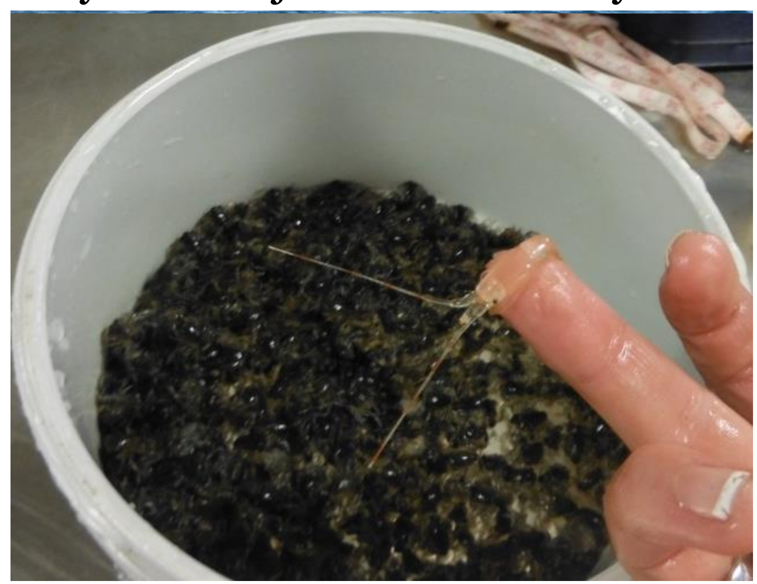


Island Biogeography theory

- Proximity of pieces of wrack to one another influences the diversity
- Large assemblages enable greater diversity

  -greater number of resources & available niches

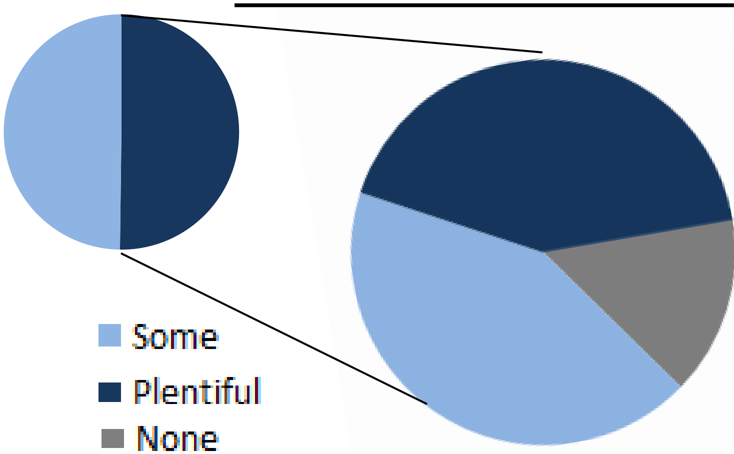
  -by chance just because they are larger



- Not influenced by amount of wrack
- community is often dominated by one or two species

Invertebrate Abundance and Diversity

Pre-Colonization



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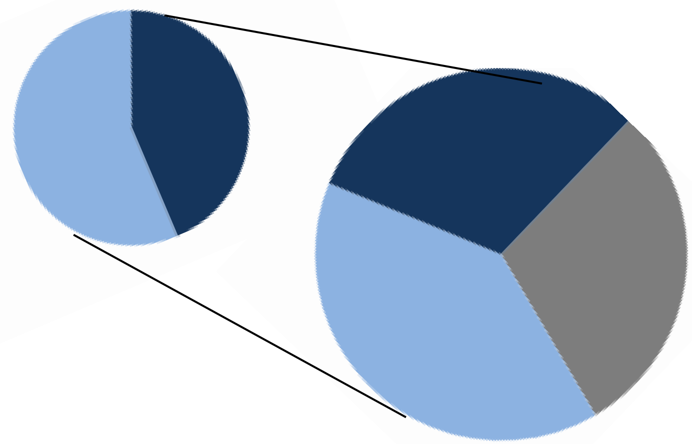
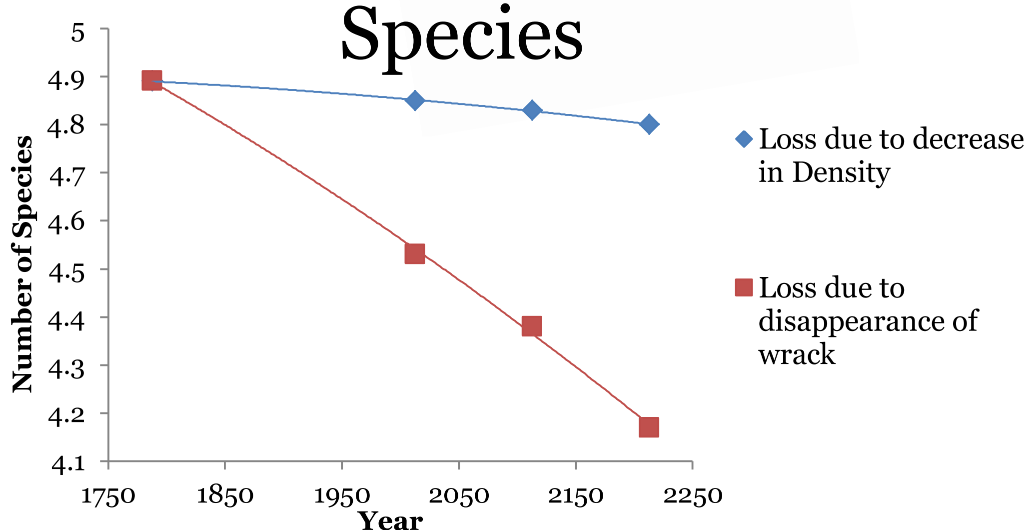
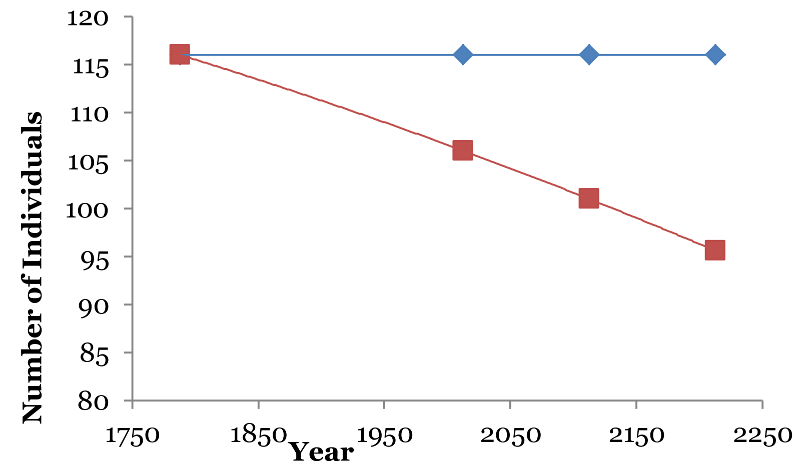


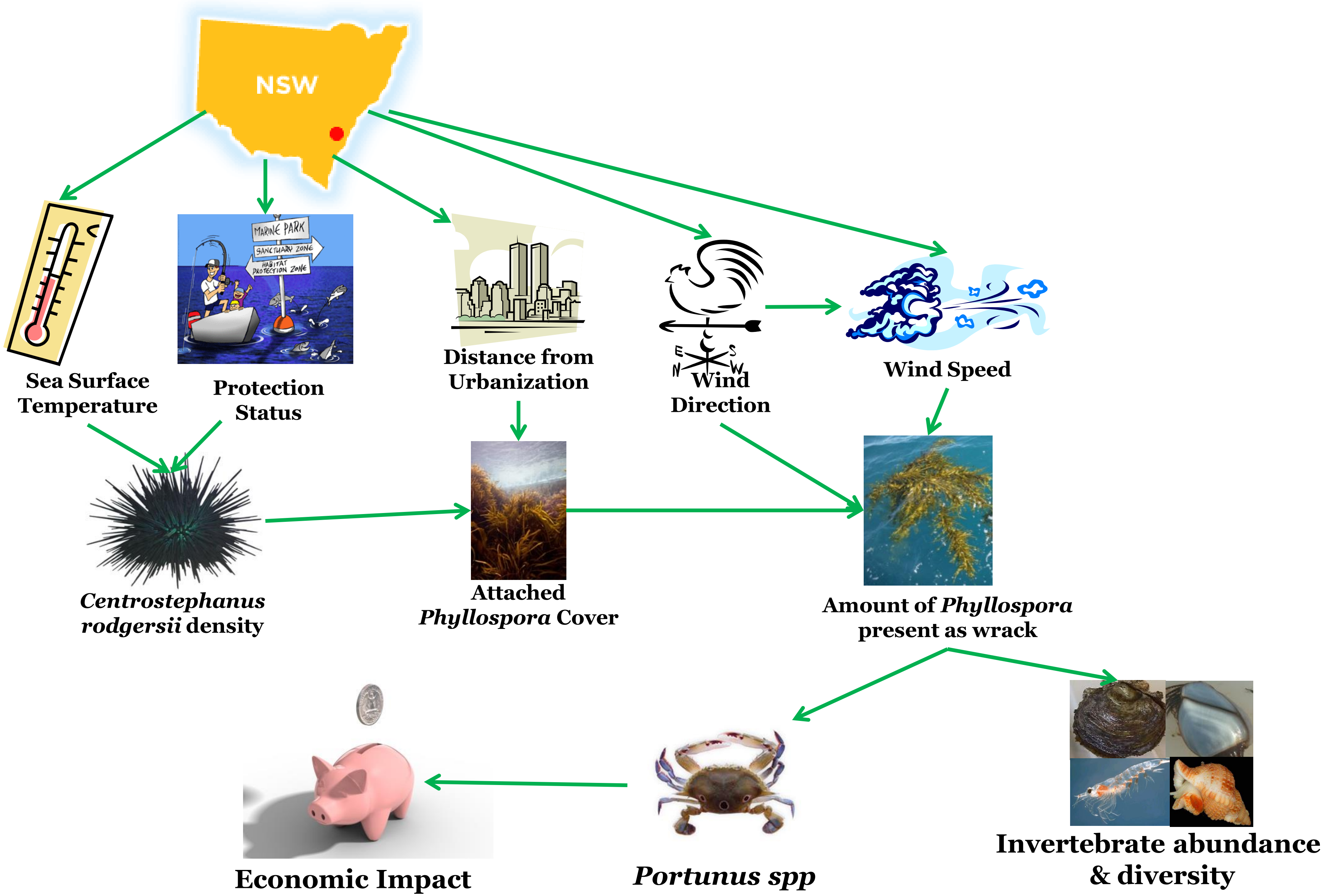
Species



Individuals

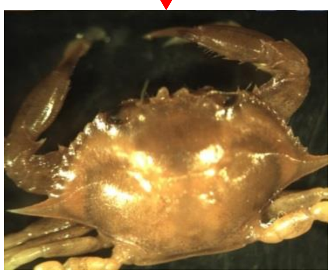


Financial impact on *Portunus* spp.



Financial impact on *Portunus* spp.

Megalopa
>5 mm



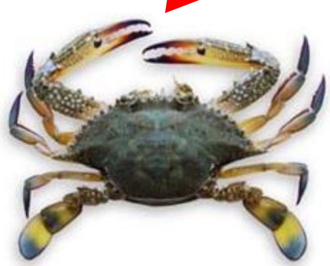
1st Juvenile Stage
≈5.6 mm

Australia-Wide Fishery

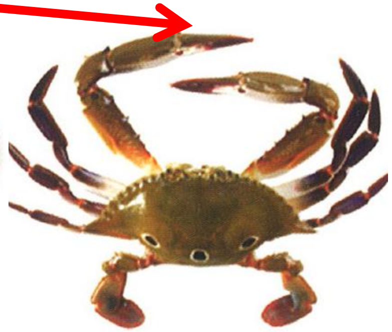
- Annual catch often in excess of 2,300 tonnes
- Valued at over $20 million per year

The NSW Fishery

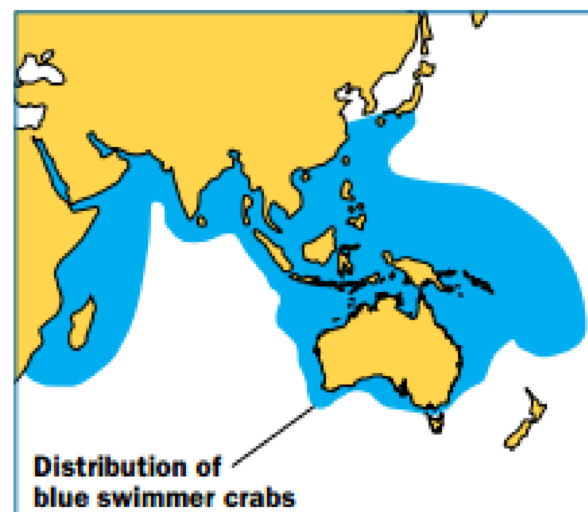
- Catch varies widely but averages 188.3 tonnes
- Valued at $1.65 million per year



Portunus pelagicus



Portunus sanguinolentus



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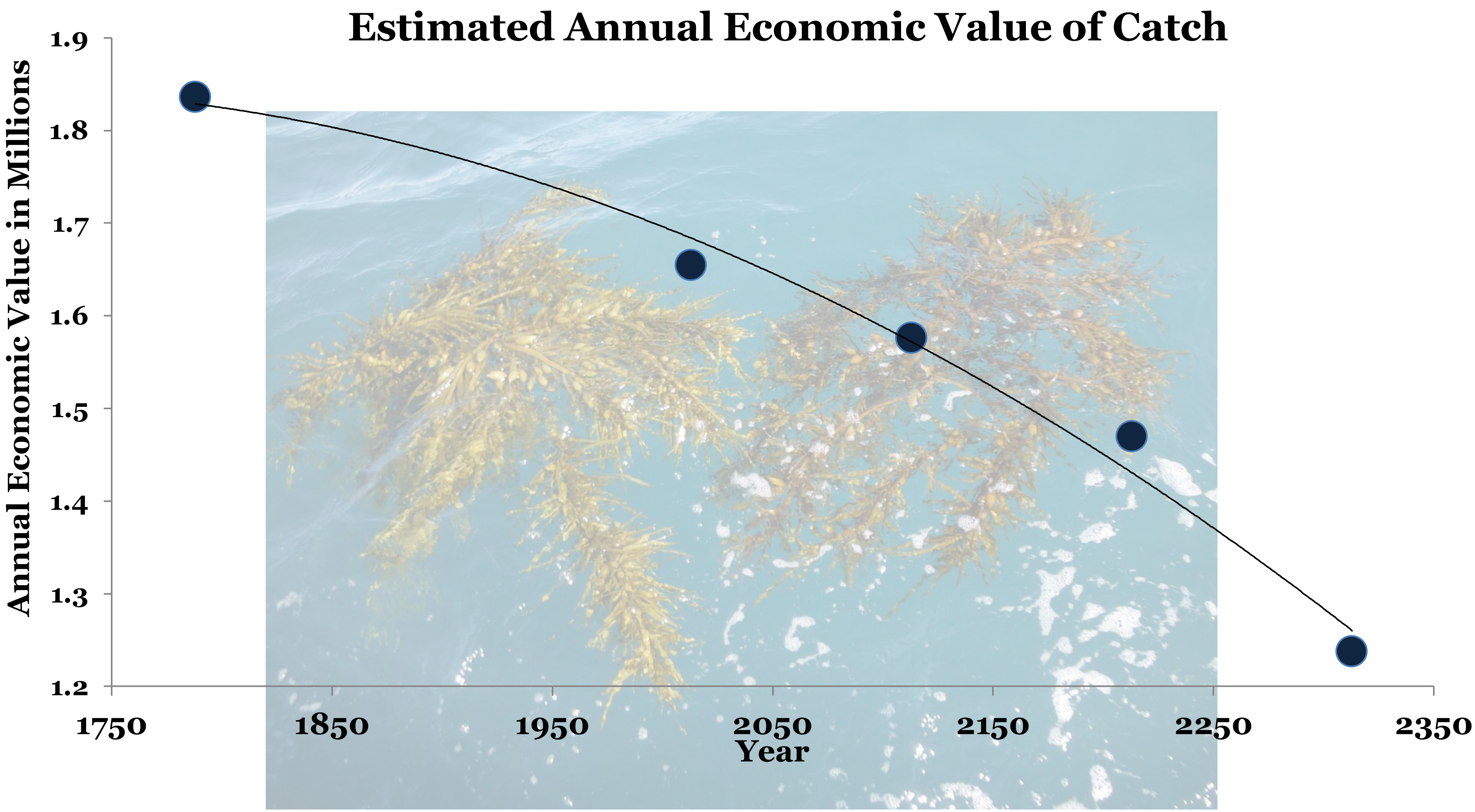
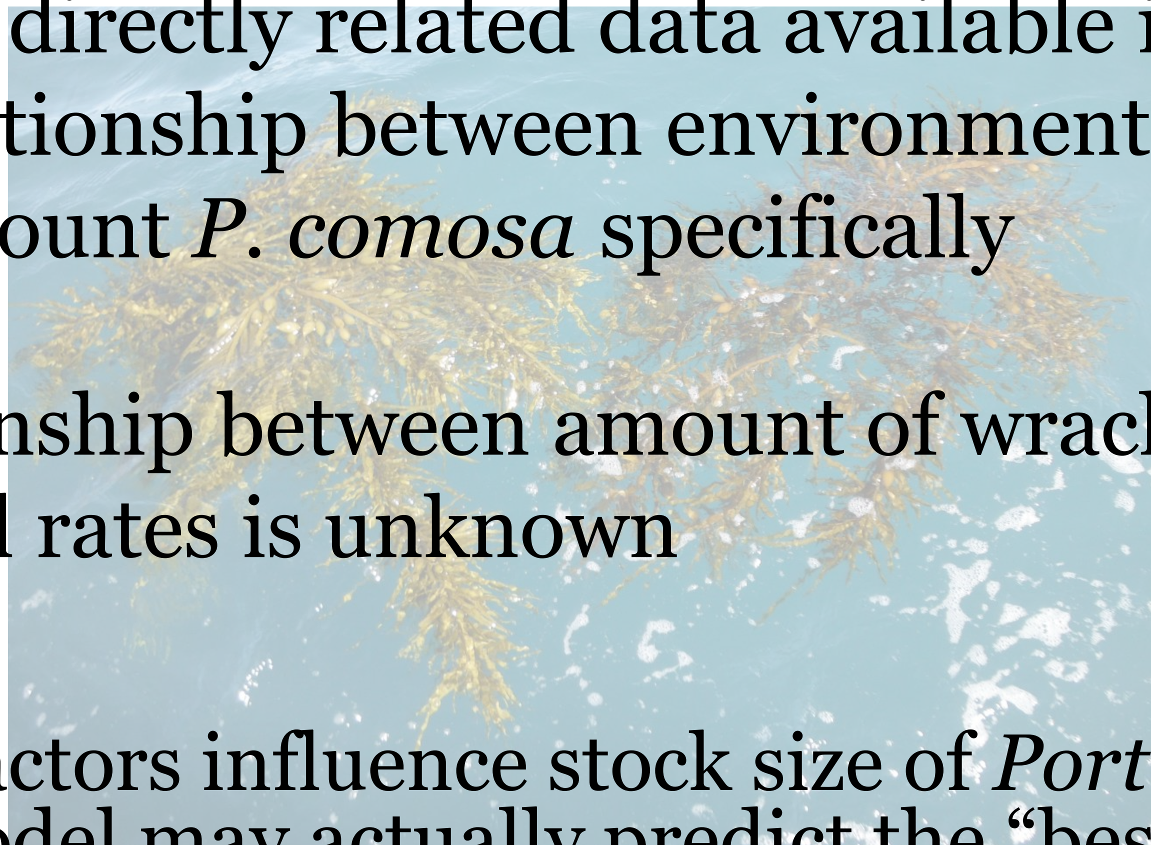


- Pre-colonization stock levels would have had an annual value of $1.8 million
- Loss of $185,000 per year by 2213 if it experiences the expected 12% decline

Current Shortcomings

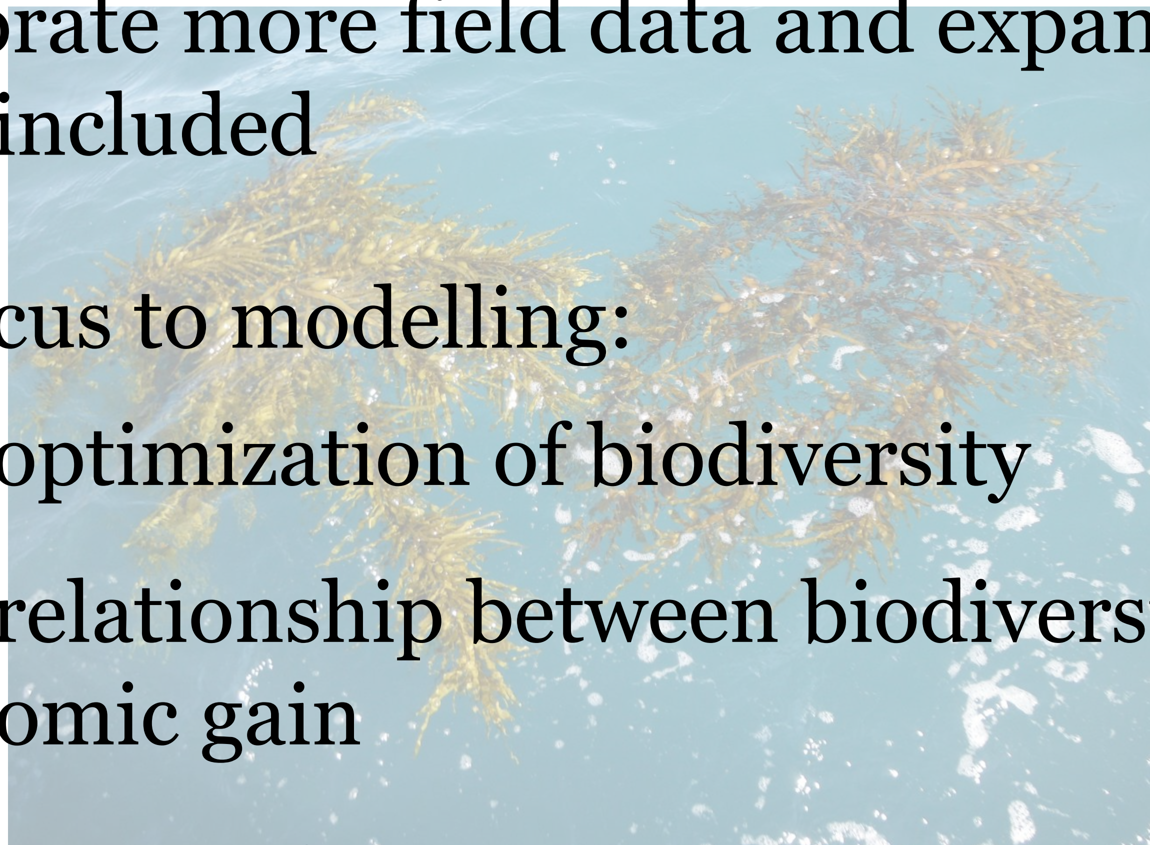


- Lack of directly related data available involving the relationship between environmental factors and amount *P. comosa* specifically

- Relationship between amount of wrack and survival rates is unknown

- Other factors influence stock size of *Portunus* spp. (this model may actually predict the "best case" scenario)

Future Direction



- Incorporate more field data and expand the factors included

- Shift focus to modelling:

  -the optimization of biodiversity

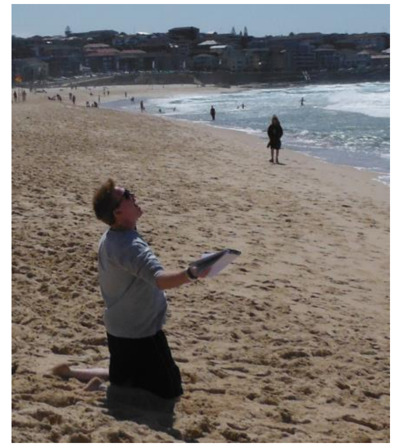
  -the relationship between biodiversity and economic gain

  -the impact of environmental protection status

Thank You!

Supervisor: Andy Davis

Trent Penman



All of my field volunteers

The ABNMS for this opportunity!

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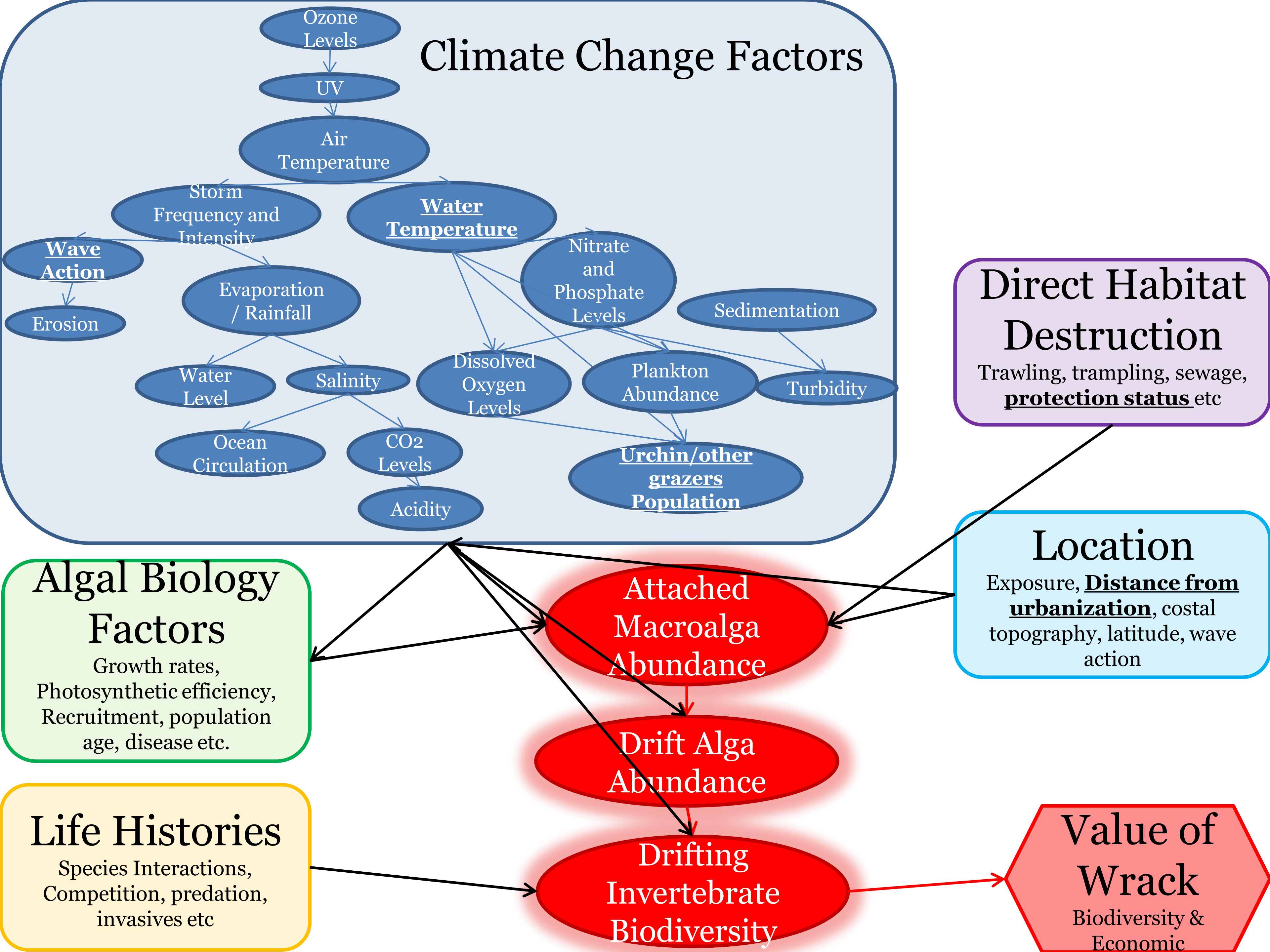

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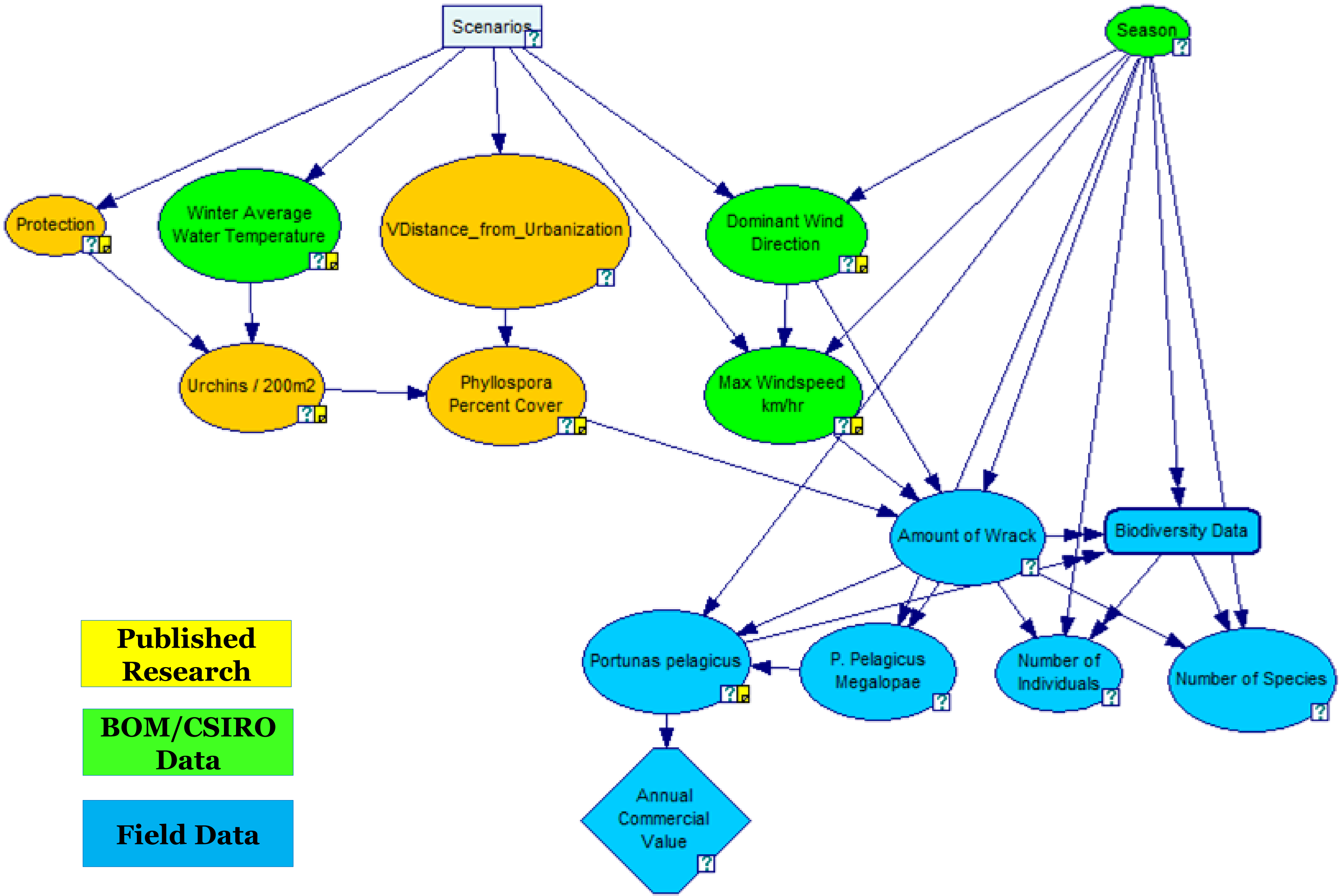

Published Research

BOM/CSIRO Data

Field Data