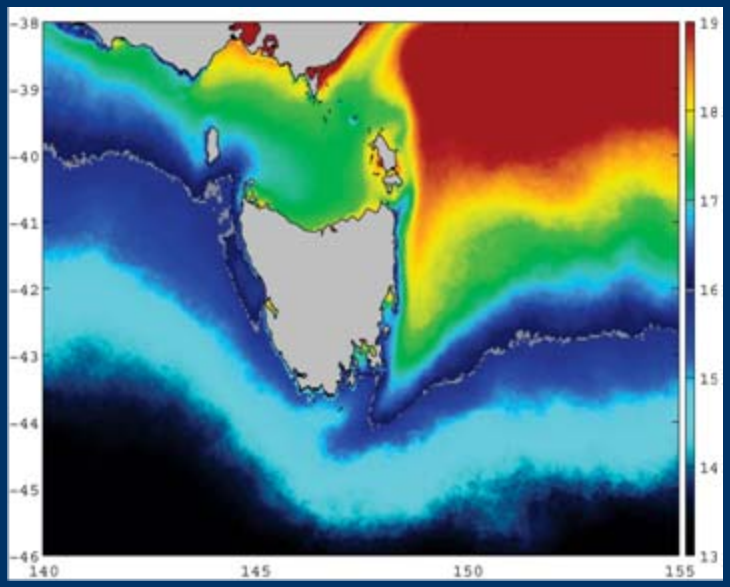
Fisheries and ecosystems in a changing climate: a case study on the Tasmanian east coast lobster fishery.



tafi
Tasmanian Aquaculture and Fisheries Institute

UTAS

Tasmania
Explore the possibilities

Australian Government
Department of Climate Change

TAFI is a joint venture between the State Government and the University of Tasmania

East Coast, Tasmania – an assessment of climate change impacts on east coast rock lobster

Case study to support a 'first pass' National Climate Change Coastal Vulnerability Assessment (NCVA)

Stewart Frusher, Gretta Pecl, Caleb Gardner, Marcus Haward, Alistair Hobday, Sarah Jennings, Melissa Nursey-Bray, Hilary Revill, Andre Punt, Ingrid van Putten

AMC
AUSTRALIAN MARITIME COLLEGE

UTAS

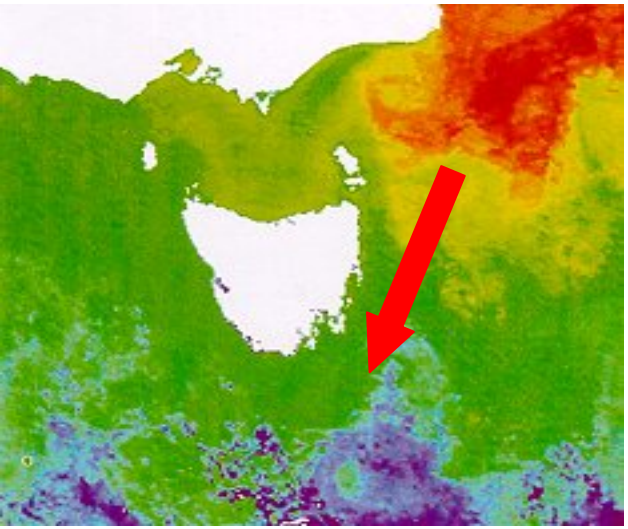
Tasmania
Explore the possibilities

tafi
Tasmanian Aquaculture and Fisheries Institute

National Research FLAGSHIPS
Climate Adaptation

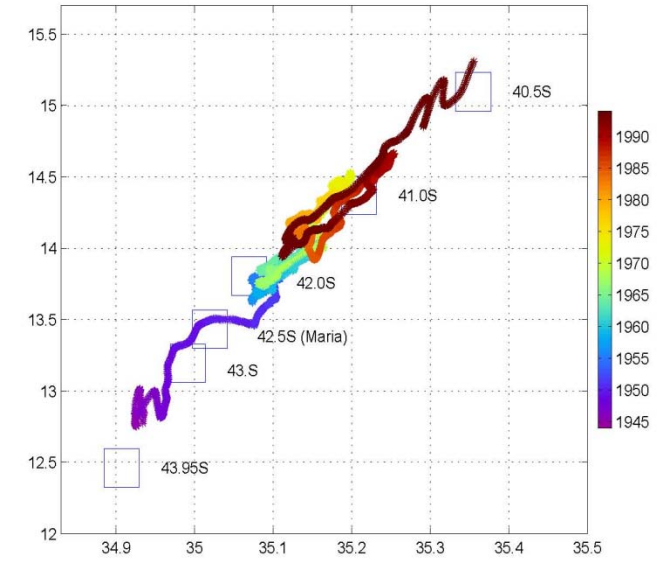
CSIRO

Climate change in Tasmania



SE Australia is predicted to be the fastest warming region in the southern hemisphere

Water temperature predicted to rise by 3^0C to 5^0C

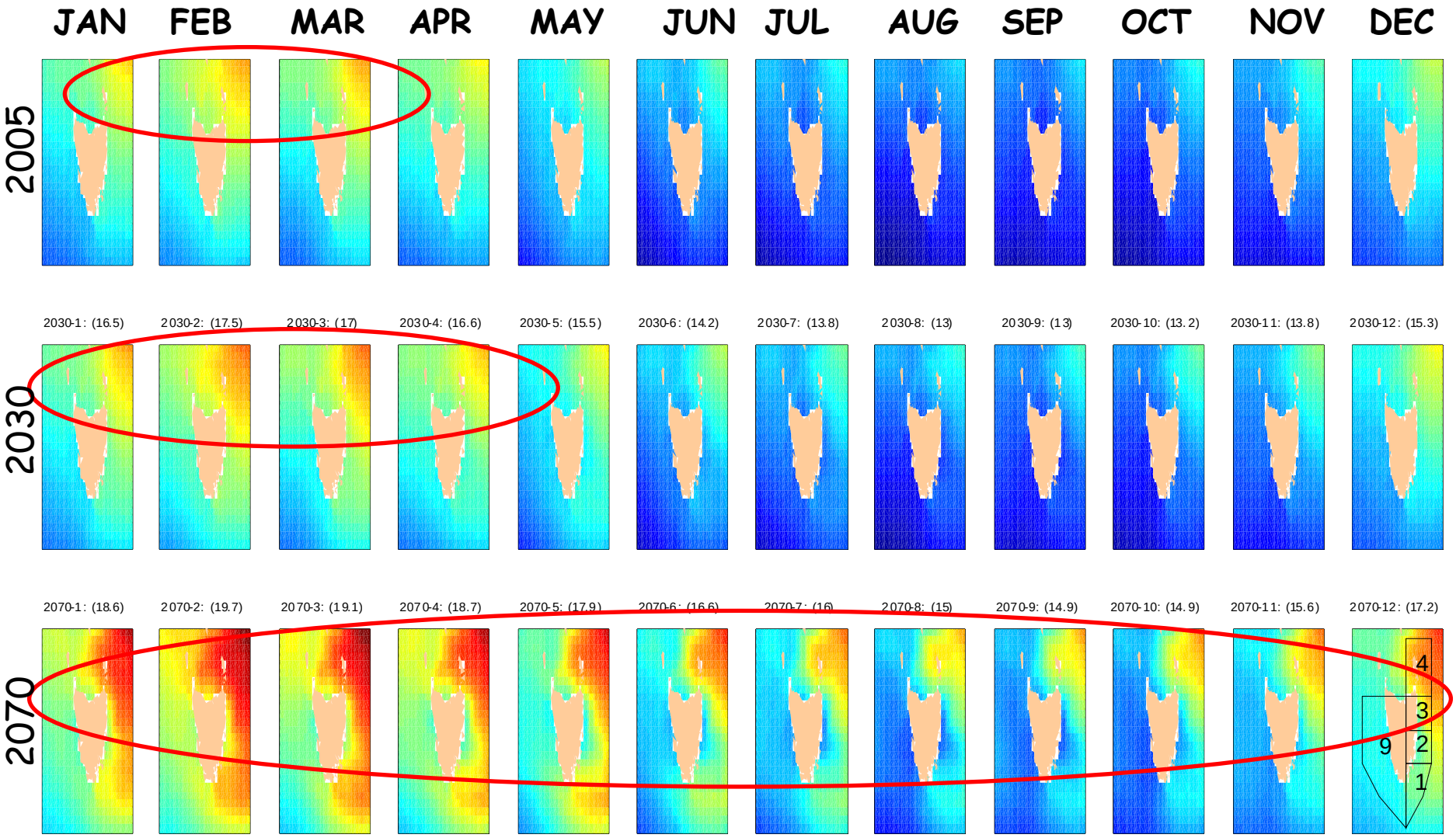


K.Hill et al (2008)

Increase in strength and southern penetration of East Australian Current

PROVIDES AN EARLY WARNING OF POTENTIAL IMPACTS

High scenario



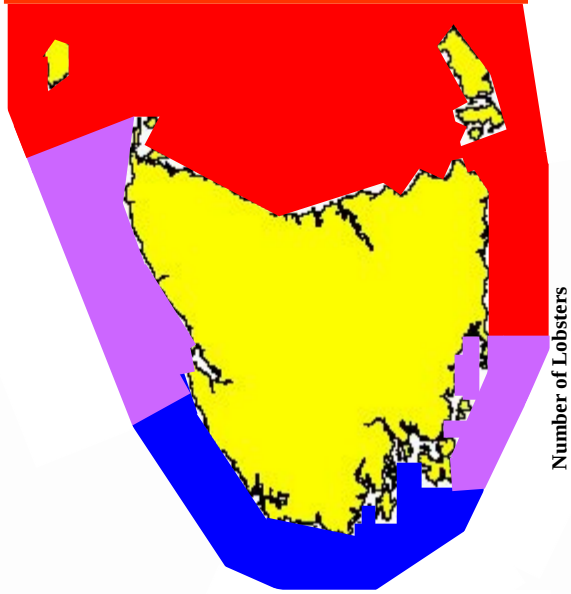
A Hobday

(24 mm CL/yr) Growth ↑

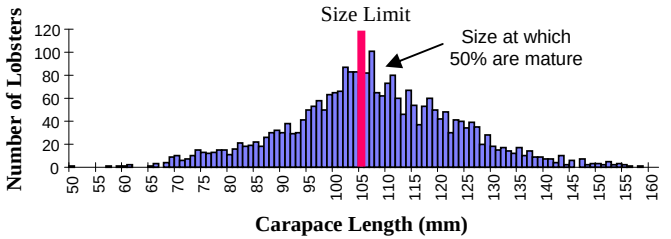
Recruitment ↓

Catch rate undersized ↓ < 2

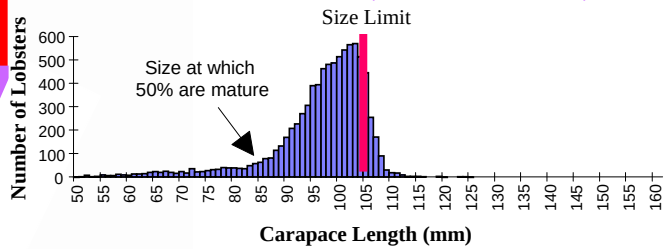
Size at maturity ↑
(105-115 mm CL)



Northern Tasmania (35 to 55 metres)



Eastern Tasmania (35 to 45 metres)



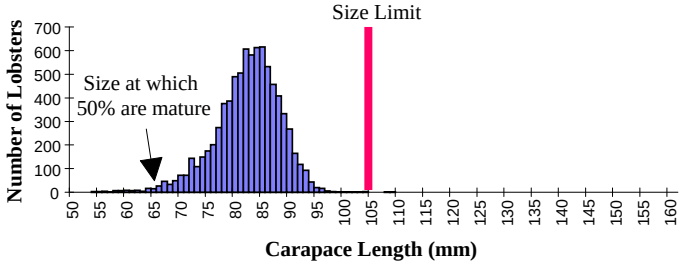
(5 mm CL/yr) Growth ↓

Recruitment ↑

Catch rate undersized ↑ > 40

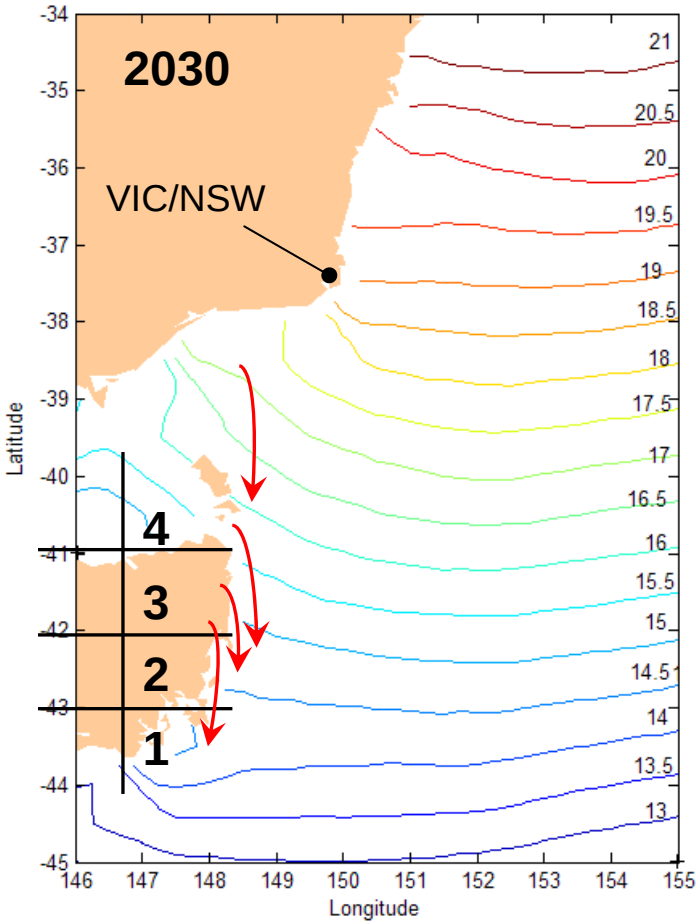
Size at maturity ↓
(65 – 75 mm CL)

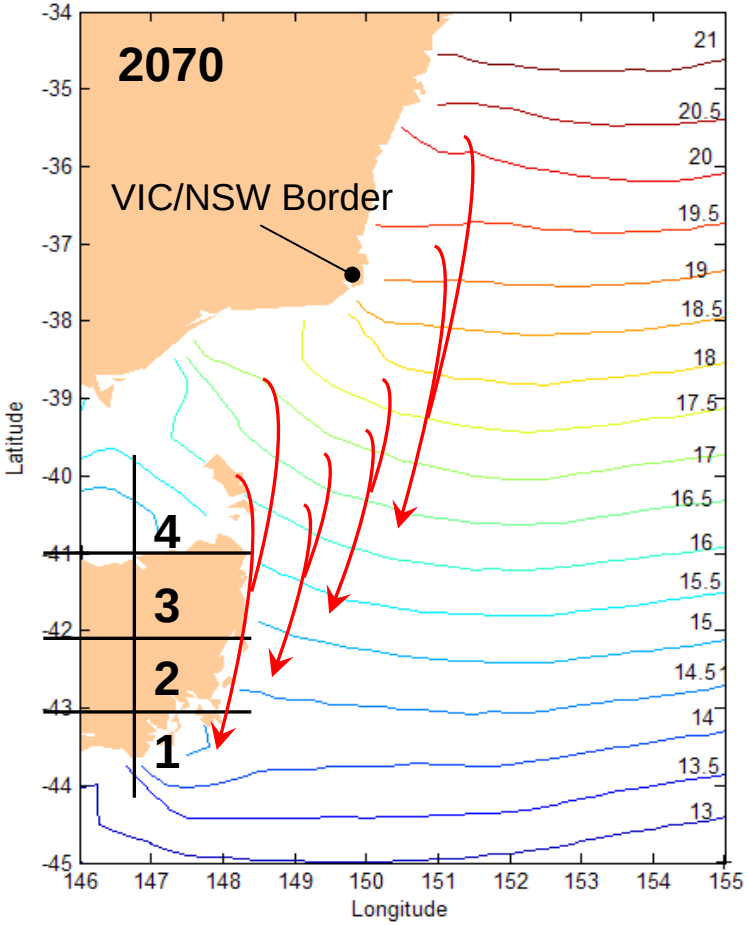
Southern Tasmania (45 to 70 metres)



Productivity - ecosystem

Water temperature* – *environmental envelopes



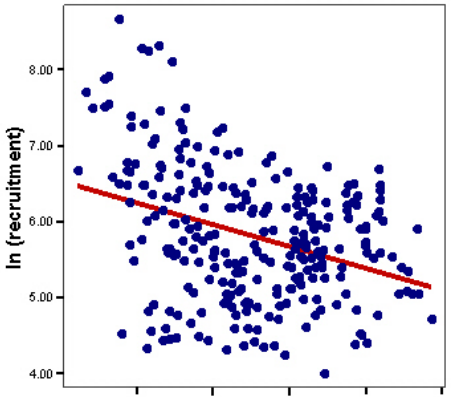


Northern waters have lower productivity

Productivity – fishery recruitment

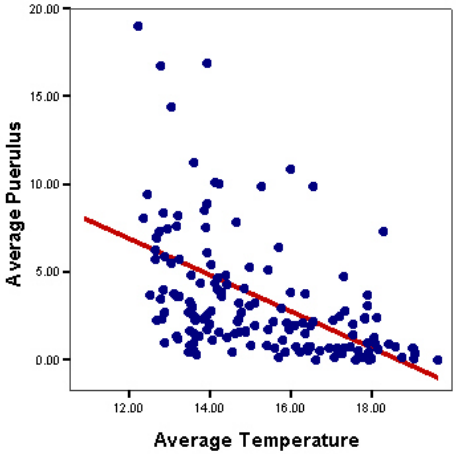
Assessment model hindcast estimates

- 8 assessment areas since 1970
- Based on recruitment to fishery (legal size class)



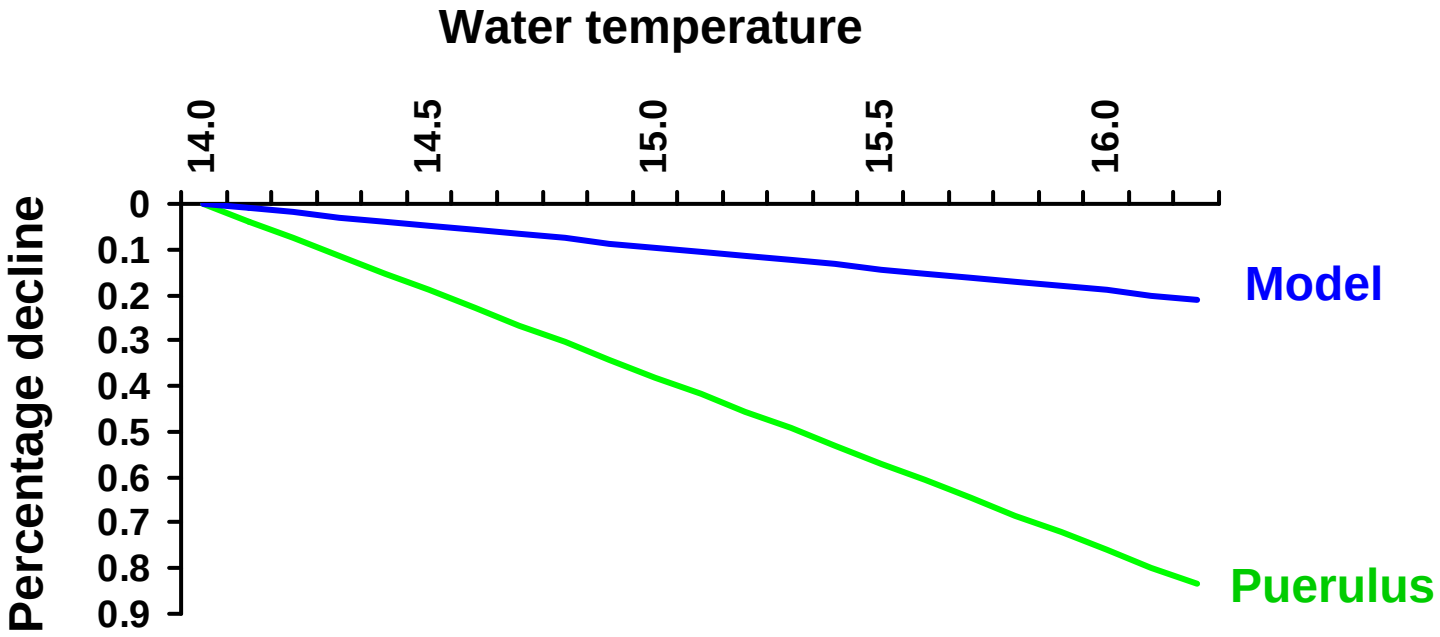
Observed larval (puerulus) settlement

- Monitored since 1991
- 3 East Coast sites



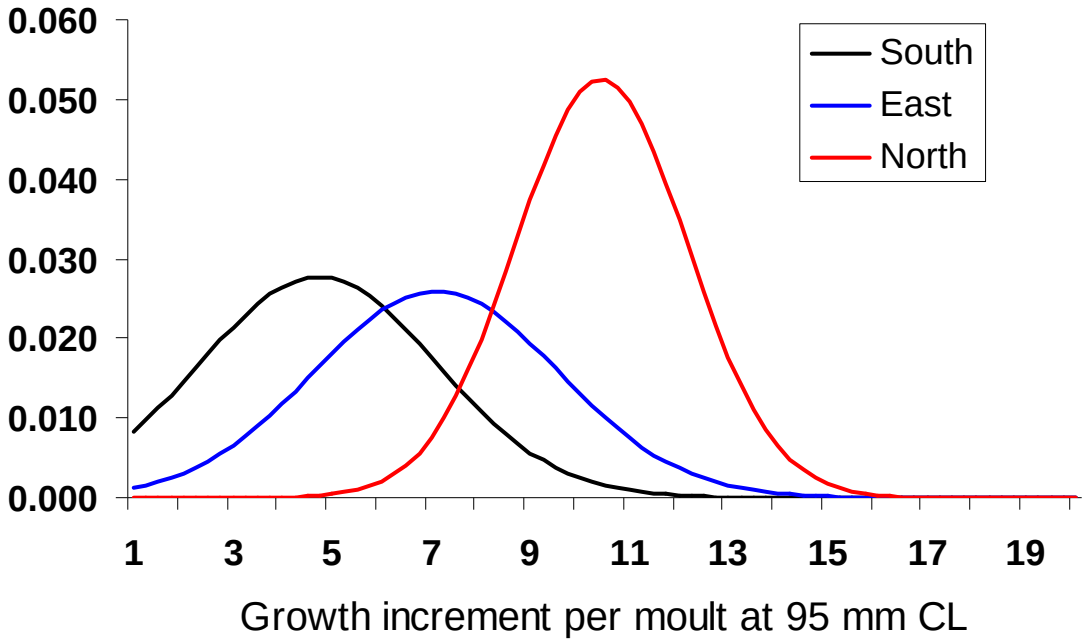
As temperature goes up, both recruitment (estimated from modelled log book data) AND settlement decline

Comparison between the percentage decline in observed **puerulus settlement** trends at Bicheno and estimated **model recruitment** trends for Area 3.



- Model estimated recruitment shows a slower decline with temperature.
- Reality may be somewhere between both.

Productivity – growth

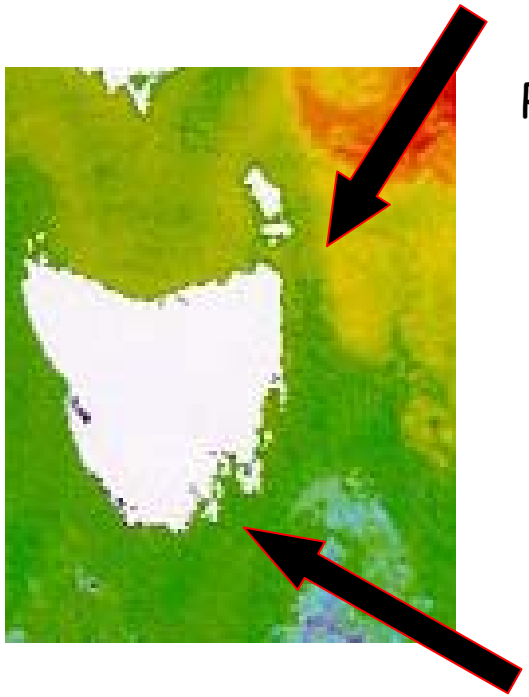


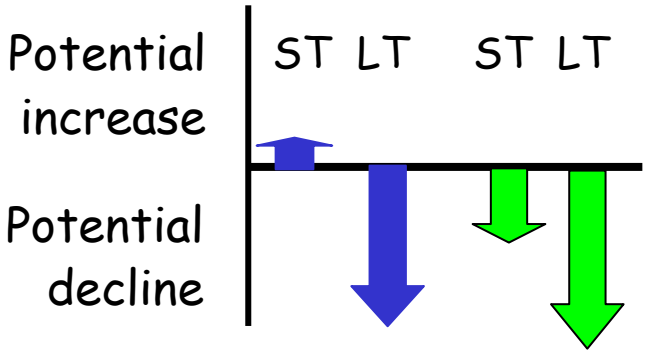
- Northern lobsters grow twice as fast as southern lobsters per moult
- At 95 mm CL, northern lobsters moult twice/year
- At 95 mm CL, southern and eastern lobsters moult once/year

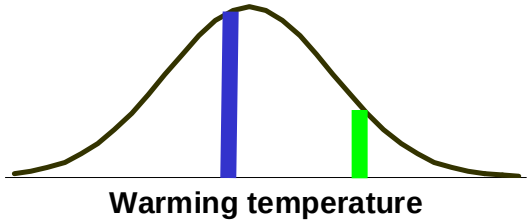
Annual Growth Rate $_{(north)}$ = 4 x Annual Growth Rate $_{(south)}$

Growth and recruitment capacity

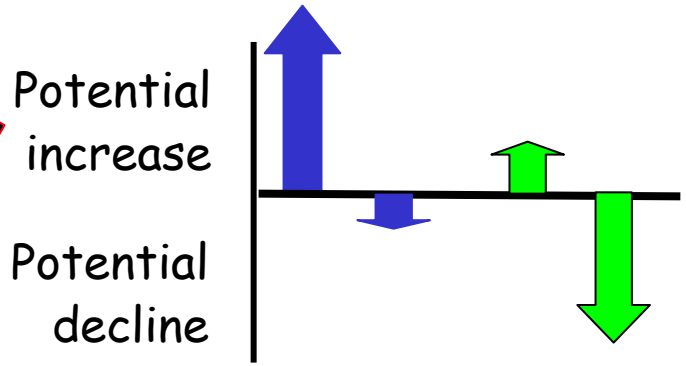
ST = Short term, LT = Long term

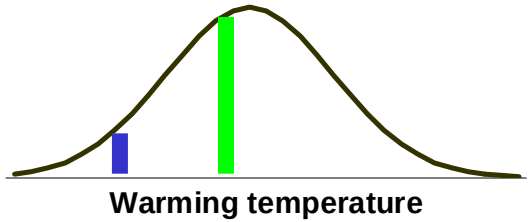






Growth Recruitment

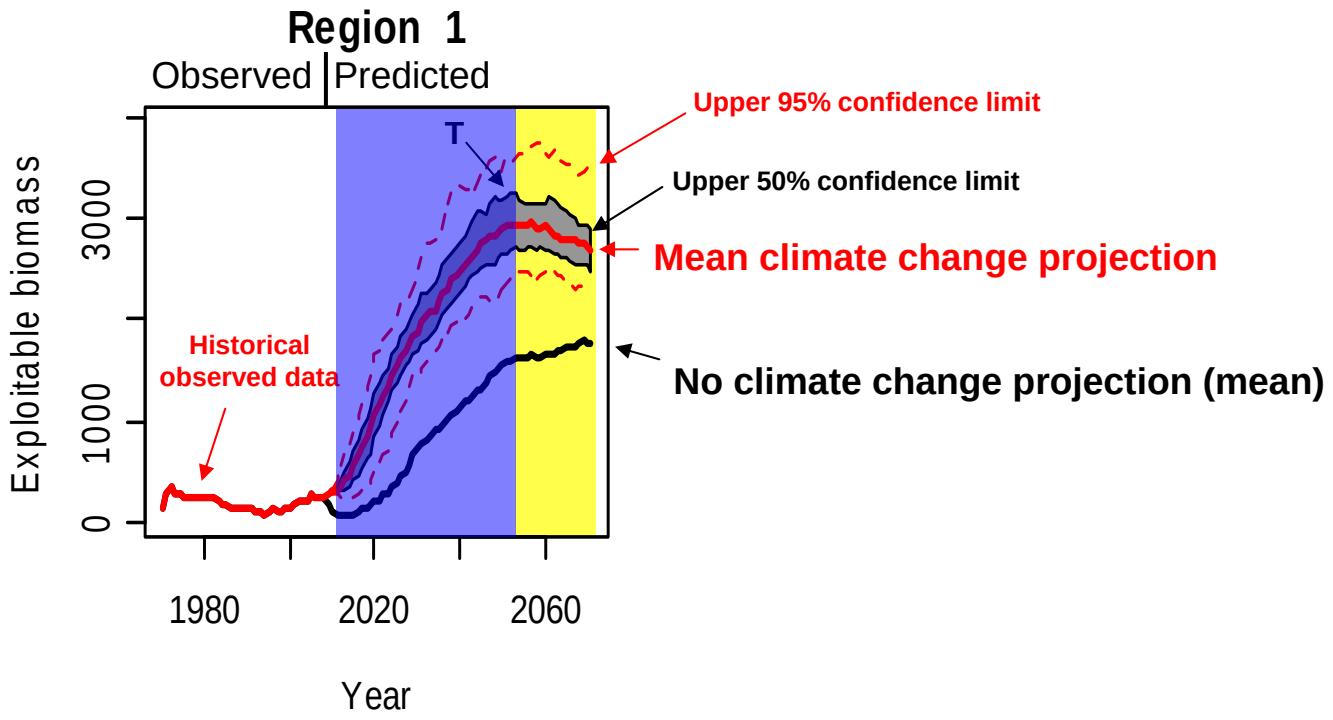




Predicted impacts as warmer waters push further south

Increases in growth >>> declines in recruitment

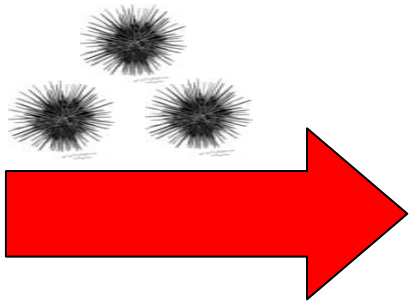
T = transition or tipping point

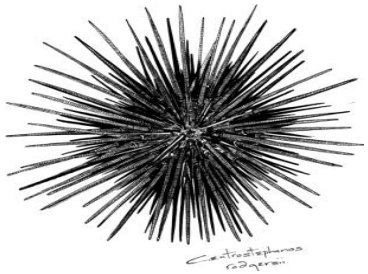


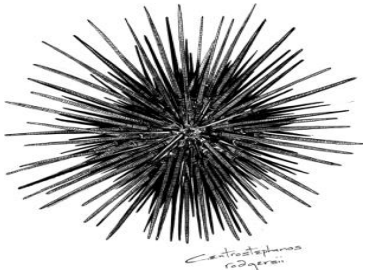
Increases in growth <<< declines in recruitment

Ecosystem issues:

Centrostephanus rodgersii

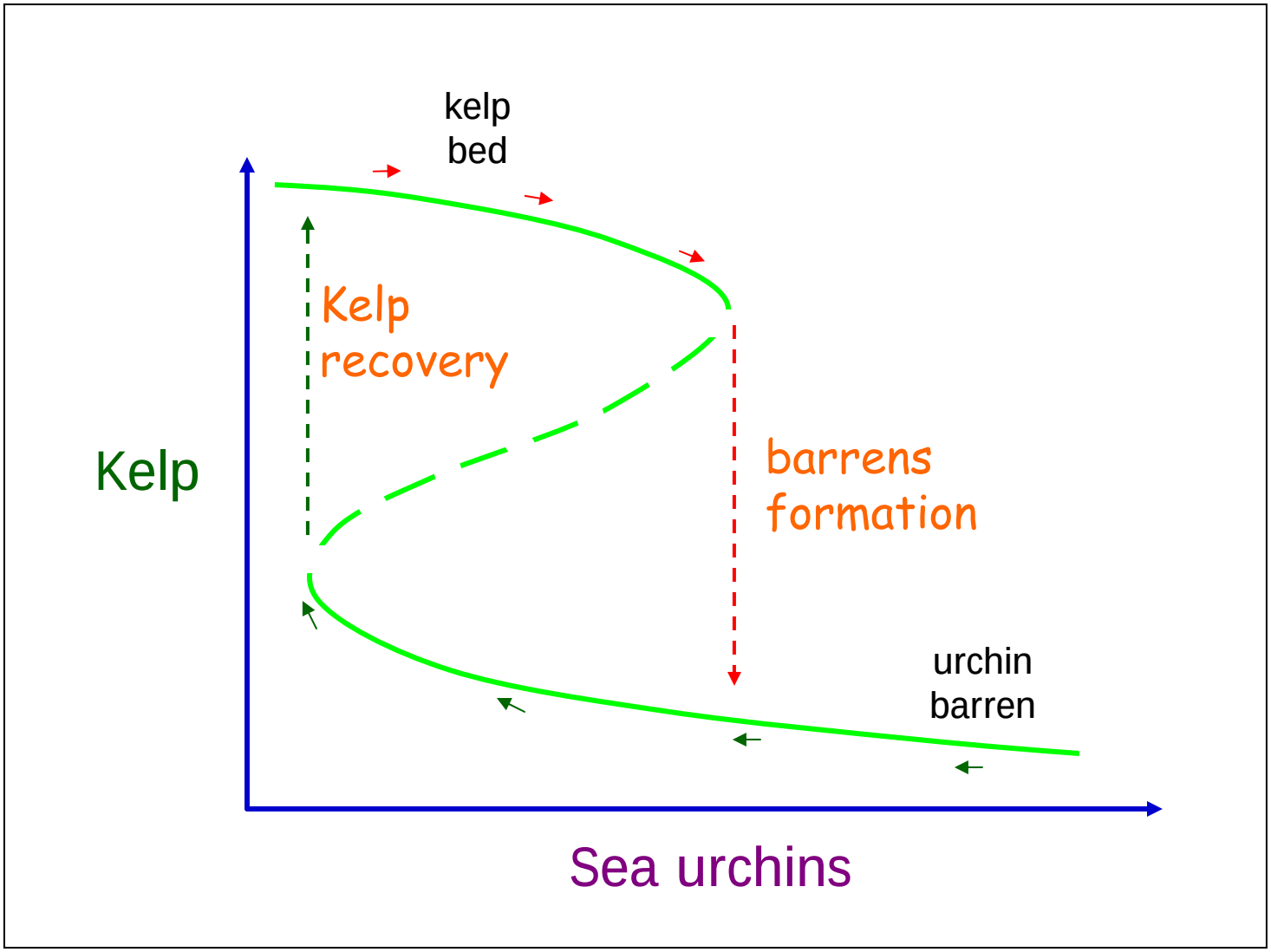






>12^{o}C during winter (August)

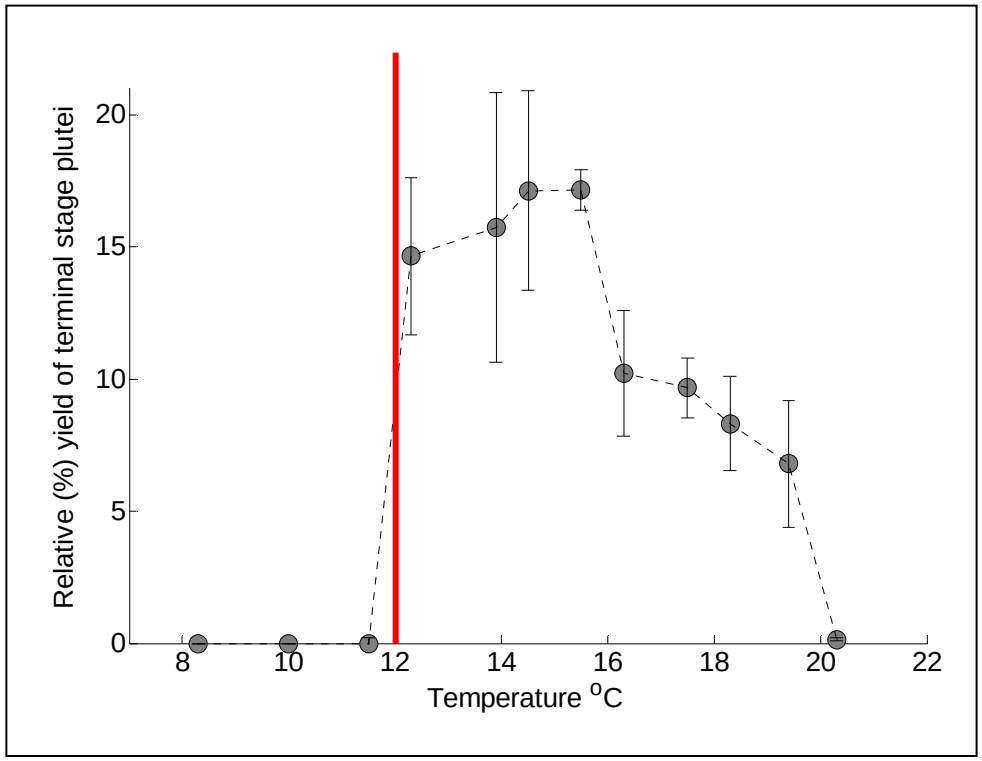
Kelp bed vs Barren – an ecological hysteresis



Hitch-hikers or population exploders!

Do they survive when they get here?

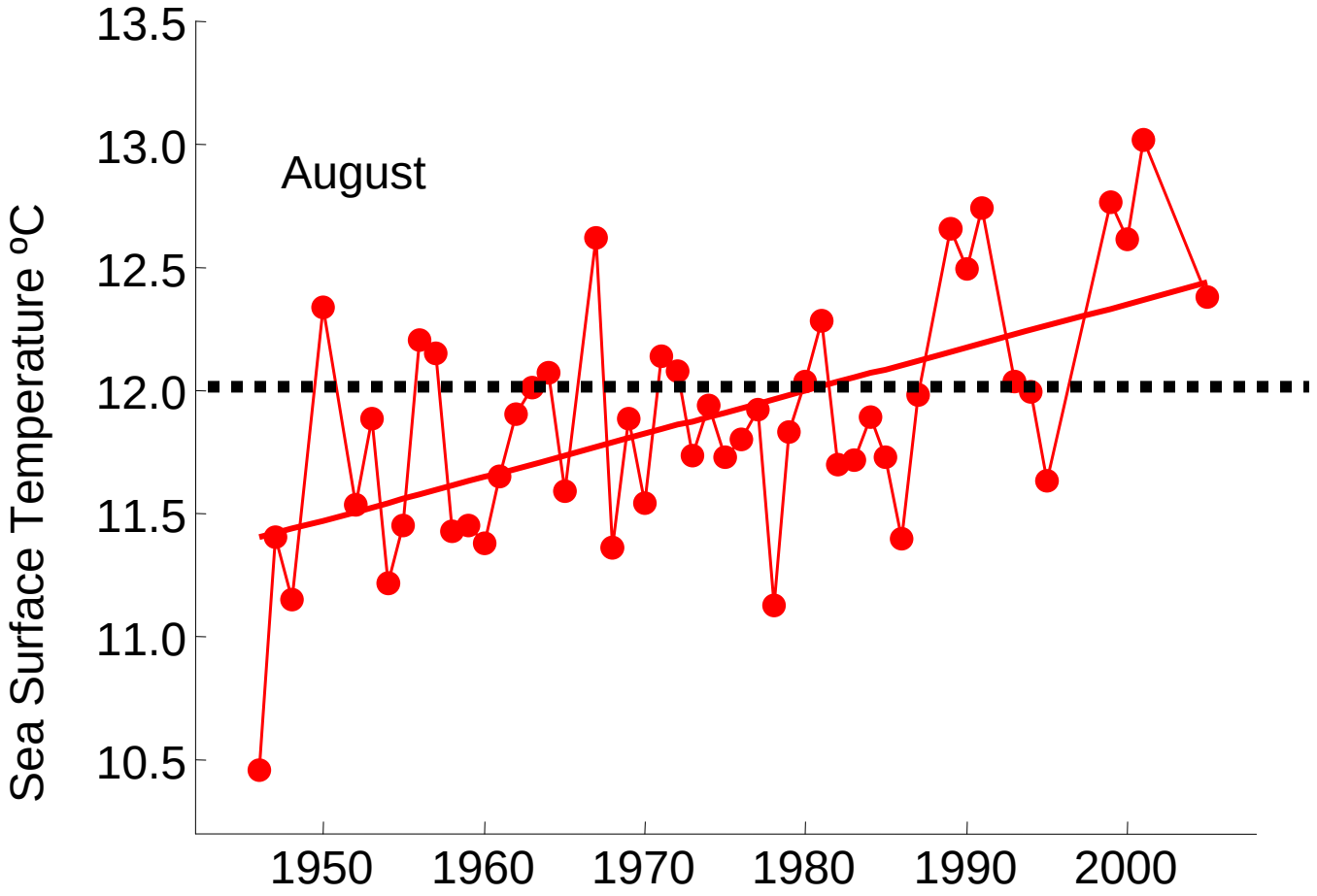
Temperature-specific development of *Centrostephanus rodgersii* larvae



Spawning period is winter (August/September)

Larvae do not complete development when winter temperatures below 12°C

Ling, Johnson, Frusher & King (2008)



Environment increasingly favourable for *C. rodgersii* to complete life cycle in Tasmania = increasing risk of further 'barrens'

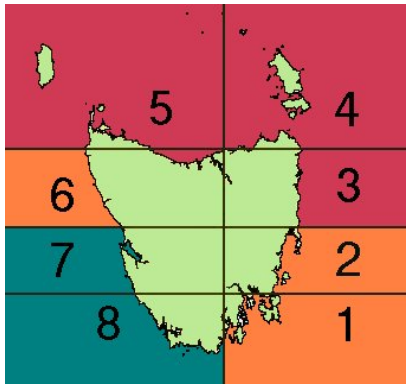
Ling, Johnson, Frusher & King (2008)

Ecosystem issues

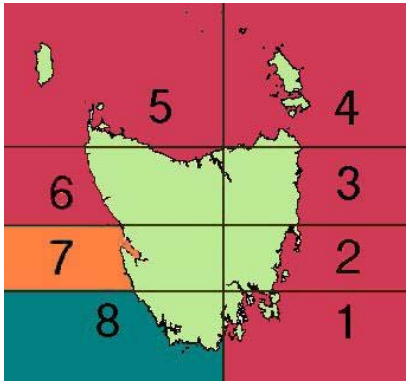
Average winter (August) water temperatures

- **Greater than 12.5^{0}C**
- **Between 12^{0}C & 12.5^{0}C**
- **Less than 12^{0}C**

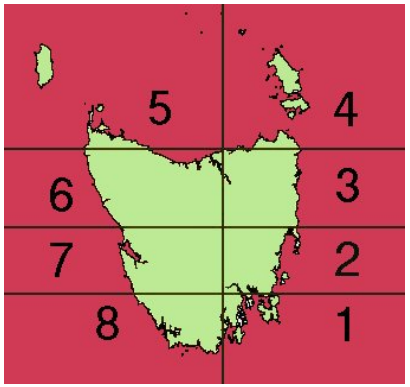
Now



2025

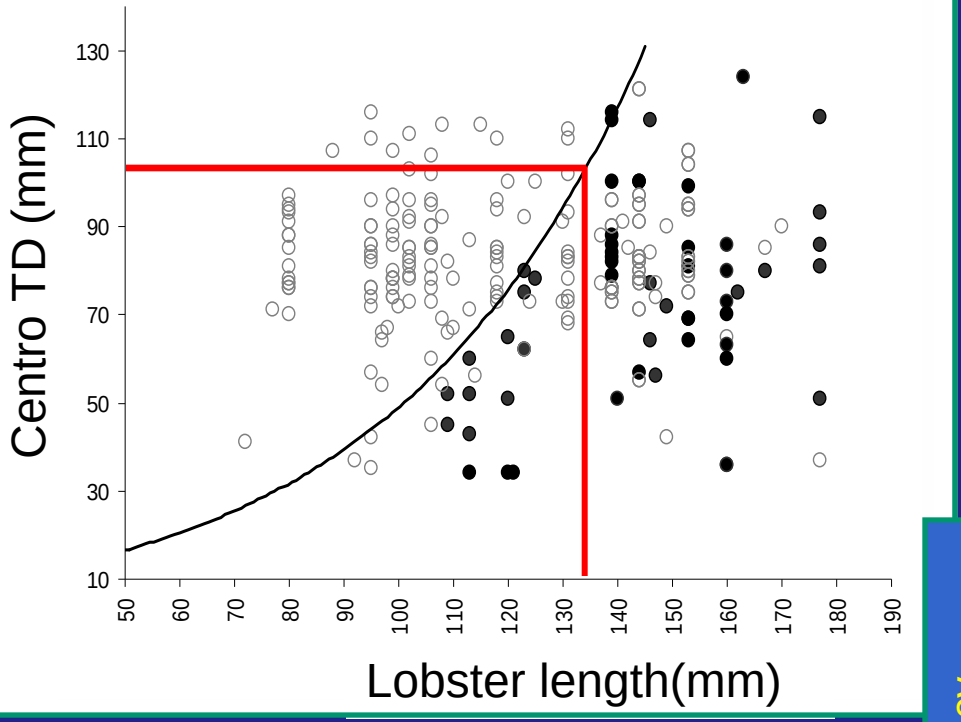


2055

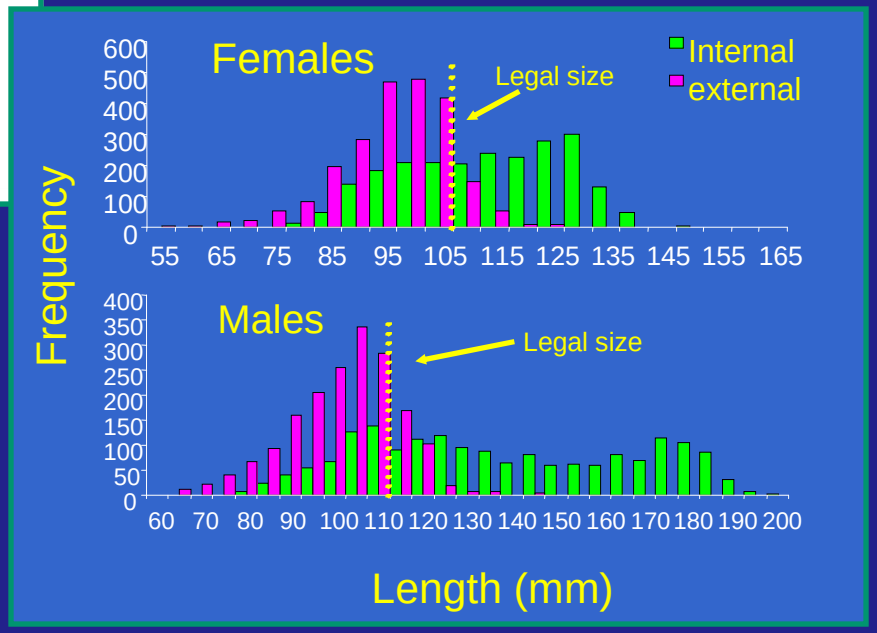


Large lobsters (> 25 mm CL above the legal size limit) are predators of *Centrostephanus.*

Towards climate change adaptation

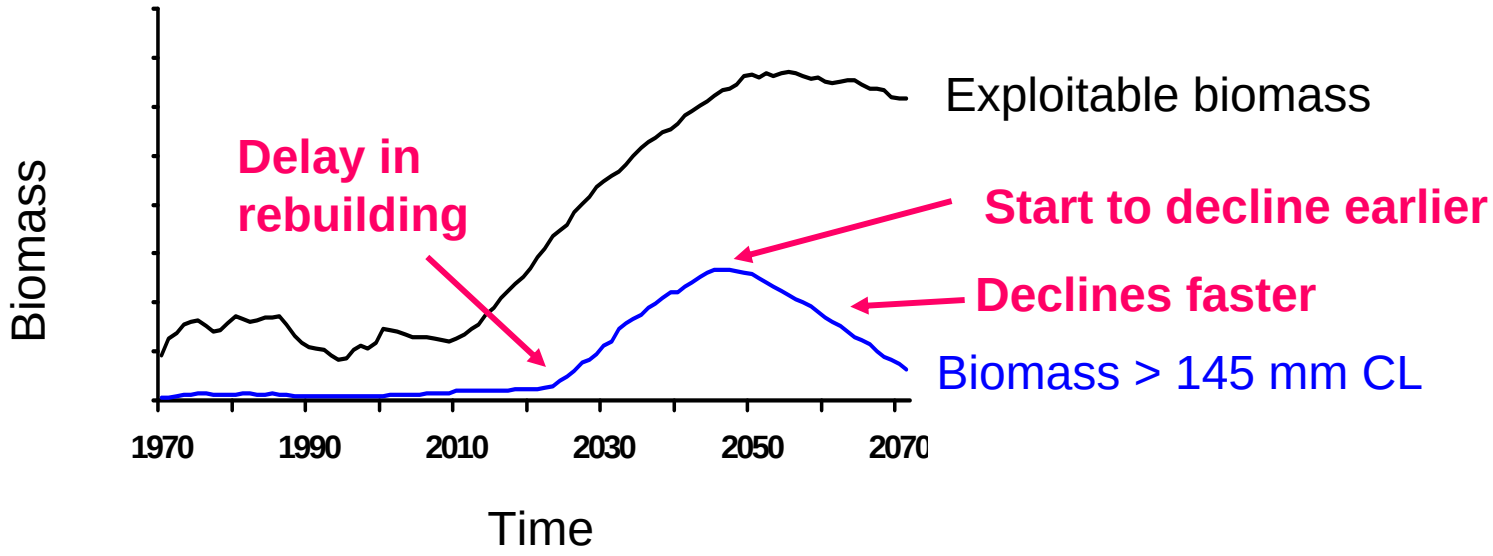


Relationship between lobsters (predator) and urchins (prey)



Length frequency of lobsters inside and external to the Maria Island MPA

Large lobsters – longer time to become established and first groups to be impacted



Need to protect large lobsters (and enable recruitment to large lobster size class)

Maximum size limits / spatial management

Commercial and recreational implications

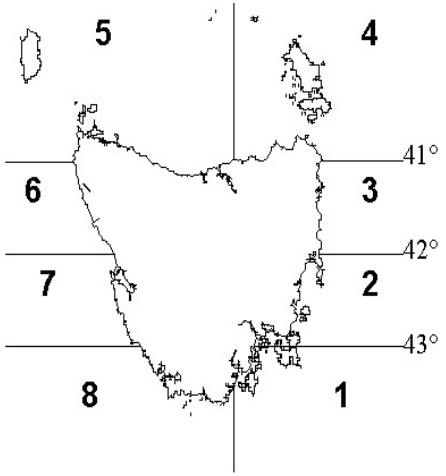
Ecosystem surprises!!

+ 0.41

+ 0.33

+ 0.22

+ 0.42



+ 0.55

+ 0.62

+ 0.70

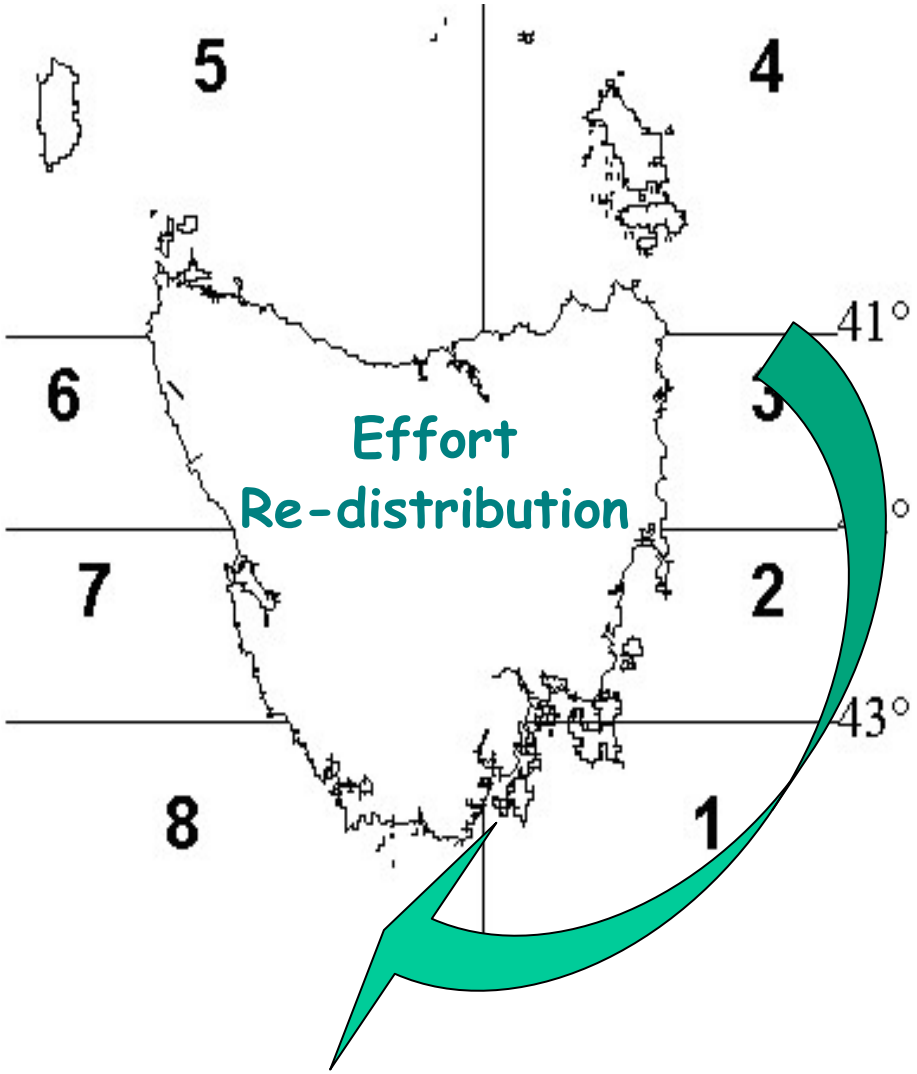
+ 0.69

- Catches recorded in lobster fisher's logbooks

- +ve correlation between increased number in traps and water temp
    - Across all regions
    - Greater on east coast

- New species invasion (*Octopus tetricus*)

Social and economic implications



Identified increased need for spatial management options (control of effort in SW)

Need for inshore management options for recreational fishery

Recognition of the need to manage ecosystems for resilience

Climate change impacts will result in a change in the goods and services provided by ecosystems for future generations.

By understanding the longer term impacts of climate change on our natural resources **and** the vulnerability of these resources to provide ecosystem goods and services, we should be able to make decisions **today** that provide improved opportunities for intergenerational equity in marine resource utilization than by making climate change tomorrow's decision.