Ingrid van Putten (CSIRO)

Sarah Metcalf (Murdoch University)
Stewart Frusher (IMAS – University of Tasmania)
Malcolm Tull (Murdoch University)
Nadine Marshall (CSIRO)
Nick Caputi,
Marcus Haward,
Alistair Hobday,
Neil Holbrook,
Sarah Jennings,
Gretta Pecl,
Jenny Shaw

Measuring the vulnerability of marine socio-ecological systems to climate impacts

A prerequisite for the identification of climate change adaptations in coastal communities

www.csiro.au

www.marinehotspots.org

Project rationale

Many small coastal communities are dependent on marine sectors

Marine sectors have been, or are likely to be, impacted by changes in the marine environment (due to climate change)

This is likely to continue

Find out how well communities might cope - based on what we can tell from their vulnerability …. and what they might do to adapt to climate impacts

Aim

To measure the vulnerability of (coastal) marine socio-ecological systems and identify adaptation options

Integrate the bio-physical with the human dimension of marine climate change

Focussing on

Small coastal communities (<30K residents)

Depending on the which State in Australia - up to 30% of people live in these small coastal communities (van Putten et al 2041)

Marine sectors (recreational and commercial fishing, aquaculture, marine tourism, charter fishing)

Proportion of that work in this sector is (on average) higher in small coastal communities

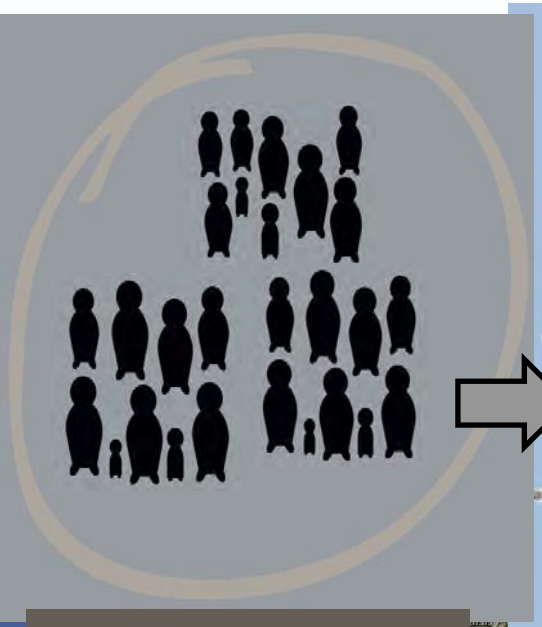
Ingrid van Putten, Sarah Metcalf, Stewart Frusher, Nadine Marshall, Malcolm Tull (2014) Transformation of coastal Communities: Where is the marine sector heading? *Australasian Journal of Regional Studies* **20(2)**, p286-324.

What we did

52 semi-structured face to face surveys
(1-2 hours each)

People from marine sectors

Where we went



Large size coastal community

Between 15,000 – 30,000 people

Surveys in 3 Australian case study coastal communities

Medium size coastal community

Between 5,000 – 15,000 people

Small size coastal community

up to 5,000 people

What we asked

What changes community members had seen (from past till now)

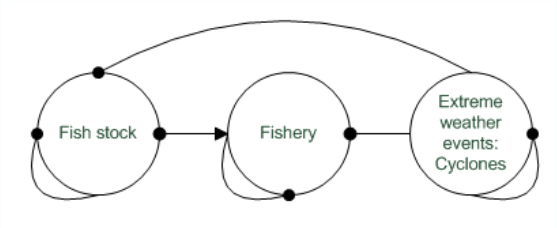
What they thought caused the change (what they attributed it to)

What they had done to deal with the changes
(and what contributed to their adaptation)

What they expected for the future
(what might they do about dealing with any new challenges)

What they said

- They had observed various changes in the marine environment (significant Local Ecological Knowledge)
- They were able to explain the reasons for the changes they observed and how they affected their industry & community
  (allowing us to draw qualitative models with feedback systems – Metcalf et al 2013)



- Some of the changes people observed they didn't necessarily attribute to climate change (even though the scientists did) (van Putten et al. in limbo)
- There were many (or maybe more) non-climate divers that shaped their industry & community
  (that can also be incorporated into qualitative models)

Metcalf S.J., van Putten E.I., Frusher S.D., Tull M., Marshall N. (2013) Adaptation options for marine-industries and coastal communities using community structure and dynamics *Sustainability Science,* DOI 10.1007/s11625-013-0239-z, 1-15.

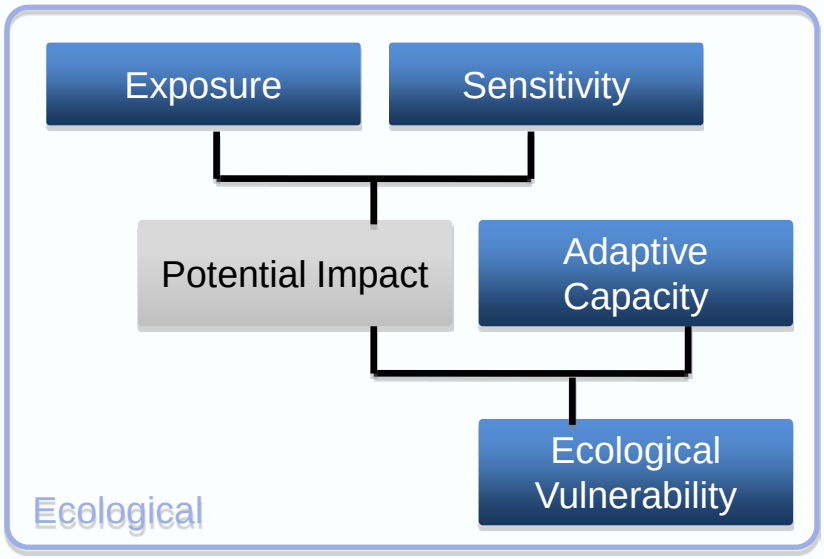
Ingrid van Putten, Stewart Frusher, Beth Fulton, Alistair Hobday Sarah Jennings, Sarah Metcalf, Gretta Pecl (in limbo) Empirical evidence for different cognitive effects in explaining the attribution of marine range shifts to climate change

What we did next

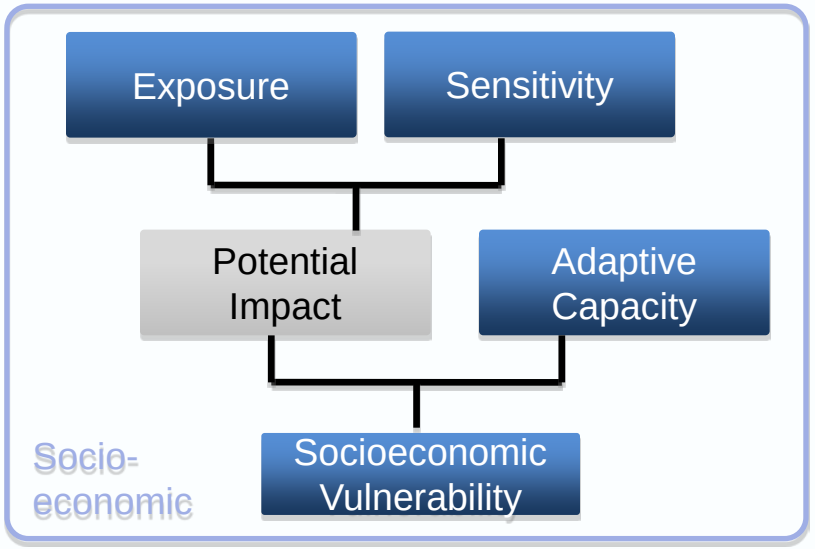
- Developed (generic and location specific) adaptation options – using qualitative models derived from survey results

- Compared case study communities to figure out how socio-ecological characteristics contribute to vulnerability

How we did that



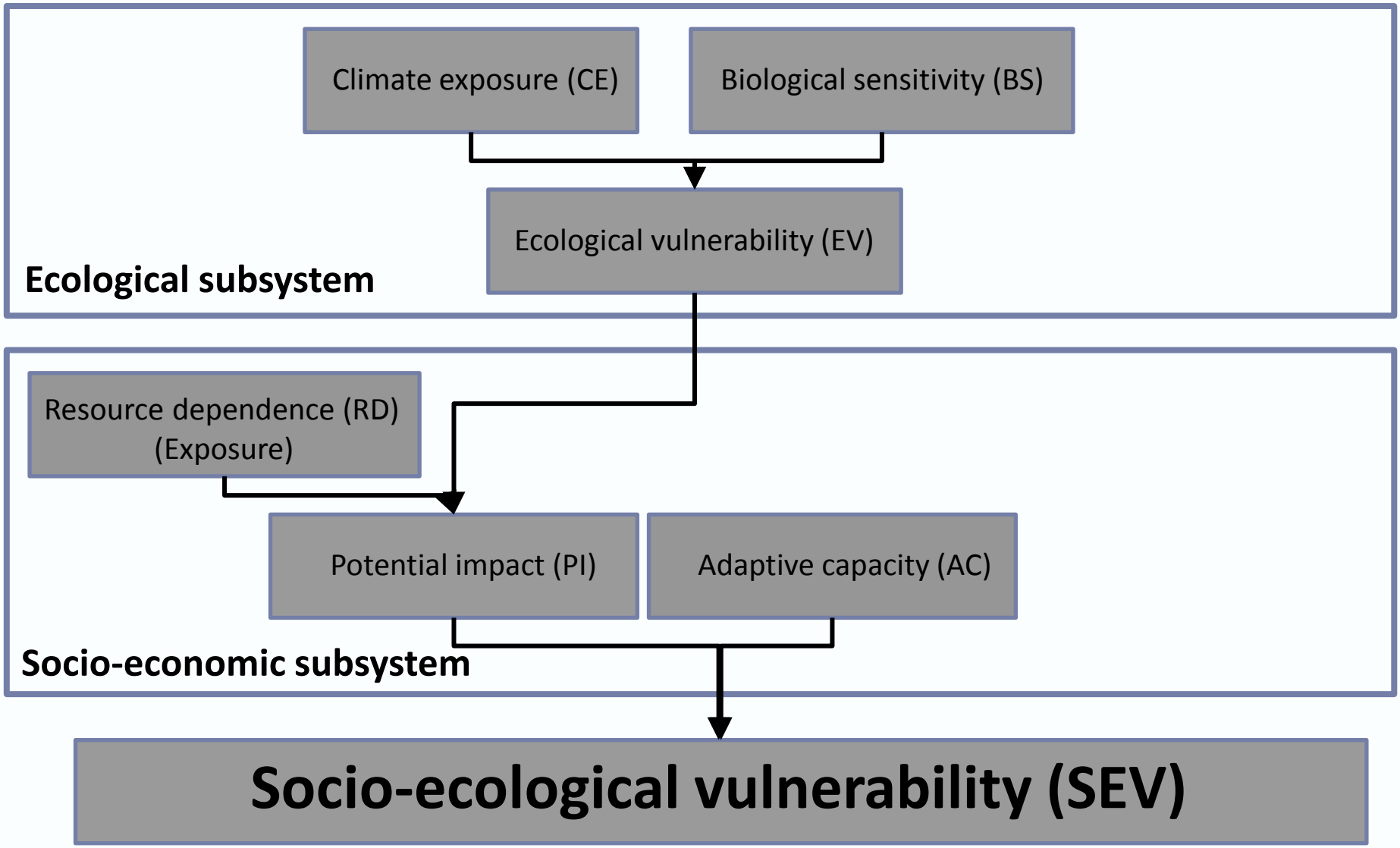
Operationalised an established framework (and changed it a bit) to calculate Socio-Ecological Vulnerability



Marshall, Hobday, Marshall, 2013 (Ecosystems)

Made the framework quantitative to calculate Socio-Ecological Vulnerability

(and also added a few things)



Framework for calculating Socio-Ecological Vulnerability

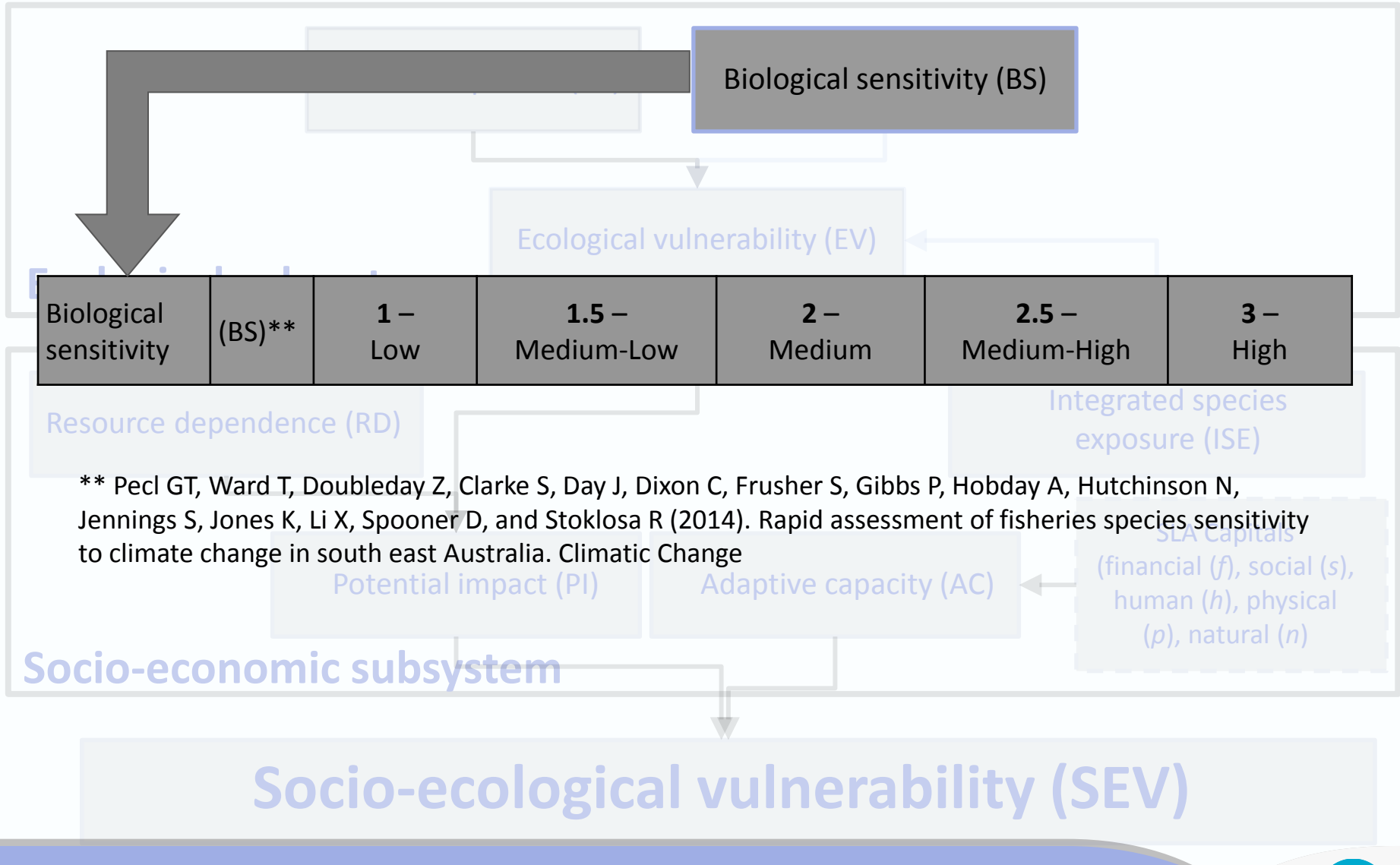
Climate exposure (CE)

$CE = \text{sum}(a^{local}\text{SST}, b^{local}\text{Ac}, c^{local}\text{R}, d^{local}\text{Cy})$

	Metric/species score
	Sea Surface Temperature change (SST) °C warming*
	Acidification (Ac)#
	Rainfall (R) projected % reduction for 2030##
	Storms & cyclones ** (Cy)

* Degrees higher in 2009 compared to an average value for the period 1880-2009 for that state, based on the HadISST dataset.
# Based on CSIRO acidification modelling (significant change=2, some change=1, no change=0).
Projected per cent change relative to 1990 state wide annual average rainfall, best-estimate outcome in a no-mitigation case from CSIRO (2008).
** Based on average increase in projected occurrences from BOM website data (greater =2, some change=1, no change =0)

Framework for calculating Socio-Ecological Vulnerability

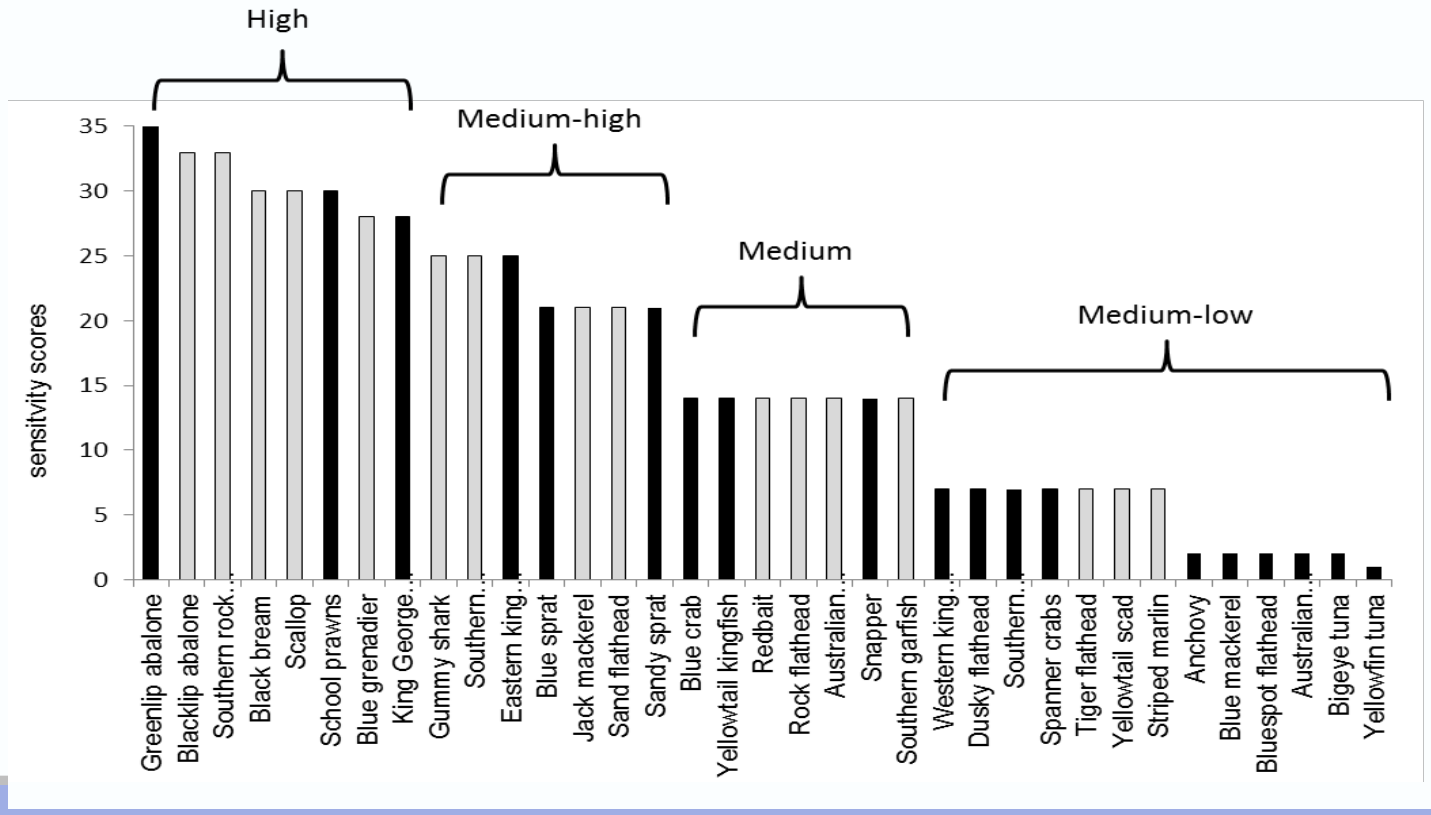


** Pecl GT, Ward T, Doubleday Z, Clarke S, Day J, Dixon C, Frusher S, Gibbs P, Hobday A, Hutchinson N, Jennings S, Jones K, Li X, Spooner D, and Stoklosa R (2014). Rapid assessment of fisheries species sensitivity to climate change in south east Australia. Climatic Change

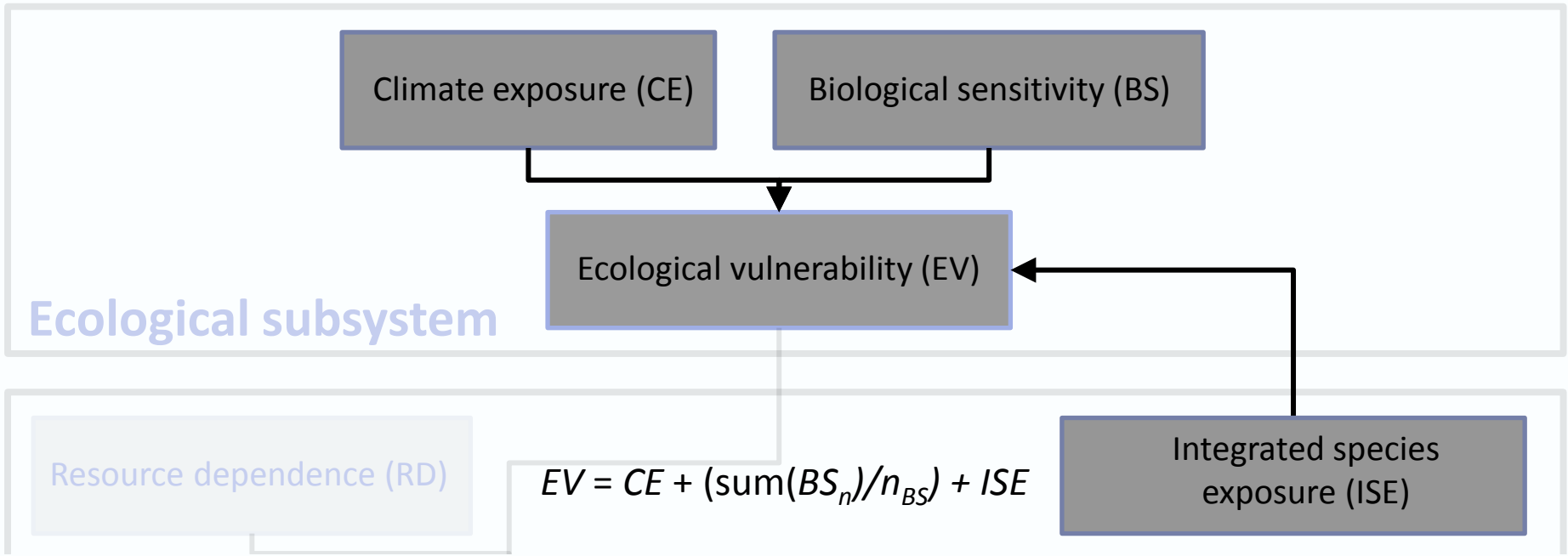
Species sensitivity assessment

Biological sensitivity	(BS)**	**1 –** Low	**1.5 –** Medium-Low	**2 –** Medium	**2.5 –** Medium-High	**3 –** High

Estimate sensitivity of species to climate drivers based on ABUNDANCE, DISTRIBUTION and PHENOLOGY



Additional variable that affects ecological vulnerability



Some species worth more (commercially) than others
Some have more social/recreational value
Some species are better managed than others

Framework for calculating Socio-Ecological Vulnerability

Climate exposure (CE)

Biological sensitivity (BS)

Ecological vulnerability (EV)

Ecological subsystem

$ISE = \text{sum}(n\text{Eb} + n\text{Sb} + n\text{Gb})/n_{BS}$

Integrated species exposure (ISE)

Economic	(Eb)	**0** – No economic value	**1** - <$5M	**2** - $5-$20M	**3** - >$20M
Social	(Sb)	**0** – No recreational/ tourism interest	**1** – Recreationally important (locally)	**2** – Recreationally important (locally and tourists)	
Governance	(Gb)	**0** – No governance issues	**1** – International agreements (NPAs) – non-binding	**2** – TEP under EPBC Act	

Framework for calculating Socio-Ecological Vulnerability

Human capital

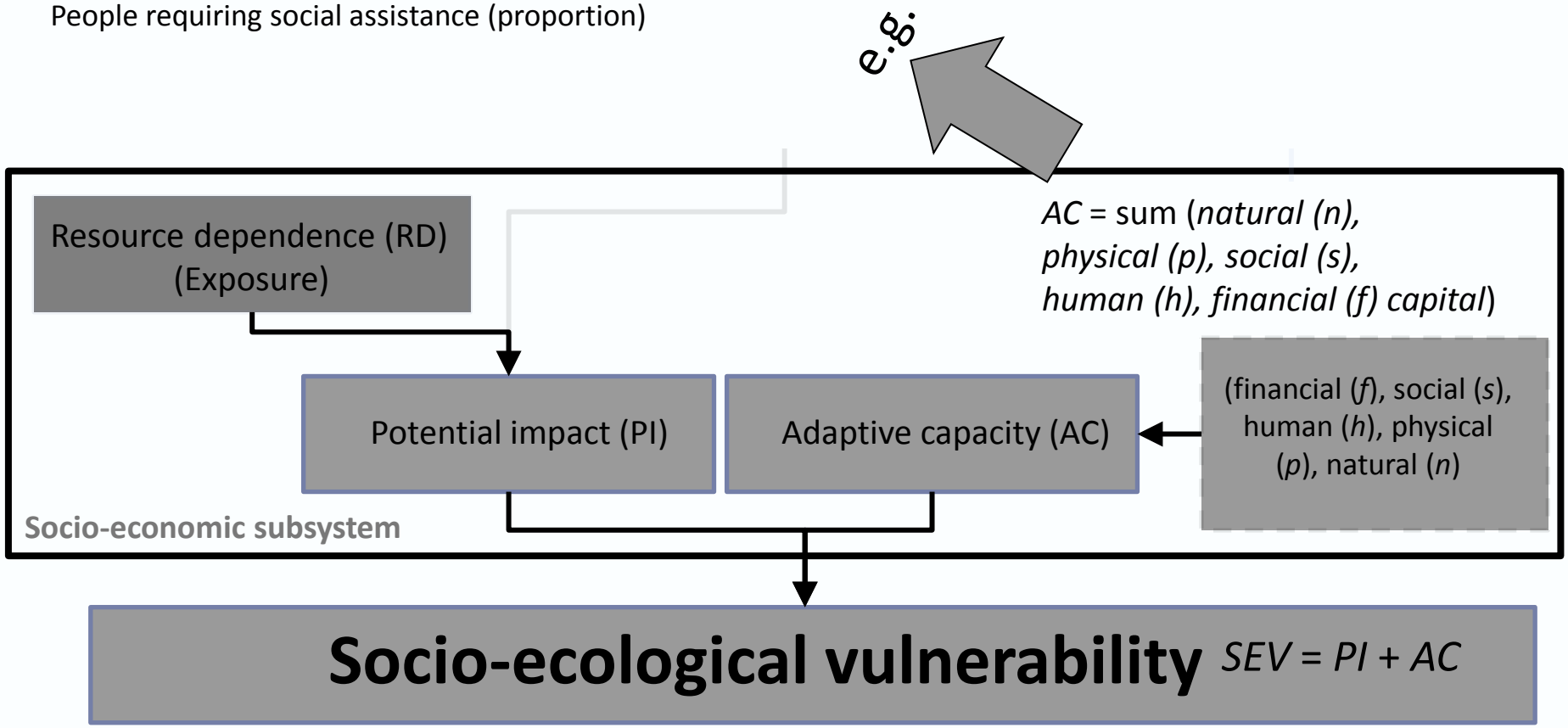
Education levels
Full time vs part-time employment
Females employed (proportion)
People requiring social assistance (proportion)

Financial capital

Mortgage repayments
Age dependency ratio

Social capital

People who volunteer (proportion)
Unoccupied dwellings (proportion)
Population change



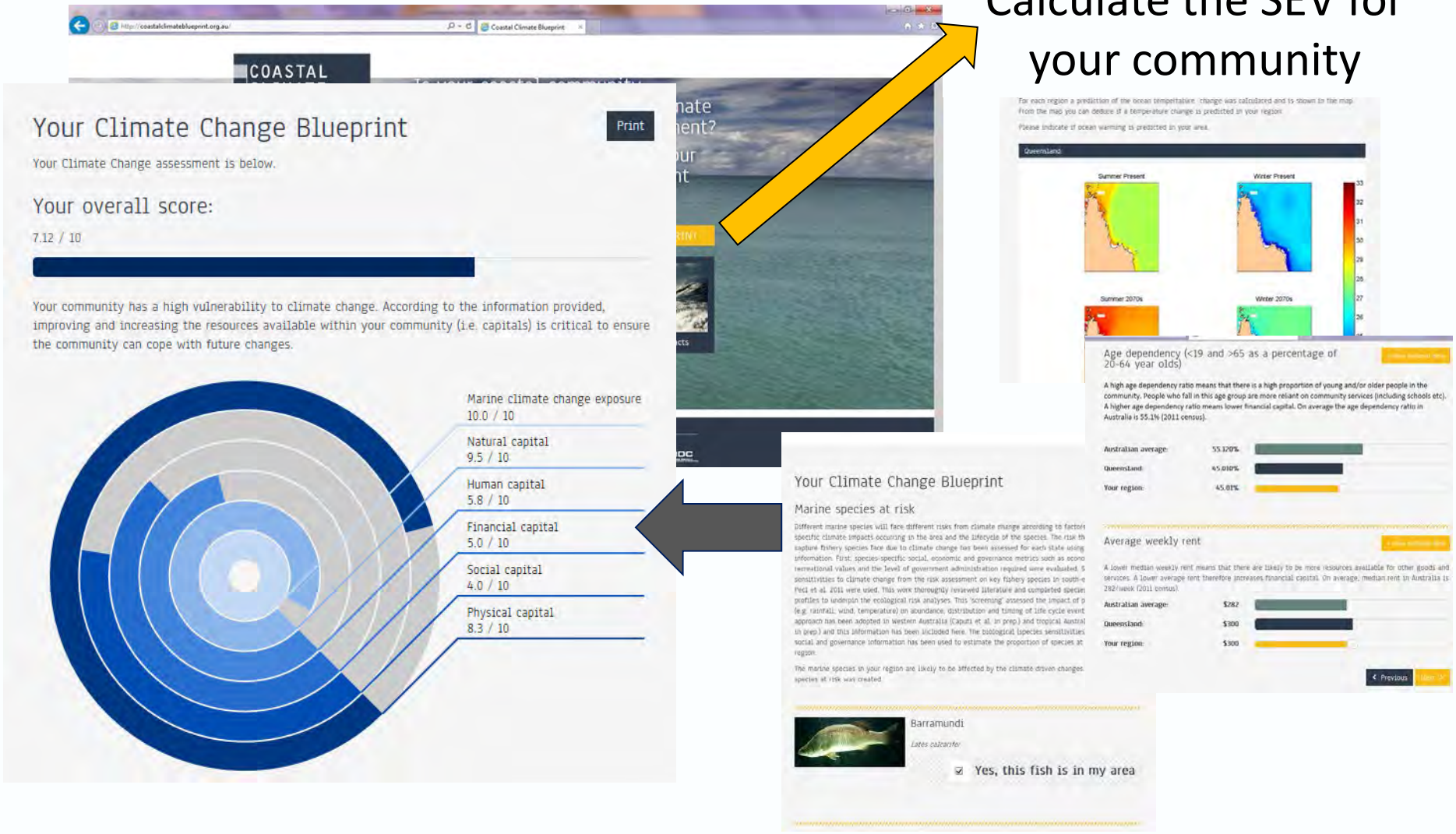
Socio-ecological vulnerability values for the coastal communities

Metric or variable
Biological sensitivity (BS)
Integrated species exposure (ISE)
Climate exposure (CE)
Ecological vulnerability (EV)
Potential impact (PI)
Adaptive capacity (AC)
Socio-ecological vulnerability (SEV)

Put SEV in context of adaptation options

Website with climate information

Calculate the SEV for your community



What is next

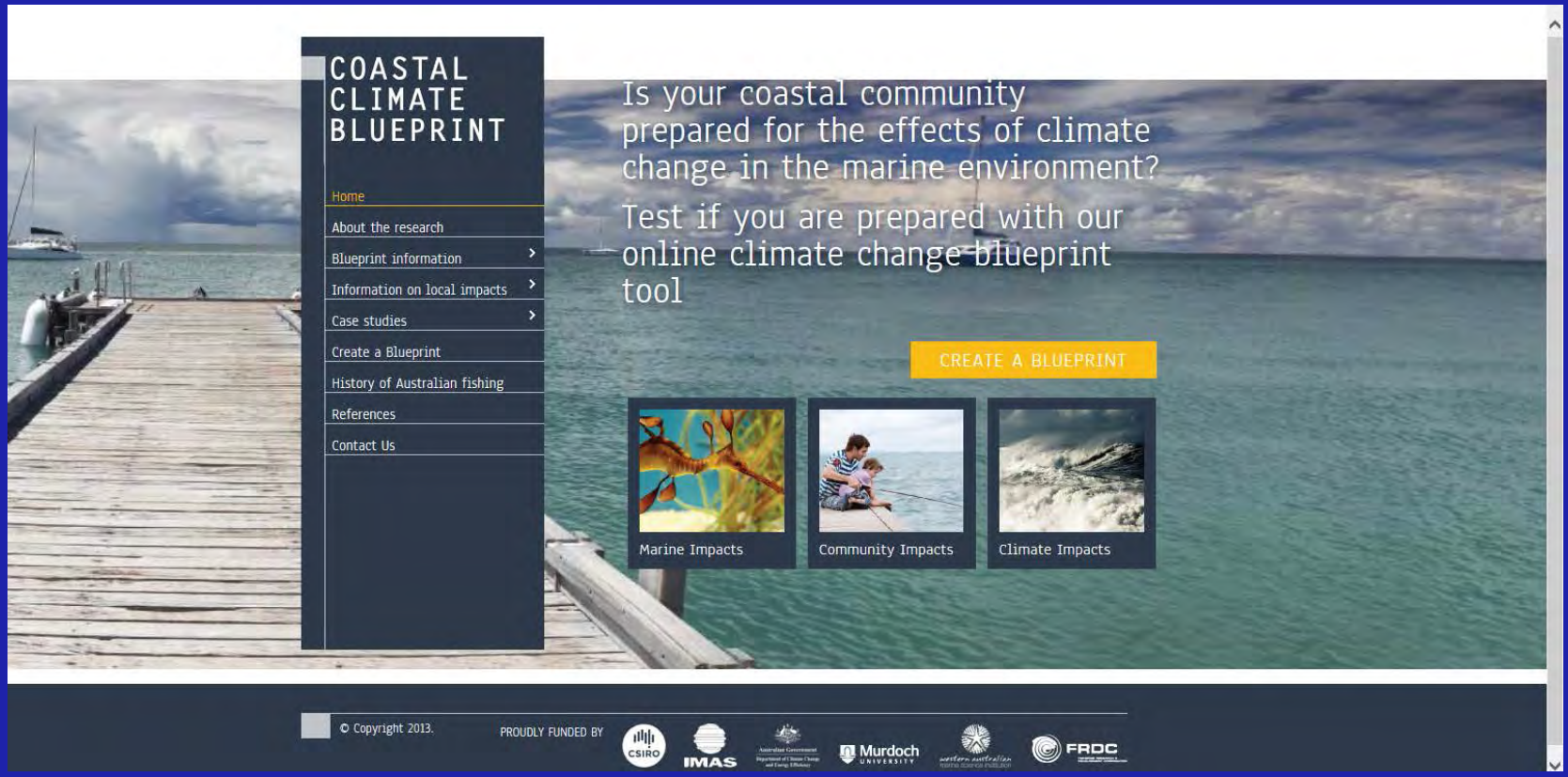
- Australia wide socio-ecological vulnerability comparison
  (currently in progress)

- Refine the measures for adaptation and exposure
  (e.g. including personal, occupational, and institutional flexibility. Also more refined measures of economic, social, historical and cultural dependence on fishing)

- Compare socio-ecological vulnerability for southern hemisphere hotspot countries
  (using standardised & culturally appropriate survey – See James Howards talk today)

www.marinehotspots.org

- Identify and prioritise adaptation options
  (based on local and larger scale needs)



Obrigado
Thank you

Ingrid van Putten
CSIRO
Ingrid.vanputten@csiro.au