Informing ecosystem-based management of the range extending long-spined sea urchin using a structured decision making process

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Decisions are most made in a realm of uncertainty

Different actors have different objectives and values

Seldom does one solution suit everyone

How do we arrive at the “best (most acceptable)” solution

Need for a “Structured Decision Making Process”

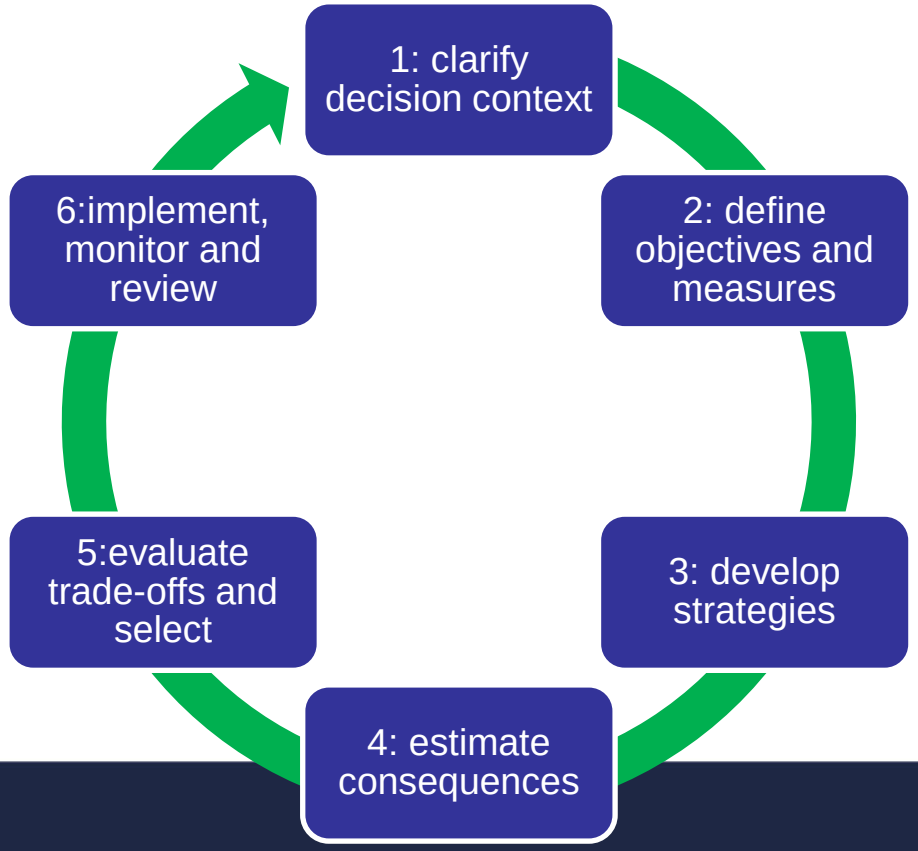
Structured decision making (SDM)

What is it?

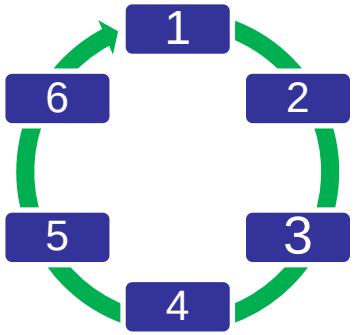
•Common sense:-The steps involved in SDM are the decision steps taken when evaluating any important decision.

•Combines decision analysis, behavioural research and applied ecology.

•There are 6 fundamental steps



Founded on the idea that good decisions are based on an in-depth understanding of both values (what's important) and consequences (what's likely to happen if alternatives are implemented).



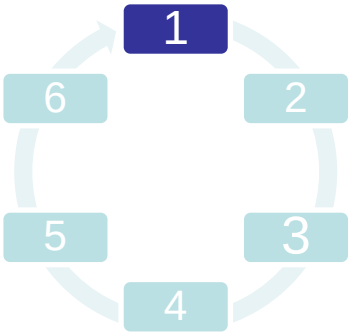
Background on structured decision making (SDM)

Why it is useful

- A way to **organize diverse sources of information** and to integrate decision analysis with deliberation
- Each step is undertaken formally and openly with key **stakeholders**
- This method is highly flexible and has been applied in a variety of contexts

Examples

- Canada: Federal fisheries management of Wild Atlantic Salmon, Forestry practitioners assessing climate change vulnerabilities and adaptation options for sustainable forest management
- USA: Fish and Wildlife Services has adopted SDM as standard practice in a variety of environmental management contexts, Department of the Interior used this method for adaptive management
- Australia: DAFF managing agricultural pests and invasive species



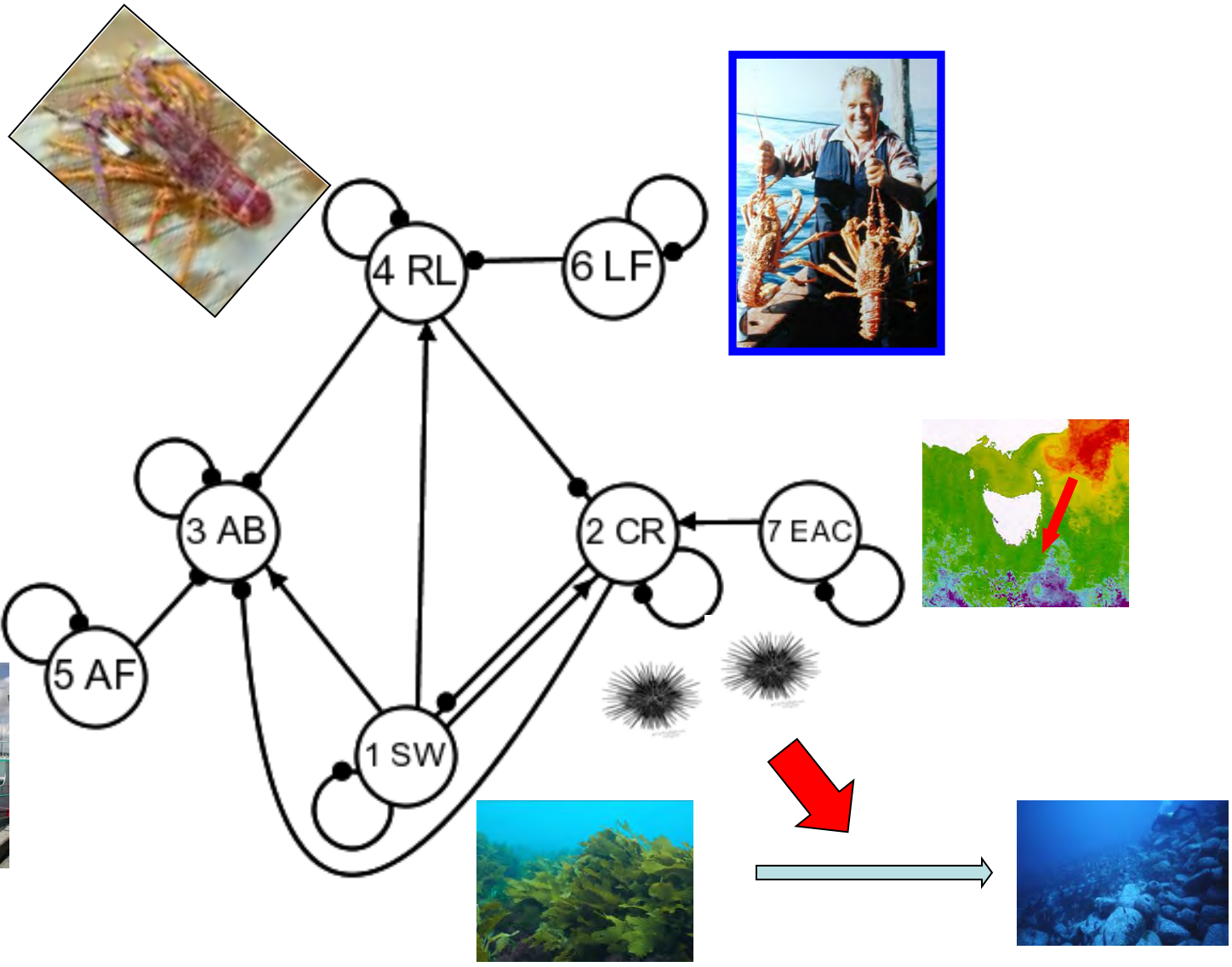
1: clarify decision context

The pilot study:

Testing the utility of a decision support tool for the ecosystem based management of multiple species and resources currently impacted by a range extending species

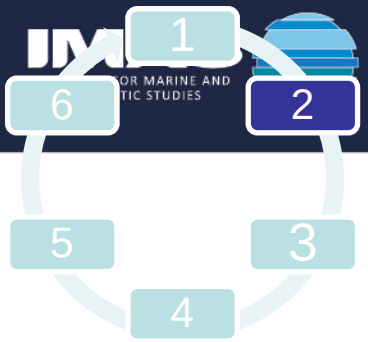
Clarifying the decision context/scope

1. Multiple stakeholder groups
2. Multiple objectives
3. Selected management strategies
4. Assessing consequences of strategies



“The System”: +ve and –ve interactions and feedbacks

Physical actors	Biological actors	Human Actors
East Australian Current	Introduced urchin	Urchin harvesters (new industry)
	Lobsters	Commercial lobster fishers
	Abalone	Recreational lobster fishers
	Kelp (Seaweed)	Commercial abalone fishers
		Recreational abalone fishers
		Lobster fishery managers
		Abalone fisheries managers
		Urchin fisheries managers
		Conservationists



2: define objectives and measures

Objectives

•We focus on performance measures, but targets and/or limits are useful as it gives us a fixed goal in assessing predicted and actual consequences of different management strategies

Examples:

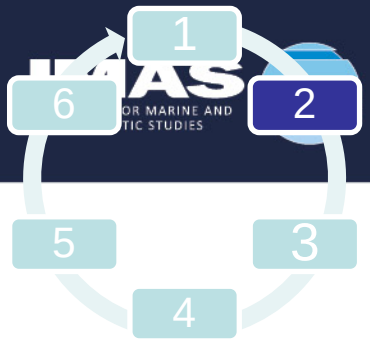
Objective – rebuilding rock lobster stock:

•To meet the 20% virgin biomass target

Objective – minimise impact to seaweed

•Reduction in urchin to the target level of 0.1 urchins /m^2 .

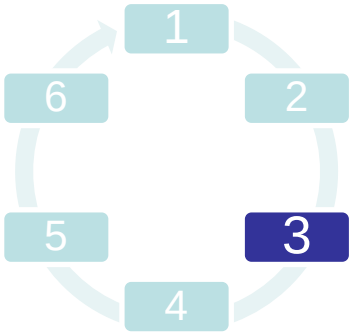
(This objective was related to abalone & probability of barren formation)



2: define objectives and measures

Performance measures quantified directly (or indirectly) from ecosystem model TRITON (OM) in addition to costs and feasibility

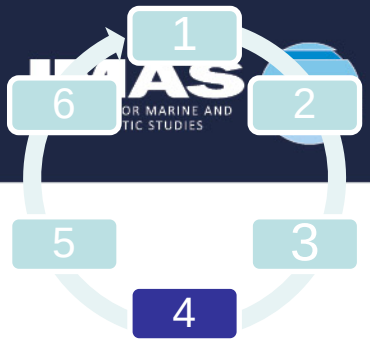
Species/resource/habitat	Example Performance metric (units)
Seaweed bed / Habitat	% seaweed cover
	Pr(barren formation)
	Bio/species diversity index
Urchin	Biomass density
	Density (# of individuals)
Rock lobster	Standing biomass relative to virgin biomass
	Relative reef productivity for lobster fishery
	CPUE
	Economic return relative to Maximum Economic Yield (MEY)
Abalone	Loss of abalone productivity due to sea urchins
	Loss of abalone fishing habitat to barrens



3: develop strategies

The range of strategies in consultation with managers (implementable) and stakeholders

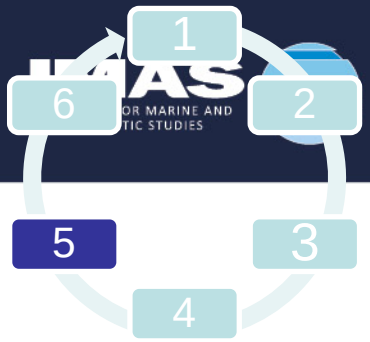
Strategy	Source
Status quo prior to east coast cap	
Introduce a maximum legal rock lobster size limit	Johnson et al (2005); Marzloff et al (2012); Johnson et al (2014)
Implement an east coast cap	DPIPWE (2013)
Reducing the recreational cap	Johnson et al (2014)
Closing the fishery at a local scale	Tisdell et al (2011)
Facilitating commercial harvest of the urchin for food consumption	Tisdell et al (2011), Johnson et al (2014)
Subsidised urchin harvesting for fertiliser use	Tisdell et al (2011)
Urchin harvest and disposal	Tisdell et al (2011)
Abalone divers smashing urchins as they go about their business	Tisdell et al (2011), Johnson et al (2014)
Commission divers to smash urchins	Johnson et al (2005); Tisdell et al (2011)
Translocating lobsters from the south west to east coast reefs	Johnson et al (2005), Pecl et al (2009), Johnson et al (2014)



4: estimate consequences

- A consequence table allows stakeholder groups to see how their performance measures fared under different management strategies relative to the performance measures of other stakeholder groups
- Barrens scenario 10 years from now (note confidence levels among strategies vary)

Strategy	Rock lobster performance measure (relative % biomass)	Kelp performance measure (urchins/m2)	Ecosystem performance measure (% probability of barren forming)	Urchin fishery performance measure (kg urchins/km2)	Abalone performance measure (relative productivity of abalone/reef)	cost to RL fishery ($NPV)	cost of additional strategies km2 ($)	feasibility
Status-quo prior to cap	0.49	1.15						
east coast cap	8.0	0.94						
east coast cap + urchin harvest	15.25	0.14						
east coast cap + translocation	8.89	0.94						
east coast cap + urchin smashing	14.4	0.32						



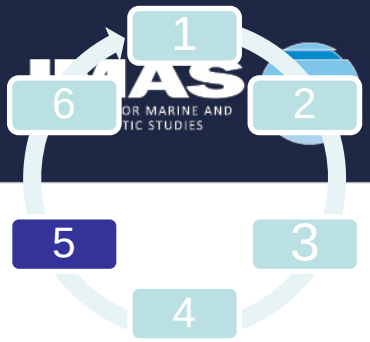
5:evaluate trade-offs and select

Options for evaluating trade-offs:

Elicit stakeholder preferences through value modelling

•Linear value modelling is where a weighted average of the objectives is computed based on preference weights on worst and best case scenarios elicited from the stakeholders.

Strategy	Rock lobster performance measure (maximise relative % virgin biomass)	Kelp performance measure (minimise urchins/m2)	Ecosystem performance measure (minimise% probability of barren forming)	Urchin fishery performance measure (maximise kg urchins/reef)	Abalone performance measure (maximise relative productivity)	weights
Scenario 1 (worst)	1.046165	1.0025	38.64	15.63567	0	
Scenario 2 (best for lobster)	33.50611	1.0025	38.64	15.63567	0	
Scenario 3 (best for kelp)	1.046165	0.06	38.64	15.63567	0	
Scenario 4 (best for ecosystem)	1.046165	1.0025	4.9	15.63567	0	
Scenario 5 (best for urchin fishery)	1.046165	1.0025	38.64	60.14999	0	
Scenario 5 (best for abalone fishery)	1.046165	1.0025	38.64	15.63567	0.99	



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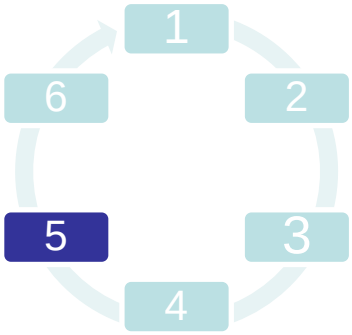
Options for evaluating trade-offs:

Elicit stakeholder preferences through value modelling

- **Example: Abalone stakeholder**

Strategy	Rock lobster performance measure (maximise relative % virgin biomass)	Kelp performance measure (minimise urchins/m2)	Ecosystem performance measure (minimise% probability of barren forming)	Urchin fishery performance measure (maximise kg urchins/reef)	Abalone performance measure (maximise relative productivity)	weights
Scenario 1 (worst)	1.046165	1.0025	38.64	15.63567	0	0
Scenario 2 (best for lobster)	**33.50611**	1.0025	38.64	15.63567	0	70
Scenario 3 (best for kelp)	1.046165	**0.06**	38.64	15.63567	0	60
Scenario 4 (best for ecosystem)	1.046165	1.0025	**4.9**	15.63567	0	85
Scenario 5 (best for urchin fishery)	1.046165	1.0025	38.64	**60.14999**	0	50
Scenario 5 (best for abalone fishery)	1.046165	1.0025	38.64	15.63567	**0.99**	100



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Options for evaluating trade-offs:

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- **Example: Abalone stakeholder**

Strategy	Rock lobster performance measure (maximise relative % virgin biomass)	Kelp performance measure (minimise urchins/m2)	Ecosystem performance measure (minimise% probability of barren forming)	Urchin fishery performance measure (maximise kg urchins/reef)	Abalone performance measure (maximise relative productivity	Score	Rank
Statue-quo prior to cap	0.03*0.7	0*0.6	0*0.85	1*0.5	0.85*1	0.521	5
east coast cap	0.79*0.7	0.56*0.6	0.20*0.85	0.44*0.5	0.94*1	1.279	4
east coast cap + urchin harvest	1*0.7	0.94*0.6	0.33*0.85	0.06*0.5	1*1	1.5745	1
east coast cap + translocation	0.88*0.7	0.58*0.6	0.20*0.85	0.43*0.5	0.94*1	1.349	3
east coast cap + urchin smashing	0.9*0.7	0.74*0.6	0.22*0.85	0.26* 0.5	0.97*1	1.391	2

Weights without knowing consequences

Weights with knowing consequences (modelled)

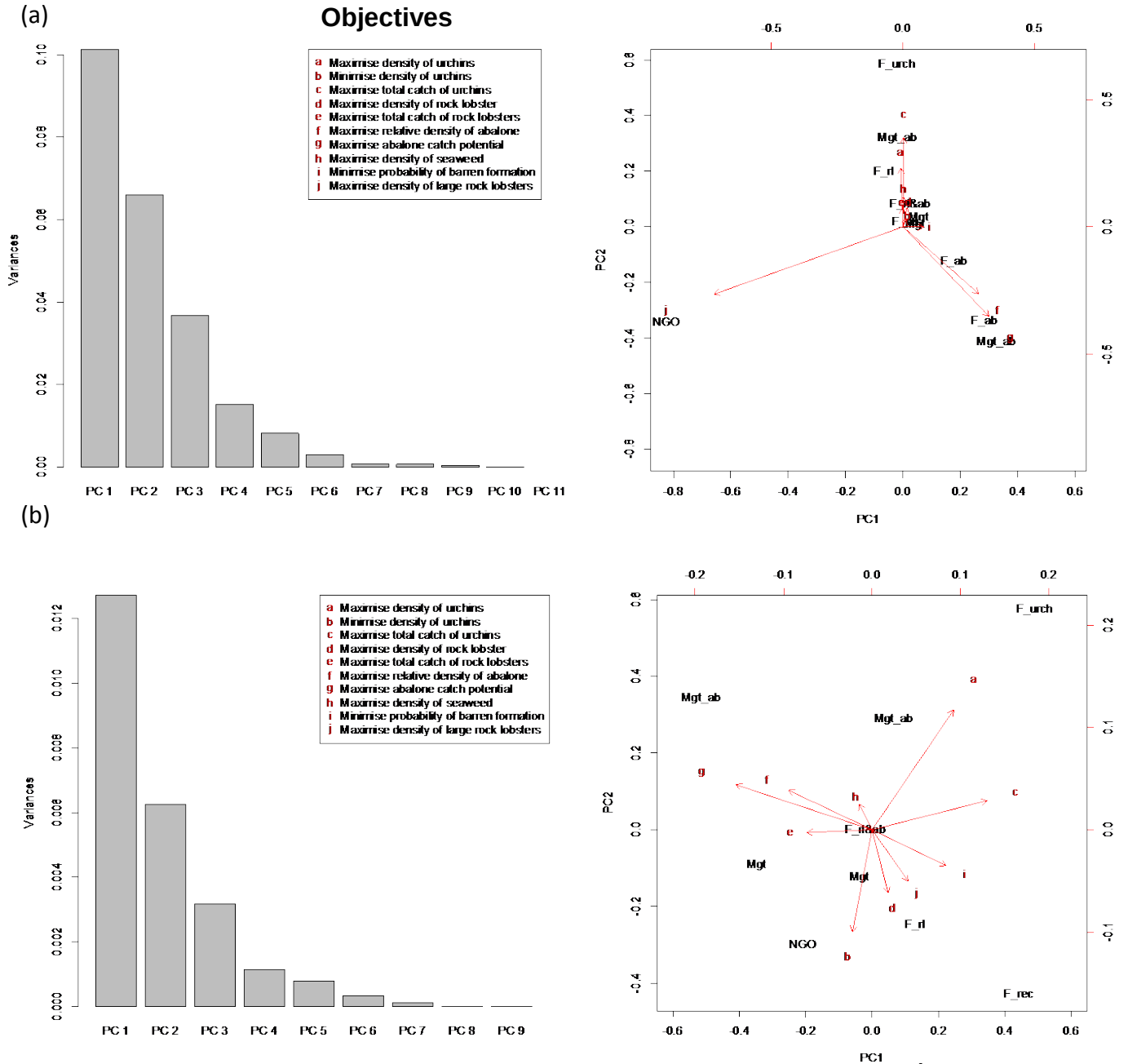


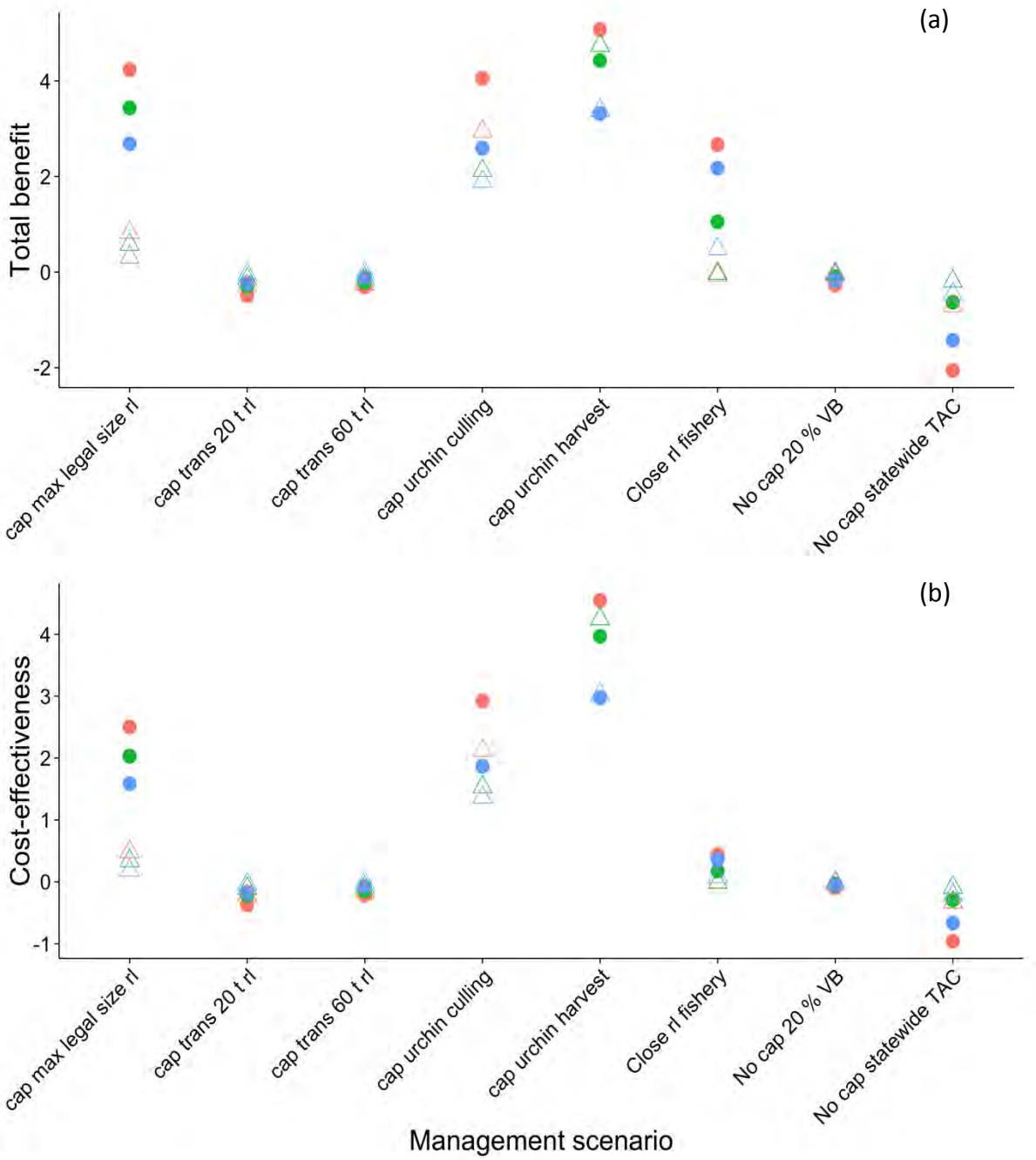
Figure 2. PCA of stakeholders' ranking of the 10 objectives during (a) the 1st and (b) the 2nd survey. The scores of individual interviewees are displayed on the first two PCs

non-barren reefs (filled circles)
barren reefs (open triangles)

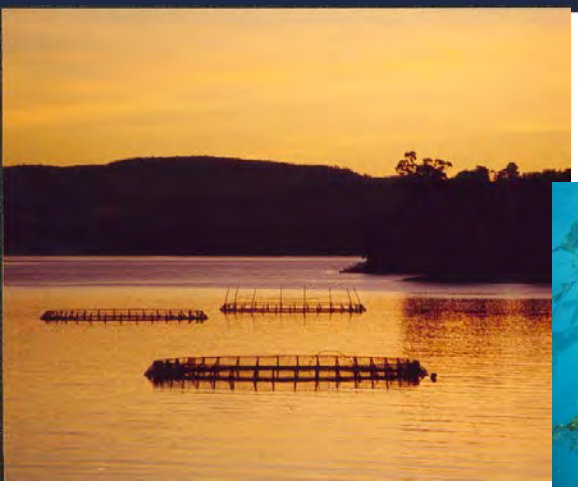
Red: considered the raw benefits of each management scenario relative to the status quo.

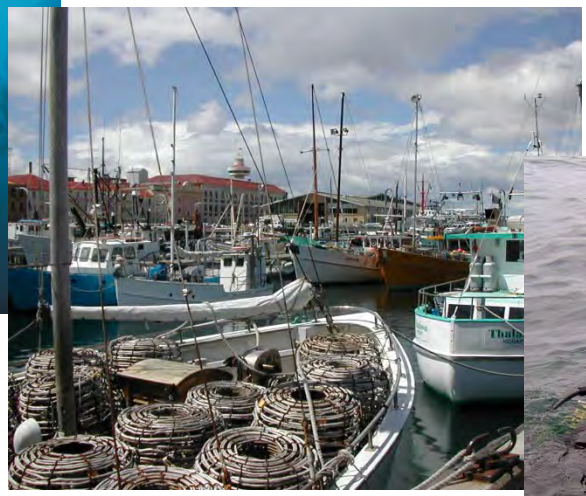
Green: factored in stakeholders direct preferences (assigned as weights) for potential management scenarios.

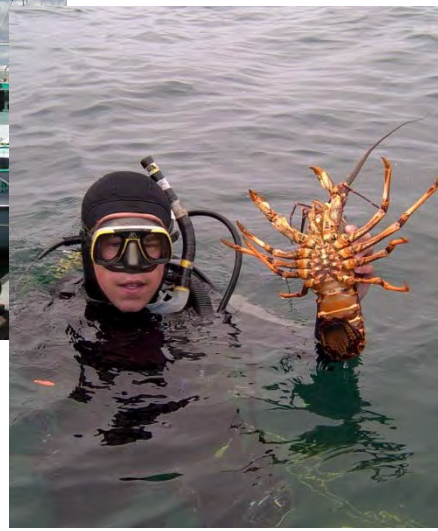
Blue: factored in stakeholder's indirect preferences for a potential management scenario through the elicitation of objective weights based on the best and worst outcomes across all potential management scenarios.



Cost effectiveness = Costs + feasibility + benefits







Thank you