Douglas Adams, Albert Einstein and economic techniques for 'valuing' the environment

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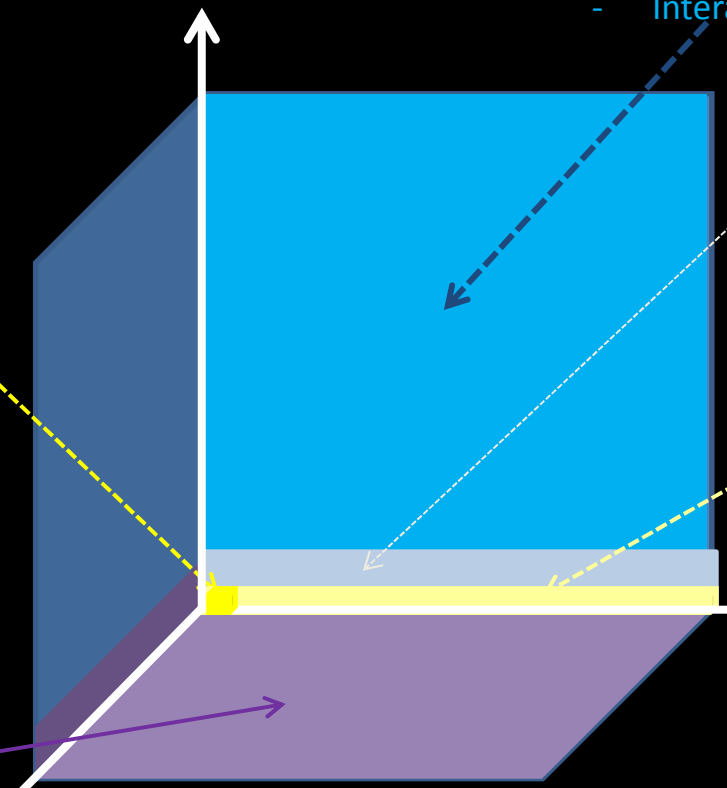
Environmental economics and scale – an overview



General equilibrium models
- Static or dynamic
- Entire population, divided into sectors
- Multiple 'products' (one for each sector)
- Interactions between sectors/products

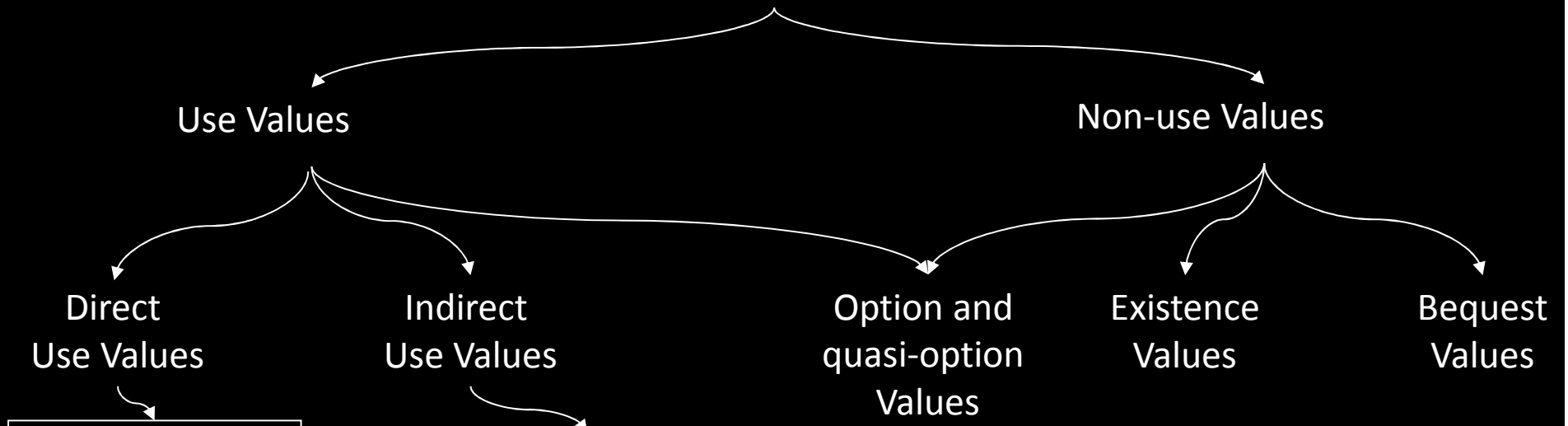
Most environmental 'valuation' methods derived for
- One point in time (static)
- One simple product
- One person

Cost benefits analysis:
- Static
- Market/population
- More than one product (or 'value')

Market (population) 'values'
- Often estimated by adding individual estimates of 'value'
- Static

Growth models (some with environmental variables e.g. CO_2)
- Dynamic
- Relatively few variables (if more than one product, highly aggregated)
- Many people (treated as one)

Total Economic Value (TEV)



Extractive uses:
- Fisheries
- Coral mining
- Bio-prospecting

Non-extractive uses:
- Recreation
- Tourism
- Research
- Education
- Aesthetic

Biological support to
- Sea birds and marine life
- Genetic resources

Physical protection for
- Water quality control
- Waste assimilation
- Erosion control
- Disturbance regulation

Global life-support
- Carbon Store

Coral reef examples adapted from Ahmed et al, 2007; and Rolfe et al, 2005

A range of Valuation Techniques

Adapted from Gregerson et al (1987), Driml (1994), Grey (1996) and Liu et al (2010).

1. Valuation techniques that use market prices
   - (a) Changes in the value of Output
   - (b) Loss of Earnings
   - (c) Preventive expenditures (mitigation costs)
   - (d) Replacement cost

Most useful when valuing services that have a market value – e.g. Goods produced, Tourism

Often used to value indirect-uses values or "regulating services " (e.g. the amount people pay to prevent beach erosion)

2. Revealed preference techniques
   - (a) Property or land value approach
   - (b) Travel cost approach
   - (c) Wage differential approach
   - (d) Acceptance of compensation

Can be used to value things like recreation and aesthetics (which don't have observable market prices)

Can only estimate Use-Values

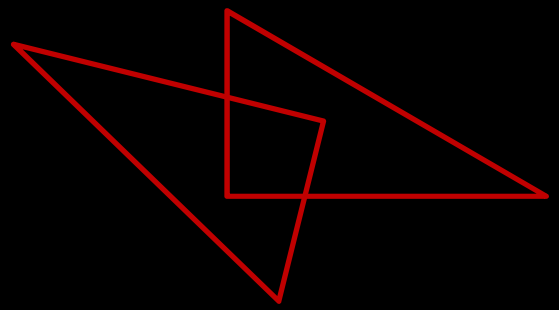
3. Stated preference techniques
   - (a) Contingent valuation
   - (b) Choice modelling / Conjoint analysis (contingent rating, contingent ranking and choice experiments)
   - (c) Paired comparison

In theory, can be used to value almost anything – depending upon how the questions are structured; doesn't always have to use $

4. Benefit Transfer

Key issues confronting those wishing to use these partial equilibrium valuation techniques at a macro scale…

- Not simply a matter of comparing values; must use the same valuation approach for valid comparisons
- Even if same valuation technique, the value of the whole may not equal the sum of each part



- Moreover, estimates sensitive to
  - Income, and changes in the distribution of income
  - Differences between expectations versus ‘reality’
  - Changes / interactions with other markets or systems

Simplistic description of ‘valuation’

Start with a ‘utility’ function (sort of like a well-being or happiness function)

Work out what makes people happy --- say money ($) and people (🚺):

U = f ($, 🚺)

If $U^1 = U^2 =$ ☺ ☺ (two options make someone equally happy)

and

U^1 = ☺ ☺ = f ($100, 🚺)

U^2 = ☺ ☺ = f ($1000,)

Then

🚺 ≈ $900 (in terms of ‘utility’)

Scaling upwards: more than one person, more than one 'good'

Person	'Value' of A
Sue	$100
John	$100
David	$2500
Total 'value'	$2700

Price-based valuation methods 'blend' preference and income effects, and one may thus give greater voice to the preferences of the rich than of the poor

Stoeckl, N., Hicks, C. Welters, R., Larson, S., Pressey, B. (in review) "To the rich man, the vote: Confronting the effect of income on estimates of the 'value' of environmental goods and services"

WTP and income in northern Australia

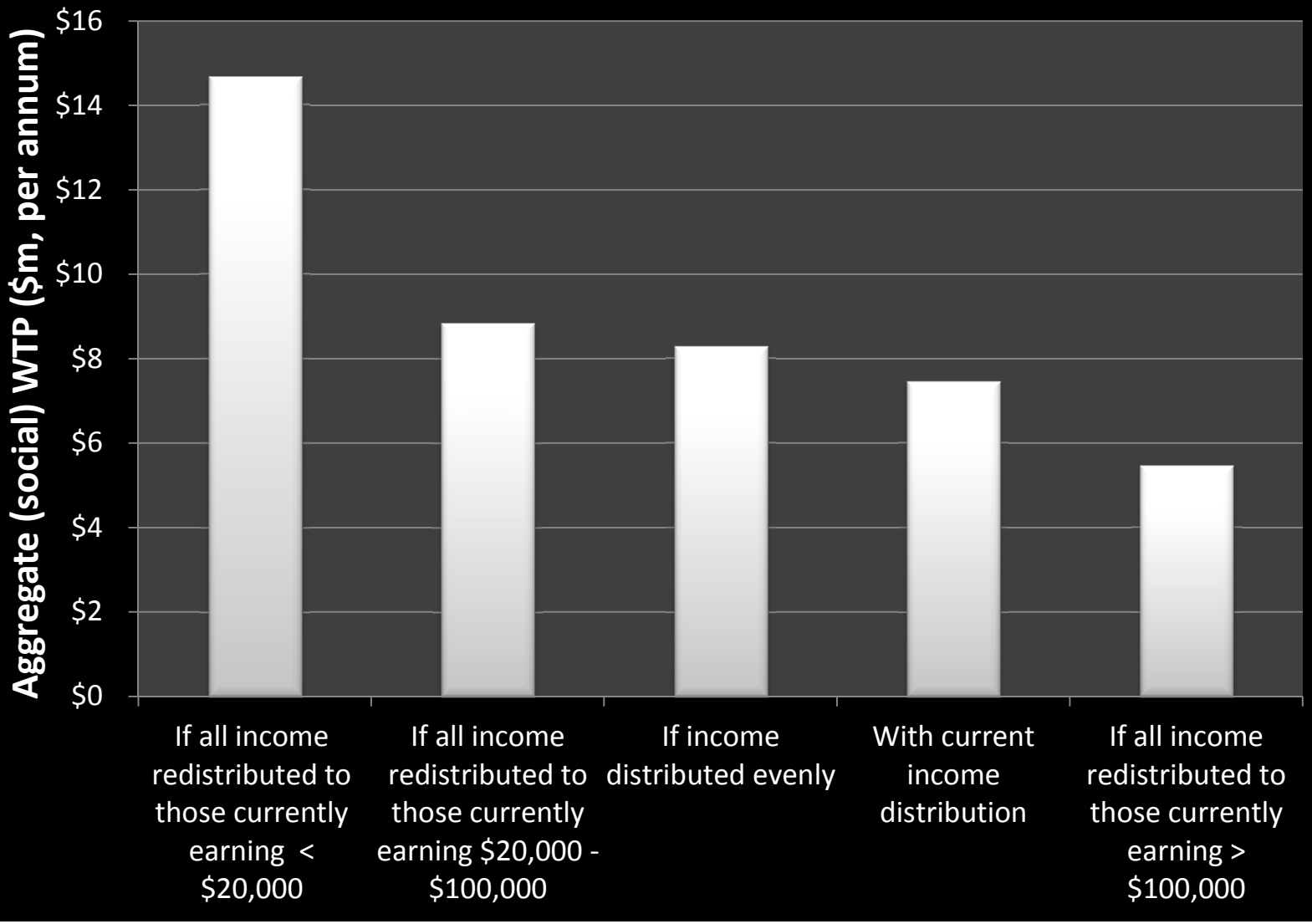
"Imagine there was going to be a development upstream from where you live. The development will not make you or your family any richer, nor will it provide employment to you or any members of your family. However, the development would reduce your opportunity to enjoy the ' (social and cultural values) associated with your local rivers and water holes (e.g. there would be fewer opportunities to go fishing, to picnic or to see the river)."

How much would you be WTP to prevent the development from going ahead?

	Household income		
	< $20,000	$20,000 – $100,000	> $100,000
WTP	$40.28	$131.09	$185.16

Aggregate WTP to avoid a 100% reduction in ability to enjoy social and cultural values associated with Australia's Tropical Rivers

(values calculated as: % of income WTP * total regional income)



Expectations versus reality

Difference between *ex ante* and *ex post* (Myrdal, 1939).

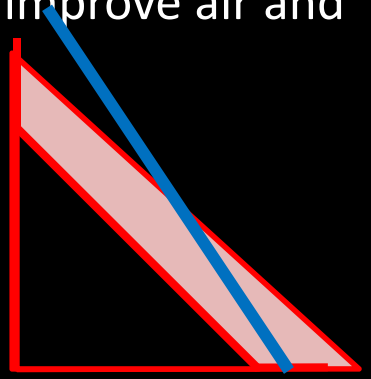
In the Townsville Region,

- *Ex ante* (expectations about) recreational catch driven by motivations (e.g. importance of fishing for fun and/or for eating)
- *Ex post* (actual) catch driven by
  - Personal variables – such as years fishing and gender
  - External variables (e.g. phase of moon)
  - Also 'availability' of fish (so interactively associated with behaviours of others).
- The marginal 'value' of a fish to recreational anglers in the Townsville region is:
  - ≈ $7 if based on expected catch;
  - ≈ $23 if based on actual catch.

Farr, M., Stoeckl, N., & Sutton, S. (in review) The Marginal Value of fish to recreational anglers: ex ante and ex post estimates are different

Changes in other markets / systems…

- Suppose estimating the 'value' of a program that seeks to improve air and water quality by raising the price of petrol
- Potential health and recreational (fishing) benefits
- Could estimate 'value' of an improvement ….



- But, an increase in price of petrol => more expensive to go motor boating => change in the 'demand' (hence WTP, or 'value' of boating)
- So estimates of 'value' depend on whether one uses GENERAL and PARTIAL equilibrium estimates (i.e. if you consider feedbacks)
- In their study, the 'value' of potential improvements in recreational values were almost always greater if considering feedbacks than if ignoring them

Carbone and Smith, 2013, Valuing nature in a general equilibrium, *Journal of Economics and Management, http://dx.doi.org/10.1016/j.jeem.2012.12.007*

The Douglas Adam (Arthur Dent) problem

- 'Values' generated from traditional economic valuation methods are not absolutes, amongst other things, they depend interactively on
  - The valuation techniques that is used
  - The distribution of income
  - Expectations (versus reality), feedbacks and interactions with other people, goods and systems

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Possibly systematic tendency to 'undervalue' environment ..?

Many approaches developed at the wrong scale and may be difficult to reconcile to a larger scale

What of non-monetary assessment methods?

Recent examples of non-monetary 'valuation' approaches

- Christina Hicks' work asking fishers to rank and rate the importance of various ecosystem services
- Silva Larson's work on importance, and *the index of dissatisfaction*
- Emerging body of literature looking at the contribution of the environment to overall quality of life / life satisfaction.

The importance of the socio-cultural 'values' associated with Australia's tropical rivers, compared to other 'values'.

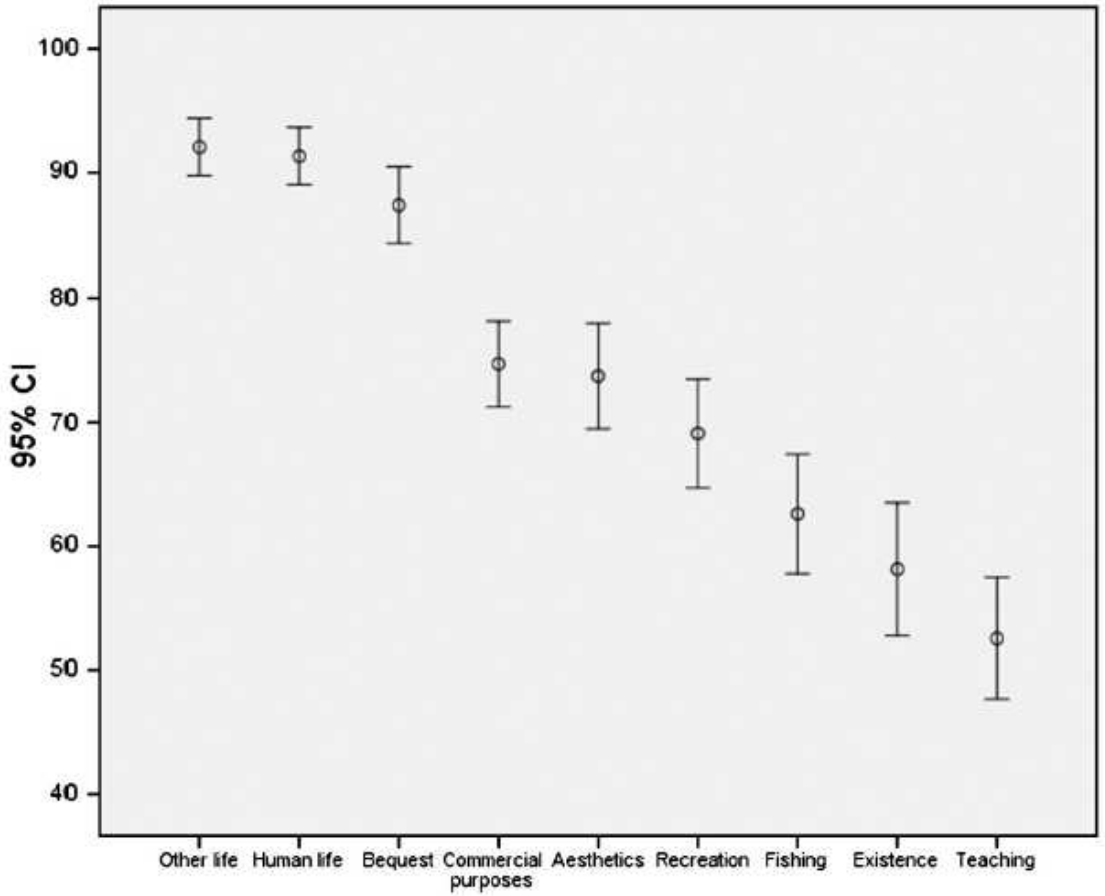


Fig. 2. Confidence intervals for importance scores assigned by respondents to a cross-section of values of the rivers.

Larson, S., Stoeckl, N., Welters, R., and Neil, B, (2013) "Using resident perceptions of values associated with the Australian Tropical Rivers to identify policy and management priorities", *Ecological Economics,* 94:8-19

Larson's 'Index of dis-satisfaction'

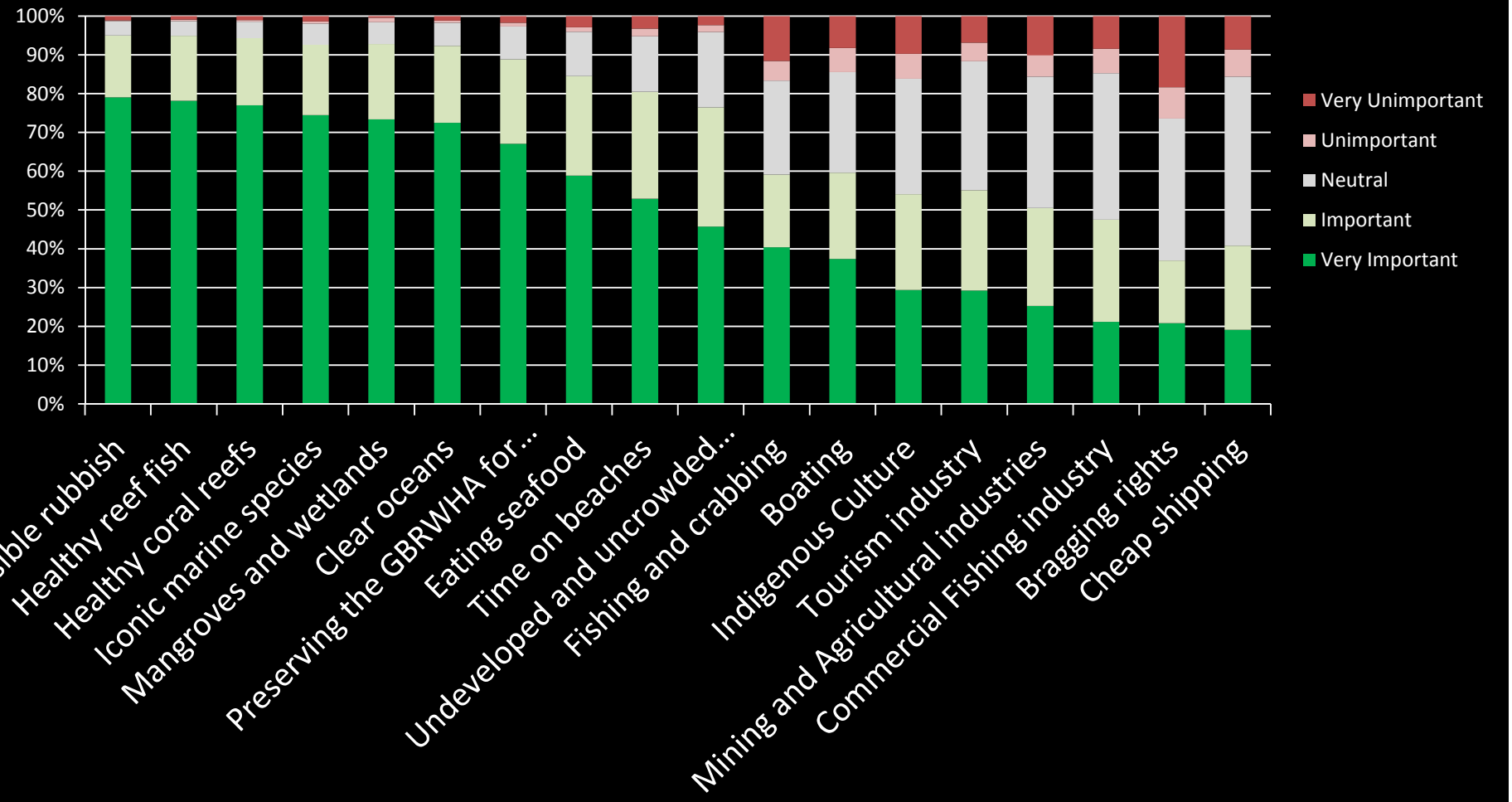
Table 4
Index of Dissatisfaction (IDS) for river values across the TR region; higher values indicate greater importance, dissatisfaction and/or a higher per cent of respondents provic
formation about the value.

Rivers for...	Mean I[a]	Mean S	% selecting	IDS	Reasons for dissatisfaction (concerns)
... Commercial purposes?	78	70	95	22	– Pollution (from mines) – Use/over-use by tourism, irrigation, commercial, domestic – Need for better monitoring – The cost of water and uncertainty about future access – Need for capture and storage (need for dams) and for improved water recy
... Human life?	93	79	98	19	– Poor water quality (chemicals) – Boundaries and regulations/Government restrictions – Use/over-use (too many bores/cattle watering points, exports to Perth, tou – Need for capture and storage (store rain water) – Need to improve environment around rivers, more trees – Concern for the future — water is not looked after
... Other life?	95	81	97	18	–
... Bequest?	92	79	95	18	–
... Fishing?	72	75	87	16	– Difficulty of access/need for permits – Rivers overfished and overcrowded by fishers
... Recreation?	78	78	89	15	– Presence of crocodiles – Many rivers/waterholes inaccessible – Lack of rangers and attention by Council
... Teaching?	66	72	80	15	– Uncertainty with access; – Insufficient acknowledgment of Indigenous rights
... Aesthetics?	81	79	91	15	–
... Existence?	80	78	73	13	– Crocodiles[b]

[a] These mean values do not exactly coincide with those presented in Fig. 2 because they only include data from respondents who answered both the importance and th
faction questions relating to each factor.
[b] This comment most likely explains why some people do not use the rivers for recreational purposes but instead simply enjoy them for their 'existence' value.

Residents of the GBR Catchment area

How important are each of the following to your overall quality of life? (N=1001)

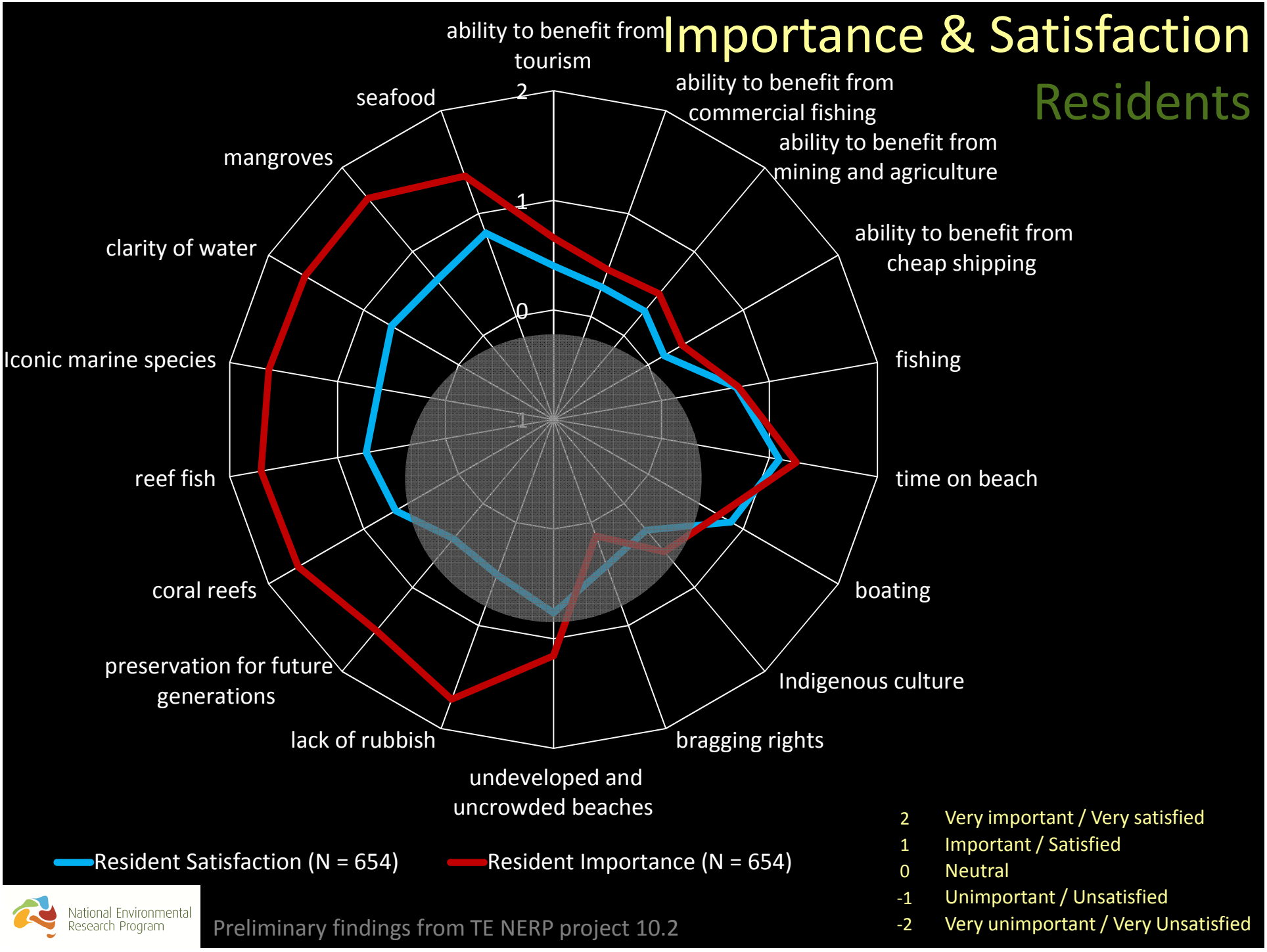


National Environmental Research Program

Preliminary findings from TE NERP project 10.2

Importance & Satisfaction

Residents

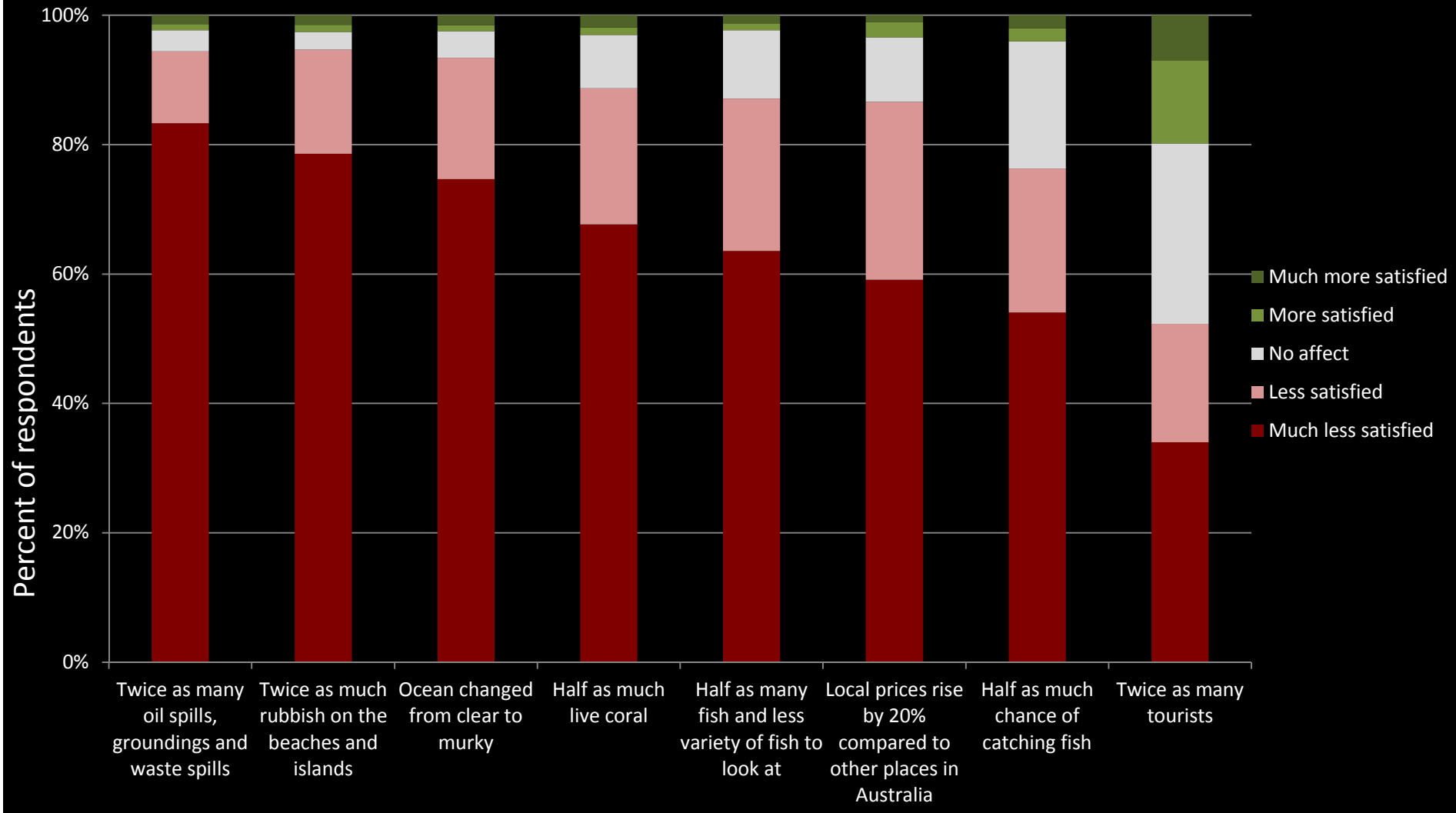


2	Very important / Very satisfied
1	Important / Satisfied
0	Neutral
-1	Unimportant / Unsatisfied
-2	Very unimportant / Very Unsatisfied

National Environmental Research Program

Preliminary findings from TE NERP project 10.2

How would each of the following affect your overall quality of life .....



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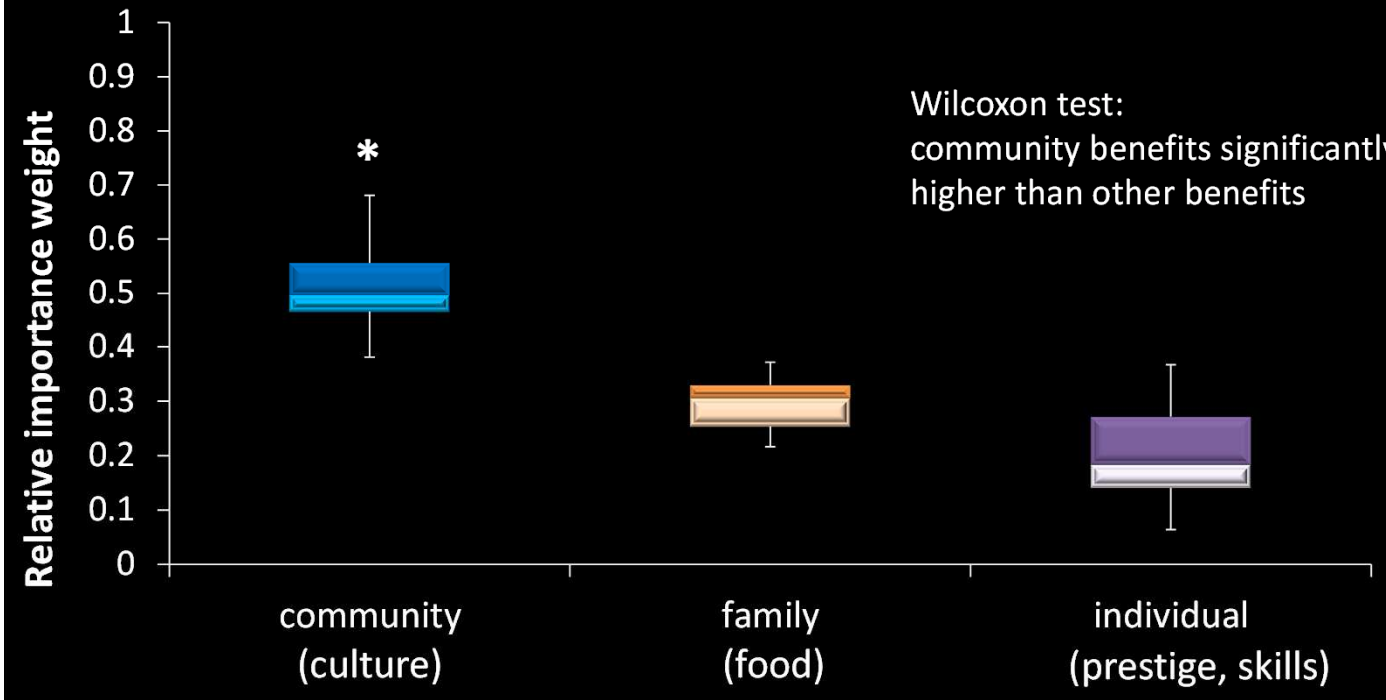
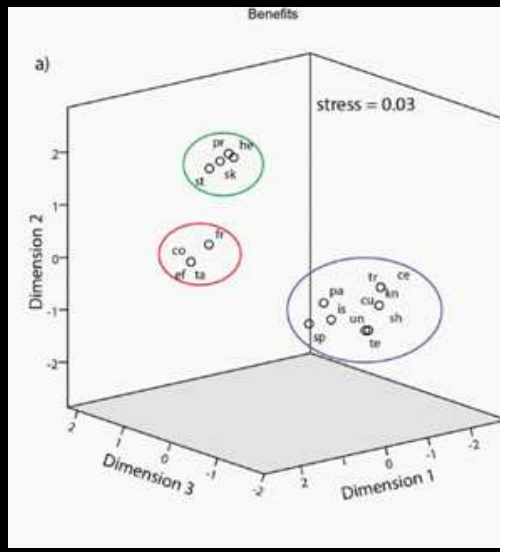
The theory of relativity … ?

- If healthy reefs are more important than the income and jobs associated with tourism, and tourism is worth ≈ $5b, does this mean that the value of a healthy reef AND tourism, combined is worth more than $10b?
- Only if these 'goods' are separable in consumption ….(sheep: mutton and wool)
- Formal economic tests for separability require that people's willingness to trade one good for another (the marginal rate of substitution, or slope of the indifference curve) does not depend upon the quantity of a third good…
    - 18 'goods' => 153 pairs of goods to trade; each to assess against the quantity of 16 other goods
- Have also been experimenting with the use of cognitive mapping exercises to test for separability

Cognitive mapping and separability…
An example based on the benefits of traditional hunting in the Torres Strait



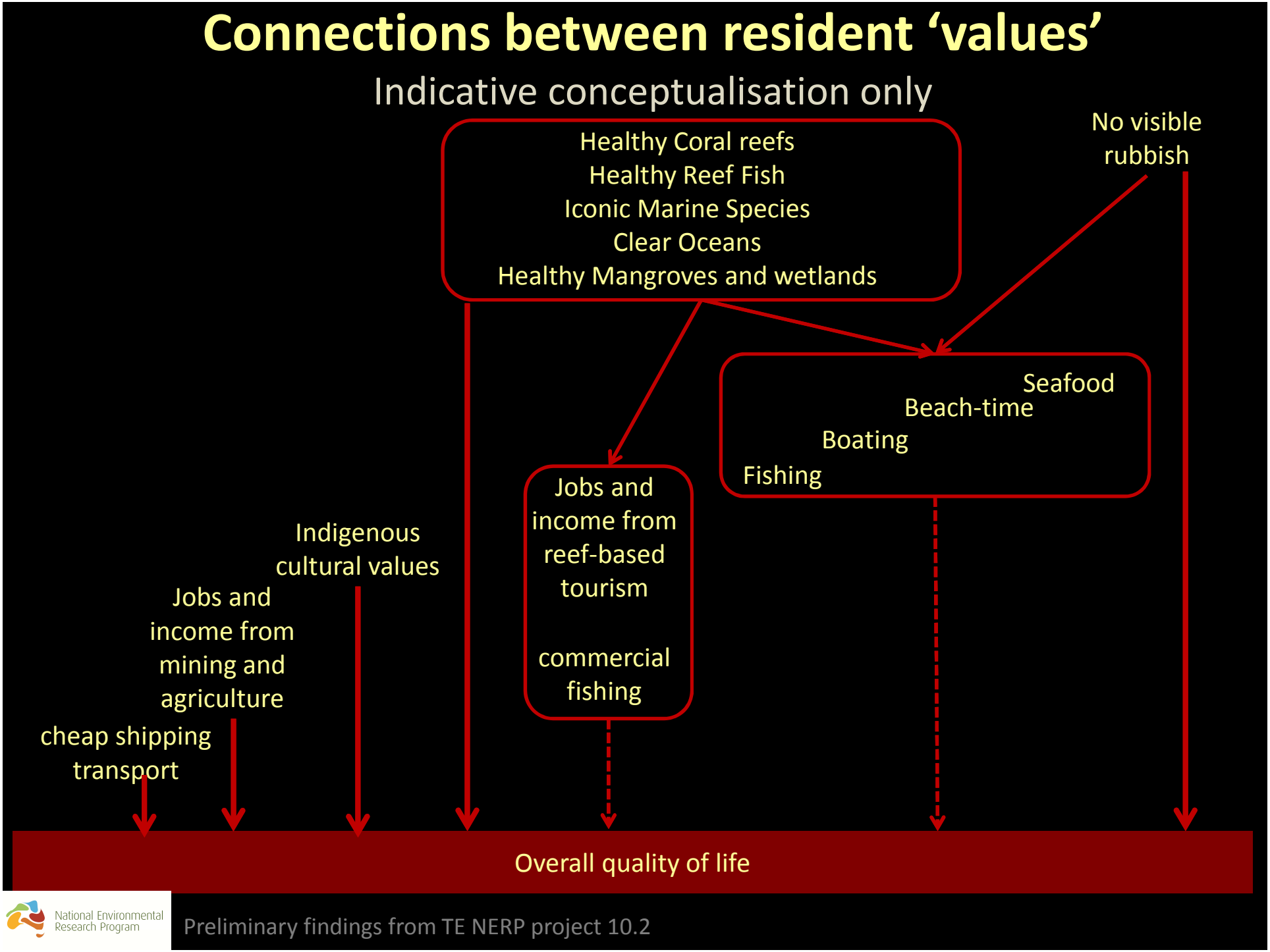
Wilcoxon test:
community benefits significantly higher than other benefits



Delisle, A. (PhD Thesis), A socio-economic investigation of the Torres Strait Indigenous dugong and turtle fisheries, James Cook University

Connections between resident 'values'

Indicative conceptualisation only



Other non-dollar denominated approaches: assessing marginal values

Start with a 'utility' function (sort of like a well-being or happiness function)

Work out what makes people happy --- say money ($) and people (🚺):

$U = f(\$, 🚺)$

If $U^1 = U^2 =$ ☺ ☺ (two options make someone equally happy)

and

$U^1 =$ ☺ ☺ $= f(\$100, 🚺)$

$U^2 =$ ☺ ☺ $= f(\$1000, \ )$

Then

🚺 $\approx \$900$ (in terms of 'utility')

So one can estimate non-market values, even if utility cannot be measured cardinally

Cardinal Alternative: ask about Life satisfaction, and estimate utility function directly

Cardinal indicators of Utility / Life satisfaction

LS = f(environment, income, age, gender, etc)

In theory, could use information from this to generate values akin to those from 'traditional' economic approaches:

$$\text{WTP to protect the environment} = \frac{\partial \text{income}}{\partial \text{environment}} = \frac{\partial LS/\partial \text{environment}}{\partial LS/\partial \text{income}}$$

Will only hold if (and only if) $\partial LS/\partial$ income is the same for all people

But can test and if necessary control for differences in income.

Moreover, this approach does not

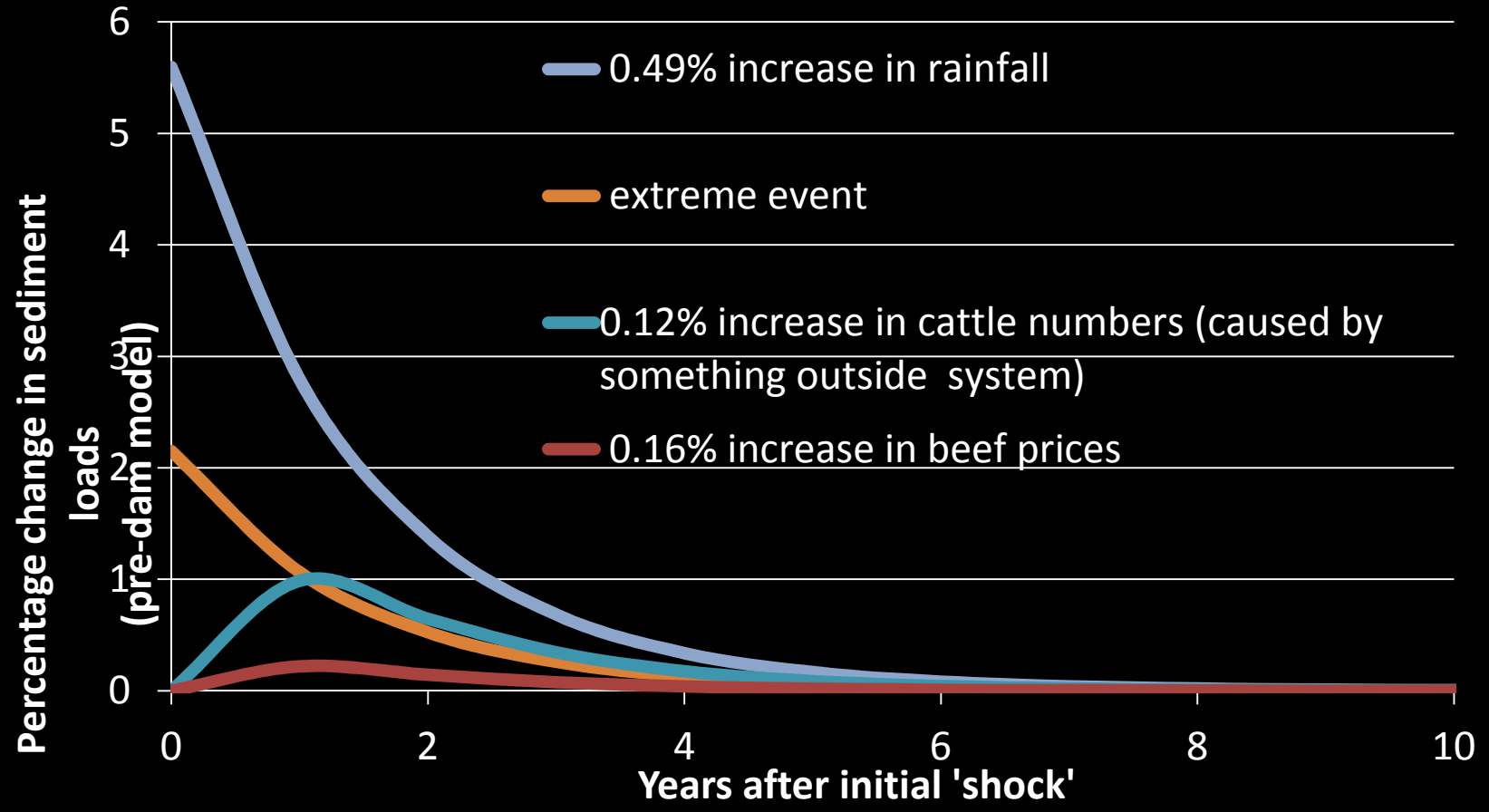
- require people to self-assess the 'value' of the environment (or other goods) – so gets away from problems of strategic responses, imperfect information and expectations
- pre-suppose 'equilibrium'

Watch this space

Other macroeconomic-type approaches…

- Coral samples collected; have hind-cast estimates of annual sediment load.
- Other data collected and collated to ensure temporal and geographical alignment (using annual ‘water years’, from late 1930’s to 2011)
  - Rainfall, temperature and a variety of measures of the intensity of rainfall
  - Beef price index; other commodity price and cost indices; cattle numbers, average land values
- Developed VECTOR AUTOGRESSIVE model to interaction between economic and biophysical systems.
  - Looks as if we CAN pick up socioeconomic ‘signal’s (e.g. prices or cattle numbers) in the sediment data once controlling for rainfall and extreme events.

Other macroeconomic-type approaches…



Jarvis, D., Stoeckl, N., Chaiechi, T. (2013) "Applying econometric techniques to hydrological problems in a large basin: quantifying the rainfall-discharge relationship in the Burdekin, Queensland, Australia", *Journal of Hydrology, http://dx.doi.org/10.1016/j.jhydrol.2013.04.043*

Chaiechi, T., Stoeckl, N., Jarvis, D., Brodie, J., Lewis, S., (in prep), Dynamic modeling of the impact of effect that changes in the socioeconomic system have upon sediment loads – A case study in the Burdekin catchment on the GBR lagoon

Douglas Adams, Albert Einstein and economic techniques for 'valuing' the environment: concluding remarks

- 'Valuation' helps highlight the importance of non-market goods
- Most current techniques derive from microeconomic, partial equilibrium models; they
  - struggle to generate information for macro/policy scale
  - possibly undervalue environment
- Non-priced techniques and/or macro scale approaches much to offer:
  - still require one to deal with issues of separability, feedbacks/interactions with other systems
  - do not necessarily require one to presume equilibrium

Perhaps Edward Lorenz can help too

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