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Putting the Spotlight on Attribute Definition: Divergence Between Experts and the Public

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Abstract

One of the key stages of designing a choice experiment is to define the attributes of interest. The attributes chosen essentially influence all subsequent activities carried out in a choice study. Surprisingly, the process of attribute definition is not the subject of critical and ongoing inquiry.

In the context of informing policy, the choice modelling literature suggests that a given set of attributes should (1) reflect public interests, (2) have a sound scientific basis, and (3) provide useful information to end-users. Fulfilling all criteria presents a challenging task to researchers. Conflicts between criteria are possible, and there are currently no guidelines to assist researchers in negotiating their way through potentially competing sets of information and viewpoints.

We investigated the potential for divergence between members of the public and scientific experts. The investigation was carried out across three environmental systems which differed according to their scale and institutional setting. The results showed that attribute definitions do indeed diverge. Critical points of divergence observed across all case studies included: the way in which the public and experts defined attributes that represented the biodiversity of the system; the public's inclusion of attributes that represented the terrestrial/marine interface; and the public's inclination to aggregate attributes when asked to choose their top picks. A number of additional points of divergence were observed, but these were case specific.

1. Introduction

Choice modelling is a survey based technique that is used to investigate the trade-offs that people are prepared to make between different goods or policies. In a choice experiment, respondents are presented with variants of the good or policy – described by a set of *attributes* – and are asked to choose their most preferred alternative. The appeal of choice modelling comes from the ability to identify the marginal values of the attributes and the willingness to pay for any alternative of interest (Alberini et al. 2007).

In theory, particular attributes are included in a choice experiment because it is known or hypothesised that they play a major role in the choice behaviour of interest (Louviere 2001). Morrison et al. (1997) stress that the selection of attributes depends not only on what is relevant to respondents, but also on the policy context and respondents' capacity to digest the information. Similarly, Blamey et al. (2000, p. 3) note that attribute selection needs to take place "from both the perspectives of the end-user (the population of interest) and the decision-makers/resource managers to ensure that the attributes are not only easily identifiable, but produce policy-relevant information".

There is potential conflict in catering for all of the aforementioned requirements of defining appropriate attributes. For example, in a conservation context, one needs to capture attributes that are scientifically relevant, but that also represent the communities perceptions of what is important and comprehendible. The potential for divergence exists where scientists may opt for attributes that represent complex ecosystem processes, versus the public that might be more concerned about iconic or social components of the environmental system.

In terms of implications on the end-user and policy relevance, the attributes need to represent both the interests of the experts and the public, ensuring that the community voice is upheld while securing scientifically sound knowledge regarding conservation preferences. Choice modelling studies may utilise both public and expert guidance in attribute definition, usually in one of two ways: (1) consulting experts to form a list of attributes, and using public focus groups to ensure that non-experts can appropriately interpret the attributes; or (2) using public focus groups to scope the issues they consider important, then consulting experts to refine the list to scientifically relevant attributes. In each case, one group is reacting to the suggestions of another.

Examining an *independent process* of attribute definition for both public and expert populations is necessary to determine whether definitions are *divergent*. This is a necessary first step in exploring the broader issue of whether experts and members of the public place different priorities on key components of the environment. For the purpose of this study there are several means by which attribute definitions may diverge: attribute definitions are considered to be *contrasting* if the attributes are described in a different way; *misaligned* if different priorities are placed on the attributes; and/or *contradictory* if different sets of attributes are put forward.

Indeed, if attribute definitions are divergent, then the question of "whose definition should prevail" must be considered. Should it be an expert-driven process based on universal scientific concepts? Or should it be a public-driven process based on citizen empowerment and participation? Alternatively, should there be some middle ground that involves a social negotiation process that

overcomes differences in the ways that experts and the public observe and interpret the environment?

To investigate the potential for divergence, this paper presents three West Australian case studies that elicit attribute definitions from both members of the public and relevant experts:

1. Tropical waterways and wetlands in the Kimberley region: conservation priorities for surface water features within a geographic region
2. Ningaloo Marine Park: conservation priorities for a fringing barrier reef within a designated marine park
3. Southwest Australian Ecoregion (SWAE): conservation priorities for biodiversity within an ecoregion

The case studies were chosen with the intention of exploring issues of scale and setting on conservation preferences. The case studies also provided different opportunities for accessing expert information and preferences.

A series of focus groups were held to investigate public attribute definitions for each case study, while a variety of approaches were applied to derive attributes that met expert expectations. The exact nature of this elicitation process is outlined in Section 3. The results from each case study are individually presented in Section 4. A discussion of emerging themes, across all the case studies, appears in Section 5. Section 6 offers a potential way forward in dealing with the normative question of "whose definition should prevail".

This paper contributes to a broader research project that aims to discern whether experts and members of the public place different priorities on key components of the environment. This is being evaluated using a series of choice experiments whereby survey participants (comprising of both experts and members of the public) have been asked to reveal their preferences for key components of a specific environmental system.

2. Background

Guidance on the design and implementation of choice experiments is now readily available (e.g., see Bateman *et al*. 2002, Bennett and Blamey *et al*. 2001, Hensher *et al*. 2005, Louviere *et al*. 2001). Once the issue and research agenda have been established, the typical choice modelling exercise consists of five components (Louviere *et al*. 2000):

1. defining attributes
2. assigning attribute levels
3. creating scenarios
4. determining choice sets and obtaining preference data

5. estimating model parameters.

In terms of these steps, the choice modelling literature, both in its application and further advancement of the method, is strongly focused on statistical experimental design and econometric technique (i.e., steps 3-5). It typically includes marginal information and explanation on appropriate attribute definition. A number of reasons for this can be speculated upon. It is perhaps that the audience for choice modelling analysis is still predominantly economists, who are possibly more inclined to scrutinise the logic and application of econometric techniques. Or, perhaps, other constraints such as time limitations prevent detailed reporting on the attribute definition process that has been followed.

It has been acknowledged that environmental complexity brings with it unique challenges in designing choice experiments (Rolfe, Bennet and Louviere 2000). However, it is not explicit whether experts and the public differ in the way in which they bring order to this complexity. If there is a difference, it will first come to bear in the way attributes are defined.

The literature on defining environmental attributes is limited to a small number of investigations involving causality (e.g., Blamey *et al*. 2002) and scope (e.g., Rolfe and Windle 2010). On the issue of causality, it has been suggested that environmental attributes should be the final outcomes or effects that represent the underlying ecological functions (Blamey *et al*. 2002). This advice arises from observations in focus group sessions that some respondents try to bring order to a choice task by assigning a greater weight to causal attributes, as compared to effect attributes. These observations were followed up with an empirical test comparing the results of a choice experiment, with and without the inclusion of a causal attribute. Indeed, the causal attribute (i.e., the loss in area of unique ecosystems) reduced the implicit price of an 'effect' attribute (i.e., number of endangered species lost) by 34%[1].

However, from a pragmatic point of view, there is a potential difficulty. Attributes need to be measurable and causal attributes are often the focus of scientific studies (Spash 2008). An alternative approach suggested by Blamey et al. (2002, p. 183-184), that accommodates this potential divergence, is to identify causally-related attributes in the preliminary design stage and make a more concerted effort to model attribute interactions through advanced experimental designs.

Scope relates to the dimensions used to define the good and the trade-off involved, and is largely set by what attributes appear in the choice sets (Rolfe and Wang 2008; Rolfe and Windle 2010). For example, the scope of a choice task can be expanded by adding or defining attributes more widely. It can also be altered by describing attributes in different ways. From the authors' observations, the desire to reduce choice complexity is often the primary driver in deciding the number of attributes, and the way in which they are described. The implications, in terms of scope, are not generally evaluated.

[1] Estimates of compensating surplus did not differ significantly across the two treatments for a given policy package. Thus, the part-worth utilities have been repackaged in such a way that the overall welfare implications are unchanged.

The use of attribute labels and 'representative' attributes can also be used to simplify choice tasks: they too have implications in terms of scope, but their ramifications have not been examined in any detail. Rolfe and Wang (2008) draw attention to the use of iconic attributes by Bennett et al (2007): Murray Cod was used to represent a more encompassing attribute, namely, threatened native fish. However, Rolfe and Wang (2008) warn that respondents may scope the attribute in different ways. This also serves to highlight the potential risk of assuming that experts deal with environmental complexity in the same manner as the public.

Focus groups have been proposed as a way of overcoming potential problems with attribute definition. Focus groups are typically a meeting of a small group of people (usually five to 10), where discussions are initiated and guided by a trained facilitator. They are a commonly used tool in psychology, which has an extensive literature on their application (Krueger and Casey 2000). According to Rolfe and Bennett (1995, p. 3) the major role of a focus group in an environmental valuation exercise is to:

1. Establish the overall framework and characteristics of the good in question including the relationship to other goods and applicable institutional settings.

2. Ascertain the extent of knowledge that people have about particular goods, and the ways in which they value those goods.

3. Identify and describe the major attributes that people consider when valuing particular goods.

4. Establish levels or ranges for the major attributes that are appropriate for making trade-offs between bundled packages of goods.

Whilst it has been suggested that the use of focus groups in the design of choice experiments is standard practice (Windle and Rolfe 2005) the tool has been adopted with limited critique and subsequent guidelines on best practice. Most academic papers on the topic of choice modelling simply state that focus groups were used to generate feedback: they do not detail the rationale for participant selection, the agenda for group discussion, or the analysis and interpretation of the dialogue which leads to decisions on design[2].

From our own experience and observation it appears that there are two alternative pathways for defining attributes, each incorporating focus groups in a different manner:

1. Expert construction of attributes; public validation via focus groups:

   When first charged with the task of defining attributes, the researcher will often seek advice from experts on how to decompose the good into meaningful attributes. On-going guidance is sought through informal networks, or in more limited cases, the establishment of a technical working group (e.g., Rolfe et al. 2004). This process generally leads to a list of 'provisional' attributes that is relevant to the context of the study, and reflects the disciplinary perspective of the researcher and experts consulted.

[2] Notable exceptions are provided by Mazur and Bennett (2008) and Windle and Rolfe (2005).

The 'provisional' list of attributes is run through a validation process whereby focus groups, comprised of stakeholders and/or members of the public, are typically used to gauge points of misunderstanding or misinterpretation in the attribute definition. This process may lead to a minor reworking of the attributes so that they are expressed better for a lay audience. It may also result in the addition or removal of attributes, with the latter more common.

2. Public scoping of issues via focus groups; expert transformation into attributes:

   Where the subject of a choice modelling experiment is particularly contentious, the researcher will most often initiate the process of attribute definition by opening it up to stakeholders and/or members of the public. Focus groups are run whereby participants are given the opportunity to voice their general opinions on the subject. In some cases, issues are prioritised through group discussion and consensus.

   This information is taken by the researcher as an indication of what attributes are applicable to the particular research context. With the help of experts, this usually involves transforming key issues into scientifically relevant attributes. The process may also provide the researcher with a greater overall understanding of public sensitivities, potential areas of misunderstanding, etc. In general, the set of attributes are not re-negotiated with the public.

In both cases, attribute selection and framing is dominated by expert judgement, and researcher discretion prevails. The objectivity of attribute definition may be disputed on the grounds that focus groups are generally not used in a systematic or accountable fashion. Thus, the extent to which focus groups are used to fulfil the role outlined by Rolfe and Bennett (1995) is questionable, particularly on points 2 and 3 outlined above.

In summary, the attributes selected for a choice modelling experiment will be a major determinant of the relevance of the valuation exercise. Greater clarity is needed on the process of attribute definition, and the implications of choices made by researchers. This review has established that there is merit in exploring an independent process of attribute definition *for both public and expert populations* to determine whether definitions are divergent.

3. Methodology

3.1 Definitions for commonly used terminology

In the context of this study, attribute definition[3] specifically refers to the process of:

1. Determining how an environmental system should be described in terms of its key elements (i.e., *the process of selecting and prioritising attributes*):

2. Establishing how these key elements should be characterised (i.e., *the process of framing attributes,* where a specific characteristic of the attribute becomes the main focus).

[3] It is important to note that the next step in designing a choice experiment, which involves the determination of attribute levels, is not part of this study.

For the purpose of this study there are several means by which attribute definitions may diverge: attribute definitions are considered to be *contrasting* if the attributes are described in a different way (i.e., the public's construct of an attribute may differ from an expert's construct); *misaligned* if different priorities are placed on the attributes (i.e., the public and experts produce a similar list of attributes, but prioritise them differently); and/or *contradictory* if different sets of attributes are put forward (i.e., some attributes appearing on the public's list do not appear on the expert's list, and vice versa).

3.2 Case studies

The three case studies were originally chosen with the intention of exploring issues of scale and setting on conservation preferences. The case studies also provided different opportunities for accessing expert information and preferences.

1. The Kimberley's waterways and wetlands represent a broad scale system in a remote part of Western Australia. The WA State Government has recently announced its plans to deliver a 'landscape approach' to conservation in the Kimberley with its new Kimberley Wilderness Parks[4]. Conservation goals in the Kimberley are set alongside pressures to tap into its vast natural resource base of minerals, oil and gas. In some cases, this has generated widespread debate and local controversy.

   Aquatic ecosystem research is currently lead by the Tropical Rivers and Coastal Knowledge (TRaCK) Consortium. TRaCK has brought together scientists from around Australia, including those with research interests in the Kimberley. The program builds on numerous former scientific ventures such as the Tropical Rivers Inventory Assessment Project, the Cooperative Research Centre for Tropical Rainforest Ecology and Management (Rainforest CRC), and the Cooperative Research Centre for Tropical Savannas (Tropical Savannas CRC).

2. The Ningaloo Marine Park represents a specific system in a remote part of Western Australia. The marine park contains the iconic Ningaloo Reef – the largest fringing coral reef in Australia and the only large reef in the world found so close to a continental land mass. The conservation significance of Ningaloo Reef was recognised in the 1960s by the Western Australian branch of the Australian Marine Sciences Association. The State waters of Ningaloo (and a 40 metre strip along the shore in the southern reaches) were declared a marine park by the Western Australian Government in April 1987. The park extended for about 260 kilometres and included about 90 per cent of the reef. To give the reef even greater protection, in November 2004 the State government formally extended the Ningaloo Marine Park to include the entire 300 kilometre length of the reef.

   Since 2006, there has been a program of intense, coordinated and collaborative research on Ningaloo. The program has brought together scientists from CSIRO, Western Australian Marine Science Institution, Australian Institute of Marine Science, universities and

[4] http://www.dec.wa.gov.au/content/view/6171/2183/

government agencies. According to promotional materials, the program has seen a 'major leap in the quantity and quality of scientific information' on Ningaloo[5].

3. The Southwest Australia Ecoregion represents a broad scale system in the most populated part of Western Australia. The SWAE has been recognised by Conservation International as one of only 34 'global biodiversity hotspots'. This recognition led to the formation of the Southwest Australia Ecoregion Initiative, with representatives from a consortium of agencies, non-governmental organisations, research centres and other groups. Since 2001 the SWAE Initiative has undertaken various bioregional planning activities, and has drawn on the expertise of scientists from government agencies and research institutions. More recently, a systematic conservation planning approach has been adopted by the SWAE Initiative. Since the end of 2008, the planning process has been fast-tracked with funding from Australian Government's Caring for Our Country initiative. To date the process has been expert driven.

3.3 Overarching design

Community focus groups were held to define attributes considered important from a public point of view for each of the three case studies. However, the methodology varied by case study with respect to experts. A variety of options presented themselves for collection of the expert information required to define attributes, namely: panel discussions, strategic planning documents, and pre-existing outcomes drawn from target setting workshops (Table 1).

Table 1: Attribute definition processes used for each case study.

Case Study:	**Attribute Definition**	
	Expert	**Public**
Kimberley waterways and wetlands	Expert panel	Focus groups
Ningaloo Marine Park	Management plan*	Focus groups
South West Australian Ecoregion	Expert workshop*	Focus groups

*Part of an institutional process, external to the research project.

3.4 Public focus groups

The public focus groups were aimed at allowing an open-ended discussion of what was considered important for each case study. Two focus groups were held for each case study, with a total of 33 participants. Approximately 33% of the participants were male, and there was an even spread of individuals over the 20 to 60 age category. Participants from the West Australian metropolitan community were selected via an exploding email process and advertisements in a primary school

[5] http://www.wamsi.org.au/sites/default/files/Ningaloo%20research%20fact%20sheet.pdf

newsletter. The focus group sessions were managed by two researchers – one facilitating the session, capturing the main points of discussion on a visible board for participants to see, and one scribing the ensuing discussion in more detail. The facilitators made use of a running sheet in each focus group to ensure consistency in the order of discussion across all groups, as shown in Appendix 1.

With regards to making introductions and getting the session started, participants were informed that the topic of discussion was to be about conservation of the relevant case study (i.e., Kimberley tropical waterways and wetlands/Ningaloo Marine Park/SWAE). They were not prompted with any further information about the case study aside from its 'title'. The intention was for an entirely open discussion that was not leading in any way.

A minor exception to the open discussion rule was made with the SWAE focus groups where there was potential for confusion over what is meant by the Southwest Australia Ecoregion. The South West of WA is generally interpreted as the area south west of Perth. In addition to the area south of Perth, the Ecoregion also extends 850 kilometres north of the city. Participants were first asked what their interpretation of the South West was in terms of boundaries, and were then provided with a map to show the northern and eastern boundaries of the Ecoregion. The coastal boundary (west and south) was not specified, allowing open interpretation of whether the coastal interface and offshore islands would be considered part of the Ecoregion. Statement of explicit boundaries was less of a concern for the Kimberley and Ningaloo studies which are more distinct and recognisable geographic areas.

Information provided to participants related to priming them to understand what was required as an end result of the discussion – that is, a prioritised set of attributes (i.e., the key elements of the system) with their associated attribute frames (i.e., how these key elements are characterised). So that participants could grasp what this meant, a generic example of a choice scenario involving wine products was presented to them (Figure 1). It was explained that there were a series of attributes (e.g., type, vintage, cost) and that they could be framed using different categorisations (e.g., for type: red; sparkling; white). They were then asked to apply this 'format' to the environmental system under consideration to develop a list of relevant attributes.

Wine Characteristic:	**Bottle 1**	**Bottle 2**	**Bottle 3**
Type	Red	Sparkling	White
Region	Barossa Valley, SA	Margaret River, WA	Swan Valley, WA
Vintage	2004	2000	2008
Cost	$30	$50	$10
Please choose your most preferred, considering your personal budget:	☐	☐	☐

Figure 1: Wine choice scenario example provided to focus group participants.

Participants where then allowed to discuss the relevant topic in stages via a brainstorming process around the table: firstly defining the attributes that they considered to be important with respect to conserving the asset; and secondly providing suggestions for framing each of the attributes. Once a comprehensive list was derived, participants were asked to then consider that only a certain number of attributes can be included in a choice scenario, referring back to the wine example[6]. Participants then generated a prioritised set of the original attributes defined, either by way of selecting those that were most important or condensing several attributes into one more encompassing attribute. The prioritisation process was achieved via group discussion, with consensus reached easily amongst participants in all cases[7].

3.5 Expert elicitation

A series of complimentary methods were used to develop expert attribute definition. Each case study presented its own opportunities in terms of available information on what experts consider important. Ningaloo has a formal management plan that relied heavily on expert input, while the SWAE Initiative has held target setting workshops with experts. These pre-existing pieces of information were utilised in considering expert attribute definitions. At the time of this research, the Kimberley case study had no equivalent to these information sets, so a deliberation process was initiated via an expert panel.

The specific details of each approach are outlined below:

1) Kimberley tropical waterways and wetlands – iterative Delphi process with expert panel:
    a. Panel selection: The scientists were selected[8] based on varying areas of expertise in tropical aquatic system ecology and management, affiliations (government/university) and levels of seniority (researchers/project managers).
    b. Independent definition: five tropical scientists each provided a list of attributes and attribute frames they considered important via email correspondence (participants were also primed with the wine example in Figure 1 above).
    c. Collective discussion: the responses from Part (a) were collated and redistributed via email amongst the scientists. Four of the five then reconvened in a focus group

[6] Note that for the SWAE focus groups the procedure was streamlined. It was assumed (correctly) that the list of attributes would be larger and more varied than that of the other case studies, and defining attribute frames for *all* attributes would be too time consuming. Thus, participants brainstormed to derive a list of attributes which were then prioritised. Attribute frames were only defined for the attributes that appeared in the priority listing.

[7] The SWAE prioritisation process also needed additional facilitation due to the attribute list being long and varied. Participants were provided with five gold star stickers and asked to position them against the attributes they considered most important individually. The group discussion and consensus process then followed as per the other case studies. The star system offered an anchoring point to centre the discussion to ensure direction was maintained in prioritising the diverse attribute list. Participants were still able to include attributes in the priority listing that did not have a star positioned against them if agreed upon in the ensuing discussion.

[8] The selection was made by a senior researcher within the TRaCK Hub (i.e., they were independent of the present study), with broad knowledge of current tropical science research projects and researchers.

session to collectively discuss the comprehensive list of attributes. Similarly to the public focus groups, the scientists were asked to refine the list of attributes to a prioritised set, firstly by each stating their own set of priorities openly around the table and then discussing consensus on a collective set.

2) Ningaloo Marine Park – strategy document:
    a. Strategy Document: the 'Management Plan for the Ningaloo Marine Park and Muiron Islands Marine Management Area 2005-2015 Management Plan No 52' (MPRA 2005) is a legislated document that contains conservation priorities. Considerable deliberation by marine experts occurs in the generation of marine management plans, essentially offering a summary of what they consider to be the key ecological and social components of the system. In this case, experts came from a variety government agencies and research institutions. Attribute definitions were derived from the priority components outlined in the Management Plan (MPRA 2005, Section 7).

3) South West Australia Ecoregion – expert workshop with validation
    a. Expert Workshop: during 2009 the SWAE Initiative held a three day Target Setting Workshop aimed at deriving conservation targets over a range of themes (birds, vegetation, invertebrates, mammals, amphibians, reptiles, aquatic biodiversity, water resources and threatening processes) for the Conservation Plan (refer to Phase 1 report to clarify details and reference). Over 60 experts (predominantly ecologists and experts from related areas of science) attended the workshop (WWF-Australia 2009). Although the intentions were directed towards the Initiative's conservation planning process, the process was ideal for the purpose of drawing out important attributes from the dialogue. The dialogue was captured by researchers involved in the current project. The attributes selected from the dialogue were those that emerged as recurrent items across a range of themes in the workshop, or those that were explicitly stated as being a high priority by a consensus.
    b. To ensure that the attributes were not biased by the researchers who captured the dialogue, a number of scientists that attended the workshop were approached to provide an independent list of attribute suggestions. A comparison of consistency across the two lists confirmed that the attributes drawn from the workshop had been interpreted correctly.

4. Outputs from public focus groups and expert elicitation

The following section provides a brief overview of the key outputs from the public focus groups and the expert elicitation on a case by case basis. Tables containing a full overview of these outputs are provided at the end of the document (i.e., starting on page 33) and are individually referenced throughout the section.

4.1 Kimberley waterways and wetlands

4.1.1 Public attribute definitions

The public focus group discussion resulted in a comprehensive list of potential attributes for the Kimberley waterways and wetlands. The attributes defined included: animal and plant species associated with the waterways and wetlands; attributes relating to the water systems themselves; reflection of the (supposed) pristine state of the Kimberley; geographical icons; cultural importance; and tourism related aspects.

A detailed list of the attributes is provided in Table 2. The table presents the attributes from both focus groups, with the attributes characterised according to whether the suggested frames were specific, catch-all, or management orientated[9]. An attribute was considered to have a specific frame if it its characterisation was explicitly linked to the attribute itself. Typically, a specific frame will be an ecological characterisation of the attribute (e.g. species numbers). An attribute was considered to have a catch-all frame if its characterisation was indirectly linked to the attribute itself. Typically, a catch-all frame will represent a fundamental ecological process (e.g., food webs and weather patterns) or relationships (e.g., predator-prey). An attribute was considered to have a management frame if its characterisation focused on the human management dimension of the attribute itself.

Nearly half the suggested frames were of a specific nature, and of these, many embodied a scientific understanding of the system (e.g., endemism, fertility). The use of catch-all frames was limited, with an emphasis on food webs, habitat and climate. The use of management frames was more extensive, with a wide variety of suggestions across the attributes. The management frames were either indicative of current pressures (e.g., level of weed invasion) or indicative of the level of response (e.g., level of participation).

When asked to prioritise the list of attributes there was a preference to combine specific attributes under a more encompassing heading, rather than exclude attributes. Specifically, attributes that were a priority in both focus groups included:

- Fauna (combination of birds, fish, mammals, reptiles and amphibians)
- Indigenous culture and communities
- Remoteness and landscape

Attributes that were mentioned as a priority in one or the other of the focus groups included:

- Flora
- Wetlands (representing all of the water bodies)
- Environment resources (the water and soil)
- Gorges

[9] Note that this distinction was not made explicitly by the focus group participants. The attribute frames were arranged under these headings after the completion of the focus group sessions.

4.1.2 Expert attribute definitions

The attribute definitions that were suggested *independently* by each expert participant are collated in Table 6. Of particular note is the way in which the attributes have been framed. For the most part, the attribute has been characterised in categorical terms, which is either quantitative (e.g., 1 month; 2 months; 3 months) or qualitative (e.g., low; moderate; high). Over half of the suggested frames are management orientated, with the remaining being evenly divided between specific and catch-all frames.

For the purpose of facilitating the subsequent group discussion, the researchers grouped the attributes under themes (e.g., flora/fauna). Participants were provided the opportunity to comment on the themes but agreed they were suitable categories for the purpose of progressing discussion.

The discussion then proceeded on a theme by theme basis with the following notable comments:

Flora/fauna

- The original attributes suggested were largely correlated, with biodiversity encompassing all but being too broad a term to define as an attribute
- Biodiversity could be represented by attributes such as:
    - Endemism – the Kimberley contains many geographically unique species, many of which are rare or threatened because of their limited distribution
    - rare/threatened species
    - species richness
    - biodiversity hotspots – that is, geographically species rich areas, such as the King Edward-Carson River system
    - representative habitats
- Exotic pests were noted as an attribute to manage against for protection of biodiversity

Flow regime

- Similarly to biodiversity, flow regime was considered as the encompassing attribute, but again too broad a term to accurately define
- The most important aspects relate to flood duration and flood extent:
    - The Kimberley is an event driven system, the flood events drive productivity and hence influence all aspects of the system
    - Flooding would be an appropriate attribute, with the attribute frame representing the duration or extent

Connectivity

- Connectivity could be interpreted in many ways:
    - It is different for invertebrates, fish, waterbirds, etc.
    - There is genetic connectivity
    - There is also connectivity in terms of fluxes of nutrients
- It is important to maintain natural levels of connectivity, with isolation and reconnection events

- Connectivity could be defined as an attribute, with the attribute frame reflecting a modified/natural state
- Variation in connectivity should ultimately be captured by the flow regime

Habitat

- Rare habitats are important to conserve, as they contain rare species – for example, the billabongs and off channel wetlands in the North Eastern Kimberley region
- Gorges are an important feature of the Kimberley relating to human use
    - The 'human' aspects (e.g., aesthetics) of the gorges are not important to protect, but community lobbying to protect these aspects can help to protect the associated ecosystems as a by-product
- The key threats to habitats are catchment activities
    - Things happening in the catchment affect water quality
    - Catchment activity could be an important attribute, addressing the threats (modified fire regimes, weeds, grazing, etc.) in the attribute frame
- Riparian zone structure could represent habitat as an attribute also, using modified/natural structure or changes in natural vegetation as the attribute frame

Cultural/socio-economic

- The primary issue in cultural terms is ensuring indigenous right to use traditional resources and maintaining their connection with country
    - 'Indigenous customary economy' uses harvest as a measure of household wealth and could be applied as an attribute
    - Indigenous Protected Areas (IPA's) are another possible attribute – would not consider this an important attribute from a scientific point of view, but IPA's are an improvement from pastoral land uses so it does have some level of environmental benefit
- Recreational fishing is an important attribute for the broader community (but not from a scientific approach), and could be represented by catch/yields

Other

- Well captured in the categories discussed above

General comments arising from the discussion indicated that there was an obvious preference for attributes that captured processes operating at the system-level. It was seen that protecting the integrity of the system essentially flows on to affect the things the community really cares about, such as biodiversity.

Several times a distinction was made between what they would value as a scientist, as opposed to a 'layperson' point of view. That is, they recognised that the community probably considers cultural, social and iconic attributes to be very important, but from their scientific perspective they placed minimal weight on the inclusion of these types of attributes given that the topic was about *conservation* of the Kimberley waterways and wetlands. They had a general preference that any

social type inclusions appeared not as attributes, but where appropriate as related characteristics that would be protected as a by-product of the environmental attributes. For example, protecting endemic species also protects traditional indigenous food sources, or better catchment management preserves the integrity of pristine iconic locations.

Interestingly, the four participants were in general agreement over the priority attributes without lengthy discussion. All four participants recognised the following as important attributes:

- Flooding
- Catchment activity
- Endemic species: all four participants considered that biodiversity was important overall, but too broad a term to be used as an attribute. Two considered that endemic species were an appropriate attribute to represent biodiversity, one preferred rare/threatened species as a measure, while the fourth was content with either provided that biodiversity was represented in some way. Consensus was quickly reached that endemism was the most appropriate attribute as many rare/threatened species are also endemics.

Representative habitat was the next most important attribute, specifically mentioned by two participants with no objection from the group.

4.2 Ningaloo Marine Park

4.2.1 Public attribute definitions

The participants in the Ningaloo focus groups again displayed a broad understanding of the environmental system. Attributes were suggested that reflected species of interest, the ecosystem and its interface with the terrestrial environment, and cultural and social aspects. Table 3 presents the attributes from both focus groups, with the attributes characterised according to whether the frames are specific, catch-all, or management orientated[10]. The distribution of suggestions across these categories was similar to results generated from the Kimberley focus group session. Again, nearly half the suggested frames were of a specific nature, and included scientific terms (e.g., rarity, density). A slightly greater proportion of catch-all frames were suggested for Ningaloo, as compared to the Kimberley. However, there was still an emphasis on food webs and climate for Ningaloo. In addition to these catch-all frames, coral and fish were suggested as indicators of the condition of other attributes (e.g., coral spawning events was suggested under the whale shark attribute).

The management frames suggested for the various attributes were of a similar nature to the Kimberley – they could be considered to be either indicative of current pressures (e.g., level of pollution) or indicative of the level of response (e.g., restriction of vehicles). Interestingly, management frames were not provided for dolphins, whales, turtles, dugongs and sea snakes, but they were provided for fish and the coral reef. Perhaps the public is less familiar with management options, beyond those promoted for managing fish stocks and reef integrity, for marine species. The

[10] Note that this distinction was not made explicitly by the focus group participants. The attribute frames were arranged under these headings after the completion of the focus group sessions.

whale shark attribute had 'research potential' as its only management frame, which possibly supports this reasoning.

When asked to prioritise the list of attributes there was a tendency to combine, rather than exclude, attributes. This was also observed in the Kimberley case study. The following attributes were considered as the main priority for Ningaloo[11]:

- Marine life
- Reef and water quality (as a combined attribute)
- Cultural aesthetics
- Coastline

4.2.2 Expert attribute definitions

As previously noted, the 'Management Plan for the Ningaloo Marine Park and Muiron Islands Marine Management Area 2005-2015 Management Plan No 52' (MPRA 2005) was used for the purpose of eliciting expert attribute definitions. Table 7 provides a list of attributes that captures the key ecological and social components of the Ningaloo Marine Park, as identified in the Management Plan. It is notable that there are a significant number of social components identified as a priority in the Plan, making up a greater proportion of the total number of social attributes than that defined by the scientists for the Kimberley case study.

Attribute frames can be identified from the text supporting each of the priority components. These frames are of both a specific nature (via the 'performance measures') and management orientation (via identified 'pressures' and articulated 'management objectives and strategies'). However, a greater emphasis is placed on management for all the components (see MPRA 2005, Section 7). For example, the water quality attribute has two performance measures, that being; (1) metals and metalloids, and (2) organic compounds. In contrast, there is a long list of pressures and management orientated statements.

Priority attributes can be inferred from the components of the system that have been identified as Key Performance Indicators (KPI's). The Management Plan suggests that KPI's "reflect the highest conservation (from biodiversity and ecosystem integrity perspectives) and management (social) priorities of the MPRA, CALM and the community" (MPRA 2005, p. 7). The following components of the system were identified as KPI's:

- Water quality
- Coral reef communities
- Mangrove communities
- Coastal biological communities
- Finfish
- Turtles
- Seascapes

[11] Only one focus group provided a prioritised list due to a delayed start constraining time in the other group.

- Wilderness

4.3 Southwest Australia Ecoregion

4.3.1 Public attribute definitions

The brainstorming exercise, to derive a list of attributes, took a different path for both of the SWAE public focus group sessions. The participants tended to suggest, in the first instance, attributes that were broad in nature. They then refined these attributes by suggesting specific examples. Although the approach to broadly then narrowly define attributes was chosen by both SWAE focus groups, they each concentrated on different forms of refinements. The first group tended to refine the broad attributes by naming places, locations or specific things. For example, beaches were defined as the broad encompassing attribute with specific attributes such as named beaches like Yallingup and Cervantes. The second group focussed on unpacking the attributes into logical categories. Beaches were once again discussed as a broadly defined attribute, which was unpacked into attributes such as sand dunes and marinas. The full list of suggested attributes is presented in Table 4, noting the broadly defined attributes and their related refinements.

The focus of attributes was unique for SWAE also. In the previous case studies there was a high importance placed on natural and untouched attributes such as environmental or ecological attributes, and also on indigenous culture. Here there was shift towards interest in iconic locations and (European) modified environments. Many iconic locations and landmarks were named, and attributes such as man-made historical features, farmland and mining resources were discussed. Conservation of these attributes was viewed positively, including those attributes relating to agriculture and mining that could be considered as counter-productive to conservation of the natural environment. Untouched environments and native plants and animals were still considered important to conserve, but in balance with sustaining the other enterprises.

Consistent with the Kimberley and Ningaloo focus groups, the SWAE groups had a preference to prioritise from the list using broadly defined attributes. Attributes that were considered as a priority by both groups included:

- Beaches and coast
- Native animals and plants
- Historical features

Priority attributes mentioned by one or the other of the groups included:

- Farmland and wineries
- Geological landmarks and natural wonders
- Resources, minerals and produce
- National parks

Table 5 presents the attributes from both focus groups, with the attributes characterised according to whether the frames are specific, catch-all, or management orientated[12]. The distribution of suggestions across these categories is in contrast to the Kimberley and Ningaloo results. Over three quarters of the suggestions fell within the management frame category. Another contrasting result is that there is a strong bias towards management frames that are indicative of the level of response (e.g., coastal zoning), rather than being indicative of current pressures (e.g., level of disturbance).

Whist there were only a few attribute frames that were catch-all in nature, it is notable that 'sustainability' was a description assigned to the 'farmland and wineries' and 'resource, minerals and produce' attributes. This suggests that although the modified environments are considered important to conserve as well as natural environments, the participants recognised that human activity needs to be managed at sustainable levels.

4.3.2 Expert attribute definitions

The attribute definitions resulting from the Target Setting Workshop and subsequent validation process are provided in Table 8. Attributes were strongly focused on measures of biodiversity, and unlike the Kimberley and Ningaloo results, there were no attributes that captured cultural or socio-economic elements of the system. The framing of the attributes do not follow the Kimberley results either. The attributes were generally not characterised in categorical terms, despite this being an objective of the target setting workshops. The suggestions were also more evenly spread across the specific, catch-all and management frames.

Further refinement of the expert attribute definitions, particularly for the purpose of identifying priority attributes, was not conducted. Both the public and expert attribute definitions were presented to a mediator group that was charged with the task of bringing the two lists together to yield a set of meaningful attributes for a choice experiment focusing on conservation planning issues and associated biodiversity values in the SWAE (see Section 6).

5. Contrasting, contradictory or misaligned attribute definitions?

This section draws on the preceding results to evaluate the extent to which attribute definitions diverge between members of the public and experts, in terms of whether definitions are contrasting, contradictory and/or misaligned.

5.1 Contrasting definitions

Definitions were considered to be contrasting if the attributes were described in a different way: in other words, the public's construct of the attribute and/or its frame differed from the expert's construct.

[12] Note that this distinction was not made explicitly by the focus group participants. The attribute frames were arranged under these headings after the completion of the focus group sessions.

The major point of *contrast* across the case studies was the way in which the public and experts defined attributes that captured the *biodiversity of the system*.

Across the three case studies, the public tended to nominate biological classes (e.g., plants, frogs, reptiles) as attributes. 'Birds' and 'fish' featured in all cases. The frames that the public used to describe these classes were commonly of a specific nature. Such frames were exhaustive and often of a scientific orientation capturing concepts such as population dynamics (in terms of density, age structure, survival rates and seasonality), richness, rarity, endemism and distribution. Frames that were of a catch-all nature were also of a scientific orientation capturing concepts such as connectivity (mainly through food webs and habitat requirements) and climatic conditions. Frames that were of a management nature captured the level of pressure the biological class was under, with feral predators the most commonly suggested frame.

Biological classes also formed the basis of the biodiversity attributes defined by experts for Ningaloo. There was a direct overlap for seven of the public and expert defined attributes. However, the expert's attribute list also contained biological classes of a more sophisticated nature, such as macroalgal and seagrass communities and invertebrates. The expert's attribute frames also differed in terms of their emphasis: the expert's frames had a strong management orientation (capturing levels of disturbance) with links to achieving conservation outcomes.

In contrast to the public and Ningaloo experts, biological classes were not the main focus for Kimberley and SWAE experts. Here, it was actually the public's *attribute frames* that aligned with many of the biodiversity attributes suggested by the experts. This alignment is found where expert attributes encapsulate population dynamics, endemism, richness, rarity and distribution. For example, in the case of the SWAE case study, the public suggested endangered species and rare flora and fauna as *attribute frames* for native plants and animals. For the experts, these frames were captured in the rare/threatened species *attribute*. The associated expert attribute frames had a strong management orientation, as per the Ningaloo case study.

In summary, a higher level of complexity is characteristic of the biodiversity attributes identified by the Kimberley and SWAE experts. Whilst the Ningaloo experts, specifically, and the public, across all the case studies, generally nominated attributes that reflected biological classes, the Ningaloo experts followed the Kimberley and SWAE experts in terms of their attribute frames. The expert attribute frames characterised levels of disturbance and emphasised conservation outcomes, whereas the public attribute frames were more focused on describing the attribute in terms of its ecology (Figure 2).

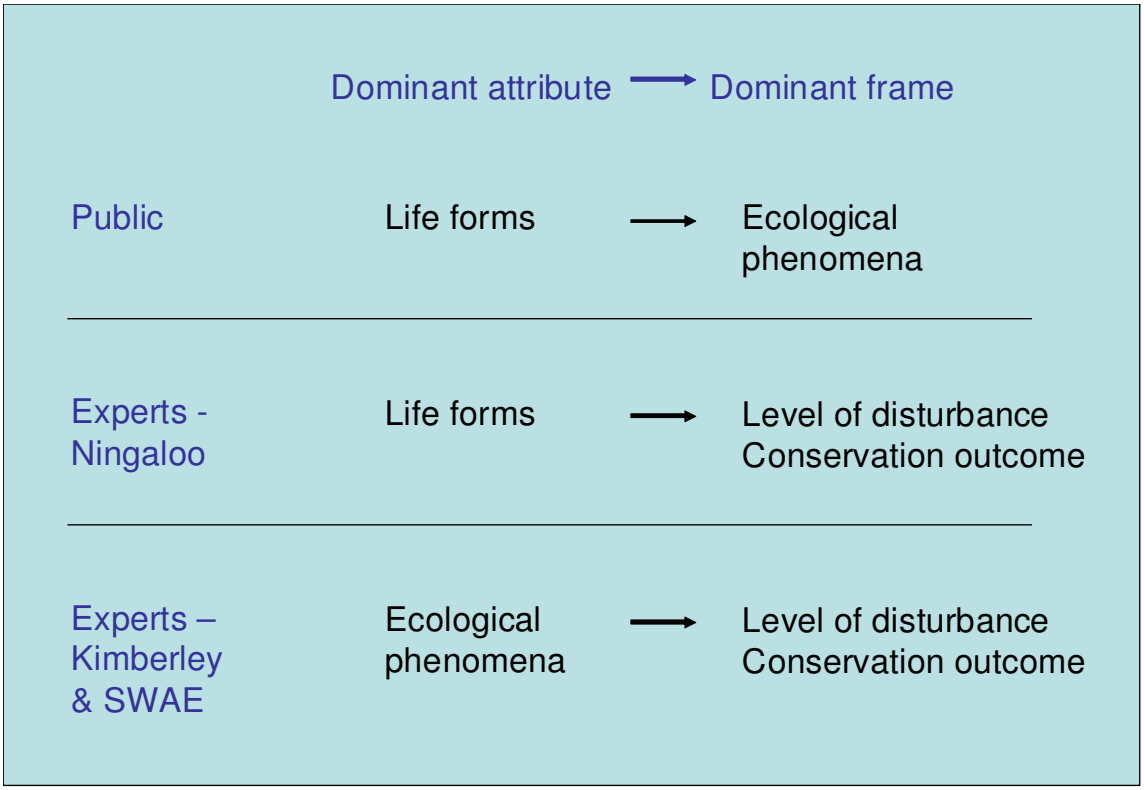

Figure 2: Conceptual overview of attribute definitions relating to biodiversity.

Another stand-out observation in relation to biodiversity was the mention of specific species. For the SWAE, the public nominated a wide variety of specific species whilst the experts did not mention any. For the Kimberley, the public mentioned the Thorny Devil, Barramundi and Boab. Experts also mentioned the Barramundi. For Ningaloo, the public mentioned the Whale Shark and Dugong. Experts also mentioned Whale Sharks and Dugongs, as well as Manta Rays.

Another point of *contrast*, observed in the Kimberley case study, was the way in which the public and experts defined attributes that captured the *freshwater elements of the system*.

For the freshwater elements of the Kimberley case study, we again observe the public's attribute frames being the actual attributes nominated by the experts. The public captured the freshwater elements of the system in broad terms, such as water, wetlands and pristine rivers. However, the public's attribute frames included aspects relating to flow and flooding, and these featured as expert defined attributes (i.e., flow regime, flood extent, flood duration).

5.2 Contradictory definitions

Definitions were considered to be contradictory if different sets of attributes were put forward: in other words, some attributes that appeared on the public's list did not appear on the expert's list, and vice versa.

The major point of *contradiction* across the case studies was the public's inclusion of attributes that captured the *terrestrial/marine interface*.

For the public, attributes relating to the terrestrial/marine interface featured in all the case studies. This was despite the Kimberley and SWAE being terrestrial case studies and the Ningaloo being a marine case study. The Kimberley included cross-boundary attributes such as the coastline and deltas, as well as beaches. The SWAE included the coast in general, reefs and marine protected areas. One of its biodiversity attributes was offshore marine life, and a number of marine species were specifically mentioned (i.e., Dugongs, Great White Sharks). The Ningaloo included attributes such as beaches, dunes and vegetation in the intertidal zone.

The experts may not have focussed on the interface simply because they have prior knowledge of the case study areas and are aware of the explicit boundaries. That is, the Ningaloo Marine Park is predominantly comprised of marine waters; the Kimberley waterways and wetlands were defined to not include the marine and estuarine environment; the SWAE Initiative had defined boundaries for the Ecoregion to exclude offshore islands. Concern for the offshore environment was, however, noted in early discussions of the Ecoregion boundaries with there being some conjecture over whether offshore islands should or should not be included (WWF-Australia 2009).

However, the experts' awareness of existing boundaries doesn't discount the fact that divergence is observed. The boundaries were initially determined by experts and at some point they ruled out including the coastal interface.

Another point of *contradiction*, observed in the SWAE case study, was the expert's omission of *cultural and socio-economic elements of the system*.

Across all three case studies, the public nominated cultural and socio-economic attributes. This was despite focus group participants being informed that the topic of discussion was to be about conservation of environmental assets within the relevant system. Experts in the Kimberley and Ningaloo case studies also nominated cultural and socio-economic attributes, more so for Ningaloo than for the Kimberley. For the Kimberley there was an overlap between the public and experts with regards to attributes relating to indigenous culture. For Ningaloo the overlap was in relation to aesthetics (or what the experts termed seascapes).

However, no such attributes were nominated by the SWAE experts. This omission is further highlighted by the public's strong interest in also conserving man-made environments such as dams, productive systems (i.e., farmland, vineyards), historical buildings and infrastructure. They also wanted to preserve the mineral resources sector. These attributes were viewed positively which might seem to be in conflict with the goal of conserving the environmental assets of the system. However, it was obvious from the suggested attribute frames that the participants were aware that balance was required to conserve man-made elements without ruining the environment.

5.3 Misaligned definitions

Definitions were considered to be misaligned if different priorities were placed on the attributes: in other words, the public and experts produced a similar list of attributes, but prioritised them differently. It is important to note that the SWAE expert process did not extend to prioritising attributes (see Section 6).

> The major point of *misalignment* across the case studies was the public's inclination to lump attributes together when choosing their top picks, which compared to the Kimberley and Ningaloo expert's preference to choose a selection of attributes that captured ecosystem integrity and the persistence of unique elements of the biota.

Across all three case studies, when it came to prioritising the attributes (with the explicit intent of being left with four to six attributes suitable for a choice experiment) the public found ways to combine various attributes so that their reduced list of attributes still captured a broader set of elements. This process of aggregation followed a logical and consensual path, with input from the majority of participants.

The Kimberley experts did not follow a similar route. Prioritising saw experts seeking attributes that best captured system-level processes (i.e., flooding and catchment activity) and the ecological 'uniqueness' of the system (i.e., endemic species and representative habitats). Whilst biodiversity was considered in the prioritisation process, it was discounted on the basis that it was not sufficiently specific.

The prioritisation process was inferred for the Ningaloo experts, via the selection of KPI's from the more expansive list of attributes. Four of the KPI's captured system level processes that if conserved would protect the integrity of the whole system (i.e., water quality, coral communities, mangrove communities, coastal biological communities). The remaining four KPI's also captured the 'uniqueness' of the system. However, this was not strictly in ecological terms, particularly with the inclusion of the seascapes and wilderness attributes.

> Another point of *misalignment*, for the Kimberley case study, was the priority the public assigned to attributes that captured the 'essence' of the Kimberley region.

The different approaches taken by the public and experts to prioritise the attributes had contrasting outcomes for divergence: the prioritised attributes for the public and experts were misaligned for the Kimberley, whereas there was considerable overlap for Ningaloo. For the Kimberley, the public placed importance on elements of the system that captured the 'essence' of the region. Through marketing campaigns, the Kimberley is strongly associated with images of remote and isolated landscapes, unique geological formations, and indigenous culture. This likely explains the public's desire to put a priority on the related attributes of indigenous culture and communities, remoteness and landscape, and gorges.

6. Bridging the divide

The results indicate that attribute definitions, in the case of the public and experts, do indeed diverge. Critical points of divergence observed in the study include: the way in which the public and experts defined attributes that captured the biodiversity of a system; the public's inclusion of attributes that captured the terrestrial/marine interface; and the public's inclination to aggregate attributes together when choosing their top picks. A number of additional points of divergence were case specific. For the Kimberley, divergence was observed in the way the public and experts defined attributes that captured the freshwater elements of the system, and the priority the public placed on attributes that captured the 'essence' of the Kimberley region. For the SWAE, divergence was observed in the expert's omission of cultural and socio-economic elements of the system.

With these results in mind, the question of "whose definition should prevail" must be considered. Whilst we could speculate on the moral and ethical implications of choosing the public's attribute definitions over experts, and vice versa, we were presented with an opportunity to try a novel approach to resolving this question. This involved instigating a 'mediator process' to come up with a list of attributes for the SWAE case study that reflected, in some way, both the public's and expert's attribute definitions that were elicited as part of this research.

This opportunity arose through members of the SWAE Initiative taking a keen interest in our broader research topic of 'preference divergence between the public and experts for the conservation of environmental assets'. Members of the SWAE Initiative openly acknowledge that the systematic conservation planning process implemented to date has largely been driven and informed by experts. They are also aware that any outputs, in terms of recommendations for new conservation areas, must receive a high level of public support to become part of the conservation estate. Thus, the topic of public and expert preferences is of immense relevance to the SWAE Initiative.

The Project Manager of the SWAE Initiative was receptive to the idea of a mediator process and helped to develop it further. It was jointly decided that the mediator team would be comprised of members of the Management Committee of the SWAE Initiative. The logic underpinning this decision was that the Management Committee represented the broad interests of the community, with members drawn from all levels of government and with representatives from non-government organisations. It was also expedient to use the Management Committee, with the Project Manager being able to quickly set up links for electronic correspondence, as well as a meeting, on our behalf.

The mediator process was carried out with four members of the Management Committee. All members received, via email, an initial briefing and the lists of attributes and their associated frames (Tables 5 & 8). The briefing provided an overview of the task, particularly in relation to requiring a short-list of attributes to feed into a choice modelling experiment. Members then attended a two hour session where the public and expert attribute definitions were discussed, salient differences were explored and given meaning, and a new attribute list was negotiated.

It is important to note that the researchers pointed out (via the electronic briefing and a verbal introduction to the mediator session) that a short-list of attributes could be achieved through a number of means. This included, but was not limited to:

- Selecting attributes that captured synergy between the public/expert lists

- Selecting attributes from either the public or expert list that were considered most important or most representative
- Condensing/collating/integrating several attributes from the public/expert lists into a new attribute that broadly captures them all

Table 9 provides the final list of attributes negotiated by the members of the SWAE Initiative Management Committee. The associated management frames were limited to one or two per attribute as suggestions were only accepted by the group if they were considered to be the most relevant and/or practical in terms of accessing available information.

Table 9. Attributes and their associated frames for the SWAE case study, which were negotiated through a mediator process involving members of the SWAE Initiative Management Committee.

Attribute	Frame
Coast/beaches	- Proportion of beach formation types in various zones (i.e., conservation, recreation etc. - Proportion of vegetation cover on dunes
Estuaries, wetlands, rivers	- Proportion of 'healthy' wetlands - Proportion of the catchment vegetated (as an indicator of disturbance to the water balance)
Threatened species and ecological communities	- Percentage protected in conservation estate
Flora and fauna habitat	- Percentage of vegetation communities that are less than 30% of their original extent
Unique/rare species	- Percentage protected in conservation estate
Ecosystem processes/landscape function	- Percentage of conservation estate linked to other reserves and/or remnant bushland
Refugia	- Percentage of granite outcrops, hilltops, ridges in conservation estate

The coast/beach attribute was included to capture the priority the public placed on this component of the system. Whilst it was acknowledged that the public also placed a priority on the marine environment, man-made features in the landscape (in terms of their cultural and historical values) and productive systems, they were not included on the basis that they were not part of the SWAE scope. It was agreed to disaggregate the public's attribute of 'native plants and animals' to better capture the biodiversity attributes proposed by the experts. The attributes, ecosystem processes/landscape function and refugia, were both taken from the expert's list. The estuaries/wetlands/rivers attribute was informed by both the public and expert lists.

7. Final remarks

Calls to bridge the gap between the language of scientists and non-scientists are commonly found in the applied sciences and science communication literature (refs). In the realm of policy, the classical model of expert-informed decision-making has also come under fire. Greater emphasis is now placed on drawing on 'good science' *and* the 'knowledge of local communities and stakeholders' (ref). It is generally assumed that both elements are reconcilable. The crucial, yet neglected point is whether they are mutually consistent and compatible.

Choice modelling can be applied to elucidate differences in expert and public preferences for the conservation of various environmental assets. This is the topic of a concerted and ongoing research endeavour. However, it would be a major oversight, in the first instance, if the issue of divergence was not explored in the initial stages of designing a choice modelling experiment – that being, the process of attribute definition.

A positive result arising from this study is that the public consistently generated a sophisticated and comprehensive list of attributes, with a strong emphasis placed on framing the attributes in specific ecological terms. This should help to overcome scepticism that the public cannot capably think about the environment, and communicate their understandings, in a scientific manner. However, there are also consistent points of divergence. These include the way in which the public and experts defined attributes that captured the biodiversity of the system*;* the public's inclusion of attributes that captured the terrestrial/marine interface; and the public's inclination to aggregate attributes together when asked to choose their top picks.

The observation of divergence raises the bigger question of whose definition should prevail. We did not address this issue directly, but instead opted for a process that might offer a middle ground. We implemented a mediator process whereby members of the SWAE Initiative Management Committee considered both the public and expert attribute definitions. The 'revised' list of attributes and their definitions were more strongly influenced by the expert definitions than the publics. However, the revised list did include beaches/coasts which was identified as an attribute of high importance to the public, and did not even appear on the expert's list.

It would be of great interest to see what attributes the members of the committee would have suggested, without prior knowledge of the public and expert attribute lists. This would have been beneficial in terms of considering whether 'peak' NRM affiliations could be utilised to a greater extent in the design of choice experiments, particularly with the aim of resolving issues of divergence. However, in this particular case, a split sample was not possible due to the small size of the committee. Another option would be to get the mediator group to come up with their own attribute list, then present them with the expert and public lists, and assess the extent to which they modified their original definitions and priorities. However, the time constraints imposed on such groups would generally preclude this more demanding process.

A number of other avenues for defining attributes are also worth pursuing. The conceptual framework for applying economic production theory to the articulation of environmental attributes has been laid out by Gibson and Burton (2009) and Boyd and Krupnick (2009). The approach is promising in terms of it providing a framework to systematically unbundle environmental systems into a series of endpoints that generate value, and linking these endpoints by way of ecological

production functions that reflect science, and management options (i.e. how management change will achieve those outcomes). However, there is still the problem of whether experts and the public have different endpoints in mind, and whose understanding of the ecological relationships should be used. One might suggest that the endpoints should be defined by the public, while one would anticipate that experts would be in a better position to define ecological relationships. However, this raises issues for valuation exercises. If there is heterogeneity in the public's understanding of cause and effect relationships, this may lead to misplaced (either increased or reduced) values being associated with different forms of management change. Further exploration of these issues is necessary, and could possibly be advanced through cognitive modelling experiments that explicitly compare the public's 'ecological mental models' with those constructed by the experts.

The 'knowledge base approach' outlined by Cleland and McCartney (2010) offers a rigorous, but less technically demanding option for attribute definition. It suggests that the 'endpoints that generate value' can be inferred from policy narratives. These narratives are constructed from an encompassing review of the literature on the topic (both published and 'grey' literature). The narratives reveal the interplay of expert rationality, activist ideology, public ecology, and indigenous ecology in the setting of conservation priorities in Australia. These 'knowledge bases' capture different modes of thinking and conduct (summarised in Table 10) and allow for the articulation of attributes that are relevant to stakeholders and decision makers.

Table 10. Knowledge bases in conservation with typical modes of logic and conduct.

Knowledge base	**Typical realm**	**Typical approach**
Expert rationalism	Universal truths	Paternalistic
Activist ideology	Place-based relationships	Confrontational
Public ecology	Varied, but emphasis generally on local relationships	Collaborative
Indigenous ecology	Place-based relationship	Dynamic

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Appendix 1: Focus Group Running Sheet

Focus Group #	**Case Study:**	**Date:**	**Venue:**

Male participants: Female participants:

Introduction

START TIME:

Present CM wine example

(*SWAE Groups: discuss south west boundaries and show ecoregion map)

Notes:

Stage 1: Attribute definition

Notes:

Stage 2: Attribute frames

Notes:

Stage 3: Priority list of attributes

(*SWAE groups: Stages 2 & 3 reversed)

Notes:

Stage 4: General comments

Notes:

CONCLUDING TIME:

Table 2: Public attribute definitions for the **Kimberley waterways and wetlands**. Note categories for attribute frames were imposed by facilitators post-discussion.

Attribute	Attribute frame[a]		
	Specific	**'Catch-all'**	**Human/management**
Wildlife generally	- Numbers - Diversity - Demographics – age and gender structure - Endemism - Species with restricted breeding grounds and nursery sites - Non-charismatic species	- Interconnection and food webs - Nursery habitats – e.g. wetlands important to sustain nurseries for fish etc.	
Birds	- Migratory birds - Breeding, chick survival rates - Restricted species and their distribution - Levels as for wildlife	- Dependence on certain flora - Availability of food sources	- Introduction of feral birds (competition) and predators
Reptiles (e.g. Thorny devil)	- Species that have been in the area for thousands of years (i.e. genetically rare species)		- Endangered species
Crocodiles	- Levels as for wildlife		
Snakes	- Numbers of successful egg hatchings - Levels as for wildlife		- Feral predators
Frogs	- Levels as for wildlife		
Fish (e.g. Barramundi)	- Fish stocks - For Barramundi: spawning and migration patterns - Levels as for wildlife		- Level of feral fish (competition) and predators
Small mammals (e.g. Spinifex marsupials)	- Non-charismatic species	- Habitat (limited ability to adapt/change environments) - Food sources	
Flora (e.g. Boabs)	- Numbers - Endemism - Diversity - Level of fringing vegetation - Integrity of vegetation patches - Level of carbon sequestration	- Interconnection (structure, habitat, soil relationships, importance of mangroves at the terrestrial/marine interface) - Microclimate	- Level of human disturbance (keeping people on paths, limiting 4wd disturbance) - For boabs – level of defacing
Soil	- Level of fertility (microbes, nutrient composition, invertebrates, inundation from flooding) - Soil type - Water holding capacity	- Types of vegetation supported	- Pollutants in soil - Salinity - Erosion level

Attribute	Attribute frame[a]		
	Specific	**'Catch-all'**	**Human/management**
Wetlands	- Permanence of water (seasonality of wet/dry cycle)	- Ability to support other systems (flora, fauna etc)	- Level of weed invasion - Level of water extraction for mining, irrigation and aquaculture
Water	- Quality – flows, watershed - River levels - Flooding events, maintaining flood regime - Water dynamics – flow speed	- Upstream catchment processes - Health of tributaries	- Level of pollution - Level of diversion - Level of abstraction
Pristine rivers	- Uniqueness - Number of them - Age of the river system (to capture what has happened to the catchment in the past)		
Coastline/deltas	- Diversity of coast - Aesthetics		- Level of traffic - Technology of boat traffic (cleaner engines) - Level of invasion (i.e. limiting spread of feral animals and plants along coast) - Level of pollution
Indigenous culture and communities	- Sacred areas and rock art		- Health of communities (physical and mental connection with land) - Traditional fishing rights - Level of participation/active involvement (in environmental management, tour guiding etc) - Land claims
Tourism	- Number of tourists, and seasonal influences on this		- Education – signage to keep people on paths etc - Level of safety - Level of impact of different types of tourism
Gorges, beaches and other iconic places (e.g. Bungle Bungles)	- Uniqueness - Aesthetic appeal		- Accessibility - Level of human disturbance (litter, defacing rocks)
Remoteness and landscape	- Connectivity of landscape - Aesthetics		- Accessibility - Level of remoteness – frequency of encounters - Indigenous caretaking – level of monitoring and management (traditional owners will detect changes in environment) - Level of disturbance and development (in terms of accountability) - Level of forward planning (putting

Attribute	Attribute frame[a]		
	Specific	'Catch-all'	Human/management
			management plans in place for anticipated future use to maintain pristine condition) - Level, zoning and organisation or tourism (in terms of accountability) - Sustainable numbers of tourists - Infrastructure

[a] Air pollution was also suggested as a frame for all attributes.

Table 3: Public attribute definitions for the **Ningaloo Marine Park**. Note categories for attribute frames were imposed by facilitators post-discussion.

Attribute	Attribute frame		
	Specific[a]	'Catch-all'	Human/management[b]
Fish	- Variety - Rarity - Numbers/density - Species: potato cod, red emperor - Seasonality - Breeding times - Migration patterns - Water temperature	- Food sources - Weather patterns	- Predators - Protection of key fish for local or international fisheries that migrate through the park - Recreational and commercial catch yield - Pollution - Aquaculture potential
Coral reef	- Magnitude (e.g. distance, aerial distribution, density) - Rarity - Fragility - Life cycle stages of coral - Spawning events - Water depth	- Weather patterns (e.g. sunlight penetration) - 'Fish friendly' corals (corals that attract certain fish)	- Predators (feral/introduced) - Public viewing coral (accessibility) - Education about how many varieties there are - Human pressures (Snorkelling/diving numbers and interference, boat traffic) - Surfing potential
Whale sharks	- Numbers - Number of females with offspring - Seasonality and migration patterns (times of year that they visit, length of stay) - Specific times of year for mating	- Food sources available - Coral spawning events - Entourage of fish that migrate with the whale sharks as indicators	- Research potential (research window and access)
Dolphins	- Variety - Size of pod		

Attribute	Attribute frame		
	Specific[a]	'Catch-all'	Human/management[b]
Whales	- Variety - Rarity - Seasonality		
Turtles	- Variety - Numbers - Survival rate of offspring - Seasonality	- Changing water temperatures (i.e. from climate change effects) - Beaches (locality of nesting)	
Dugongs, sea snakes and other marine life	- As per whale sharks and fish	- As per whale sharks and fish	
Native bird life	- Variety - Numbers - Fish dependent species		
Cultural aspects: aesthetics (e.g. views, infrastructure) and tourism	- Numbers of tourists - Holiday seasons - Tourism ritual types (schoolies, family holidays etc) - Tours (organised tours versus self-directed) - Cost (travel costs, financial accessibility) - Number/types of accommodation (resorts, caravan parks, holiday houses, camping) - Infrastructure (e.g. availability of entertainment venues, medical facilities)	- Tourism dollars coming back into local community	- Frequency of visitors returning (impact of repeat visitors versus 'once in a lifetime') - Exposure – promoting the area (and enhancing conservation awareness) - Passes to get into the park - Restriction of areas/vehicles
Water quality		- Coral spawning events - Time of year/weather patterns	- Level of pollution - Usage (swimmers, boats etc)
Beach	- Dune stability	- Condition of surrounding native flora - Weather patterns (in terms of storm event erosion and its effect on beach access) - Wildlife dependent on beach (e.g. turtles)	- Accessibility (e.g. for 4wd's, boats, pedestrians) - Number of people using the beach - Recreational uses of the beach (e.g. swimmer friendly) - Infrastructure - Level of pollution/overall cleanliness
Intertidal zone (shallow areas, dunes and vegetation)	- Level of erosion - Types/quantities of vegetation - Presence of wildlife		- Preserving the area (dunes, shallow area etc), important to protect both terrestrial and marine systems - Pollution - 4wd access - Impact of vehicles - Other human impacts (e.g. activities,

Attribute	Attribute frame		
	Specific[a]	'Catch-all'	Human/management[b]
			numbers, littering)
Ecosystem in general		- Life cycles - Connectivity - Defined by all of the other attributes as indicators of the ecosystem	

[a] Seasonality and weather patterns were suggested as being suitable frames for all attributes.

[b] Pollution, water temperature (in relation to the impact of climate change) and usage were suggested as being suitable frames for all attributes.

Table 4: Attributes nominated by the public for the **Southwest Australia Ecoregion**. Note categories for attributes were imposed by facilitators post-discussion.

Broadly Defined Attributes	Narrowly Defined Attributes	Specifically Named Attributes
Beaches	- Sand dunes, Lancelin to Geraldton in particular – undisturbed versus disturbed - Marinas and ports	- Horricks - Greens Pool, Denmark - Cervantes - Hamelin Bay - Yallingup Beach - Redgate Beach - Bremmer Bay
Coast	- Coast in general - Reefs - Marine Protected Areas	
Geological Landmarks		- Pinnacles - Wave Rock - Stromatalites - Yallingup Cave system
Natural Wonders		- Kalbarri - Blow-holes, Albany - Canal Rocks, Yallingup
Historical Features	- Wineries - Historical towns, buildings and locations generally - Cultural places, including indigenous	- Albany whaling station - Busselton Jetty and underwater observatory - HMAS Sydney Shipwreck - Lighthouses: Cape Naturaliste and Augusta

Broadly Defined Attributes	Narrowly Defined Attributes	Specifically Named Attributes
		- War memorial, Kings Park - Kalgoorlie - CY O'Connor and the gas pipelines
Waterways	- Rivers - Lakes - Estuaries, particularly Perth estuaries - Wetland systems, particularly Perth metropolitan - Inland waterways - Floodwaters - Groundwater systems	- Swan/Canning River - Avon River - Blackwood River - Cascades (waterfalls in river), Pemberton - Lake Moore - Lake Clifton
Dams		- Bigbrook Dam, Pemberton - Honeymoon Pools (dam & campground), Collie - Mundaring Weir
Islands		- Penguin Island - Rottnest Island - Molloy Island, Blackwood River
National Parks	- Marine Protected Areas	- Cape Leeuwin - Kings Park - Nornalup-Walpole - Cape Naturaliste
Wildlife Parks		- Cohuna - Caversham
Native Animals	- Fauna in general - Fish - Reptiles - Frogs - Birds - Offshore marine life - Endangered animals - Animals endemic to the south west	- Whales - Penguins - Quokkas - Dolphins - Dugongs - Black Cockatoos - Black Swan - Chuditch - Possums - Kangaroos - Wallabies - Great White Sharks - Marron and yabbies - Bilbies - Moths
Native Plants	- Prehistoric trees (e.g. herbarium collection at Kings Park)	- Karri Forest

Broadly Defined Attributes	Narrowly Defined Attributes	Specifically Named Attributes
	- Rare trees and other flora - Virgin (i.e. old growth) forests - Regrowth forests - Flora endemic to the south west	- Gloucester tree and Diamond tree, Pemberton - Greenough 'sideways' trees
Recreational items and tourist attractions	- Tourism values generally - Recreational fishing	- Bibbulmun Track - Cape to Cape track - Tree top walks, Kings Park & Walpole - Gloucester Tree - Yallingup Caves (Jewel, Mammoth & Crystal caves)
Resources	- Mining (as a positive) - Produce from the land (in terms of a sustainable economy)	
Farmland/agriculture	- Wineries/vineyards - Stock - Crops - Irrigation - Belt of green - Replanted roadside vegetation	
Infrastructure	- Roads	
Weather	- Solar energy	

Table 5: Public attribute definitions for the **Southwest Australia Ecoregion**, for attributes identified as a high priority. Note categories for attribute frames were imposed by facilitators post-discussion.

Attribute	Attribute frame		
	Specific[a]	**'Catch-all'**	**Human/management**[b]
Coast/Beaches	- Erosion - Beach formation types (e.g. blowholes, rocky outcrops) - Sand quality (whiteness)	- Fish stocks	- Increase number of Marine Protected Areas - Fish catch limits - Stricter fining mechanisms for overfishing - Accessibility: *Restrictions (e.g. for 4WD's, dogs, people) *charging for access (user fees versus free access) *parking availability - Coastal zoning – restricting the urban sprawl

Attribute	Attribute frame		
	Specific[a]	**'Catch-all'**	**Human/management**[b]
			- Cleanliness – number of clean ups per year - Facilities at the beach (camping, parking and service facilities such as Rangers maintaining campsites) - Volunteers - Level of disturbance *untouched/modified *isolation, i.e. level of congestion - Surf conditions (e.g. enhancing with artificial reefs) - Recreation opportunities
Native plants and animals	- Rare fauna - Rare flora - Persistence of species - Old-growth forests - Regrowth forests - Endemics		- Endangered species - Level of eradication of feral animals - Seed banks maintained at the Kings Park herbarium - Level of restrictions *Zoning – restricting the urban sprawl *Quarantine - Promotion of growing native gardens to public
Historical and cultural features	- Level categories of buildings, trees, housing, remains, sacred sites - Cultural significance		- Level of tourism promotion & public awareness (e.g. promotion of national significance) - Related job opportunities - Visitor facilities - Accessibility - Level of maintenance of current historical features (i.e. listed sites) through upkeep and restoration
Landmarks			- Accessibility (for example for the pinnacles): *level of managed/guided tours; *restricting access (to prevent people walking/climbing on the feature) but being careful not to ruin the aesthetics with artificial structures
Farmland and wineries	- Varietal ability (diversity of produce, capacity to grow different varieties)	- Sustainability	- Groundwater use (e.g. by plantations extracting too much water) - Level of clearing - Level of restoration of farmland - Grower alliances - Boutique industries/brands

Attribute	Attribute frame		
	Specific[a]	**'Catch-all'**	**Human/management**[b]
Resources, minerals and produce		- Sustainability - Impact on environment	- Road systems and transport infrastructure - Site restoration - Profitability - Employment, both sustainable current and future - Communities
National parks	- Number of national parks		
Waterways[c]			- Level of pollution - Quarantine - Policing usage and recreational activities - Recreational opportunities - Management of the waterways (e.g. stormwater, sewage) - Incidence of algal blooms - Level of pollution - Quarantine - Policing usage and recreational activities

[a] The attribute specific level of preservation (i.e. maintaining natural condition) was suggested as being suitable across all attributes.

[b] The human related levels of education/awareness and employment opportunities were suggested as being suitable across all attributes.

[c] Waterways was not part of the original prioritised attribute list, but was considered important enough that attribute levels should be defined for it also.

Table 6: Expert attribute definitions for the **Kimberley waterways and wetlands**. Note attribute categories were imposed by facilitator after the first round of responses from experts.

Attribute	Attribute frame
Flora/fauna	
Biodiversity	- All species conserved Loss of 1% of species Loss of 5% of species
Populations of aquatic biota	- Local scale Regional Global
Rare and threatened species	- Could list them specifically or split into animals, plants and ecosystems - Categories – listed endangered, vulnerable, rare or priority under State or C'wealth legislation
Aquatic fauna	- Natural – the composition, abundance and population dynamics of aquatic fauna (e.g. macroinvertebrates, fish, water dependent reptiles (turtles, crocodiles, lizards, snakes), waterbirds) unaffected by human activities and other impacts such as those listed above (as well as over-exploitation). Modified – some aspects of aquatic fauna composition, abundance and population dynamics moderately affected by human activities and other impacts. Highly modified – many aspects aquatic fauna composition, abundance and population dynamics highly affected by human activities and other impacts.
Aquatic flora	- Natural – the composition, abundance and population dynamics of aquatic flora (i.e. aquatic and semi-aquatic plants) unaffected by human activities and other impacts such as those listed above (as well as over-exploitation). Modified – some aspects of aquatic flora composition, abundance and population dynamics moderately affected by human activities and other impacts. Highly modified – many aspects aquatic flora composition, abundance and population dynamics highly affected by human activities and other impacts.
Barramundi catches	- Low Moderate High
Flow regime	
Flow regime	- Natural and categories of hydrological change. - Levels of climate change effects
Environmental flows	- Flooding during the wet season is maintained without flow regulation or excessive water abstraction
Flood extent	- 1% of catchment 5% of catchment 10% of catchment
Flood duration	- 1 month 2 months 3 months
Waterhole persistence	- Every year Twice every three years Once every two years
Flow regime	- Natural – major components of the flow regime (e.g. magnitude, timing, frequency, duration, rate of change, variability, predictability) unaffected by human activities such flow regulation (due to dams & weirs), riparian and groundwater extraction, land use change and/or climate change. Modified – some major components of the flow regime moderately affected by human activities and/or climate change. Highly modified – most major components of the flow regime highly affected by human activities and/or climate change.
Connectivity	
Connectivity (hydrological and biological)	- In-channel, floodplain, estuary, groundwater - Could measure the number of connectivity opportunities to determine effects of mgmt, though this would be species-specific
Effect of rivers in estuaries	- Ensuring that either inputs or flow regimes in rivers do not adversely affect the health or productivity of downstream estuaries
Connectivity – lateral & longitudinal movement	- Natural – connectivity uninterrupted by artificial barriers such as dams, weirs, road crossings, altered flow regimes that prevent floodplain inundation. Also, natural barriers to

Attribute	Attribute frame
of materials (sediment, nutrients) and biota (e.g. fish, crustaceans)	connectivity unaffected by intra/inter-basin transfers. Modified – connectivity periodically interrupted by artificial barriers. Also, natural barriers to connectivity periodically breached by intra/inter-basin transfers Highly modified – connectivity always interrupted by artificial barriers. Also, natural barriers to connectivity continuously breached by intra/inter-basin transfers.
Habitat	
Freshwater habitats in downstream gorge areas (eg base of major waterfalls)	- Opportunities for biotic exchange among river may be greater on the plateau, but highly constrained down in the gorges. Thus, endemism is likely to be much higher for these parts of the rivers
Aquatic habitat	- Waterhole refugia - Wetlands, - Flowing river reaches - Gw/hyporheic zones - Estuaries - Microhabitats (backwaters, woody debris, riffles etc)
Habitat quality	- Intact food webs - Water quality - Microhabitat availability - Toxins/pesticides - Productivity
Water quality	- Natural – water quality (e.g. dissolved oxygen, temperature, turbidity, salinity, nutrients, toxicants) unaffected by human activities such as land use (agriculture, urban, industrial), water resource development (e.g. hypolimnetic flow releases), climate change (i.e. temperature) and sea level rise (increased salinity in lowland wetlands). Modified – some aspects of water quality moderately affected by human activities, climate change and/or sea level rise. Highly modified – many aspects of water quality highly affected by human activities, climate change and/or sea level rise.
Riparian zone	- Natural – riparian zone structure (i.e. native vegetation species composition, recruitment dynamics, channel form) and function (nutrient and sediment interception, delivery of allochthonous material to aquatic ecosystems) unaffected by human activities such as land use (agriculture, urban, industrial), vegetation clearing, water resource development (e.g. altered flow regimes, inundation of riparian zones in impoundments), invasive plants (i.e. weeds) and animals (e.g. trampling by pigs, buffalo, etc). Modified – some aspects of riparian zone structure and function moderately affected by human activities and other impacts Highly modified – many aspects of riparian zone structure and function highly affected by human activities and other impacts
Aquatic habitat structure	- Natural – aquatic habitat structure (e.g. riffle-pool availability, substrate composition, submerged and bankside physical structures (woody debris, root masses, undercut banks), aquatic plant beds, etc) unaffected by human activities and other impacts such as those listed above. Modified – some aspects of aquatic habitat structure moderately affected by human activities and other impacts Highly modified – many aspects of aquatic habitat structure highly affected by human activities and other impacts
Cultural/socio-economic	
Water resource utilisation	- Indigenous - Tourism/recreation - Agricultural - Industrial
Indigenous harvest	- Low Moderate High
Other	
Sustainable ecosystem	- Maintaining or improving biodiversity of fish, macroinvertebrates and vegetation - Maintaining the density or biomass of plants and animals - Reducing weeds and other exotic pests - Reducing soil erosion particularly from cattle access to waterways - Regulating burning regimes

Attribute	Attribute frame
Ecosystem health	- Ecological processes functioning as per a healthy ecosystem, e.g. no algal blooms, no excess nutrients
King Edward-Carson River system, including floodplain billabongs of the Carson (eg Mool Mool lagoon)	- These rivers connect at the estuary, but have contrasting hydro-geological features, and contrasting species of biota. Collectively, this river system is the *most species rich for fish and atyid shrimps in WA*.

Table 7: Expert attribute definitions for the **Ningaloo Marine Park**, extracted from the Marine Park Management Plan (MPRA 2005).

Attribute	
Environmental	**Social**
Geomorphology	Maritime heritage
Sediment quality	Seascapes
Water quality	Wilderness
Coral reef communities	Water sports
Filter feeding communities (other than coral reefs)	Marine nature-based tourism
Shoreline intertidal reef communities	Coastal use
Soft sediment communities	Recreational fishing
Macroalgal communities (including mudflats)	Scientific research
Mangrove communities	Education
Coastal biological communities	Commercial fishing
Seabirds, shorebirds and migratory waders	Petroleum development
Finfish	
Invertebrates	
Sharks and rays	
Whale sharks	
Dugongs	
Manta rays	
Whales and dolphins	
Turtles	

Table 8: Expert attribute definitions for the **Southwest Australia Ecoregion**. Note attribute categories were imposed by facilitator after the Target Setting Workshop.

Attribute	Attribute frame
Theme: Biodiversity	
Rare/threatened species (flora and fauna)	• Populations protected • Population size • Population viability • Number of extinctions prevented • Recovery to an improved conservation status • Connectivity e.g. Using a poorly connected spp. as a surrogate (reptiles)
Centres of endemism for flora and fauna	• Proportion of species within group protected
Species representation	• IBRA subregions • Rainfall gradients • Darling Scarp divide

Attribute	Attribute frame
Short-range endemics spp., particularly invertebrates	• Area of habitat protected • Number of species protected • Range restriction - Placement of reserves (e.g. categories such as coastal plain, wheat belt etc where many endemics are restricted in range due to development/clearing) - Resource limitations - Barriers to upstream movement for aquatic spp. (e.g. Lamprey)
High levels of beta diversity within Wheatbelt vegetation communities	• Representation across the region at regular intervals • Area protected
Declining Wheatbelt birds (identified in the literature by experts) not yet considered threatened	• Area of habitat protected
Theme: Vegetation	
Vegetation communities	• Representation within protected areas • Viability
Representative landscapes containing >30% remnant vegetation	• Area of remnant vegetation • Degree of connectivity (e.g. vegetation width) • Vegetation patch size (e.g. hectares; perimeter to area ratio) • Level of protection • Viability of flora and fauna populations • Keystone species (e.g. Beard's list) • Endemics • Phytophthera susceptibility • Land categories (non-intensive, cropping, grazing etc) • Fire frequency/intensity (in relation to seed storage etc)
Theme: Water Resources	
Wetlands	• Health of groundwater dependent wetlands - Stygofauna populations • Health of freshwater wetlands of the wheatbelt - Water quality (salinity, pH) - Hydroperiod - Proportion of catchment protected • Proximity to bushland (i.e. in terms of being more valuable when embedded in or adjacent to bushland) • Buffer zones against adjacent land uses (e.g. 50m above geomorphic line) • Ancient drainage lines (paleochannels)
Catchment	• Natural/modified • Connectivity (hydrological) • Level of vegetation in basin • Level of protection of upper catchment or sub-catchments
Theme: Other	
Functionality	• Orchids – good relationship with insects • Birds – pollinators, nectavores etc
Refugia, especially climate refugia (e.g. Mesic sites such as granite outcrops, particularly in the transitional rainfall zone)	• Granite outcrops - Size - Size/depth of pools - Natural drainage/modified drainage • Extent across the Transitional Rainfall Zone • Area protected • Hilltops/ridges