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Research article

Eliciting human values for conservation planning and decisions: A global issue

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1. Introduction

The MEA (2005) biodiversity synthesis emphasizes the important global contribution of natural biological elements to human well-being. In turn, wellbeing itself depends on satisfying some combined provision of human values, and it is these values that in principle drive decisions concerning the allocation of natural resources among competing demands (Gregory et al., 2012; Wallace, 2012). If we extrapolate current global pressures – ranging from climate change to accelerating resource use by an expanding human population – it is clear that competition for natural biological resources will continue to increase, leading to more intense conflicts and trade-offs amongst contending interests (McShane et al., 2011). In this environment, achieving conservation objectives requires a sound understanding of the attitudes and values of stakeholders and decision-makers (McShane et al., 2011; Madden and McQuinn, 2014; Redpath et al., 2013). That is, managing competing human values is central to decision-making concerning the conservation and use of natural resources. Thus, developing a classification of values consistent with identifying synergies and trade-offs in decisions, selecting key stakeholder representatives, and generating methods for eliciting and rating values are all vital considerations in biological conservation planning.

Planning processes have advanced considerably over the past two decades and basic components – including objective setting, risk management, dealing with uncertainty and selection of operational actions – are outlined in a range of publications (e.g., CMP, 2013; Gregory et al., 2012; Knight et al., 2006; Lockwood et al., 2006). While these authors and many others acknowledge the importance of human values, there is considerable scope for developing methods that more explicitly link human wellbeing and related values into conservation planning. This linkage is still in its infancy, as underlined by the Conservation Measures Partnership's comparatively recent recognition of human values as a component of planning in on-line documents (CMP, 2013). The point is further exemplified by Knight et al. (2010), experienced and well-credentialed workers in conservation planning, who recognized that the effectiveness of their strategy development was undermined by inadequate knowledge of some stakeholder values. We suspect this comment applies equally to all those (and certainly ourselves) who have engaged in operational planning, management, or policy development.

An important constraint in many decision processes is that outputs are required in short timeframes with limited resources – and this in an environment where the total global resources for conserving biodiversity already fall well short of what is required (Polasky, 2012). Consequently comprehensive stakeholder analyses, such as that by García-Llorente et al. (2011), where the actual survey work alone took eight months and involved 477 face-to-face interviews, are often not practicable. Also, to comprehensively rate many of the human values arising in biological conservation

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decisions requires non-market measures such as contingent valuation or deliberative money valuation. However, these and related techniques are costly to implement and require specialist expertise (Birol et al., 2006; Turner et al., 2010). Therefore, there is a global need for methods that effectively elicit and rate human values for decision-making with limited resources and within short time-frames (<6 months). Besides rating the importance of human values in a specified context, it is also desirable that elicitation methods assess uncertainty and the level of agreement within stakeholder groups.

We address the above issues by building an efficient methodology for values elicitation, based on the framework outlined by Wallace (2012), with a focus on three aspects:

1. Stakeholder selection and engagement, with a view to ensuring that socio-political aspects are transparent;
2. Classification and description of values so that they explicitly link to human wellbeing and are readily used to highlight synergies and trade-offs; and
3. Elicitation and analytical processes that efficiently rate the importance of values linked to biological elements and, at the same time, describe the level of certainty and agreement amongst stakeholders concerning their ratings.

We explore each of these aspects based on planning for the Lake Bryde catchment in south-west, Western Australia. We emphasize at the outset that outputs from the work described below may be used with a wide range of decision tools; that is, we aim to achieve better informed decision processes, not replace those that already exist. Finally, we focus on biological elements, the living elements of systems, but the approach may also be applied to abiotic elements, or a mixture of abiotic and biotic elements.

2. Methods

2.1. Study area

Lake Bryde catchment is one of six catchments selected to capture important, representative samples of biological elements threatened by hydrological changes, particularly salinisation, in the agricultural areas of south-west, Western Australia (Wallace et al., 2011). In these landscapes knowledge of the life histories and ecology of the biota is generally poor, there are limited resources for planning, and complex threatening processes operate over long timescales (George et al., 2008; Horwitz et al., 2008; Wallace et al., 2011). The Lake Bryde catchment is about 140,000 ha in area and lies some 300 km south-east of Perth. Most of the catchment consists of agricultural lands used for grain and sheep production, with some 25% remaining as natural vegetation that has mostly been set aside for a range of conservation purposes. Management of public conservation lands is undertaken by the Department of Parks and Wildlife (DPaW), a state agency.

2.2. Selecting the consultation approach and stakeholders

We adopted the broad definition of a stakeholder as those who can affect, or are affected by, a decision (Reed, 2008). Stakeholder engagement methods should address three important questions (adapted from Pellizoni, 2003): a) who should participate in the planning process? b) who will organize discussion and decide planning methods, including how stakeholders influence the setting of planning issues? and c) how is the stakeholder process connected with final decision-making? In addressing each of these questions below we have consciously aimed to describe the reasoning underlying our approach. Although such logic is not always explicit in planning documents or related research, it explains the aims and socio-political context of stakeholder engagement.

2.2.1. Who should participate in the planning process?

Because the biological elements under consideration are managed by a state government, a representative democracy, it is assumed that stakeholders should represent the state community. Taking the lead from Pellizoni (2003), two broad options for engagement are to involve the state public as a group of non-organized lay citizens, for example, via public surveys; or alternatively, to engage interest-group representatives. We chose to engage interest-group representatives because: we wanted to maximize the exchange of information and ideas with a group of stakeholders recognized as having knowledge pertinent to the planning situation; stakeholder engagement takes place over an extended period, and face-to-face interaction with a consistent group of people provides important opportunities for sharing knowledge and increasing mutual understanding; and it was important for stakeholders to have some direct interest and commitment to the planning outcomes to enhance their level of engagement and thus minimize hypothetical bias (Harrison, 2006). This approach is consistent with many features of best practice participation outlined by Reed (2008), particularly those related to building trust, mutual learning and knowledge sharing, and continuing involvement throughout the planning process. Furthermore, in line with the comments of Pellizoni (2003), stakeholders were expected to contribute to the planning process through their knowledge and other competencies – they were not merely representatives of narrow interest groups. None of these participation characteristics can practicably be achieved using the extensive surveys required to engage non-organized, lay citizens.

Having established that stakeholders should represent interest groups, the question becomes: which groups? The classification of Duane (1997) efficiently encompassed key stakeholder groups for our work while minimizing the complexity of categories. Duane's categories are (paraphrased):

a. Communities of place – individuals tied to a specific geographic space;
b. Communities of identity – individuals linked to each other through social characteristics, noting that these links may transcend place (e.g., religious or political groups); and
c. Communities of interest – those tied to a particular ecosystem or resource as beneficiaries of that resource or contributors to its condition.

Most stakeholders belonged to formal or semi-formal groups. This maximized the number of people represented in the elicitation process. The stakeholders selected spoke for communities of place and communities of interest, with one aim being to capture expert community knowledge concerning each of the values (Table 1). The list of stakeholders invited, and those who attended, are described with their community relationships in Supporting Information. Ten stakeholders ultimately provided ratings, 8 through the main workshop, and a further 2 through separate sessions. The same method was followed in all elicitation processes. Although a group of 10 may seem small, in our experience this is typical of many natural resource management committees, which, through their affiliations, may ultimately represent hundreds or many thousands of stakeholders. Also, based on experience with expert groups, Aspinall and Cooke (2013) suggest that 8–15 experts is a reasonable number for eliciting responses on a particular problem. They also note that there seems to be diminishing returns with group sizes over 20 people. This is broadly consistent with work using Delphi techniques and focus groups.

Table 1
Lake Bryde values classification – includes only those values that may be derived from biological elements (see Supplementary Information for the full definition and description of values used with stakeholders).

Value	Description
Adequate resources	Includes all food and fiber for humans derived from biological elements
Aesthetic pleasure	Scenic and other aesthetic values of natural biological elements
Health (physical environment)	The contribution from biological elements to the quality of our chemical and physical environment
Health (protection from other organisms)	The protection of human health from damage by other organisms
Knowledge-heritage	The use of biological elements for scientific, heritage and educational purposes
Meaningful occupation	Broadly defined here as work occupation or equivalent that provides one or more people with satisfying tasks
Philosophical-spiritual contentment	The explicit or implicit set of philosophical beliefs within which humans operate, includes belief in the intrinsic values of nature
Recreation	The importance of biological elements for leisure activities
Future options	Strictly speaking not a single value, however, where stakeholders want to maintain the option of using biological elements into the future for any one or more of the above values, this category is used

2.2.2. Who will organize discussion and decide planning methods, including how stakeholders influence the setting of planning issues?

As the agency responsible for managing conservation lands targeted by the planning process, DPaW organized the workshop and decided on the elicitation and analytical methods in discussion with collaborative partners from Horizon. There was no practicable alternative given that stakeholders are time poor and the elicitation techniques applied were largely experimental. This did place significant responsibility on the DPaW officers, particularly those working locally, to ensure effective, two-way communication with stakeholders. In addition, all stakeholders were provided with opportunities to directly influence the planning process, specifically, the classification of values and listing of biological elements (sections 2.3 and 2.4). Stakeholders were weighted equally in the elicitation process and analysis, further encouraging their engagement.

2.2.3. How is the stakeholder process connected with the final decision-making?

Stakeholders were informed at the outset that workshop outputs constitute advice to the agency and would be considered in the context of the agency's statutory responsibilities. However, it was also stated that on the two prior occasions where values had been similarly elicited, the results were taken unchanged into the planning process and published, and that this approach was proposed for Lake Bryde. That is, stakeholders' views demonstrably had significant weight and were publicly reported. It was hoped that this would encourage full engagement and avert hypothetical bias. Such bias may occur when stakeholders see their views as not contributing to outcomes, in which case elicitation results may differ from instances where stakeholders know the outputs will make a real contribution (Harrison, 2006; Karrasch et al., 2014).

2.3. Values classification and ratification with stakeholders

There are many definitions and classifications of values that might be applied in natural resource decisions. Broad options include: a recent variant of the MEA (2005) classification of ecosystem services; a total economic value approach (Robbins and Daniels, 2012); one of the many more social science based options (e.g., Montgomery, 2002); or some mixture of these different approaches (Chan et al., 2012). In the extensive literature examined none of the values classifications were coupled with supporting criteria, and from the perspective of analyzing synergies and trade-offs in decisions, all contained inherent classification problems. Most frequently such problems involved the mixing of means and ends at the same level, an important issue where any form of economic analysis, or objective comparisons, are proposed (Boyd and Banzhaf, 2007; Gregory et al., 2012; Wallace, 2007). Therefore, we adopted the definition and classification of values outlined by Wallace (2007, 2012), which is designed both to avoid such problems and to make explicit the linkage of values and wellbeing. In this work, values are defined as “enduring beliefs concerning ultimate, preferred end-states of existence. They comprise the total set of end-states needed for human wellbeing including those essential to human survival and reproductive success” (Wallace, 2012, pp 2–3). The values classification used here (Table 1, plus Supporting Information) uses the end-states of existence themselves (such as adequate resources and aesthetic pleasure) to represent values. The end-states are drawn from the existing literature where they meet the classification criteria listed below.

The classification described in Wallace (2012) was reduced to a list of values applicable to natural biological elements (Table 1). To avoid double-counting and related problems, the classification was developed to meet six criteria based on Burgman (2005), Salafsky et al. (2008) and Wallace et al. (2016). That is, that the classification should be:

a Readily understood by those applying the classification;
b Exhaustive, in that there is a classification category for each benefit to be allocated to a value type;
c Redundancy-minimizing among categories. That is, each benefit to be classified fits only within one value category;
d Consistent, in that components at the same level within the classification are of the same type; and
e Scalable, that is, may be applied across the full range of relevant spatial and temporal scales.

These criteria are self-explanatory except for (d), where the meaning of “the same type” needs clarification. In this respect there are three unifying features across the values. Firstly, they comply with the definition of fundamental objectives (Gregory et al., 2012), in particular, they are each an ultimate response to a “why is that important?” question. Secondly, all values represent desirable end-states of existence for humans, and thus aspects of wellbeing. Thirdly, their realization by humans is dependent, at least in part, on the structure and composition of biological elements. Links to biological elements are obvious where the fulfillment of a value is direct, such as the use of native animals as a food resource, or the aesthetic enjoyment of woodland vegetation. However, the realization of values may also be indirect. This may occur, for example, where the current composition and structure of a vegetation biological element reduces salinisation or erosion on adjoining agricultural land, thus increasing the supply of food (adequate resource value). Hence, achievement of each value listed in Table 1 may be linked to biological elements, either directly or indirectly. Each value also encapsulates aspects of wellbeing that are not captured by another value, although there is still potential for overlap. Coordinators of the elicitation workshop ensured that double-counting was avoided by allocating, through discussion with stakeholders, any ambiguous benefits to a single value. It was also made clear to stakeholders that more than one value may be associated with an individual element. The use of explicit criteria to underpin the classification helped clarify the concept of values and facilitated their definition with stakeholders.

To gain a shared understanding with stakeholders of the values and to minimize linguistic uncertainty the following four steps were taken:

1 The facilitators (first and third authors) explained the planning context and then discussed with the stakeholders, as a group, each of the values listed in Table 1. Stakeholders were asked for examples of how each value might be realized in the Lake Bryde catchment, and their examples were displayed on a white board.
2 Stakeholders were split into groups of 2–3, and within these groups they generated further examples of how values could be realized from the Lake Bryde biological elements.
3 Additional examples generated by step (2) were also captured on a white board and discussed. These steps clarified the meaning of values among workshop participants, including facilitators.
4 Finally, the stakeholders were asked whether any values were missing from the list, but none were identified. That is, the stakeholders endorsed the classification of values.

During steps 1 to 4 facilitators consciously avoided any commentary that might bias stakeholders' scores through framing or anchoring effects (Luchini and Watson, 2013; Page et al., 2012). By this point in the elicitation process stakeholders and ourselves shared a common understanding of the values that might be realized from the biological elements in the catchment. This was important, as it ensured information symmetry and definitional certainty amongst stakeholders when they rated the importance of values. At the same time, it was stressed that stakeholders may or may not agree on the relative importance of specific values, and that no views on value importance were 'wrong'.

2.4. Catchment biological elements

The specific groupings of biological elements, all natural elements, considered in this case study were:

– Yate (*Eucalyptus occidentalis*) swamp vegetation community
– Salmon gum (*Eucalyptus salmonophloia*) woodland vegetation community
– Other woodland vegetation communities
– Mallee (*Eucalyptus* spp) shrubland
– Samphire vegetation community (mostly *Halosarcia* spp)
– *Melaleuca* spp vegetation assemblage.
– *Duma horrida* subsp. *abdita* vegetation community (an endangered community)
– Fungi
– Aquatic invertebrates
– Terrestrial invertebrates
– Amphibians
– Reptiles
– Waterbirds
– Terrestrial birds
– Mammals

Stakeholders were presented with additional information (e.g., species lists) to clarify each category. Biological elements were restricted under the relevant funding program to native species and communities currently found in the Lake Bryde system that are at risk of hydrological change, particularly waterlogging and salinisation (Wallace et al. 2011). Experts from DPaW prepared an initial list of elements based on their view of the most coherent element groupings given the ongoing risks from hydrological change. This list was then discussed with, and amended by stakeholders prior to the elicitation process. Agreement amongst stakeholders on the biological elements under consideration is essential to ensure that all stakeholders and those analyzing the results use the same set of biological elements.

2.5. Elicitation methods

Various priority-setting methods have been used in natural resource management. These range from voting schemes (Kangas et al., 2006) to more complex stated preference and revealed preference techniques, all with their specific uses and limitations (Birol et al., 2006; Kant and Lee, 2004; Turner et al., 2010). A barrier to the application of the more complex, quantitative methods is their requirement for substantial resources in terms of personnel, information, expertise, time and funds (Birol et al., 2006; Turner et al., 2010). Even semi-quantitative methods (e.g., Koschke et al., 2012) demand significant resources and expertise. Needing to make management decisions but with modest resources, a common situation in operational management, we developed elicitation and analytical processes that allowed stakeholders to efficiently rate the importance of values arising from the biological elements specified above.

We used two approaches to elicit stakeholder views: an assessment of value importance on a continuous scale (interval-based); and a priority ranking of values on an ordinal scale. For both, a number of techniques were used to reduce potential bias during the workshop. First, the information sharing methods described above were designed both to ensure equal information amongst participants and to reduce linguistic uncertainty (particularly ambiguity). Care was also taken to avoid framing and anchoring. In addition, all scoring by stakeholders was anonymous to ensure that stakeholders could score values without fear of their position being revealed, and to minimize the potential for strategic voting (Kangas et al., 2006). Voting anonymity also reduces "halo" effects, under which responses may be biased due to stakeholders being influenced by strong, authoritative personalities, or those with perceived power (ACERA, 2010). For all of the elicitation procedures stakeholders were asked to consider values associated with the biological elements over a 20 year period. Thus, stakeholders had both temporal and spatial boundaries for their scoring. Elicitation was conducted via the following steps:

a Stakeholders were first asked to score, from the perspective of their stakeholder group, the importance of each of the values (Table 1) associated with the biological elements under consideration. Specifically, each workshop participant was asked to fill in a score sheet with an ellipse that captured the importance of each value (position on a linear scale) and the participant's uncertainty about this importance (width of each ellipse, i.e., an interval from the left to the right endpoint, Fig. 1). It was clarified that the uncertainty could result from several factors, e.g., lack of knowledge or variability. We then asked participants to put a mark within the ellipse to indicate their best estimate of the actual importance of the value (cross in Fig. 1). Prior to the elicitation, the procedure for scoring was demonstrated via a food-tasting example to avoid anchoring effects.

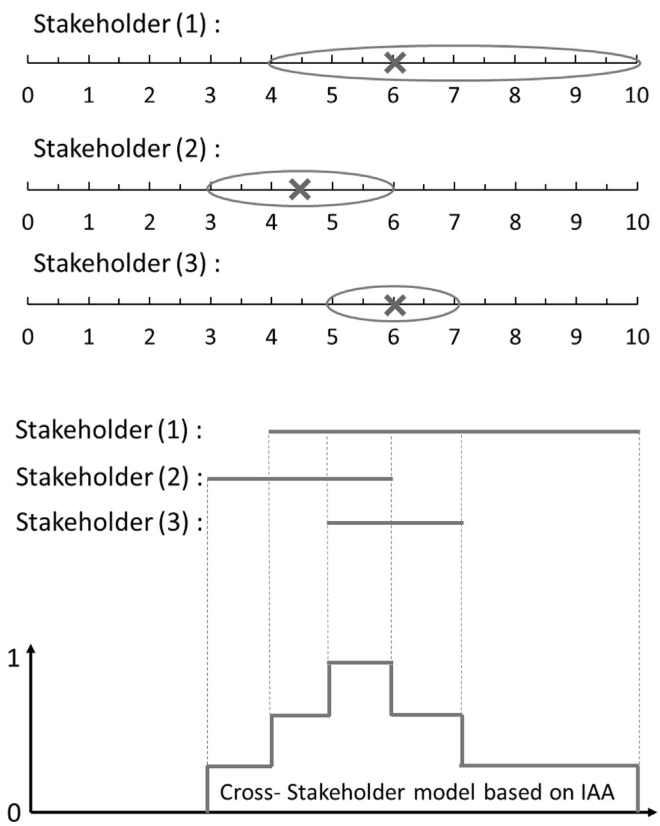

Fig. 1. Example of importance ratings for three stakeholders: each stakeholder provides their response by drawing an ellipse on a continuous scale. The ellipses are encoded as intervals, which in turn are aggregated using the Interval Agreement Approach (Wagner et al. 2014) into a type-1 fuzzy set. Note that the best-estimate ratings (i.e. crosses on rating line) are not used for the creation of the cross-stakeholder model; they are captured solely as an additional means of comparison with the ranking approach.

b Following (a), stakeholders individually and anonymously ranked the values, using a strict ordinal ranking. That is, they were asked to ascribe rank 1 to the most important value arising from the biological elements, rank 2 to the second most important value, and so on to rank 9. Each rank from 1 to 9 had to be used, therefore, no equal rankings were possible (i.e., no two values were ranked identically). In contrast to the importance rating approach, stakeholders undertook this ranking from two perspectives, that of their stakeholder group and secondly from their personal perspective. Participants were asked to score their stakeholder perspective first on the assumption that, having thought it through from the perspective of their stakeholder group, they would more readily revert to and accurately report their personal views.

c During the workshop the facilitators provided stakeholders with a preliminary assessment of their scores so that they received some immediate feedback. More detailed feedback on all the results were provided in a summary report and in a second, later workshop.

During previous catchment planning, only the method outlined under (b) was used to assess the importance of values. However, strict ordinal methods do not account for uncertainty, and assume both equal distances between ranks and that there are no equal ranks. To counteract these unsatisfactory assumptions, the more comprehensive, interval-based method outlined under (a) was developed. We included a best-estimate in order to provide an additional means of comparison to the ordinal rankings (b). We discuss and contrast the outcome of the approaches below.

2.6. Analytical methods

The data generated by the elicitation processes was analyzed as follows.

2.6.1. Processing of interval-based importance ratings and best estimate data

The following steps were used to process interval data described above (see Fig. 1 for a pictorial illustration):

a For all ellipses provided by participants, the endpoints were coded, resulting in a single interval per participant and value.

b For each value, all intervals were aggregated using the Interval Agreement Approach (IAA) (Wagner et al., 2014). In essence, the IAA combines individual intervals into a model/distribution – a type-1 fuzzy set by focusing on n-tuple overlap of the intervals. In other words, the resulting type-1 set captures areas rated by many people with a higher degree of membership than areas rated by few or only a single participant. Fig. 1 diagrammatically illustrates the modeling process.

c Apart from the rich information on stakeholder agreement levels (discussed below), a number of statistics may be computed from the resulting models to compare them with traditional approaches. The most common statistic, which is used in this paper, is the centroid (i.e., the centre of gravity) of the IAA model. It captures the representative single value or central tendency of the model and thus enables comparison with the outcomes of the best estimate and ranking approaches.

Further, in order to capture the best estimate data (crosses in Fig. 1), we averaged the best estimates for the importance of each value across all stakeholders, thus providing a means of comparison to the IAA centroids and the aggregate ranks discussed below.

2.6.2. Processing of the ranking data

In order to generate overall, cross-stakeholder ranks for each value (ordinal rank approach), we averaged the individual ranks assigned to a given value to calculate one cross-stakeholder rank per value. The resulting rank ordering can be compared to the central tendency (centroid) of the cross-stakeholder rating models and the best estimate averages as detailed above.

3. Results

3.1. Importance ratings and best estimates

We analyzed the importance ratings using the IAA to describe the importance of each value from stakeholders' perspectives. Based on the resulting models, two separate aspects were considered. Firstly, we ranked importance ratings on the basis of their centroids giving the following order of value importance (listed from most to least important): knowledge-heritage, future options, recreation, aesthetic pleasure, meaningful occupation, health (physical environment), adequate resources, philosophical-spiritual contentment and health (protection from other organisms) (see Supporting Information for scores).

A second analytical method involved aggregating the interval data as described above and shown diagrammatically in Fig. 1. The results from this analysis are shown in Fig. 2. In this figure, increasing scores on the y-axis reflect increasing agreement amongst stakeholders, and increasing scores on the x-axis show increasing level of importance ascribed to the value. Three trend types are apparent from this analysis. Firstly, for three values –

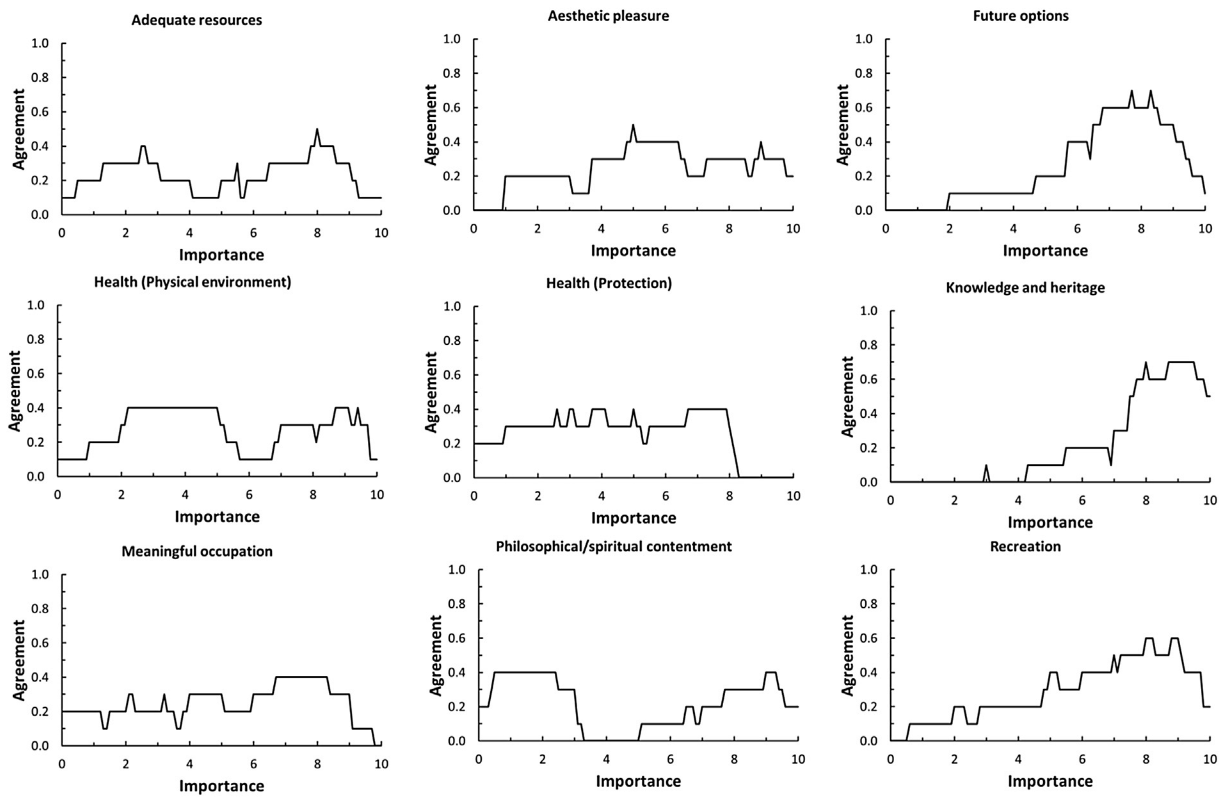

Fig. 2. Stakeholder assessments of value importance (interval-based approach) arising from the specified biological elements in the Lake Bryde catchment.

knowledge-heritage, future options, and recreation — there is general agreement amongst stakeholders that these values are important. For a further three values — health (physical-chemical environment); adequate resources; and philosophical-spiritual contentment — stakeholders separate into two groups (i.e., form a bimodal distribution) with one group considering these values to be important, and the second group seeing them as comparatively unimportant. For the remaining three values there is little agreement amongst stakeholders, and the scores are widely spread. The information in Fig. 2 provides valuable insights into the level of agreement amongst stakeholders concerning the importance of individual values.

Based on the premise that the priority values guiding the planning process should be those for which stakeholders agree on their high importance, the values of knowledge-heritage, future options and recreation are the most important (Fig. 2), priorities supported by the centroid data. With stakeholder agreement, these three values have been taken into the planning process as the priorities driving goal formation and priority setting amongst the biological elements. We also captured the best estimates within the provided intervals (see Fig. 1), the averages of which (Supporting Information) are largely consistent with the IAA centroids results.

3.2. Ranking elicitation

Results from the ordinal rankings are provided in Tables 2 and 3. The rankings by individuals scored from their stakeholder perspective (Table 2) are in broad alignment with those outlined above from the importance ratings, with two of the three highest priorities being the same across both approaches. In the case of the high ranking for adequate resources under the ordinal approach, an examination of Fig. 2 (from interval-based data) shows that this value's importance is strongly bimodal amongst the stakeholder group. Thus, the ordinal score disguises the low agreement amongst stakeholders. This underlines the greater usefulness of the importance ratings, which explicitly depict the bimodal nature of the stakeholder scores and provide a much more quantitative view of both value importance and agreement amongst the stakeholder group, while avoiding unwarranted assumptions concerning the equality of gaps between ordinal intervals and the uniqueness of rankings.

That the outcomes from the two ranking processes (Tables 2 and 3) are quite different in many instances suggests that the stakeholders are able to separate their personal views from that of the stakeholder group they represent. While some stakeholders may have gamed the system, the parsimonious explanation is that they are able to distinguish and separately score their two viewpoints. The differences are very obvious in the case of adequate resources and spiritual-philosophical contentment values where some individuals have provided very different scores, and overall, the two values significantly change their positions in the rankings.

3.3. Comparison of interval-based and ordinal ranking approaches

To statistically explore the results from interval-based and ordinal methods, we compared the IAA centroids (Supporting Information), the average best estimate (Supporting Information) and the average rank (Table 2) pairwise using Pearson's correlation, resulting in:

a There was a positive correlation between the IAA centroids and the best estimate averages, $r = 0.8823$, $p = 0.0016$.
b There was a negative correlation between the IAA centroids and the average ranks, $r = -0.7717$, $p = 0.0148$.
c There was a negative correlation between the best estimate averages and the average ranks, $r = -0.8626$, $p = 0.0028$.

Table 2
Ordinal ranking of values from a stakeholder perspective, with ranking 1 = highest score for that value, and rank 9 = lowest score for that value.

Value	Participant										
	A[a]	B	C	D	E	F	G	H	I	J	Average[b]
Knowledge-heritage	5	1	2	1	2	7	5	2	5	1	3.1
Adequate resources	4	8	1	3	7	4	1	1	8	5	4.2
Future options	3	5	3	6	4	5	3	6	7	4	4.6
Health (phys. Env.)	6	3	4	2	8	1	6	7	4	6	4.7
Recreation	2	7	9	9	5	6	4	3	1	2	4.8
Aesthetic pleasure	9	4	8	8	1	3	2	5	6	3	4.9
Philosophical-spritual contentment	1	2	7	4	3	8	9	8	9	8	5.9
Health (protection)	8	6	5	7	9	2	8	9	3	7	6.4
Meaningful occupation	7	9	6	5	6	9	7	4	2	9	6.4

[a] Columns labeled A to J each represents a single, anonymous stakeholder. Person A in this table corresponds to person A in Table 3, and similarly for B to J.
[b] Lowest average score (Knowledge-heritage) is the highest ranked value (most important) arising from the biological elements – that with the highest average (Meaningful occupation) is the lowest ranked (least important).

Table 3
Ordinal ranking of values from a personal perspective, with ranking 1 = highest score for that value, and rank 9 = lowest score for that value.

Value	Participant										
	A[a]	B	C	D	E	F	G	H	I	J	Average[b]
Knowledge-heritage	3	2	3	1	5	7	3	1	2	1	2.8
Aesthetic pleasure	2	4	2	9	1	3	2	3	1	3	3.0
Health (phys. Env.)	7	1	7	2	8	1	1	6	5	2	4.0
Philosophical-spiritual contentment	1	3	1	5	6	8	6	8	4	9	5.1
Future options	6	7	4	7	2	4	5	5	8	6	5.4
Recreation	5	5	6	8	4	6	9	4	3	4	5.4
Adequate resources	8	8	5	3	7	5	7	2	9	8	6.2
Health (protection)	9	6	8	6	9	2	4	7	6	7	6.4
Meaningful occupation	4	9	9	4	3	9	8	9	7	5	6.7

[a] Columns labeled A to J each represents a single, anonymous stakeholder. Person A in this table corresponds to person A in Table 2, and similarly for B to J.
[b] Lowest average score (Knowledge-heritage) is the highest ranked value (most important) arising from the biological elements – that with the highest average (Meaningful occupation) is the lowest ranked (least important).

The negative correlation in the latter two cases is expected because for ranks, a smaller rank reflects greater importance, while for importance ratings (i.e., for best estimates and IAA centroids) a larger value reflects greater importance. In summary, all three approaches provide comparable outputs; however, the interval-based information employed for the IAA models encodes additional information which provides useful insights concerning the level of agreement amongst stakeholders. The approach also avoids assumptions inherent in the ordinal method outlined above.

4. Discussion and conclusions

The results provide an explicit priority of values based on stakeholder importance ratings and level of agreement. Although all values are potentially important, where resources are limited establishing priorities amongst values allows biological elements and management activities to be rated. Based on the results reported above knowledge-heritage, future options and recreation are the values of highest priority to Lake Bryde stakeholders. This information is being used to inform management goals and rate the importance of biological elements according to the strength of their association with the values, and thus their contribution to human wellbeing (Smith et al. unpublished data). These priorities will guide allocation of resources and facilitate management efficiency and effectiveness.

A number of factors may detrimentally affect elicitation processes. The methods outlined have addressed many of these, including, but not limited to, "halo" effects, anchoring, framing, prejudice arising from the facilitation process or strong personalities, strategic voting, and linguistic ambiguity. Although we aimed to ensure equal information and knowledge amongst stakeholders, we have not been able to quantify the degree to which this was successful. Where practicable, it would be useful to test this immediately prior to the elicitation process.

From a methodological perspective there are two other potential problems. Firstly, the extent to which the stakeholders represented either the state community or their stakeholder group is open to question. Whether it is preferable that decisions on behalf of the state community be made by some form of citizen vote, or by a set of well-informed stakeholders representing key communities as outlined here, is a case in point. We have taken the view that a group of equally informed stakeholders provides a more robust basis for planning, particularly where management and planning are complicated and proposed over decades. This is consistent with the general conclusions of two recent reviews of success and failure in conservation management (Madden and McQuinn, 2014; Redpath et al., 2013). Concerning whether individuals fairly represented their stakeholder groups, the results (Tables 2 and 3) show that they ranked values differently when asked to provide their personal views. This suggests that they effectively quarantined their personal views from those of their stakeholder group. In future, we may undertake analyses using crowd sourcing to test the extent to which participants reflect broader, community interests.

Secondly, there are questions concerning the stability of elicitation results over time. Although the approach aimed to capture enduring beliefs concerning the desirable end-states of human existence, priorities amongst values will potentially change through time. A useful aspect of our approach is that it is readily applied as a web-based system that stakeholders can access on a continuous basis (i.e., they can express when their priorities change). This allows managers to update and quantify changes in stakeholder value preferences over time. Certainly, it is desirable that such outputs are regularly reviewed with stakeholders to ensure that they continue to be relevant to operational management. That all those participating in the elicitation process have accepted the results provides a firm basis for on-going planning.

Despite the above issues, the relative importance of values arising from a defined set of biological elements has been transparently elicited and fully documented. Stakeholders, managers and planners now have a common understanding of the biological elements and the associated human values and wellbeing. The approach has also revealed the diversity of views within the stakeholder group, especially with the bimodal split over three values (Fig. 2) highlighting topics that are likely to be controversial during planning and implementation. The bimodal split within the spiritual-philosophical and adequate resource value scores almost certainly quantifies a divide along production-conservation lines that will need to be managed. This divide may reflect a deep-seated dispute over pathways to human wellbeing. A fundamental advantage of the approach outlined is that it facilitates detection of such issues enabling their investigation and management.

It was noteworthy that all the sub-components of values elicited from stakeholders during the workshop fitted within the classification outlined in Table 1, suggesting that the criteria underpinning the classification are robust, at least for this task. Unpublished work on a recent pilot project with a completely different group of 12 stakeholders in the United Kingdom supports this conclusion. Meeting the classification criteria for values outlined in the methods section is particularly important when establishing priorities, adding values, conducting trade-offs amongst values or undertaking benefit-cost analyses. Where a classification proves inadequate, the underlying criteria are an important starting point for redevelopment and adaptation.

Finally, the advantages of the interval-based scores over the ordinal methods are apparent. Not only does the interval-based approach obviate the need for questionable assumptions – such as that there is an equal distance between each rank and that there are no equal ranks – the combined capture of uncertainty, the strength of group agreement and value importance provide a much richer set of data for analysis and interpretation. Quite apart from the benefits of quantifying the relative importance of values, the interval-based approach generates a wealth of information concerning the level of agreement amongst stakeholders, invaluable for managing negotiations and other socio-political aspects of planning and conflict resolution. We are confident that our approach provides a useful basis for efficiently generating crucial information for conservation planning. As outlined in the introduction, we see this method as better informing, rather than supplanting, existing planning methodologies.

Supporting Information

Detailed description of each value (Appendix S1), stakeholders and their community links (Appendix S2), IAA centroid scores for values (Appendix S3), and Average for best estimates (Appendix S4) are available online. The authors are solely responsible for the content and functionality of these materials. Queries (other than absence of the material) should be directed to the corresponding author. All material listed in the text as in Supporting Information may be accessed through the link provided below under Appendix A.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.jenvman.2015.12.036.

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