Marine Policy 83 (2017) 48–54

Contents lists available at ScienceDirect

Marine Policy

journal homepage: www.elsevier.com/locate/marpol

Does membership matter? Individual influences in natural resource management decision making

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ARTICLE INFO

Keywords:
Management advisory committee
Stakeholder preferences
Multiple objectives
Decision making

ABSTRACT

Increasingly, natural resource management decision making is being undertaken by management committees that consist of a range of stakeholder groups. Representatives on these committees potentially have widely differing objective preferences. Consequently, there exists the potential for management decisions to be affected not only by the type of representation, but by the individuals themselves. In this paper, the robustness of management decision making to both the stakeholder representation and the individual representatives is tested using the case of fisheries management, for which a number of studies have been undertaken in Australia to assess objective preferences within a multi-objective framework. The results suggest that, in most cases, management decisions are robust to membership, but in a small number of instances the actual composition of individuals in a committee may result in different decisions.

1. Introduction

Stakeholder participation is becoming increasingly embedded in national and international environmental and natural resource management policy, as managers recognise the need to understand who is affected by their decisions, and consequently who will aim to influence their outcomes [1]. While this is partly in recognition that stakeholder, and the community in particular, approval is necessary for developing social licence to operate [2,3], stakeholder participation also brings other benefits to decision making. In many cases, decisions are made under conditions of imperfect information and uncertainty [4], and stakeholder input into the management decision process helps to improve the perception of legitimacy of the outcome in the light of this uncertainty [5]. Further, stakeholder participation is helpful in the co-production of knowledge, as stakeholders have experience and understanding of the system that may go beyond that available to the managers and scientists [6,7]. Hence, while stakeholder participation complicates the strategic decision-making processes, it also increases the likelihood that the managers will be able to develop effective and acceptable management options [8].

Stakeholder participation has been particularly recognised as important in a wide range of environmental and resource management decisions e.g [9,10]. Fisheries management decision making as used an example for this analysis. There is a long history of stakeholder involvement in fisheries management, with it seen as a critical component of management success [11]. While there are many models of co-management, ranging from consultation only through to full self-management, the model that has developed mostly in Australia [12], North America [13], Europe [14] and many other regions of the world is that of government, industry and other stakeholder participation in management advisory groups.

While these systems have generally been considered successful, the focus of previous studies has largely been on the process rather than outcomes [15–17]. In contrast, the decisions, and how decisions are made, under co-management have rarely been examined e.g [18]. Concerns have been raised about the potential adverse influence of self-interested stakeholders on management outcomes in some cases e.g [19–22]. Studies of individual stakeholder objective preferences have also generally found substantial variation both within and between stakeholder groups, which may influence their preferred management option depending on the expected outcome of each e.g [23]. Potentially, the group decisions under co-management may differ from one group to the next based on the combination of individuals in the group, even if the groups have common representational structures.

In this study, the potential impact of heterogeneity in stakeholder preferences on the outcome from a set of hypothetical management advisory committees is examined. Using data collected across several objective preference studies in Australia [23–25], the influence of how committee membership may affect management decisions, and how robust these decisions are to the individual representatives on the

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http://dx.doi.org/10.1016/j.marpol.2017.05.024
Received 9 March 2017; Received in revised form 11 May 2017; Accepted 12 May 2017

committees is tested. Three types of potential influences are considered. First, the impact of incrementally adding different types of stakeholders to a committee is considered. Second, management committee structures currently used in Australia and the US are simulated. Finally, an all-industry committee is simulated, representing self-management. Before this, the outcomes of the previous studies on objective preferences are summarised, highlighting the between and within group heterogeneity.

2. Variation in stakeholder objective preferences between and within groups

Stakeholder representatives on management advisory groups are individuals with potentially different views around the relative importance of different management objectives, and hence may value outcomes of a particular management option differently. While their views largely reflect those of the group they are representing, individuals within this group will have differing strengths of opinion about the relative merits of different outcomes from management.

Several studies have been undertaken in Australia in recent years to assess different stakeholder groups' priorities in terms of potential social, economic and environmental outcomes from fisheries management [23–25]. These include studies of all Commonwealth fisheries [25], the Queensland east coast trawl fishery [23], and a range of fisheries (including inshore, offshore and recreational fisheries) in the southern waters around Tasmania, southern New South Wales and Victoria [24]. The data from these studies, all undertaken using the same methodology (the Analytic Hierarchy Process (AHP) [26])[1] were pooled to provide a larger cross section of preferences for the triple bottom line objectives.[2] The number of individuals within each stakeholder group in each survey is presented in Table 1. The relative importance of social, economic and environmental objectives (i.e. objective weights) were elicited for each individual.

The within and between variability in stakeholder objective importance from the pooled results of these previous studies is illustrated in Fig. 1. From Fig. 1, Environmental objectives were generally of highest importance for the environmental NGOs and scientists (who provide stock assessment advice). Economic objectives were considerably more important for the commercial fishers and economists than other stakeholder groups, while social objectives were most important for social scientists and recreational fishers. However, in all cases, there was considerable variability within each group, and the overall distribution in preferences for each objective for each stakeholder group overlapped to some extent. For example, while social scientists had the highest median preference score for social objectives, some social scientists had a lower preference score than some commercial fishers (who as a group had a lower median preference score for social objectives).

3. Simulating decision making in fisheries management

Fisheries management in Australia is largely undertaken in consultation with industry and other stakeholders. In many cases, and particularly at the Commonwealth fisheries level (i.e. for fisheries managed by the Federal Government), this is undertaken through management advisory committees. Similar approaches are undertaken elsewhere, such as the Regional Fisheries Management Councils in the USA, and the Regional Advisory Committees in the European Union. While the ultimate responsibility for final management decisions of these committees varies, at the least the committee provides advice to the final decision maker as to the preferred management option.

Table 1
Number of survey respondents from each group with preference information.

Stakeholder group	Commonwealth fisheries survey [25]	Queensland fisheries survey [23]	Southern fisheries survey [24]	Total representatives
Managers	17	24	16	57
Commercial fishers	12	19	17	48
Recreational fishers	7	10	9	26
Scientists	12	0	18	30
Economists	8	0	2	10
Social Scientists	7	0	2	9
Environmental NGOs	6	23	0	29

Given the variability between stakeholder groups in terms of preference for different management outcomes, it is conceivable that the composition of these committees in terms of stakeholder representation may influence the choice of preferred management decision. Further, given the variability in preferences within stakeholder groups, then it is possible also that the final committee's position depends not only on the stakeholder groups represented, but also the combination of individuals representing the stakeholder groups.

To examine this, the decision making process for a hypothetical committee with different types of membership was simulated. A set of potential management options are presented to the committee (Table 2), each involving an improvement in one objective, no change in a second and a deterioration in the third. That is, each option involves an explicit trade-off in the outcomes.[3]

These are assessed in two ways. First, a management committee is incrementally constructed with additional stakeholder groups joining at each stage. The aim of this is to see how composition of the committee affects the preferred management option. Second, committees based on the Australian Management Advisory Committees (MACs) structure and those of the US Regional Fisheries Management Councils are simulated as examples of more realistic committee structures.

3.1. Sequential committee membership in a hypothetical committee

Membership of the committee is drawn randomly from the set of individuals that participated in the previous studies, each within a pool of similar stakeholders (Table 1). The membership of the committee is also developed sequentially, starting with fisheries managers, then industry members, scientists, environmental NGOs, economists and social scientists. The latter are not generally included in Australian fisheries management advisory committees, but there is growing interest in including social aspects into decision making in Australia at all levels of government (with many States having loosely defined social objectives) [27,28].[4] Recreational fisher representatives are not

[1] The AHP involves a series of bivariate comparisons, where two objectives are compared at a time. From these, the relative importance weighting of each objective can be determined. Full details of the methods used are presented in each of the case studies identified.

[2] Different sub-objectives were found in all three studies, although the hierarchical approach of the AHP required all studies to assess the objective preferences at the higher level before considering the more detailed lower level objectives. The two latter studies also identified a series of governance objectives. These were removed and the remaining social, economic and environmental objectives re-scaled to provide a comparative set of priorities.

[3] This is potentially artificial, as in most cases it is expected that management options can be derived that can produce improvements in all three objectives, but to differing degrees. Often, both economic and environmental objectives can be improved simultaneously, although these are usually at the expense of social objectives. A potentially infinite range of possibilities can exist in terms of how these might vary. In contrast, the chosen set of management options are a discrete and finite set.

[4] Others have also suggested that social scientists must be viewed as a necessary and permanent part of such groups [29].

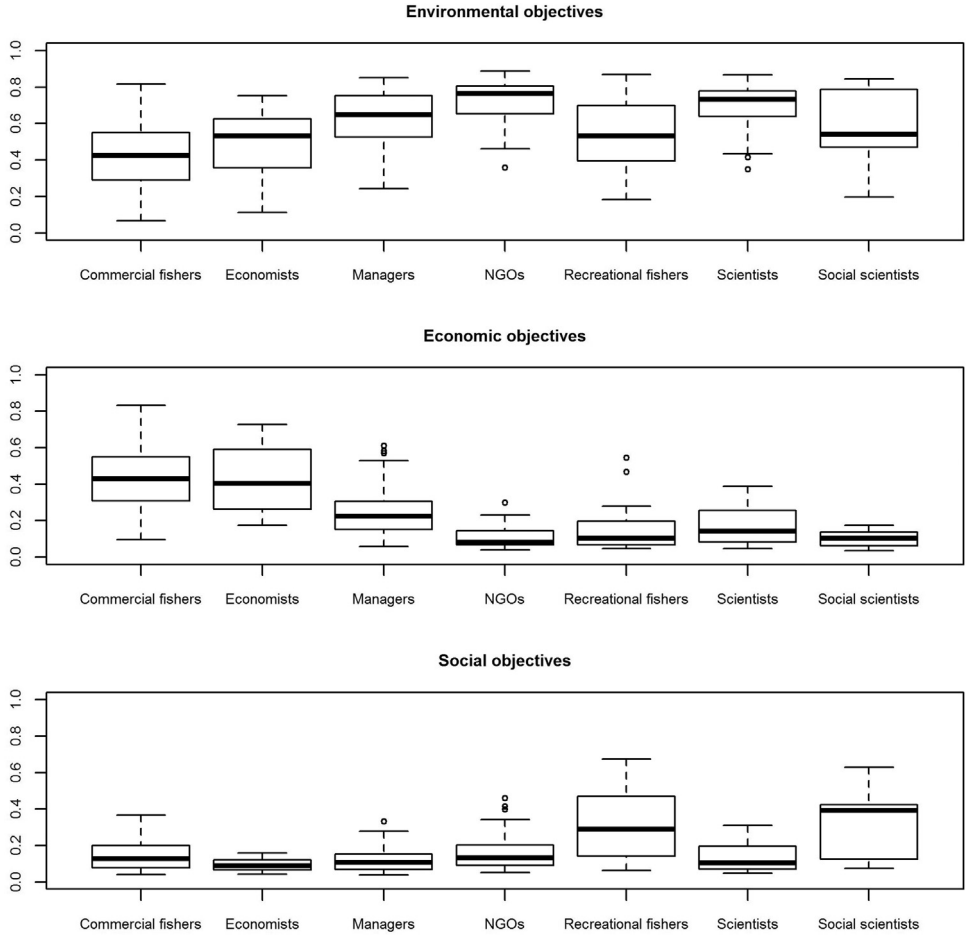

Fig. 1. Distribution of preferences for environmental, economic and social objectives by stakeholder group.

Table 2
Hypothetical management options and outcomes.

Option	Management outcome		
	Environmental	Economic	Social
1	1	0	−1
2	1	−1	0
3	0	1	−1
4	−1	1	0
5	0	−1	1
6	−1	0	1

generally included in Australian Commonwealth management committees, but are often considered in State advisory committees (where these exist).

The weights of the individuals are multiplied by the outcome measures to determine a score for each management option, consistent with the theory of relative valuation of orthodox economic science [30]. These are summed across the different stakeholders to provide an overall score for each option at the committee level.[5] The option that receives the highest score is assumed to be the option that the management committee chooses.

This approach requires a number of assumptions. First, it assumes that each individual behaves consistently given their previously "stated" objective preferences. Second, it presumes that the individuals do not attempt to influence each other (i.e. change the others' preferences), and that each is considered equally important in the decision making process. This is counter to experiences elsewhere, where industry has been seen to have a disproportionate influence [19]. Third, and related to the last point, it assumes that the overall "sum" of preferences is representative of the views of all. The sensitivity of this compared to a vote-based system (where an individual votes for their preferred option regardless of the strength of preference) is considered further in the study.

In each case, 2000 runs with random draws (with replacement) from each of the stakeholder groups represented on the committee are made to capture the effects of the individual as well as the stakeholder representation.

3.2. Australian and US committee structure

Management advisory committees in practice tend to have several representatives of each stakeholder group (rather than just the one assumed in the simulations in Section 3.1). Australian MACs generally consist of one fisheries management representative; three industry representatives; a science representative; an economics representative and generally an environmental NGO representative. Others can be included also if deemed necessary. These are often supported by another advisory subcommittee that assess the available science and provides options and their own recommendations to the MAC. This also has a similar structure, with the chair of the subcommittee being the science member on the MAC. In these simulations, the existence of the subcommittee is not ignored, but is effectively assumed that the

[5] Each representative is assumed to have an equal importance rating. Other systems have been proposed that impute an importance rating based on level of agreement, reducing the influence of dissenting individuals [e.g. 31, 32]. These approaches were not considered appropriate, nor were consistent with the practices in most management committees.

outcomes of the different options presented to the MAC are those of the subcommittee.

The US Regional Fisheries Management Councils (RFMCs) have varying structures. In this case, the structure of the Gulf of Mexico is assumed, namely as it includes recreational fishers. The structure of the council includes six management representatives (state and Federal); four commercial fishers; four recreational fishers; and three "general" appointments. For the sake of the simulations, it is assumed that these consist of one economist, one social scientist and one NGO (so that the full range of "bias" is represented).

Again, in both cases, 2000 runs with random draws (with replacement) from each of the stakeholder groups represented on the committee are made. These are drawn from the set of Australian stakeholders, whose views may not be identical to those of the US stakeholders. However, it is the structure of the committee that is being considered, and the impact of variability in individual preferences on outcomes given these structures. The optimal management option is again based on the sum of the scores given to each option by the committee members.

3.3. Industry self-management

As an extreme example, the case of Industry self-management is also considered. Such management has been successful in some fisheries that operate within an ITQ framework e.g [33]. and has been suggested as a potential management option for small scale commercial fisheries [34,35], as well as other fisheries more broadly [36–40]. Co-management systems that devolve operational decision making to industry are also in place in some fisheries in Australia [41–44].

Assuming the influence of any extreme views will decrease with the number of members, three sizes of a self-management committee are simulated: 5, 8 and 10 members. These are drawn randomly from the set of commercial fishers in the data, with 2000 random draws undertaken.

4. Results

4.1. Impact of committee membership on decisions

Individual stakeholders were introduced to the management committee one at a time, largely reflecting the order in which participation in fisheries management decision making has developed over time in Australia and elsewhere. Only one of each stakeholder group joined the committee, so the balance between groups was equal.

Despite the heterogeneity in preferences, managers on their own favoured the first management option in all simulations (Table 3). This involves an outcome of environmental improvement, no change to economic performance but a reduction in social outcomes. Introducing an industry member to the group has little impact on the choice of best option, although, in a small proportion of times, no social change (with the resultant economic loss) was preferred over no economic change (but social loss). The addition of a scientist to the committee again resulted in only the first option being chosen. The scientists have a strong environmental preference (Fig. 1), and are fairly balanced between economic and social outcomes. The NGOs in the sample had a very strong environmental preference, but many placed most of the balance of their preference on social outcomes. As a result, the second option (i.e. environmental improvement, economic decline but no change in social outcomes) was chosen in a small number of instances. Adding an economist (with a stronger economics than social preference) reduced the likelihood of option two being selected, while adding a social scientist again resulted in option two being selected a number of times. The addition of a social scientist in the final set of simulations also resulted in option three being chosen a very small proportion of times. The third option involved improvement in economic performance, no environmental change and a social loss.

While this latter result seems counter intuitive, given that it was due to the addition of a social scientist, it reflects the overall combination of preferences of the committee. Some social scientists had a relatively balanced view between economic and social objectives, while some industry members had very strong economic preferences. Hence, the combination of individual members can result in very different management outcomes in some circumstances, although the probability of this happening appears to be very low.

4.2. Multiple individual stakeholder representatives

The above analysis assumed equal representation of each stakeholder. In most fisheries management committees, several representatives of some stakeholder groups are members, resulting in a potentially unequal influence on the decision making process.

Two examples of different management structures are presented in Table 4. The Australian MAC model has a higher proportional representation of industry than other stakeholders. From Fig. 1, most industry members have fairly balanced preferences for economic and environmental outcomes, although these vary within the group. As a result, in a small number of instances, the option that improved economic performance over the other objectives (with environment no change) was selected.

Modelling the committee on the Gulf of Mexico RFMC, which has multiple managers, industry, recreational fishing and other stakeholders, the first option was chosen in all instances. Where individual preferences did vary, the large number of members (i.e. 17 in total) resulted in extreme views of individuals having a negligible impact on the overall outcome.

4.3. Industry self-management

If industry were fully responsible for decision making, then in most instances the first management option would be selected (i.e. environmental improvement with no economic loss but some social loss) (Table 5). However, in around 17–20% of the time, the option with

Table 3
Proportion of times the option is chosen by the committee.

Membership	Management option (environmental, economic, social)[a]					
	1 (1,0,−1)	2 (1,−1,0)	3 (0,1,−1)	4 (−1,1,0)	5 (0,−1,1)	6 (−1,0,1)
Managers	100.0%					
Plus industry	93.2%	6.8%				
Plus scientist	100.0%					
Plus NGO	98.7%	1.3%				
Plus economist	99.6%	0.5%				
Plus social scientist	95.5%	4.5%	0.1%			

[a] 1= improvement, 0= no change, −1= decline. Management options are as described in Table 2.

Table 4
Outcomes under management committees with multiple individual stakeholder representatives.

Membership	Management option (environmental, economic, social)[a]					
	1 (1,0,−1)	2 (1,−1,0)	3 (0,1,−1)	4 (−1,1,0)	5 (0,−1,1)	6 (−1,0,1)
MAC	97.8%		2.2%			
RFMC	100.0%					

[a] Management options are as described in Table 2.

an economic improvement but no environmental loss would also have been chosen (option 3) – a larger proportion of times than in the other simulations. In no cases – as with the other committee structures examined – was an option chosen that resulted in a deterioration of environmental performance, even if it resulted in improved economic or social outcomes (i.e. options 4 and 6).

The increase in the number of fishers in the self-management committee reduced the incidence of options 3 and 2 being chosen – the latter to negligible levels. The influence of fishers with strong views – either towards social or economic outcomes – on the outcome lessens the more fishers in the decision making process.

4.4. Influence of assumptions about the decision making process

The simulations assumed that each individual scored each option based on the outcome under each objective and the weight given to that objective. The combined scores were used to determine the overall committee choice. In reality, such scoring is unlikely to take place, but instead individuals will vote for which option they prefer. Individuals with very strong views (represented by a high score) may potentially attempt to influence other votes (particularly if in a minority), potentially causing conflicts in the committees (but not necessarily changing the committee choice).

Given the general dominant preference for environmental outcomes in many stakeholder groups, the analysis was run with options 3 and 5 as the only alternatives. That is, only a direct trade-off between economic and social outcomes is considered with no environmental change. The individual scores given to each option in three sets of runs (chosen not randomly from the full set of runs, but to illustrate the key issues) is presented in Table 6. As the outcomes are either $(1,-1)$ or $(-1,1)$ for the economic and social objectives, the scores for the two options are the same but opposite sign.

The analysis was based on the overall sum of scores of the individuals. However, votes were assigned to each option based on the score (i.e. if positive it is assumed that the individual would vote for that option). The possibility of strong views were also considered, which was arbitrarily assumed to be a score above 0.4. As the environment component of the score is zero (due to no impact), and the score is then based on the difference between the remaining social and economic weights, a score of above 0.4 represents a high proportion of the overall weight given to that objective.

In the first set, an overall preference (based on the sum) for the economic gain (and social loss) is found. Using a voting system, again the economic outcome would have been chosen. However, no individual had a strong preference for either option. In the second set, the option favouring the economic outcome would again be chosen based on the sum of scores and votes. However, three members had strong opinions, and it is likely that the decision would have involved strong debate. In the third run, the economic option is preferred based on the sum of scores, but the difference between both options is negligible. On a vote basis, it would have tied if each individual voted according to their score. However, one individual (the social scientist) had a strong preference for the social option, and may have been able to sway the decision to this option given the weaker preferences of the other members. In this case, the analysis may have predicted the "wrong" outcome given the approach used.

The number of instances in which the outcome of the scoring approach is close (i.e. less than 0.1) was found to be only a small proportion of the model runs (less than 10 per cent) (Fig. 2). In most cases (over 80%), the scoring system resulted in a clear overall preference one way or the other (i.e. more than 0.2). Hence, while the potential exists for one individual to influence the decision when others are largely indifferent, this is likely to occur in only a small proportion of instances. Of course, these decisions may still have resulted in much dispute within the committee.

5. Discussion and conclusions

Increased participation of stakeholders is seen as a key component of the development and implementation of effective natural resource management plans. In fisheries, this ranges from simple advisory committees with limited responsibility to co-management groups which have a predominant management decision making role, at least on an operational level.

While these have largely proved successful, there has been criticism that industry has too much power in the advisory committees due to the number of members relative to the other stakeholders [19]. The results of this study suggest that these criticisms may be unfounded. In both management committee structures examined, the simulated decisions (in terms of choice of best option) were fairly consistent, with differing outcomes in only a small proportion of decisions. These differing decisions were largely due to the combination of individuals across all stakeholder groups rather than the dominance of industry in the committee.

In the simulations of the full set of management options, the dominance of the first option (with occasional choice of the second)

Table 5
Outcomes under self-management with varying numbers of fishers in the committee.

Membership	Management option (environmental, economic, social)[a]					
	1 (1,0,−1)	2 (1,−1,0)	3 (0,1,−1)	4 (−1,1,0)	5 (0,−1,1)	6 (−1,0,1)
Five fishers	76.4%	3.3%	20.4%			
Eight fishers	81.9%	1.6%	16.6%			
Ten Fishers	82.1%	0.3%	17.6%			

[a] Management options are as described in Table 2.

Table 6
Sum of preferences, votes and strong views.

Members	Management option score (environmental, economic, social)[a]					
	Set 1		Set 2		Set 3	
	3 (0,1,−1)	5 (0,−1,1)	3 (0,1,−1)	5 (0,−1,1)	3 (0,1,−1)	5 (0,−1,1)
Manager	0.1021	−0.1021	0.1622	−0.1622	0.1743	−0.1743
Industry	−0.0953	0.0953	0.5152	−0.5152	−0.0953	0.0953
Scientist	0.0522	−0.0522	0.0522	−0.0522	0.1844	−0.1844
NGO	0.0221	−0.0221	0.0221	−0.0221	−0.0027	0.0027
Economist	0.1983	−0.1983	0.5595	−0.5595	0.1983	−0.1983
Social scientist	−0.0474	0.0474	−0.4561	0.4561	−0.4561	0.4561
Sum	0.2321	−0.2321	0.8552	−0.8552	0.0030	−0.0030
Votes	4	2	5	1	3	3
Strong preference (> 0.4)	0	0	2	1	0	1

[a] Management options are as described in Table 2.

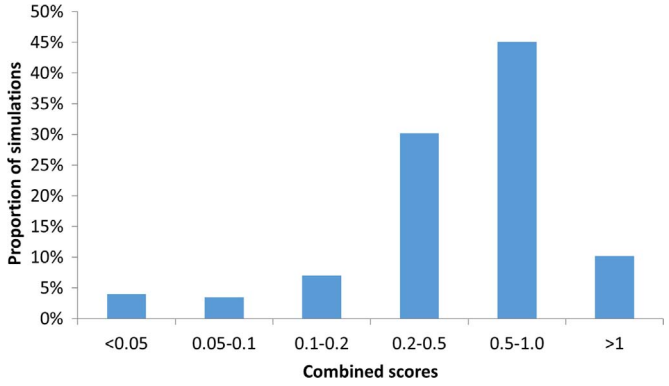

Fig. 2. Proportion of runs with different combined option scores. The smaller the value of the combined scores, the closer the options were in terms of overall preferences. A small value also suggests only a weak preference by most of the individuals in the committee. A value above 0.2 is generally associated with a clear majority preference for that option. A value above 1 roughly indicates universal agreement with strong individual preferences.

can be considered also to reflect lexicographic preferences. Namely, environmental benefits are considered more important than positive economic and social outcomes; but given environmental outcomes are achieved, a reduction in social outcomes is preferred to a reduction in economic outcomes. This is largely consistent with the relative preferences of most stakeholder groups in Fig. 1.

The relative low importance of social outcomes in the decision making process may reflect the historical dominance of environmental, and more recently economic objectives in fisheries management. Maximum economic yield was implemented as a target for Commonwealth fisheries management in 2007 [45], the year before the survey of Commonwealth managers' objectives was undertaken [25]. Prior to this, fisheries management had a predominately environmental focus, and this may have influenced the distribution of managers' priorities. Social objectives have no formal status in Commonwealth fisheries, and are poorly defined in State fisheries. While effort to establish appropriate social objectives for fisheries management has recently been undertaken [27,28,46], the other two objective studies used in this analysis pre-dated this work [23,24]. As a result, the weight given to social objectives by the non-social science stakeholders may be lower than what might be currently observed if these individuals had been resurveyed, given that greater awareness now exists around the importance of social outcomes. This may have resulted in a higher proportion of the alternative options being selected by the simulated management committee.

The analysis also used individual objective outcome preferences, and it was assumed that these individual preferences determined the choice of management option. In some cases, particularly for government management representatives, stakeholders may take a "corporate" view – or what they believe to be the corporate view – in discussing management options rather than express their own views. Experiences in the corporate world suggests that the organisational political process results in lower level managers usually conforming with the values of the CEO even if they hold intrinsically different values [47]. Other studies have found that an organization's predisposition to one outcome over another influences the lenses and filters that individual representatives use when stating their own preferences [8]. These influences can be seen in the objective weightings used, as clear trends in preferences by stakeholder group could be observed. Adopting a corporate position in decision making may further reduce the effects of the individual variability seen in the data, but may also result in increased polarisation of views between different stakeholder groups.

The analysis also does not take into account uncertainty in the information feeding into the decision making process. Bax et al. [48] found that, in the presence of uncertainty, both industry and managers are more likely to take an optimistic viewpoint which may strengthen their preferences for management options that may, in hindsight, be less than optimal (or even detrimental) for the fishery. Similar issues have been seen in other business decision making contexts, where under conditions of uncertainty, managers tend to overestimate the benefits and underestimate the costs [49]. Potentially, expanding decision making groups to include those with a more neutral view with regard to uncertainty (e.g. scientists and economists) may help offset some of this tendency, and hence in this regard composition may matter.

While the results suggest that the potential for an individual to influence the outcome of the management committee is small, this does not mean that lively debate and disagreement does not take place in management advisory committees. Indeed, the authors' own experiences in participating in such groups suggest that such debate, sometimes heated, is commonplace. However, the final decisions arising from these debates usually reflect the initial majority views.

With growing multiple use of the marine environment, involvement of other stakeholder groups in management decision making is also likely to increase. In some areas, tourism operations may have a stake in marine resource management, while in other areas oil and gas industries may be significant. These stakeholders are not currently included in the analysis, primarily as they have not been included in the previous fisheries-focused surveys used for the simulations. Undertaking similar studies in these sectors may provide useful insights into how their involvement in marine resource management may affect outcomes. This was beyond the scope of the current study, but is an area of potential future research.

The results of the study suggest that, over all, fisheries management outcomes derived through management advisory committees are

relatively robust to membership, although in a small number of incidents different outcomes were “chosen” by the simulated committee. This proportion increased under self-management scenarios, but in all cases an option that resulted in reduced environmental outcomes was not chosen.

Acknowledgement

This paper is a contribution to the Marine Biodiversity Hub, a collaborative partnership supported through funding from the Australian Government's National Environmental Science Program. The study was undertaken as part of the Project B1 - Road testing decision support tools via case study applications. The authors would like to thank Eva Plaganyi-Lloyd and an anonymous reviewer for comments on an earlier draft of the paper.

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