Aquatic ecosystems in inland Australia: tourism and recreational significance, ecological impacts and imperatives for management.

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Abstract. The value of aquatic systems for biodiversity, agriculture, pastoralism and mining is widely recognized, whereas their significance for tourism and recreation is often poorly acknowledged. We surveyed protected-area managers, local governments and tour operators (river and general) to determine how aquatic systems are used in inland Australia for tourism and recreation and the perceived impacts of those uses. Inland waterbodies were reported by all respondent groups to be highly significant foci for visitors. Natural features were rated as more important to visitors than infrastructure by protected-area managers and river-tour operators, whereas all respondent groups identified water clarity, water quality and accessibility to water as important aspects of visitor appeal. Although >75% of respondents nominated visitors as being environmentally aware, visitors were reported to have a range of negative effects on the ecological condition of inland waterbodies, especially on water quality, erosion and the loss of fringing vegetation. Managing the recreational use of inland waterbodies will become increasingly important as demand from all sectors intensifies and climate-change impacts become more severe. Management must take into account variations in perceptions by different stakeholder

groups and the paradox of inappropriate visitor behaviour despite visitors' apparent environmental awareness.

Keywords: protected areas, visitor impacts, ecological condition, local government, arid zone

Running head: Inland waterbodies vital for tourism and recreation

Introduction

Australia is the driest inhabited continent, having a higher proportion of arid (49%) and semi-arid regions (20%) than Africa (20% and 17%, respectively) or even the Middle East (50% and 16%, respectively) (Williams 1998). In such a dry and expansive environment, reliable bodies of freshwater play a crucial role, both in the ecology of terrestrial and aquatic ecosystems and in the utilization of biotic and abiotic resources by human populations (Box *et al*. 2008). Stimulated by concerns about potential impacts of inappropriate land-use and excessive water extraction, a growing body of research has examined the ecological structure and function of aquatic systems in inland Australia (e.g. Boulton and Brock 1999; Arthington and Pusey 2003; Kingsford 2006; Sheldon *et al*. 2010).).

The increasing utilization of aquatic resources has similarly generated a growing body of research on the social, political and management implications of water scarcity and on the values that inland freshwater aquatic systems have for the Australian population (Smith 1998; Wishart 2006; Cathcart 2009). Reliable fresh waterbodies have been, and still are, of great cultural significance to inland Aboriginal communities (Smith 1998; Box *et al*. 2008), and their location and permanence often determined whether the early European exploration of inland Australia was a triumph or a tragedy (Cannon 1999). Anecdotally, it is clear that aquatic systems have retained a critical importance into more modern times. Along the highway from Alice Springs to Darwin, for example, the very names of the townships – Barrow Creek, Tennant Creek, Newcastle Waters, Daly Waters, Pine Creek, Adelaide River – indicate the value placed on aquatic systems by European colonizers of inland Australia. Similarly, many iconic 4WD tracks and destinations in inland Australia, such as the Canning Stock route in Western Australia and the Oodnadatta Track in South

Australia, largely follow the presence of waterholes, artesian mound springs or other sources of permanent freshwater (Johnson and de Courcy 1998).

Although attention on the values and utilization of reliable water resources in inland Australia has focussed mainly on agriculture, pastoralism and mining (e.g. Smith 1998; Yencken and Wilkinson 2000; Aplin 2002), one widespread and vital activity has been largely neglected by researchers: tourism and recreation. In 2007-2008, tourism Australia-wide directly accounted for 3.6% of gross domestic product, >10% by value of total exports and 4.7% of total employment (Department of Resources, Energy and Tourism 2010b). Although tourist expenditure in Australia is centred on the capital cities and the Gold Coast, in regional areas nature-based tourism is a highly significant economic and social activity (Department of Resources, Energy and Tourism 2011). In arid central Australia, for example, tourism accounts for nearly 25% of the economic output of the region (Department of Resources, Energy and Tourism 2011). Tourism activities such as participation in outback safari tours have seen an average increase of 17% per year between 1989 and 1995 (Blamey and Hatch 1996) and, more generally, nature-based tourism accounts for almost two-thirds of all international tourist activities in Australia (Department of Resources, Energy and Tourism 2010a).

It is highly likely – and one of the aims of this paper is to investigate – that aquatic systems play a crucial role in tourism and recreation in inland Australia and, in turn, are affected by visitation and by management interventions that seek to minimize adverse ecological impacts. Whilst the broad cultural and aesthetic appeal of aquatic systems to humans is well-documented (e.g. Carr 2006; Tuohino 2006; Pitkanen 2008; Prideaux and Cooper 2009), surprisingly little is known of their significance to tourism and recreation in inland Australia. However, given the extent of arid and semi-arid environments across Australia (Williams 1998) and the patchy distribution of reliable waterbodies in these regions (Box *et al*. 2008), it is likely that aquatic systems are critical foci for tourism and recreation.

The appeal of aquatic systems for tourism and recreation in arid and semi-arid regions is multifaceted. On one level, there is a real sense of mystery and relaxation associated with waterbodies (Bricker and Kerstetter 2002; Tuohino 2006; Pitkänen

2008; Mullins 2009). McComb and Lake (1990) noted that the Australian population – both Aboriginal and European – has a deep-seated appreciation of inland waterbodies that has almost ethical overtones. Mosisch and Arthington (1998, 2004) argued that ease of accessibility, smoothness of the water and high perceived levels of safety were factors responsible for the growing trend for recreational boating activities to occur on inland rather than coastal waterways. They noted also a growing public demand for the development of more reservoirs, lakes and streams for recreation (Mosisch and Arthington 1998; 2004). Coupled with the anticipated drying out of the Australian continent under most climate-change scenarios (Schreider *et al*. 1996; Chiew and McMahon 2002; Steffen *et al*. 2009) and the apparent rapidity of warming in inland Australia (Box *et al*. 2008), the demand and high appeal of aquatic systems for tourism and recreation in inland Australia is likely to continue to grow.

Seemingly, no nation-wide study has examined the significance of aquatic systems for tourism and recreation in inland Australia, nor systemetically assessed the ecological impacts of visitor activities and their implications for management interventions to minimise those impacts. The few published investigations are mostly local or regional (e.g. Edmonds *et al*.1985; Hadwen *et al*. 2003; Hadwen *et al*. 2005). Indeed, the recent critique by Crase *et al*. (2010) of linkages betweeen water and tourism in Australia concluded that there was no clear understanding of the relationship between the two and that this knowledge gap limited the development of appropriate management actions and the formulation of improved policy.

In this study, we examined the relationship between aquatic systems and tourism and recreation in inland Australia. The study had three main aims. The first aim was to determine whether aquatic systems were focal points for tourism and recreation in inland Australia and, if so, how they were used. We predicted that waterbodies would be disproportionally important for tourism and recreation in inland Australia in comparison with their (generally limited) spatial extent. This prediction was based on the well-documented general appeal of aquatic ecosystems to humans (Carr 2006; Pitkanen 2008; Prideaux and Cooper 2009), an appeal that would be expected to apply especially strongly in arid and semi-arid climates, where surface water is scarce. Second, we sought to determine whether visitor activities had adverse impacts on the ecological condition of inland waterbodies. We predicted they would,

on the basis of similar impacts demonstrated for coastal aquatic ecosystems (Butler *et al*. 1996; Hadwen *et al*. 2005), and that impacts would revolve around issues related to visually obvious factors (e.g., water clarity) and access-related factors such as erosion and trampling of riparian vegetation. Indeed, it is possible that recreational impacts would be even greater in inland aquatic systems than in coastal settings, because of the limited number of aquatic sites and access points available for visitation. Third, we sought to determine how the different groups involved in providing or managing water-based tourism and recreational activities in inland Australia perceived the factors that made aquatic ecosystems attractive to visitors, the ecological impacts of those uses, and the imperatives that limited the effective management of the resource. We predicted that there would be significant differences in perceptions across different stakeholder groups with, for example, managers of protected areas being particularly concerned about biodiversity impacts. Moreover, we predicted that the management of inland aquatic ecosystems would be reported as not being adequately resourced to manage visitors and their potential impacts on waterbodies. As the scope of the investigation was nation-wide, field-based empirical analyses across the entire country were not feasible. Instead, we undertook a series of detailed, stakeholder-specific surveys to obtain information from the four major groups involved in the management and use of inland aquatic systems for tourism and recreation across all States and Territories of the country.

Methods

General approach and survey design

Four survey instruments were developed to collect information on visitor use and the perceived importance of inland aquatic systems from four stakeholder groups: i) managers of protected areas (including national parks, state forests and designated conservation areas); ii) local councils (i.e. local government, including city and regional governments); iii) general-tour operators (i.e. a generic group of tourism operators that did not have a specific emphasis on activities in or around aquatic environments); and iv) operators of river- and/or lake-tours (i.e. tourism operators with a specific focus on activities in or around aquatic environments). The protected-area and local-council groups were selected because of their roles and responsibilities

in managing not only the different types of aquatic systems in inland Australia but also with tourism and recreation in these areas. In their survey, protected-area stakeholders were required to answer questions in light of experiences and perceptions within their jurisdiction, which mostly include natural aquatic systems such as lakes, wetlands, streams and rivers. In contrast, local councils are often responsible for highly modified and artificial aquatic systems, including weir pools and dams, as well as some natural systems that lie outside of protected areas. Given these differences in jurisdictional boundaries and operations, we sought to collate information from on-ground natural-resource managers (in both protected-area management and local government) across all available aquatic systems in inland regions of Australia. The final two stakeholder groups (general and river-tour operators) were included to provide a stronger focus on the tourism and recreation industry and the activities of tourists in inland Australia.

Each of the four surveys was designed with questions requiring a combination of box ticking (55–68% of the questions, depending on stakeholder group), Likert ranking (12–14% of questions) and open-ended, written-answer (18–33% of questions) responses. More written-answer questions were asked in the local council and protected-area manager surveys, as the respondents were asked specific questions relating to the ecological condition and management of the sites within their jurisdictions. The Likert-ranked responses were on a scale of 1–4 (where 1 = not at all important, 2 = not very important, 3 = important, 4 = extremely important, with a fifth option, 5 = not applicable). Whilst the questions varied for each target audience across the different surveys, numerous identical questions were asked of all groups, to facilitate cross-group comparisons. Thus, the local-council and protected-area manager surveys shared fourteen identical questions, of which nine were common to all four surveys. These shared questions all related to the core elements of this study in that they asked respondents for their perspectives on the appeal of aquatic systems to visitors, the activities visitors partake in, and the potential environmental consequences of visitation. The surveys were detailed and lengthy (~7 pages), and this complexity may have influenced the response rate (see Discussion). The pragmatic trade-off was between collating sufficient and detailed information with a detailed questionnaire versus higher response rates but with less useful information from a simpler instrument. We opted for the first compromise.

For the purposes of the study, respondents across the local council and protected area groups who indicated that beaches, estuaries and/or coastal environments fell within their jurisdictions were not included in the analyses. This filtering ensured that the focus of the study remained on the role of inland aquatic systems in supporting tourism and recreation rather than on coastal systems. Similarly, the questions asked of the general and river tour operator groups focused on inland waterbodies and the degree to which tours made use of them. Visitors themselves were not a target of the investigation, for two reasons. First, the focus of the study was to examine the distribution, importance and management of tourism and recreation in and around inland aquatic systems as reported by a diverse range of on-ground managers. Second, there was a pragmatic issue: given the huge geographical area covered in the study, coupled with the low population density and strong seasonality of visitation in much of arid and semi-arid Australia (Hadwen *et al*. 2011), it was not practicable to adequately canvas visitor perceptions as part of this study.

Survey distribution and respondents

A total of 574 surveys was sent out by mail to representatives from all four stakeholder groups in all States and Territories of Australia. Contact details were obtained from phone books and websites. The majority of surveys was sent to protected-area agencies and local councils (386 surveys), with the remainder sent to the general and river tour-operator groups. Surveys were distributed in mid-September 2004 and the last completed survey was returned at the end of November 2004.

Despite our targeting the four particular stakeholder groups, there were some instances when returned surveys had been completed by people outside of the targeted groups or across jurisdictions that were wider than expected. For example, for the protected-area surveys there were several occasions where a single individual (usually a manager from a regional office of a protected-area agency) completed surveys for a number of national parks within the region. Similarly, for local council surveys, the intention was to target the most appropriate section of the local government authority. In most cases, this involved directly contacting tourism and development and/or environmental services branches or their equivalents. However, for some of the

smaller local councils that did not have such specialist departments, surveys were usually returned directly from the mayor's office. When this occurred, responses were generally from the upper levels of management. More detailed responses were typically provided by respondents from local councils with dedicated tourism and/or environmental branches than when responses came from senior management. Across both general and river/lake-tour operator groups, responses were routinely returned from company managers and owners, a response which perhaps reflects the small size of most operations. For these groups, the responses and their level of detail tended to be uniform regardless of the level of active involvement (in tours) of the respondent.

Protected-area and local-council survey instruments

The range of general information gathered for protected-area managers (PA) and local councils (LC) included size of region, types, distributions and importance of aquatic systems, annual visitor loads and normal duration of visits, accessibility issues and visitor activities. In addition, a series of questions aimed to assess how built features (e.g. infrastructure) and natural features (e.g. streams and rivers) influenced visitors' decision-making processes. There were also questions relating to the importance of a wide range of physical, chemical and biological characteristics of aquatic sites in influencing visitor perceptions, motivations and behaviors. The remainder of the survey was designed to collate information relating to the perceived environmental awareness of visitors and the degree to which visitor activities currently and/or potentially affect the condition of aquatic ecosystems. In this section of the survey, respondents were encouraged to identify specific management objectives and operations as well as any knowledge gaps that currently inhibit their capacity to evaluate visitor impacts and sustainably manage the waterways under their management control.

Tour-operator survey instruments

For both the general-tour operator (GTO) and the river/lake-tour operator (RTO) surveys, data were collected on the size of the business, the range of trips undertaken and the number, duration and size of trips undertaken each year. Respondents were also asked to nominate the frequency of stops at aquatic sites across all the tours they

offered. This question aimed to examine the relative importance of rivers, streams and lakes in tour itineraries, especially for the GTO group for which aquatic ecosystems presumably did not represent their primary interest. Tour operators were also asked to assess the influence of built (infrastructure) and natural features in influencing the visitor decision-making processes and to rank the importance of physical, chemical and biological characteristics of aquatic sites in influencing visitor behaviors. In addition, RTO respondents were asked to outline the reasons behind the selection of locations for rest stops and overnight stays on their trips, to assess the relative importance of visitor infrastructure and natural area aesthetics on the decision-making processes underlying their tour itineraries.

Survey analyses

We used three approaches to analyse the survey responses and draw comparisons across the four stakeholder groups. First, we collated responses from all groups, prepared basic statistical summaries, and sought to draw together common threads and obvious differences across the various groups using simple descriptive statistics. To this end, medians of responses of 1-4 were calculated to summarise responses to Likert-type questions. For other questions, data were summarised as the percentage of total respondents nominating the listed responses. Summaries are shown in Tables 1, 2 and 3, with supplementary information in the Accessory Publication Tables 1 and 2.

Second, this preliminary method of data analysis was supplemented by the use of non-metric multi-dimensional scaling (NMDS) to evaluate responses to questions common to all four survey groups, using the PRIMER multivariate software (Clarke and Gorley 2001). In addition to describing the distribution of responses across survey groups in multivariate space, we conducted pairwise comparisons, using the ANOSIM procedure in PRIMER, to determine whether responses across the different groups were significantly different from one another. When these pairwise comparisons were statistically significant ($P<0.05$), we determined which questions were driving the differences by using the SIMPER procedure in PRIMER. We identified the questions that drove the observed differences up to a cumulative total of 25% of the variation between groups.

Third, the open-ended written-answer survey questions were evaluated both qualitatively and quantitatively to identify important or common themes (if any) across the four survey groups. An initial inspection of the written-answer responses indicated that a number of themes was frequently expressed; in some cases, the same issues were common across a number of the different stakeholder groups. To quantify which of these themes were common across groups and which were expressed by single groups only, we developed a numerical coding matrix to determine how often (by percentage of respondents) each of eight commonly reported themes was cited by each stakeholder group. Themes relating to increasing visitor numbers, litter, the amount and scale of development and infrastructure, education, coordination of management, funding and resources, the adequacy of environmental monitoring and water availability were frequently expressed and the written responses relevant to these themes are discussed qualitatively in the Results.

Results

Of the 574 surveys dispatched, 94 were returned, representing an overall response rate of just under 17% (Accessory Table 1). Responses were received from every State and Territory (Figure 1), although the response rate differed substantially across jurisdictions and different stakeholder groups. Protected-area managers and river-tour operators provided higher response rates (around 20 %) than local councils (16 %) or general-tour operators (11 %). This level of response – and the large total number (94) of detailed responses received – allowed us to make statistically valid comparisons across groups and draw strong conclusions as to the way aquatic ecosystems are used and managed with respect to tourism and recreation in inland Australia.

Significance of inland aquatic ecosystems for tourism and recreation

Protected-area and local-council respondents reported the presence of a wide range of aquatic environments in their area of jurisdiction (Table 1). Streams and rivers were the aquatic systems most commonly nominated, with > 85% of respondents from both groups indicating that lotic environments existed within their jurisdictions. Substantially more local-council respondents (relative to protected-area respondents)

stated that lakes and wetlands were common in their areas. Some respondents from the two survey groups indicated that coastal aquatic systems (especially estuaries, beaches and the ocean) also occurred within their region, reflecting the fact that some predominantly inland councils and protected areas also include small sections of coastline.

Across local-council and protected-area survey groups, there were consistent responses regarding the areal extent occupied by aquatic systems, with respondents indicating that they most often occupied < 5% of the region (Table 1). The low areal extent nominated for aquatic ecosystems presumably reflects the scarcity, at least seasonally, of surface waters across much of inland Australia. Despite the rarity and intermittency of aquatic systems, > 94% of protected-area respondents stated that these systems represented a significant component of the landscape. The comparable value for local council respondents was considerably lower, at ~50%.

Annual visitor numbers to locations in inland Australia were highly variable, with protected-area and local-council respondents indicating a wide range of annual visitor numbers to their regions (Table 1). Although both survey groups spanned a range from < 1 000 to > 500 000 visitors per annum, the distribution of responses across the annual visitor-number categories differed between the groups. Visitation information from protected areas was unimodal (almost 60% of respondents nominated the range between 5 000 and 50 000 annual visitors) whereas data from local councils was bimodal (around 20% of respondents indicated that annual visitor numbers were < 20 000 and 20% indicated that annual visitor numbers were > 50 000). Additional information regarding visitors, including length of stay and modes of transportation, are provided in Accessory Publication Table 2.

What features attract visitors and what activities do visitors partake in?

Table 2 summarises responses to the Likert-type questions about visitor decision-making and factors influencing the condition of aquatic ecosystems. Natural and built features were reported as important factors in attracting visitors to inland Australia by all stakeholder groups. There were, however, differences across the groups in the degree to which the natural (scenery, streams/rivers/lakes, plants, animals and forests)

and built environments (toilet and camping facilities, nearby towns, nearby accommodation, boating facilities and bushwalking trails) were reported as influencing visitors' decisions to visit a particular region or destination. For example, natural features were rated as being more important to visitors than built features by both the protected-area manager and river-tour operator survey groups. Such differences were not evident among the general-tour operator and local-council survey groups; for both these, the natural and built features were reported as being of equal influence to visitor decision-making.

All four stakeholder groups indicated that water clarity, water quality and accessibility to the water were important factors that influence visitor perceptions of water-based activities (Table 2). Protected-area managers tended to rank all factors lower than did the other three survey groups, suggesting either that water-based activities were scarce or not important to this survey group, or that visitors to protected areas tended to have different perceptions (and associated acceptance) of natural ecosystems than did visitors on tours or in more modified areas. Apparent differences in visitor expectations were also revealed by the fact that local-council respondents tended to place greater relative importance on land-based facilities and the presence of boardwalks and jetties than did all other survey groups. This result indicates that local-council respondents consider infrastructure to be a component that can influence the tourism and recreation potential of aquatic ecosystems. The other important difference among survey groups found general-tour operators ranking the number of other visitors at a site as being more important to the enjoyment of their guests than was apparent from the other survey groups.

The activities undertaken by visitors were generally similar across all four survey groups, with bird watching, relaxing, picnicking, hiking/bushwalking and swimming the most frequently nominated activities undertaken by visitors (Table 2). Even so, a wide range of other activities was also nominated, albeit at much lower frequencies than those listed above. Local-council respondents, for example, identified recreational activities that required equipment and infrastructure (e.g. power boating, water skiing, water sports, land-based sports, sailing and jet skiing) more frequently than did both tour operator groups and the protected-area managers (Table 2). This result is consistent with the finding that natural and built features were

identified as equally important to visitors by local-council respondents (see above), reflecting the wide range of activities undertaken by residents and visitors within the large multiple-use areas under council jurisdictions.

Visitor environmental awareness and ecological impacts

Across all survey groups, > 75% of respondents nominated that visitors were environmentally aware (Table 3), suggesting a general belief that visitors were mindful of their activities and the environment around them. The highest rates of environmental awareness were reported in the two tour-operator groups (86% and 89%), perhaps reflecting the efforts of many tour businesses to educate their clients about important environmental features and the sensitivity of aquatic systems to disturbance.

Nevertheless, more than half of all respondents across the four stakeholder groups indicated that they believed tourist activities had degraded the ecological values of aquatic ecosystems in their regions (Table 3). The highest levels of impact were reported among the tour operators, although many respondents from these two groups suggested that adverse environmental impacts were attributable to independent tourists (i.e. those not on the tours). All stakeholder groups indicated that erosion and poor water quality were the main ecological impacts arising from tourism and recreation within their jurisdiction. Trampling and removal of shoreline vegetation, both strongly linked to erosion and water quality, were also frequently identified as threats to aquatic ecosystems across all groups. Moreover, all groups except the general-tour operators indicated that increased nutrients and algal blooms were significant problems in inland waterways. Notwithstanding the commonality of erosion, poor water quality and loss of fringing vegetation in the replies, <45% of respondents agreed on all of the listed threats (Table 3).

One interesting result was that > 80% of river-tour operators indicated that infrastructure and development within protected areas represented a significant threat to the aquatic systems they used (Table 3). River-tour operators tended to agree with protected-area managers as to the critical environmental threats that degraded aquatic systems (e.g. erosion, poor water quality and trampling and removal of shoreline

vegetation), but also frequently nominated additional factors such as noise pollution and power boating (including jet skis and water skiing).

Tourism and recreation were frequently nominated as activities that led to environmental degradation, and on the Likert scale were the third-most frequently nominated threat identified by protected-area, local-council and general-tour operator respondents (Table 3). Interestingly, river-tour operators did not rate tourism and recreation as a major threat, ranking it well below other factors such as fire, development within and outside of protected areas, and trampling of shoreline vegetation. More than two-thirds of protected-area and local-council respondents indicated that littering, trampling and camping in undesignated areas were common within their regions (Table 3).

Multivariate analyses of survey data

The NMDS analysis of the questions common to all the four sets of questionaires revealed several important differences across respondent groups (Figure 2). ANOSIM pairwise comparisons identified significant differences between i) local-council respondents and protected-area managers; ii) local-council respondents and general-tour operator groups; and iii) protected-area managers and general-tour operator groups (Table 4). Subsequent analysis of these comparisons with SIMPER showed that similar questions were driving differences across the three statistically significant comparisons, most notably questions relating to feeding of wildlife, the presence of infrastructure such as jetties and boardwalks and extractive human activities such as hunting and fishing (Table 5). Given that many of these activities and facilities tend to be absent in protected-area settings, it is no surprise that these elements were revealed as being influential in the SIMPER analyses.

Responses to open-ended, written-answer responses

Respondents from all survey groups provided written comments relating to current and required monitoring programs and visitor management actions, the potential environmental impacts around aquatic ecosystems of tourism and recreational activities, and other threats to sustainable visitor use of aquatic systems. There was a

wide range of detailed comments, and consistent themes were sometimes apparent across two or more different groups of stakeholders (Table 6). The most common themes included issues of increasing visitor numbers (raised by 85% of protected-area managers and 38% of general-tour operators, but not all all by river-tour operators), littering (also important to protected-area mangers but not to tour operators), development and infrastructure (most often raised by river-tour operators), education and knowledge, funding and resources, management coordination, monitoring and increasing visitor numbers (Table 6). In addition, over one-half of river-tour operators identified the lack of water and/or reliable flows as a major issue that affects their operations. The following sections report the major findings of the written components of the survey, across these theme areas, arranged by survey group.

Protected-area respondents. For this group, a recurring theme was lack of funding and staff to initiate and maintain monitoring activities. Some of these problems reportedly related to the operational structure of State-based natural-resource-management agencies, with one respondent explicitly stating that '[senior] management is not funding management of increased recreational use', highlighting the reluctance of some protected area agencies to recognize visitor use as a factor potentially contributing to environmental degradation and protected area management responsibilities.

In addition to a general lack of resources to support effective management, many protected-area respondents indicated that there was insufficient knowledge of aquatic ecosystems, their biota and ecological processes to initiate an informed monitoring program. Indeed, one respondent commented that there is 'little knowledge of aquatic life (freshwater) by visitors and park rangers' and that 'park rangers in general have poor knowledge of aquatic freshwater systems – therefore [it is] difficult to impart to visitors important messages'. These sentiments were frequently articulated across all protected area respondents, reflecting the terrestrial focus of many protected area management agencies and the limited capacity of existing organizations to adequately assess and monitor aquatic environments.

Local-council respondents. Local-council respondents identified similar themes to those from the protected areas, with lack of funds and resources for monitoring and

management listed as common problems. One respondent summed up the magnitude of the problem in a small regional community as: 'Lack of funding - who is going to pay for it? With only a small number of rate-payers and little tourism industry, the task of managing is left to community volunteers and small communities. With limited funding for tourism infrastructure, the Council does not have the critical mass (7500 population base) to commit large funds. Little or no funding support from State and Federal bodies'.

Whilst funding concerns were the dominant comment from local-council respondents, there was some variability in responses to the question regarding knowledge gaps. As one survey respondent suggested, 'there is no knowledge gap, there is an educational and communication gap…what is required is a focus in schools, promotional literature and signage'. Comments such as these, relating to education and environmental understanding, were prominent in responses from local government, with numerous respondents providing comments like '[there is a] lack of general education into the impact of tourist activity in aquatic areas'. This comment presumably relates to the reported 'lack of ongoing monitoring', 'lack of appropriate baseline data' and the lack of understanding of the 'connection between activity on land and [its] effect on aquatic ecosystems'.

General-tour operator respondents. Most of this group of respondents agreed that visitor numbers in protected areas were increasing and that high visitor loads at key sites were damaging those ecosystems. For example, one respondent commented 'too many people visiting the same areas each year is destroying those areas'. In response to high visitor loads, GTOs were generally supportive of increased infrastructure and hardening, as pointed out by one respondent who commented that 'recent improvements and 'hardening' of some high impact areas are steps in the right direction' (underlining in original response). In addition to hardening at focal visitor sites, GTO respondents suggested that revision of accessibility and the implementation of visitor caps might also assist in minimising the impacts of visitors. Indeed, more than a third of GTO respondents suggested that resource-management agencies should investigate the potential of restricting public access to certain sites or sections of protected areas. These sentiments are consistent with the prevailing tour operator belief that the broader public (i.e. free independent travelers, rather than

543 those involved in commercial, organized tours) were more likely to damage aquatic
544 ecosystems than were visitors on their tours. As one respondent commented, ‘as a tour
545 operator – we are passionate and committed to environmental sustainability. Private
546 travelers are likely to be less committed…perhaps [we need] research into this?’
547
548 Lake- and river-tour operator respondents. Consistent with the scarcity of surface
549 water in many parts of inland Australia, more than half of the river-tour operator
550 respondents highlighted the lack of water and concerns over changes in flow regimes
551 as critical management concerns and threats to the environmental and economic
552 sustainability of their operations. This is significant in that at the time of survey, much
553 of south-eastern Australia was in the grip of a severe drought. As one respondent
554 from a river-rafting operation indicated, ‘lack of even/reliable water flows – makes
555 trip scheduling difficult and probably adversely affects biota’. Based on their
556 comments, it was obvious that the RTO respondents were acutely aware of the impact
557 that flow variability/climate change and other non-tourism water issues (and users)
558 can have, not only on their business interests, but also on the condition of the aquatic
559 systems they use.
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561 **Discussion**
562
563 *Significance of aquatic systems for tourism and recreation in inland Australia*
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565 Our results provide multiple lines of evidence to support our prediction that aquatic
566 ecosystems in inland Australia play a disproportionately important role in supporting
567 tourism and recreation by attracting and concentrated visitors and their activities.
568 Although aquatic systems almost usually occupied only a small area of a given
569 jurisdiction (typically <5%), they were rated by 50% of local-government respondents
570 and 94% of protected-area respondents as being significant components of their
571 region (Table 1). Similarly, the median response to Likert-type questions for the
572 importance of aquatic features (e.g. streams, rivers, lakes) in a region by the four
573 stakeholder groups ranged from 3.2–3.9, not only considerably above the value of 2.5
574 indicating neutrality but also consistently higher than scores for a range of other
575 attributes, such as the presence of bushwalking trails, forests, and built infrastructure
576 (Table 2). Finally, the written respondents to open-ended questions across all four

stakeholder groups consistently indicated that the diversity, abundance and aesthetic qualities of aquatic systems made them critical features of the landscape.

This conclusion highlights the appeal of surface water as a backdrop for general land-based recreational activities in inland Australia (e.g. bushwalking: see Blamey and Hatch 1996), as a specific focus for water-based recreation (e.g. swimming, boating, fishing: see Mosisch and Arthington 1998, 2004), and the presence of water as a significant element in its own right for tourism (e.g. tours that track along and between rivers; see Prideaux and Cooper 2009). Whilst some components of this appeal may stem from a subliminal need for a refuge from the hot and dry conditions common in inland Australia and the need for a reliable source of drinking water, there is also evidence that the aesthetic appeal of aquatic systems plays an important role in attracting visitors and facilitating recreation (Bricker and Kerstetter 2002; Carr 2006; Tuohino 2006; Pitkänen 2008). In addition to the historical importance of inland aquatic ecosystems in both Aboriginal and European settlements (McComb and Lake 1990; Box *et al*. 2008; Cathcart 2009), the appeal of inland waterbodies has flowed into the contemporary tourism industry, as evidenced by the high proportion of promotional materials and tours now focusing on these sorts of habitats (Hadwen and Arthington 2003; Tuohino 2006). To conclude, the findings of our study indicate strongly that inland waterbodies are highly significant sites for tourism and recreation in Australia.

What features attract visitors and what activities do visitors partake in?

Irrespective of survey group, natural values were consistently nominated as factors that influenced where visitors go in inland Australia, a result that further supports the degree to which the natural environment underpins tourism and recreational activities in Australia (Sun and Walsh 1998; Buckley 2002b). Critical features, such as scenery, forests, aquatic systems and the local fauna and fauna, were consistently viewed as highly influential determinants of visitor decision making processes across the survey respondents. Hadwen and Arthington (2003) reported similar findings from surveys conducted on the World Heritage-listed Fraser Island, where freshwater lakes are prominent features and tourism icons. In that study, visitors placed a very high value on wilderness aesthetics at popular lake sites and expressed distaste for the presence

of visually intrusive infrastructure (including boardwalks, toilets and shower facilities).

Whilst local-council respondents noted the appeal of natural features to visitors, they also indicated that built features, such as toilet and shower amenities, site-hardening infrastructure (boardwalks, concrete paths, fences) and nearby accommodation and entertainment opportunities, were often equally as important as natural features in influencing visitors' decision-making processes. This result reflects the wide range of activities undertaken by visitors at sites managed by local councils; many of the activities nominated by local-council respondents require more infrastructure than that which is typically provided within protected areas. These responses are not particularly surprising, as the importance of recreation opportunities and the associated infrastructure costs is reflected in local-government expenditures (Wong 1996; Dredge 2006). In addition, many of the waterbodies falling under the jurisdiction of local-government authorities are artificial aquatic systems, such as dams, reservoirs and weir pools. Given this context, it is not surprising that built values were assessed as being of equal importance as natural values by the majority of respondents from the local-council survey group.

The appeal of aquatic systems as focal sites for inland tourism and recreation in Australia is further underscored by the very large number of visitor activities reported as being routinely undertaken at aquatic sites. Whilst many of these activities did not directly rely on the aquatic systems themselves (e.g. hiking and bushwalking, picnicking, relaxing), it appears that undertaking these activities near a waterbody is highly appealing to visitors. As Carr (2006) and Tuohino (2006) noted, the aesthetic appeal of waterbodies might play an important subliminal role in attracting visitors to a destination. Furthermore, given that bird watching was the most commonly nominated activity across all four of our survey groups, the mere fact that the presence of a waterbody in inland Australia might increase the diversity and abundance of wildlife (e.g. Caughley *et al*. 1985; Box *et al*. 2008) may also play an important role in attracting visitors interested in viewing Australian wildlife.

Ecological impacts and environmental awareness

Most respondents suggested that visitor activities adversely affected the ecological condition of aquatic ecosystems (Table 2). Respondents reported a wide range of ecological impacts, but erosion and poor water quality were commonly mentioned issues. Trampling and removal of shoreline vegetation, which are both strongly linked to erosion and water quality, were also frequently identified as important issues. With the exception of general-tour operators, all stakeholder groups indicated that increased nutrients and algal blooms were significant problems in inland waterways.

These findings support the prediction that visitor use is likely to have deleterious consequences in focal aquatic sites and mirrors the findings from numerous other studies, often on coastal systems, that have shown that visitors can degrade the condition of aquatic ecosystems, particularly influencing the water quality in oligotrophic (low-nutrient) water bodies such as dune lakes and rainforest streams (Butler *et al*. 1996; Outridge *et al*. 1988; Hadwen *et al*. 2005). As noted by Hadwen *et al*. (2007), icon sites like aquatic ecosystems often receive unsustainably high visitor loads, so links between site appeal and visitor impacts are not unexpected.

A paradox in these findings is that, across all four survey groups, respondents consistently reported that visitors were thought to have high levels of environmental awareness. This result may be a reflection of the strong appeal of nature and wilderness in influencing visitor decision-making processes in Australia, where the natural environment is the major theme of the tourism industry's imagery and marketing effort (Bushnell *et al.* 2001; Aplin 2002; Worboys *et al*. 2005).

Management of inland aquatic ecosystems in light of tourism and recreational use

The third of our aims related to how the different groups involved in providing or managing water-based tourism and recreational activities in inland Australia perceived the value of aquatic ecosystems, their use by visitors and the imperatives that limited effective management of the resource. Our hypothesis that there would be significant differences in perceptions across the different stakeholder groups was supported, and respondents from the four different survey groups often had quite different perceptions and responsibilities about visitor activities and their impacts in and around aquatic systems (Figure 2, Tables 2, 3, 4 and 6). In protected areas such

as national parks, resource managers and tour operators tend to be especially mindful of the balance required between providing amenities and protecting the natural values of heavily visited sites (Aplin 2002; Jamal 2004; Worboys *et al*. 2005). In contrast, particularly around reservoirs and artificial waterbodies, local councils often try to enhance recreational opportunities by providing built amenities that make access easier or safer and visitors' experiences more pleasant, within the constraint of the primary need of these facilities to provide water for potable, stock-and-domestic or irrigation use. Ultimately, and depending on the ecological system and management objectives (e.g. provision of clean water, conservation objectives etc), a range of built and natural features may provide the kinds of experiences that visitors are looking for within any given region. In addition, the equivalent values attributed to natural features and infrastructure by local council survey respondents may be due to the reduced presence and therefore lower rank given to the importance of natural features, rather than a relative increase in the importance of the built environment *per se*. Perhaps this reflects the degree to which natural components of the landscape have disappeared in many heavily modified regions, and/or the disproportionate area of built and managed environments within the boundaries of some local government authorities.

Tour operators responding to our survey frequently reported that site hardening (i.e. the development of infrastructure to reduce environmental impacts of visitors) and/or restrictions on access represented the best ways to sustainably manage tourism and recreation in protected areas. Other studies have also shown that this is a common belief among tour operators, with hardening serving to increase site carrying capacity and reduce the visibility and perceived severity of visitor impacts (Smith and Newsome 2006). However, there is also some evidence to suggest that hardening and provision of amenities at icon aquatic sites may result in a downturn in visitor loads, as 'naturalness' has been shown to be an essential feature that attracts visitors to particular sites (Hercock 1999; Hadwen and Arthington 2003; Petrosillo *et al*. 2007). Nevertheless, in public spaces outside of protected areas, hardening and/or site access restrictions may be appropriate management strategies to limit visitor impacts and/or increase site carrying capacity. Conversely, as indicated by Waitt *et al*. (2003), a number of types of water infrastructure (e.g. weirs and irrigation structures) are generally not seen in a positive light by visitors, so local governments looking to

maximize tourism and recreational opportunities may need to carefully balance aspects of site utility with those of site aesthetics.

A second important difference between local-council and protected-area respondents reflects the fact that protected-area managers do not always view tourism in a positive light, as visitors can detract from the natural values of the protected areas and negatively affect the conservation goals of these areas (Cole and Landres 1996; Buckley 2002a). In contrast, many local councils have responded to increasing tourism interest in their regions by actively promoting their towns and natural assets (Richins and Pearce 2000; Sorenson and Epps 2003; Jackson and Murphy 2006; Nepal 2008). Considering the significantly broader scope of responsibility of local councils compared with those of protected-area managers, coupled with the wide range of threatening processes outside of protected areas, many local-council respondents likely consider tourism and recreation more of an economic opportunity than an environmental threat. Evidence of the opportunities tourism can bring to regional centres and local communities is widespread and growing, especially in light of the creation of strong destination images and tourism clusters in regional Australia (Richins and Pearce 2000; Dredge and Jenkins 2003; Mules 2005). However, numerous researchers, such as Hohl and Tisdell (1995) and Gossling (2001), have found that the development and management of tourism in remote communities was hampered by a suite of economic, environmental and social issues. We did not examine the role played by remoteness, yet it could well be that some of the more remote towns in inland Australia are the most heavily influenced by visitor seasonality and demand. More research is required to determine the willingness and capacity of local governments to support tourism initiatives and whether these motivations are influenced by their distance from other population centres.

The results of multivariate analyses revealed considerable differentiation between the various respondent groups, with ANOSIM identifying significant differences between i) the local council and protected area respondents, ii) the local council and general tour operator respondents, and iii) the protected area and general tour operator respondents. The factors driving the differences across respondent groups tended to revolve around the presence of extractive activities, such as fishing and hunting and other illegal activities within protected areas – like feeding aquatic

747 wildlife. The perceived importance of jetties and boardwalks was also an important
748 discriminator between the some of the survey groups, with protected-area respondents
749 always valuing these built aspects of the landscape lower than did local-council and
750 tour-operator respondents. The significance of infrastructure and the built
751 environment is an important consideration around waterbodies and numerous studies
752 have advocated for a hardening around fragile sites (Smith and Newsome 2006).
753 However, Smith and Newsome (2006) identified the risks associated with 'impact
754 creep' around the edges of hardened structures, so careful planning and maintenance
755 is required to support infrastructure. This may be a significant issue in inland
756 Australia, where distances are vast and resources are limited to provide and maintain
757 the necessary built facilities. Furthermore, care must be taken that recreation and
758 tourism does not detract from the aesthetics of natural sites, particularly since many
759 visitors to protected areas do not want their experience compromised by
760 anthropogenic structures such as hardening of sites (Hadwen and Arthington 2003).
761
762 Most survey respondents recognised the need for monitoring and management
763 of the condition of waterbodies used for recreation and tourist activities, supported by
764 adequate funding and sufficient knowledge of aquatic systems to design effective
765 monitoring and management programs. In broad terms, the respondents provided
766 evidence supporting the second and related hypothesis, that the current management
767 of inland aquatic ecosystems would be reported as not being adequately resourced to
768 manage visitors and their potential impacts on waterbodies. This problem of
769 insufficient resourcing for monitoring visitor activities and impacts is not restricted to
770 aquatic ecosystems (Hadwen *et al*. 2007). However, the large number of respondents
771 who indicated (mostly in the open-ended, written-answer section of the survey
772 instrument) that aquatic systems are generally less well understood, and more poorly
773 managed, than their terrestrial counterparts, highlights a fundamental shortfall in the
774 capacity of resource managers to appropriately manage and assess the sustainability
775 of use of aquatic sites in inland Australia. Managers charged with the responsibility of
776 managing aquatic resources clearly understand that a wide range of potential impacts
777 may result from visitor activities. However the precise nature of impacts and their
778 consequences and how best to monitor them effectively depends upon the types of
779 activities, the visitor loads and the timing and duration of visitation at particular sites

(Hadwen *et al*. 2007). Unfortunately, this detailed information is lacking in most jurisdictions.

Validity of the conclusions

Since our results have a number of significant implications for the way inland waterbodies are used by and managed for tourism and recreation, it is appropriate to consider briefly the limitations of the methods we used and the strength of the conclusions we draw. Fundamentally, the results hinge on the validity of the survey approach. We sent out 574 surveys to representatives from four major stakeholder groups in all States and Territories of Australia. Ninety-four surveys were returned, which represents an overall response rate of just under 17%. This is better than the <10% commonly reported for medium-length surveys with no incentives and not dissimilar to the 15–30% range reported for medium-length surveys with incentives and follow-up (PeoplePulse 2011). The response rate was likely to be influenced strongly by the detailed nature of the surveys (7 pages) and the considerable thought and time investment they required for completion. Whilst a simpler survey instrument with incentives for completion (e.g. cash payment) would likely have yielded a better response rate, the more detailed proformas were required to generate the data needed for us to answer the diverse research questions outlined in the Introduction. Moreover, there is good evidence that valid conclusions can be drawn from surveys with response rates of around 20% if the questions are appropriate and well framed (Vissner *et al*. 1996; Keeter *et al*. 2006).

The critical point is that we had a large number of highly detailed responses (94 in total) to analyse. This number resembles or exceeds those in a number of broadly similar studies of the way natural-resource managers or tourism operators perceive, use or manage natural systems (e.g. 17 and 31 in Burton (1998); 26 in Kasim (2009); 42–104 in Spenceley (2008); 49 in Page and Thorn (1997); 130 in Bousset *et al*. (2007)). Inevitably, there may be a bias in that we received replies only from respondents who were interested enough to answer the survey; such a limitation applies to all survey approaches unless respondents are compelled to reply. We conclude, therefore, that it is possible to use these data to make statistically valid comparisons across groups and draw strong conclusions as to the way aquatic

ecosystems are used and managed with respect to tourism and recreation in inland Australia

Conclusions and implications

Our study reveals the critical importance of aquatic systems as foci for recreation and tourism across all the States and Territories of inland Australia. It is surprising that such nation-wide information on a critical natural resource has not been collected before, given the Australia's high proportion of arid and semi-arid lands, the cultural and economic significance of aquatic ecosystems in Aboriginal and European societies, and the role played by permanent water in the ecology of arid and semi-arid landscapes (Box *et al*. 2008). The information collated and analysed here should contribute towards better understanding of the currently turbulent relationship between the water and tourism/recreation industries in inland Australia (Crase *et al*. 2010). Although visitors were perceived to be aware of the ecological sensitivity of the environments they visited and used for active, water-based recreation and tourism, many respondents indicated that increases in visitor numbers to waterbodies were threatening the ecological condition of these sites, and, directly or indirectly, their conservation values. These findings suggest that the condition of inland waterbodies is not only threatened by broad-scale land uses such as agriculture, pastoralism and mining (e.g. Smith 1998; Yencken and Wilkinson 2000; Aplin 2002) and the effects of water extraction and regulation for irrigation (Kingsford *et al*. 1998; Sheldon *et al*. 2002), but also from visitor activities at focal waterbodies arising from tourism and recreation.

The need for an informed and well-resourced approach to the monitoring and management of aquatic ecosystems was highlighted by all sectors surveyed and has been the topic of numerous other studies (e.g. Mosisch and Arthington 2004; Hadwen *et al*. 2008). Furthermore, the strong desire of the survey respondents to better understand responses of aquatic systems to visitor-based activities highlights some of the knowledge deficiencies that scientific investigation must address in the near future, as well as highlighting the managerial responsibilities of existing organizations, especially with regard to ecological monitoring and visitor management. Explicitly linking human demands for water, which include tourism and

recreation demands, with what we know of the ecology of inland waterbodies, is a critical element in ensuring that these systems are sustainably managed. Ultimately, the identification of particular inland waterbodies that could support increasing visitor loads and still provide other ecosystem services to local communities is paramount to ensure that such systems are managed sustainably. Identifying refugial inland waterbodies has been the focus of many studies in the ecological literature (Box *et al*. 2008; Sheldon *et al*. 2010). This could become even more important in light of the anticipated changes in climate, altered river flow regimes, and other developments (agriculture, pastoralism, mining and tourism) in inland Australia that would be expected to have adverse effects on freshwater ecosystems and ecosystem services in future.

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Table 1. Summary of responses to questions relating to the type, significance and extent of aquatic systems and the number of annual visitors by protected-area (PA) and local council (LC) survey respondents. Data are presented as per cent of total respondents nominating the listed responses.

Question	PA	LC
Number of respondents	36	34
What types of aquatic environments are there in your region?		
Lakes	19	68
Streams and rivers	97	88
Billabongs	17	15
Wetlands	22	74
Coastal lagoons	0	3
Estuaries	3	15
Beaches and ocean	3	6
Mound springs	3	6
What percent of the region is composed of aquatic environments?		
<5%	47	44
5–10%	22	35
10–25%	17	18
25–50%	8	3
>50%	6	0
Are aquatic environments a significant component of your region?		
Yes	94	50
How many visitors does your region receive annually?		
<1000	8	4
1000–5000	8	11
5000–20 000	31	19
20 000–50 000	28	11
50 000 –200 000	14	21
200 000 –500 000	3	18
> 500 000	8	18

Table 2. Median responses to Likert-ranked questions about visitor decision making and factors influencing the condition of aquatic ecosystems as reported by protected-area (PA), local council (LC), general-tour operator (GTO) and river/lake-tour operator (RTO) survey respondents. Likert ranks were 1 = not at all important, 2 = not very important, 3 = somewhat important, 4 = extremely important, 5 = not applicable. * denotes questions that were not asked across all survey groups, hence the blanks in the table.

Question	PA	LC	GTO	RTO
Number of respondents	36	34	17	7
How important are the following features in attracting visitors to your region?				
Resident animals	3.0	3.0	4.0	3.0
Resident plants	3.0	3.0	3.0	3.0
Streams / rivers / lakes	3.0	3.0	4.0	4.0
Forests	3.0	3.0	4.0	4.0
Scenery	3.0	4.0	4.0	4.0
Toilet and camping facilities	3.0	3.0	3.0	3.0
Boating facilities	1.0	2.0	1.0	3.0
Bushwalking trails	3.0	3.0	4.0	2.0
Nearby accommodation	2.0	3.0	3.0	3.0
Nearby towns	2.0	3.0	2.0	2.5
Culture and entertainment*		3.0		
With respect to water-based activities, how important are the following factors?				
Water quality (absence of odours)	3.0	4.0	3.0	4.0
Water clarity	3.0	3.0	3.0	3.0
Water temperature	2.0	3.0	3.0	2.5
Lack of underwater plants	2.0	3.0	2.0	2.0
Lack of emergent plants	2.0	3.0	2.0	3.0
Lack of logs/rocks in water	2.0	3.0	2.0	3.0
Land-based facilities	1.0	3.0	3.0	2.5
Presence of jetties/boardwalks	3.0	3.0	2.0	2.5
Accessibility to water	3.0	3.0	3.0	4.0
Number of other visitors	3.0	3.0	3.0	3.0
Local plants and animals	3.0	3.0	3.5	4.0
How important are the following factors in influencing the health of aquatic ecosystems in your area?				
Development outside park boundaries	3.0	3.0	3.0	3.0
Development within park boundaries	3.0	3.0	3.0	2.5
Nutrient inputs from camp grounds	3.0	3.0	3.0	2.5
Nutrient inputs from swimmers	2.0	2.0	3.0	2.5
Trampling of shoreline vegetation	3.0	3.0	3.0	4.0
Fire (prescribed burning and/or wildfires)*	3.0		3.0	4.0
Camping	3.0	3.0	3.0	2.5
Fishing	2.0	3.0	3.0	2.5
Power boating	1.0	3.0	3.0	3.5
Sailing and canoeing	1.5	2.0	2.0	2.0
Feeding of fish/turtles/water birds	2.0	2.0	3.0	3.0
Hunting	2.0	2.0	4.0	2.0
Tourism/recreation	3.0	3.0	3.0	2.0

Table 3. Summary of visitor activities, environmental awareness and current impacts on the condition of inland waterways reported by protected-area (PA), local council (LC), general-tour operator (GTO) and river/lake-tour operator (RTO) survey respondents. All responses are presented as the percentage of total respondents nominating the listed responses. NA = not applicable. NB: the final question was not asked in the GTO and RTO surveys.

Question	PA	LC	GTO	RTO
Number of respondents	36	34	17	7
What activities do visitors partake in during their visit to your region?				
Bird watching	89	77	71	43
Relaxing	89	85	77	57
Hiking and bushwalking	86	82	94	29
Picnicking	86	91	71	29
Camping	72	74	NA	NA
Swimming	67	44	59	57
Fishing or hunting	42	59	18	14
Kayaking / canoeing	33	41	12	29
Sunbathing	19	12	29	0
Rock hopping	25	15	18	0
Power boating	6	27	0	0
Water skiing	8	35	0	0
Water sports	8	32	6	29
Land-based sports	8	56	6	0
Sailing	3	21	0	0
Jet skiing	6	15	0	0
Wildlife feeding	6	18	12	14
Are visitors generally environmentally aware?				
Yes	74	79	89	86
Do any visitor activities influence the health of aquatic ecosystems in the region?				
Yes	59	53	77	86
Which of the following activities influence the health of aquatic ecosystems in your region?				
Trampling and removal of shoreline vegetation	63	71	41	67
Erosion and poor water quality	75	71	41	83
Increased nutrients and algal blooms	50	67	18	50
Camping	42	29	29	NA
Infrastructure and development within Parks	46	33	29	83
Fishing or hunting	33	29	24	33
Oil and petrol pollution	21	38	18	33
Wildlife feeding	13	24	18	17
Noise pollution	13	9	24	50
Power boating (including jet skis and water skiing)	8	33	29	33
Canoeing / kayaking	0	8	6	0
Sailing	0	0	6	0
Not answered	33	38	29	17
Which of the following activities occur within your region?				
Littering	47	85	NA	NA
Trampling of vegetation by hikers and bushwalkers	71	68	NA	NA
Camping in undesignated areas	71	62	NA	NA

Swimming	27	41	NA	NA
Fishing and hunting	53	44	NA	NA
Addition of soaps/detergents/nutrients to waterways	47	41	NA	NA
Mistreatment of toilet and camping facilities	52	35	NA	NA
Non-motorised boating	27	44	NA	NA
Power boating	9	44	NA	NA

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Table 4. Pairwise ANOSIM comparisons from the non-metric multi-dimensional scaling (NMDS) analyses evaluating differences in responses to common questions asked of the protected-area, local council, general-tour operator and river-tour operator survey groups. (P = 0.001; 999 permutations).

Groups for pairwise comparisons	R statistic	Significance level
Local council vs. protected-area manager	0.085	0.001*
Local council vs. general-tour operator	0.540	0.001*
Local council vs. river-tour operator	0.312	0.030
Protected-area manager vs. general-tour operator	0.450	0.001*
Protected-area manager vs. river-tour operator	0.229	0.088
General-tour operator vs. river-tour operator	0.094	0.262

1133 **Table 5**. Output from SIMPER analyses of drivers of differences between local
1134 council, protected-area and general-tour operator survey groups on the basis of their
1135 responses to questions asked of all four groups.

Comparison	**Average abundance**	**Average abundance**	**Cumulative %**
Local council vs. protected-area manager			
Sailing and canoeing	2.83	3.31	3.40
Hunting	3.23	3.73	6.69
Feeding of fish/turtles/water birds	3.17	3.43	9.90
Presence of jetties/boardwalks	3.39	3.10	13.09
Boating facilities	3.60	3.06	16.28
Nutrient inputs from swimmers	2.81	2.92	19.40
Power boating	3.41	3.80	22.44
Fishing	3.31	3.22	25.40
Local council vs. general-tour operator			
Development within park boundaries	3.36	0.06	5.21
Nutrient inputs from swimmers	2.81	1.82	8.62
Feeding of fish/turtles/water birds	3.17	1.94	11.86
Fishing	3.31	1.76	15.09
Nutrient inputs from camp grounds	3.22	2.00	18.31
Power boating	3.41	2.12	21.34
Hunting	3.23	2.47	24.37
Sailing and canoeing	2.83	1.82	27.39
Protected-area manager vs. general- tour operators			
Development within park boundaries	3.22	0.06	4.93
Sailing and canoeing	3.31	1.82	8.49
Power boating	3.80	2.12	12.03
Feeding of fish/turtles/water birds	3.43	1.94	15.52
Nutrient inputs from swimmers	2.92	1.82	18.93
Hunting	3.73	2.47	22.30
Nutrient inputs from camp grounds	3.45	2.00	25.54

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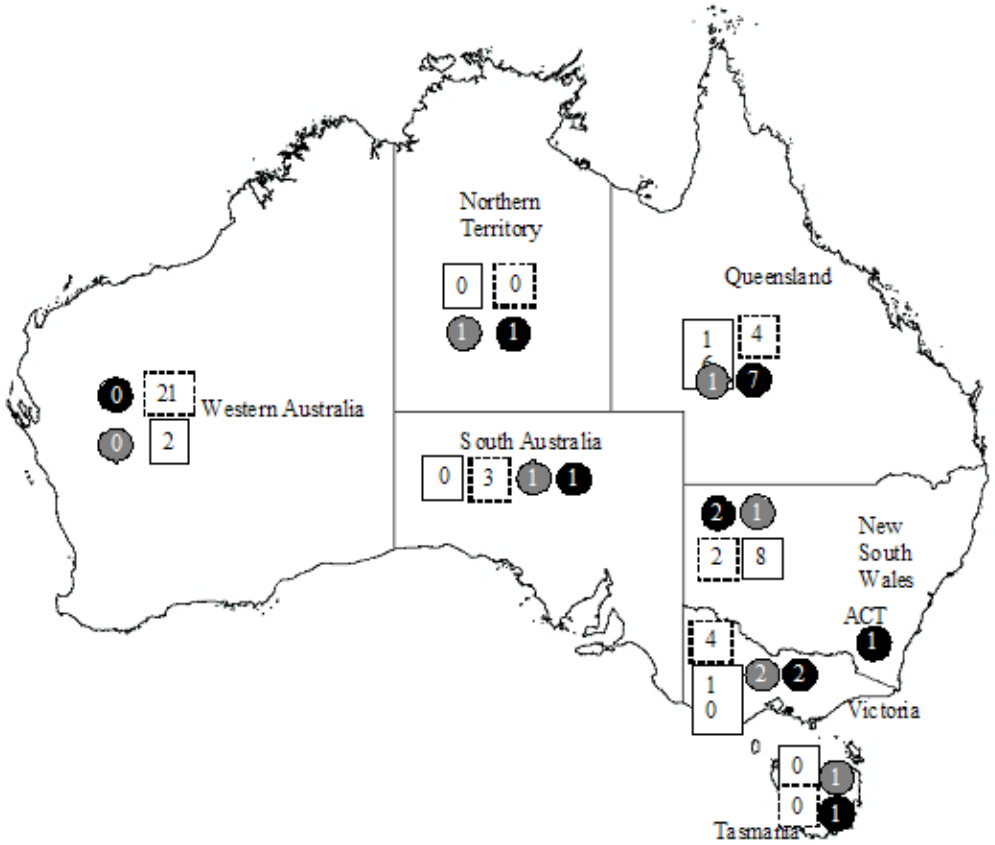
Table 6 Results of simple coding of open-ended written-answer survey questions as reported by protected-area (PA), local council (LC), general-tour operator (GTO) and river/lake-tour operator (RTO) survey respondents. The reported values represent the percentage of respondents, from each survey group, who raised the theme in their written responses.

Theme	Protected area	Local council	General-tour operator	River-tour operator
Increasing visitor numbers	85	14	38	0
Education/knowledge	60	47	23	0
Funding and resources	55	39	23	0
Litter	35	28	0	0
Monitoring	30	6	8	43
Development and infrastructure	0	22	23	57
Coordination of management	0	19	0	0
Lack of water/reliable flows	0	0	0	57

Captions for Figures

Figure 1. Distribution and numbers of completed surveys from protected-area managers (solid line boxes), local councils (dotted line boxes), general-tour operators (solid circles), and river/lake-tour operators (open circles) returned, sorted by State or Territory. Numbers inside boxes and circles indicates the number of completed surveys returned for that respondent group in that area.

Figure 2. Non-metric multi-dimensional scaling (NMDS) plot for responses to survey questions common to all four survey groups.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1
Queensland
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4
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7
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21
Western Australia
0
2
South Australia
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1
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1
2
8
New South Wales
ACT
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Victoria
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1
Tasmania

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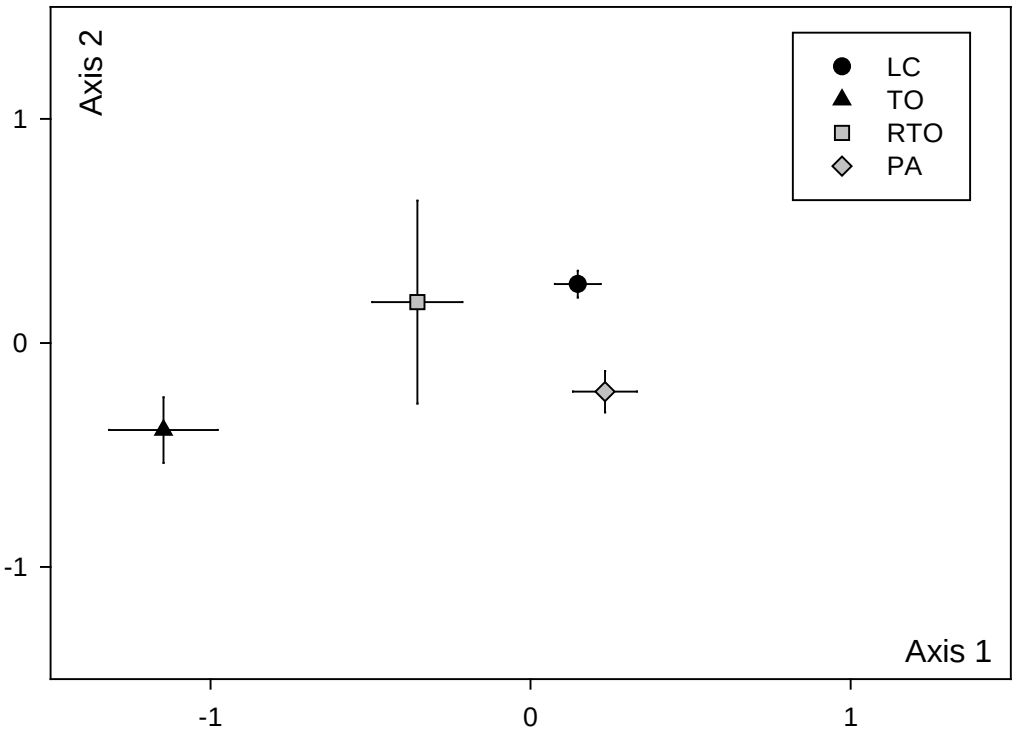

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Accessory Table 1. Survey response rate and level of respondent interest in further involvement across the four target stakeholder groups.

Stakeholder group	Number sent	Number returned	Response rate (%)	Respondent interest (%)
River/lake tour operators	36	7	19	71
General-tour operators	152	17	11	65
Local councils	208	34	16	89
Protected-area managers	178	36	20	77
Total	574	94	17	81

Accessory Table 2. Methods of transportation and duration(s) of stays of visitors, as reported by protected-area (PA), local council (LC), general-tour operator (GTO) and river/lake-tour operator (RTO) survey respondents. Data are presented as per cent of total respondents nominating the listed responses. na = not applicable.

Question	PA	LC	GTO	RTO
Number of respondents	36	34	17	7
How do visitors come to your region?				
2WD vehicles	86	97	12	57
4WD vehicles	94	77	59	29
Commercial bus	56	85	53	71
Bicycle / walking / hiking	36	44	0	0
Boat (includes powered and non-motorised)	7	10	18	29
Plane	na	21	0	14
Train	na	32	0	0
How long do visitors spend in your region/on your tours?				
1 day	36	41	38	86
1-2 days	56	28	13	14
3-5 days	8	9	31	0
> 5 days	0	3	19	0
Don’t know	0	19	0	0