



Human values and aspirations for coastal waters of the Kimberley

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WAMSI Kimberley Marine Research Program Report

Project 2.1.2

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WAMSI Kimberley Marine Research Program

Initiated with the support of the State Government as part of the Kimberley Science and Conservation Strategy, the Kimberley Marine Research Program is co-invested by the WAMSI partners to provide regional understanding and baseline knowledge about the Kimberley marine environment. The program has been created in response to the extraordinary, unspoilt wilderness value of the Kimberley and increasing pressure for development in this region. The purpose is to provide science based information to support decision making in relation to the Kimberley marine park network, other conservation activities and future development proposals.

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Front cover images (L-R)

Image 1: Satellite image of the Kimberley coastline

Image 2: Researchers preparing for aerial flight (Image: J. Strickland-Munro)

Image 3: Humpback whale breaching, Exmouth (Image: Pam Osborn)

Image 4: Barn Hill coastline (Image: J. Strickland-Munro)

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Executive summary

This is the final report of the Western Australian Marine Science Institution Kimberley Research Node Project 2.1.2 “Human values and aspirations for coastal waters of the Kimberley”. The Kimberley Marine Research Program, which guides projects conducted as part of the Kimberley Marine Research Node, focuses on two major areas of research: biophysical and social characterisation (providing foundational data sets and better understanding impacts) and understanding key ecosystem processes. This final report, and its four associated Technical Reports, addresses the first major area of research by contributing to social characterisation of the Kimberley coastline and marine environment. It goes beyond a focus on people as the cause of impacts to help understand peoples’ needs and values. The study area for this research project encompasses the coast and its waters extending from the south western end of Eighty Mile Beach to the Northern Territory Border.

Stakeholders targeted in the research included Aboriginal Traditional Owners; Aboriginal and non-Aboriginal residents; tourists and the tourism industry; commercial and recreational fishing interests, and aquaculture; Federal, State and local government; mining, oil, gas and tidal energy interests; marine transport and aviation; and environmental non-government organisations and the broader WA public. These stakeholder groups represent key local interests in the marine environment as well as those based further-afield. Throughout the project, a major focus was engaging with Aboriginal Traditional Owners, Kimberley residents and visitors as key stakeholder groups. Traditional Owners, elders and Aboriginal rangers from the Karajarri Traditional Lands Association were also involved. Researchers from Murdoch University, the University of Western Australia and the University of Queensland conducted the research.

Three phases of research were undertaken over the project’s three and a half year lifespan. In 2013, Murdoch University researchers conducted face-to-face interviews with a broad and diverse sample of 232 stakeholders associated with the Kimberley coast and marine environment. These interviews used participatory mapping to document spatially explicit information on how people value the coastline and marine environment. The inductive, qualitative research approach identified 17 discrete, emergent value categories relevant to the study area. Information on management preferences was also gathered alongside socio-demographic information.

In 2015, researchers from Murdoch University collaborated with those from the University of Western Australia and the University of Queensland to conduct a combined, two-part online public participation GIS (PPGIS) mapping and discrete choice experiment survey. Online survey content was informed by findings from the interviews. In the first part of the online survey, respondents were asked to participate in a mapping exercise where they freely located markers representing values and management preferences onto a Google® map of the study area. Respondents could choose from a pre-defined set of 14 value and 13 management preference options, with these options derived from the previous interview research. Socio-demographic questions were also posed. In the second part of the online survey, respondents participated in a choice experiment where they were required to choose their preferred option between alternative management scenarios across a number of hypothetical management zones within the study area. Each competing scenario was comprised of differing levels of management outcomes (attributes), which were also derived from the values and preferences identified in the first, interview-based phase of research.

The final phase of research followed a mutually negotiated, agreement-based process with the Karajarri Traditional Lands Association. This final phase of research, also conducted in 2015, involved researchers from Murdoch University in collaboration with representatives from the Karajarri Traditional Lands Association. Traditional Owner concerns and interests guided research design, which was focused on exploring the activities undertaken and management improvements desired by visitors to the Port Smith coastal area, located within the Karajarri Indigenous Protected Area.

Each phase of research was underpinned by the intent of making social data spatially explicit so that it could be readily integrated with existing planning and management approaches. In addition, the research sought to

address the deficit of social data for the Kimberley coast and marine environment, by compiling broad-scale baseline data on values and preferences for the entire region. This information provides essential baseline information on human values and aspirations critical for future planning and management of the Kimberley marine environment.

Key findings and implications for management

The following key findings and implications derive from an integration of the PPGIS mapping and choice experiment modelling research results (Technical Reports 2 and 3). A key finding and recommendation regarding Port Smith, another component of this study, concludes this section (see Technical Report 4 for more details). Given the wide range of jurisdictions covered in this study and its component parts the key findings and management implications in this final report are relevant to a broad range of end users including those within the Department of Parks and Wildlife and external bodies. Within the Department of Parks and Wildlife, potential end users include marine and terrestrial protected area planners, regional managers and operational managers, education officers and social scientists. Outside of Parks and Wildlife, this information will be of interest to Local Government Authorities, Traditional Owner groups and organisations, Regional Planning bodies, industry, tourism operators and bodies, and Government Departments including the Departments of Transport, Fisheries, Premier and Cabinet, and State Development, among others.

In the following list, the key finding is presented first (numbered) followed by the associated management implication, given in italics. This study crossed a range of jurisdictions from Parks and Wildlife managed lands and waters to Indigenous Protected Areas, with the following key findings and management recommendations regarding values, management preferences and management choices clearly relevant to a range of jurisdictions. These key findings and management implications are:

1. The Kimberley coastline is valued for its use (e.g. recreation) and non-use (e.g. biological, bequest) values. Strong support exists for marine and coastal protection and conservation along the whole coastline. This also includes support for sanctuary zones as part of these conservation efforts.

Management implication: Management to maintain both biodiversity and the visitor experience is important along the entire coastline and there is community support for this, locally and further afield. Recognition of biodiversity and social values should be promoted through education programs to raise awareness.

2. Although some regions may attract high levels of attention at particular periods of time, because of specific events, underlying this is a general set of values that should be reflected in management and the allocation of management resources. Of particular note is non-use values, such as bequest and spiritual values, which are held by residents and non-residents and can be significantly impacted upon by proposed development.

Management implication: The importance assigned to both use and non-use values means that good planning must take both types of values into account when considering changes to management or potential developments.

3. High conservation values are evident for the Roebuck Bay region and Dampier Peninsula.

Management Implication: There is value in increasing conservation protection efforts in the Roebuck Bay region and Dampier Peninsula. For the Dampier Peninsula, largely held under Native Title and not subject to Department of Parks and Wildlife management, this presents an opportunity for whole of government support for Traditional Owners to pursue conservation activities over important land and sea country.

4. Residents and non-residents of the Kimberley hold largely similar values and management preferences, with several exceptions. Residents were more likely to identify recreation and

recreational fishing values while non-residents were more likely to identify biological/conservation and wilderness values. For management preferences, residents were more likely to identify 'add recreational facilities' and 'new port development' whereas non-residents did not display a propensity for any given preference over others.

Management implication: While the results indicate that residents and non-residents display high similarity in values and management preferences, significant differences exist for a small number of value and preference associations. These will require careful consideration in any stakeholder engagement and the weighting of interests according to stakeholder group remains an important policy and planning decision. Similarly, education and interpretive material may need to be made relevant to the different audiences.

5. For management preferences, PPGIS mapping results did not necessarily equate with the overall spatial pattern derived from choice experiment findings.

Management implication: This implies that those that have not visited the area or who do not have detailed knowledge of the Kimberley may potentially be interested in planning for a given area. This understanding emphasises the need to broadly define and engage with a wide range of stakeholders (both residents and non-residents) for planning and management purposes.

6. While people value existing recreation opportunities in the region, they may have low demand for additional recreation facilities.

Management implication: For managers and planners this means careful consideration of the motivations behind proposals to increase recreational facilities in the region, to ensure that additional recreational developments do not compromise existing values.

7. The Dampier Peninsula region evidenced conflicting findings for recreation preferences. PPGIS findings indicate positive values for recreational use and a preference for improved facilities. Choice experiment findings however indicate a general aversion to significantly increasing the overall level of recreational development.

Management implication: The levels of recreation facilities provided on the Dampier Peninsula are a key issue for future policy makers and planners particularly due to the ease of access to this area by residents and non-residents alike. This may be particularly relevant where improved road infrastructure is put in place.

8. Eighty Mile Beach appeared the least valued zone in terms of both number of PPGIS markers placed and preferences for management outcomes. However, the zone has a high level of visitation and is more accessible than the northern zones.

Management Implication: Managers could consider undertaking a survey of visitors to the Eighty Mile Beach region to determine visitor origin and values associated with the area in comparison to the other regions of the Kimberley. The results of a focused survey may highlight the need for the development of a tourism or conservation product based on the region's rich biodiversity, Aboriginal culture, and pearling and pastoral history. Such research would complement the intensive visitor research conducted in the Port Smith area.

9. Aboriginal culture and heritage values are widespread across the study area and respondents are positively predisposed towards increasing Aboriginal management.

Management implication: Opportunities exist for a range of groups including the Department of Parks and Wildlife, Traditional Owners, Tourism WA and tourism operators to build upon and develop new conservation and tourism-related products that harness stakeholder interest in Aboriginal culture. With additional resourcing and training, Aboriginal ranger groups in particular present an ideal means of combining conservation, tourism and Aboriginal culture in a manner that will help to foster greater understanding of, and support for, cultural values and Aboriginal management of the coastal and marine environment. Initial discussion with PBC or equivalent Indigenous management groups would assist in directing the appropriate direction for the development of any opportunities.

10. Dampier Peninsula and to a lesser extent, Roebuck Bay and northern Kimberley regions, are areas of

particularly high value for Aboriginal culture, heritage and management.

Management implication: Dampier Peninsula, Roebuck Bay and northern Kimberley regions are high priorities for management attention to ensure that the broad suite of values associated with Aboriginal culture are adequately recognised and supported in both policy and planning. Engagement of Indigenous groups in regional and local policy and planning would provide consistency across the Kimberley while maintaining localised focus.

11. There is disagreement over where development should take place. The region surrounding Roebuck Bay and the marine environment of Dampier Peninsula, highlighted as hotspots for both 'pro-development' and 'pro-conservation' preferences, are areas of potential development-related conflict.

Management implication: For planners and managers this means careful consideration of any development proposals in potentially conflicted areas to ensure that such proposals do not have an adverse impact on existing conservation values. Further, this knowledge can be used to determine stakeholder group preferences and lead to the development of appropriate information for stakeholder engagement, relevant to each stakeholder group.

12. Both PPGIS and choice experiment methods can help planners and managers to understand the complex nature of human values that exist along the Kimberley coast. In particular, the two methods combined can provide rich detail on how particular places are valued and what management is preferred for these places into the future, as well as providing insights into people's preferences for management outcomes when there are trade-offs between outcomes or between regions.

Management implication: The combined methodologies as applied in this research have a number of potential uses. In the short term, they can guide decisions about management frameworks for MPAs, and provide relevant information so that the public supports these measures. Over the medium term, they can assist in developing education and compliance programs that will best suit the values and preferences of the local and visitor community to meet aspirations and enhance experiences. Over the long term, they can be used to monitor values and attitudes to determine if management strategies (including education components) have been effective.

Management implication: Managers should consider repeating these combined methodologies to ensure currency of social information. A five-year monitoring period is suitable, or monitoring in line with MPA review processes or with any other major change planned for the region (i.e. improved access, new development, etc) and should take into account the spatial scale of existing MPAs of interest at that time. Further discussion with researchers for regional and localised monitoring over short and longer time frames should be discussed.

13. The study in Port Smith found visitors hold a similar set of values for this area as found for the Kimberley marine environment generally. The actual activities and management preferences related to access points, use of 'no access' areas, interest in Aboriginal culture and rangers and a need for improved interpretation, maps and guides. For further details on this study refer to Technical Report 4.

Management implication: This site specific information should feed directly into management plans and priorities for the Port Smith area including focusing management resources on access points and on improving maps, guides and other interpretive material and ranger presence (including Indigenous rangers) to improve visitor experience and conservation outcomes.

Future research and monitoring recommendations

This research has provided a valuable insight into how a broad and diverse range of stakeholders value the Kimberley coast and marine environment, and their preferences for its future management. A number of areas for future research and monitoring are evident, based on our findings:

1. Ongoing monitoring of human use and aspirations is essential for the effective planning and

management of this vast, and biologically, culturally and socially rich region. Marine protected areas as loci for these values provide a natural point of focus for monitoring efforts. Social monitoring could be readily added to the biophysical monitoring already underway for marine parks by the Department of Parks and Wildlife. Replication of the online PPGIS/choice experiment survey every five years would provide a broad scale, cost effective means of accessing and engaging the diversity of stakeholders with interests and influence in the Kimberley. In parallel, qualitative research methods such as face-to-face interviews are needed to understand the values and management preferences of Traditional owners and other Aboriginal people. Relevant agencies and organisations would do well to commit to qualitative monitoring conducted at a similar time scale (i.e. every five years or in line with MPA review or major changes in the region) to complement the quantitative monitoring achieved by online PPGIS/ choice experiment methods.

2. Valuable partnerships have been developed through this research with Aboriginal bodies across the region, notably with the Karajarri Traditional Lands Association and Nyamba Buru Yawuru, and much effort has been invested in achieving the participation of Aboriginal people. As both cultural, and increasingly legal custodians of the Kimberley landscape, Traditional Owners are managers (i.e. more than stakeholders) whose central role in future planning and management is critical. Future research should endeavour to engage Traditional Owners and other Aboriginal representatives in research design, data collection and analysis as appropriate. Involving Traditional Owners and others (e.g. Aboriginal rangers) in social research development, training and data collection techniques, as undertaken in this project, presents one means of achieving this. This approach would also achieve two-way skills and knowledge transfer and assist in building ownership over social research and its application to local planning and management. The northern Kimberley region presents an area where particular focus is required.
3. Four areas are recommended for future research, as extensions to the spatial choice experiments conducted in this project:
 - a. The statistical models referred to in this report and presented in Technical Report 3 represent a preliminary investigation of the data collected from this research. Further analysis and study is required to tell a more comprehensive story of the values and preferences that local residents and visitors hold for the Kimberley. In particular, a study of preferences according to interest and stakeholder group, and/or location, and can be used to improve education and understanding around management strategies.
 - b. Undertaking a choice experiment focusing solely on the marine species and ecosystems that underpin management of marine protected areas. This would allow the inclusion of attributes reflecting a greater range of marine protected area management outcomes, rather than the presence of sanctuary areas alone, and how preferences for marine management may vary among zones.
 - c. Undertaking research in communicating the consequences of management of remote wilderness areas to respondents who may not have never visited the area. The amount of information provided to respondents, and the way in which information is presented, will affect the values people express through their choices in the choice experiment. Thus, it is extremely important that information about environmental management changes and their impacts is presented to stakeholders in a way they can understand and use. There is no research to-date on the best way to communicate the current status and the consequences of management in remote wilderness areas such as the Kimberley.
 - d. Undertaking further research into how specific values vary at different scales, for example within the management zones. A valuation study that focuses on a single smaller area would be of very helpful to identify preferences for different marine management options within a more finely defined spatial scale, and explore the integration of these values within a formal marine spatial planning process.

Products and tools

This project has produced a number of products and tools available to user groups. These include:

Products:

1. Overview and individual heat maps for inductive, emergent values associated with the Kimberley coast and marine environment (derived from face-to-face interviews, see Technical Report 1 <http://researchrepository.murdoch.edu.au/25482/>). These maps provide guidance as to where certain value types are concentrated and which areas hold multiple values.
2. GIS aggregate data supporting heat map development for Technical Report 1 are available to planners and managers and may be used to inform broad-scale planning. The Department of Parks and Wildlife holds a copy of this aggregate data set.
3. Overview and individual point density maps for i) values and ii) management preferences associated with the Kimberley coast and marine environment (derived from the online Public participation GIS study, see Technical Report 2 <http://researchrepository.murdoch.edu.au/30129/>). These maps provide a validation of previous value heat maps and similarly provide guidance as to where certain value (and preference) types are concentrated and which areas hold multiple and/or potentially complementary or conflicting values and preferences.
4. GIS marker database that was used to generate point density maps for Technical Report 2 is available to planners and managers and may be used to inform broad-scale planning. Associated data obtained from the PPGIS survey (see Technical Report 2, Appendices 2 - 4 for survey questions) is also available. The Department of Parks and Wildlife will be provided with a copy of the marker database and associated data.
5. Six choice experiment survey datasets, with content as detailed in Technical Report 3 available <http://www.wamsi.org.au/research-site/social-values>.
6. Individual point density maps for i) values ii) activities and iii) desired improvements associated with the Port Smith area (derived from visitor surveys, see Technical Report 4 available <http://researchrepository.murdoch.edu.au/25482/>). These maps provide guidance as to where certain value types, activities and desired improvements are concentrated and which areas hold multiple values.

Tools:

1. Choice experiment research methodology as presented in Technical Report 3. Note that choice experiments require careful design and are not straightforward. Practitioners using choice experiment methodology need rigorous expert training before designing choice experiment surveys, defining statistically valid choice sets, and analysing discrete choice experiment data.
2. Management preference choice models estimating willingness to pay for the management preferences for different zones of the Kimberley.
3. Full choice experiment survey - found in Appendix 3 (derived from the online choice experiment, see Technical Report 3).
4. PPGIS survey found in Technical Report 2 (refer to Appendix 2).
5. Interview protocol, questions and accompanying maps used in the first qualitative phase of this project. See Technical Report 1, Appendices 2 - 4 for details.

Although access to these tools is available, it is critical, both in terms of the validity of the findings and the cost-effectiveness of research, that social scientists, geographers with GIS expertise and environmental economists are involved in the design, execution and analysis of this research, both in PPGIS and choice

experiments. The design of these research methods is an expert process. Who is surveyed and how they are accessed are critical design features. Also essential is expert analysis of results, in determining what and how to map regarding values and preferences, and how to select, develop and implement choice sets in choice experiments, and then develop and test models that are realistic and robust.



1 Human values of the Kimberley coastline and marine environment – overview of the technical reports

The research project was carried out in three phases. This approach ensured that subsequent phases were informed by preceding research. Thus, research undertaken in Technical Report 1 (face-to-face interviews with stakeholders) provided information that underpinned online survey development reported in Technical Reports 2 (PPGIS values and preference mapping) and Technical Report 3 (choice experiment). The third phase of research, reported in Technical Report 4, involved negotiated, agreement-based research undertaken in partnership with the Karajarri Traditional Lands Association.

Technical Report 1 (<http://researchrepository.murdoch.edu.au/25482/>) reports on findings from interviews and participatory mapping held with 232 stakeholders across the Kimberley, in Darwin and Perth. The research identified 17 discrete, emergent value categories associated with the Kimberley coast and marine environment. A broad range of stakeholders was targeted for participation in the research, including Aboriginal Traditional Owners; Aboriginal and non-Aboriginal residents; tourists and the tourism industry; commercial and recreational fishing, and aquaculture; Federal, State and local government; mining, oil, gas and tidal energy interests; marine transport and aviation; and environmental non-government organisations. Respondents were asked to hand-draw polygons representing areas of value on hard copy maps of the study area, and this information was subsequently digitised and used to produce individual ‘heat maps’ indicating areas of greater value density for each emergent value category. A key finding from the research is that the entire Kimberley coast is valued, often for multiple values. The emergent value categories derived from the interviews, together with unpublished data gathered on management preferences, provided the basis for the online survey reported in Technical Reports 2 and 3.

Technical Report 2 (<http://researchrepository.murdoch.edu.au/30129/>) reports on findings from an online PPGIS survey where 372 respondents were required to place digital markers representing values and preferences onto a Google® map of the study area. The survey targeted similar stakeholder groups as previous interview research: visitors to the Kimberley; local residents; local, State and Federal Government employees; scientific researchers; members of the tourism industry; environmental non-government organisations; oil and gas industry workers, Aboriginal people; commercial fishing and aquaculture workers; and others. Respondents were presented with a defined list of 14 values and 13 preferences to choose from during the mapping exercise. The values and preferences derived through earlier face-to-face interviews informed the content of these lists, which also aligned with the broader PPGIS and place values literature. A total of 19,157 value and preference markers were placed in the PPGIS survey. Findings concur with those of the interview-based research: the entire Kimberley coast is associated with some form of value. Virtually the entire study area coastline was also associated with some form of management preference. Point density maps for each individual value and management preference were generated and provide an indication of areas of greatest value and preference intensity. A breakdown of value and preference mapping by stakeholder domicile is also presented.

Technical Report 3 (<http://www.wamsi.org.au/research-site/social-values>) reports on findings from a choice experiment (CE) survey undertaken as part of the online survey. As the choice experiment was run as an integral part of the online survey, the same stakeholder groups were targeted for involvement. This continuation of the PPGIS survey was completed by 320 respondents. This sample is labelled the ‘Public’ sample (Kimberley stakeholders who completed both PPGIS and CE components of the survey). These respondents were presented with different combinations of hypothetical management outcomes (i.e. attributes) and costs occurring in differing management zones across the study area. They were asked to choose their preferred option, thus forcing respondents to make trade-offs between different levels of different combinations of management outcomes in different zones. Each respondent answered six choice questions. Econometric models were estimated on the choice data to unpack how respondents valued the different management attributes in the different zones. In addition to this ‘Public’ sample, a sample of 1,092

respondents were recruited from an online commercial research panel. These were largely Perth metropolitan residents. This sample is labelled the 'Panel' sample to differentiate it from the 'Public' sample above. Sub samples of the 'Panel' completed an identical PPGIS/CE survey to that of the 'Public' sample, while others completed alternative CE designs. Findings show that people who may not necessarily identify as Kimberley stakeholders still hold values for the region. Our results further show that there is some spatial differentiation in preferences for the attributes across the study region. These spatial differences, and the willingness to pay for management attributes are calculated and presented in Technical Report 3.

Research reported in Technical Report 4 (<http://researchrepository.murdoch.edu.au/30194/>), involving visitor surveys with 97 tourists and local residents, was developed following conversations and acknowledgements of the knowledge gaps identified in Technical Reports 1-3. These knowledge gaps centred on the need to build agreement-based research with Traditional Owner groups, with the research focus on stakeholder values and preferences adjusted to explicitly suit the expressed needs and interests of Traditional Owners. Thus, research presented in Technical Report 4 emerged through, and was undertaken as, a negotiated partnership approach with the Karajarri Traditional Lands Association.

2 Materials and methods

The research project used a range of qualitative, participatory mapping and statistical modelling research methods. Full details of the specific methods used in each phase of the research project may be found in the relevant Technical Reports.

3 Results: Joint research integration

The remainder of this Final Report presents integrated research findings from the combined online survey (PPGIS values and preference mapping and choice experiment components) reported in Technical Reports 2 and 3. These combined findings offer a valuable dataset that can be analysed to provide a richer picture of human values and aspirations for the Kimberley coastline and marine environment than either method on its own. Both components were undertaken as a single research exercise by respondents. Both seek to reveal underlying stakeholder preferences with the intent of informing planning and management. The online PPGIS mapping exercise explored stakeholder values and preferences in an unconstrained manner. That is, respondents were free to choose as many markers as they wished to place, as well as the geographic location in which they placed markers. In contrast, the choice experiment component explicitly constrained respondents in their choices regarding management outcomes and geographic locations within the study area. It did this by asking respondents to choose their one preferred management option from a range of outcomes and locations. This methodology explicitly requires respondents to make trade-offs among management outcomes and geographical locations.

3.1 Stakeholder characteristics

The following discussion draws on information collected from the stakeholder groups through the online survey. This information was reported in Technical Report 2 and presented as the 'Public' data-set in Technical Report 3. Table 1 presents respondent characteristics from the PPGIS values and preference mapping results and the choice experiment. Stakeholder groups involved in the survey included visitors to the Kimberley; local residents; local, State and Federal Government employees; scientific researchers; members of the tourism industry; environmental non-government organisations; oil and gas industry workers, Aboriginal people; commercial fishing and aquaculture workers; and others. Respondent numbers are smaller in the choice experiment than in the PPGIS mapping (Table 1) because some respondents did not complete the entire survey to the end—and therefore did not complete the choice experiment questions. Thus, the choice experiment sample is a slightly smaller subset of the 372 PPGIS respondents. They are comparable however in terms of gender balance, age, and self-identified stakeholder group affiliation.

Table 1. Respondent characteristics for the ‘Public’ sample, for those completing the PPGIS exercise, and the subgroup who completed the choice experiment.

Respondent characteristic	PPGIS	Choice experiment
Sample size	n=372	n=320
Age, mean	48 years	48 years
Gender	46% Female	45% Female
How did they rate their knowledge of the Kimberley coast?		
Poor	1.3%	0.9%
Below average	8.6%	7.9%
Average	38.2%	38.1%
Good	41.1%	43.7%
Excellent	10.2%	9.4%
Self-identified stakeholder group		
Current or former Kimberley resident	31.4%	34.0%
Aboriginal	2.7%	2.5%
Visitor	47.6%	47.8%
Commercial fishing, pearling or aquaculture	1.1%	0.9%
Commonwealth government employee	1.6%	1.6%
State government employee	15.9%	16.6%
Local government employee	1.9%	1.6%
Non-government organisation member	6.45%	7.5%
Work in tourism industry	8.6%	9.7%
Work in oil and gas industry	2.2%	2.2%
Researcher	16.4%	18.7%
Other	14.8%	15.6%

3.1.1 Resident versus non-resident analysis

This section explores how respondents mapped according to their residency status. First, an overview of respondent domicile is given. This is followed by analysis of significant differences in how Kimberley versus non-Kimberley residents mapped i) values and ii) management preferences. An analysis of mapping differences among the three coastal Shires in the Kimberley – the Shires of Broome, Derby/West Kimberley and Wyndham/East Kimberley – was explored. However, sample sizes for each Shire were too small to conduct valid statistical analysis.

Stakeholder domicile

Almost 32% of survey respondents were current residents of the Kimberley region. The majority of respondents (68.3%) did not live in the region. Table 2 provides an indication of the relative proportions of residents originating in the three coastal Shires of the Kimberley. Residents of the Shire of Broome comprised the greatest proportion of those identifying as Kimberley residents, followed by residents of the Shire of Wyndham/ East Kimberley. However as almost 34% of Kimberley residents did not provide their postcode a degree of uncertainty surrounds these figures.

Table 2. Stakeholder domicile within the Kimberley region.

	Percentage of Kimberley respondents
Shire of Broome	31.4%
Shire of Derby/ West Kimberley	12.7%
Shire of Wyndham/ East Kimberley	22%
No postcode given	33.9%

Resident versus non-resident mapping: Values

Chi-squared analyses of significance were performed to analyse differences in how Kimberley residents mapped values compared with non-residents (see Technical Report 2 for further details of statistical analyses). Table 3 highlights those values for which a statistically significant difference in propensity to map (likelihood of mapping a particular marker) was evident. Residents were significantly more likely to place markers relating to recreation and recreational fishing values. Non-residents were significantly more likely to place markers for biological/conservation and wilderness/ pristine values.

Table 3. Values with statistically significant differences in propensity to map (likelihood of mapping marker). p-values associated with the Chi-squared analyses are indicated in brackets.

Stakeholder	Value
Resident	Recreation (0.001) Fishing (recreation) (0.000)
Non-resident	Biological/conservation (0.004) Wilderness/pristine areas (0.033)

Point density maps for the four value categories evidencing statistically significant differences in the numbers of markers placed – recreation, recreational fishing, biological/conservation and wilderness/pristine – are given below.

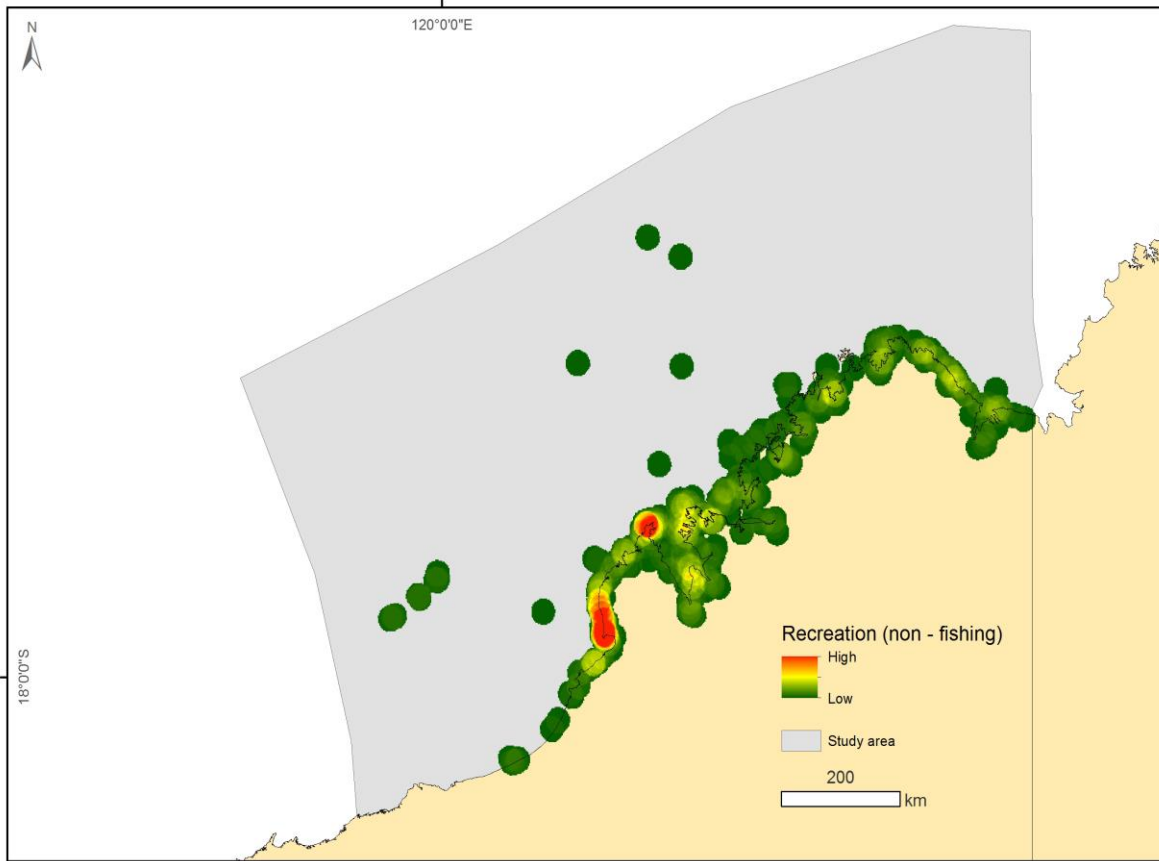


Figure 1. Resident mapping for recreation value (N=89)

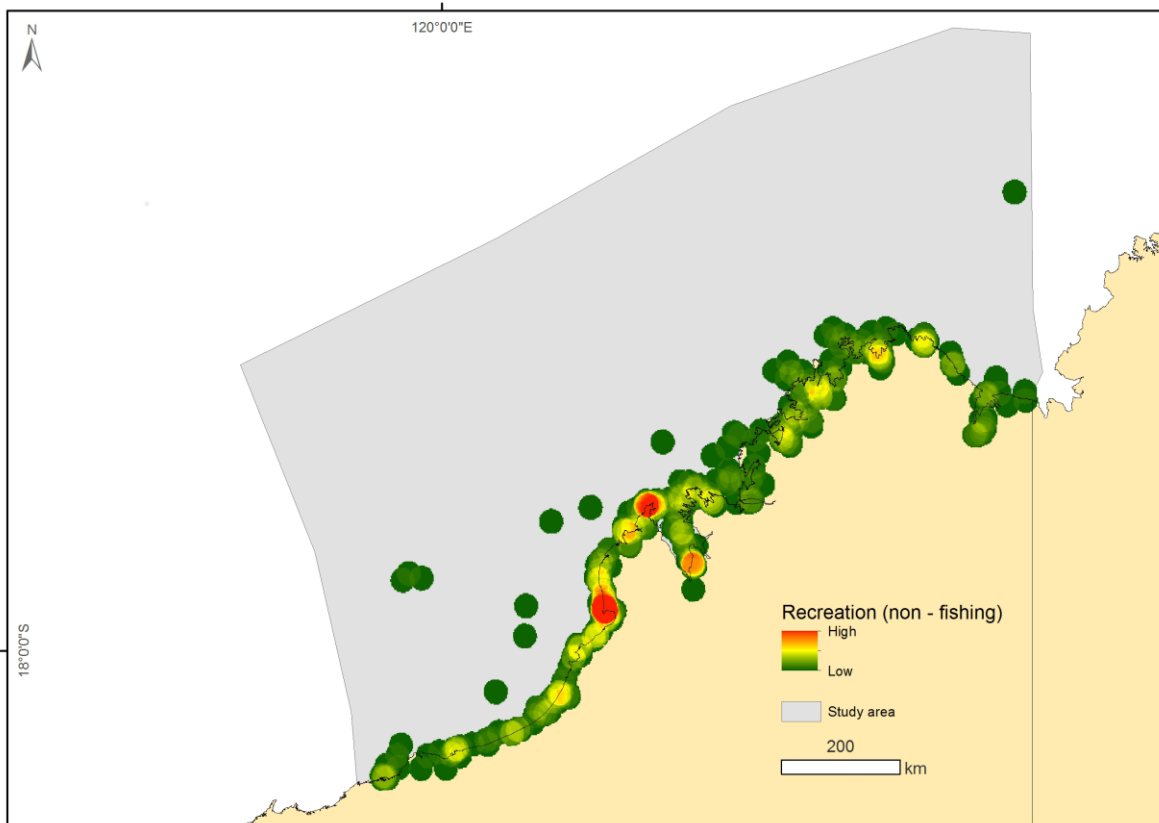


Figure 2. Non-resident mapping for recreation value (N=145)

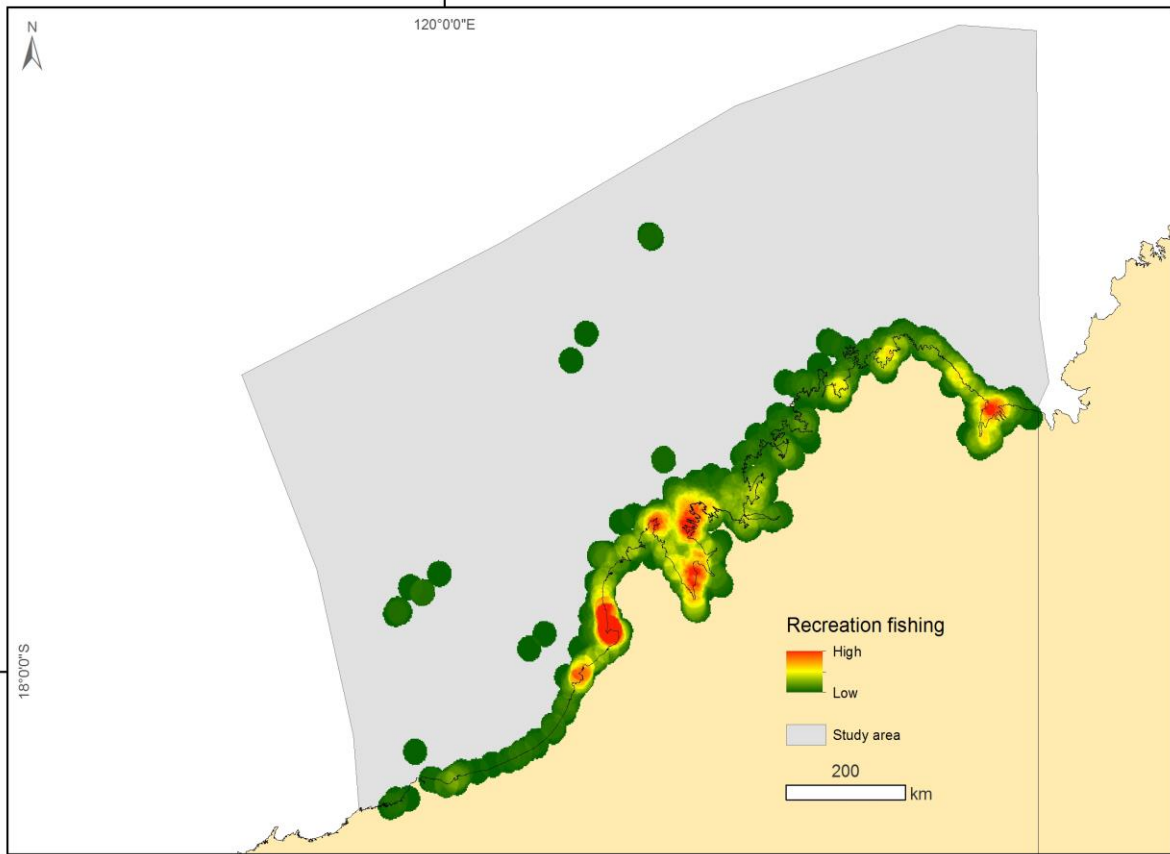


Figure 3. Resident mapping for recreational fishing value (N=99)

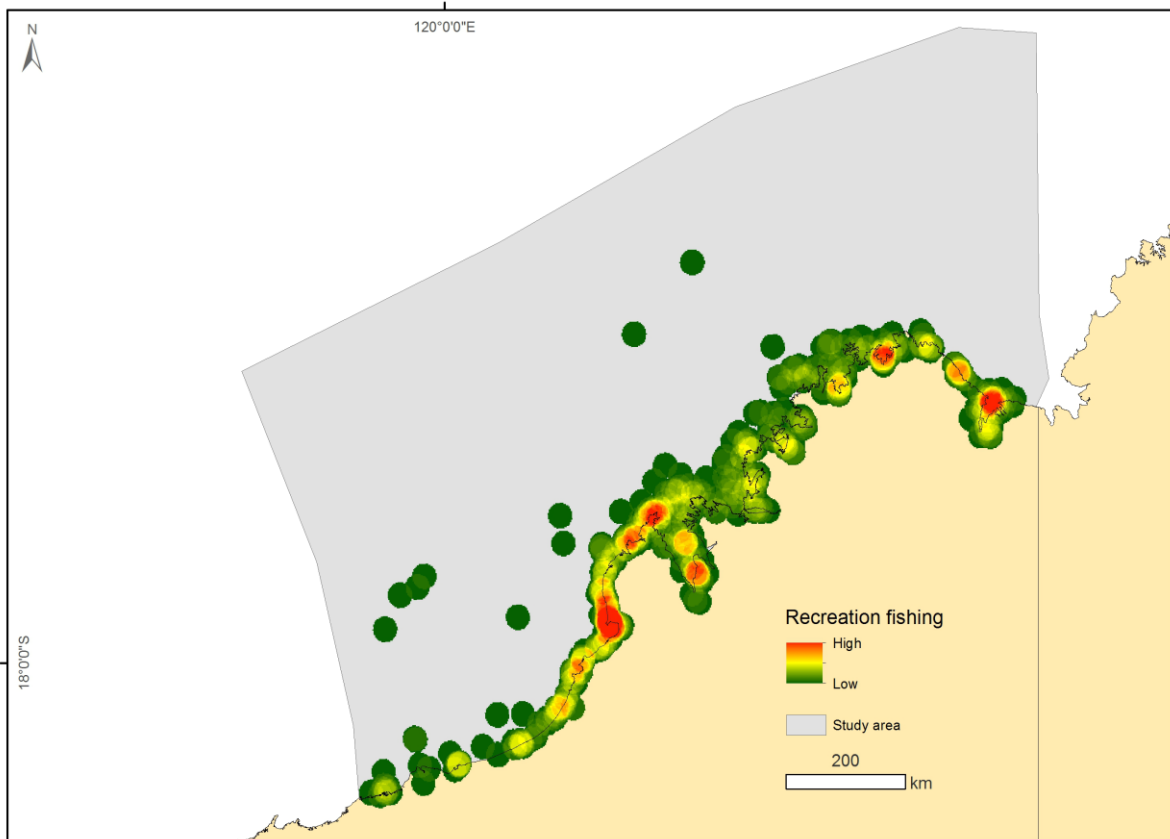


Figure 4. Non-resident mapping for recreational fishing value (N=126)

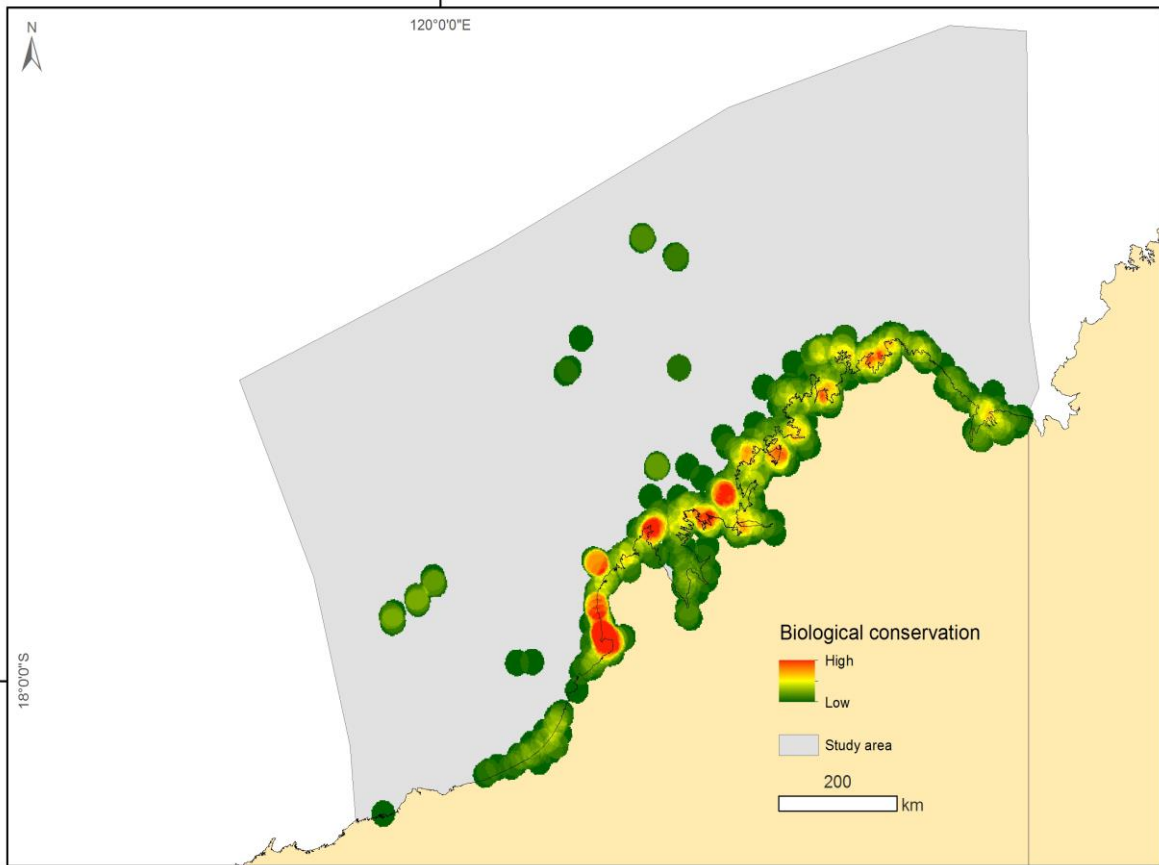


Figure 5. Resident mapping for biological/conservation value (N=60)

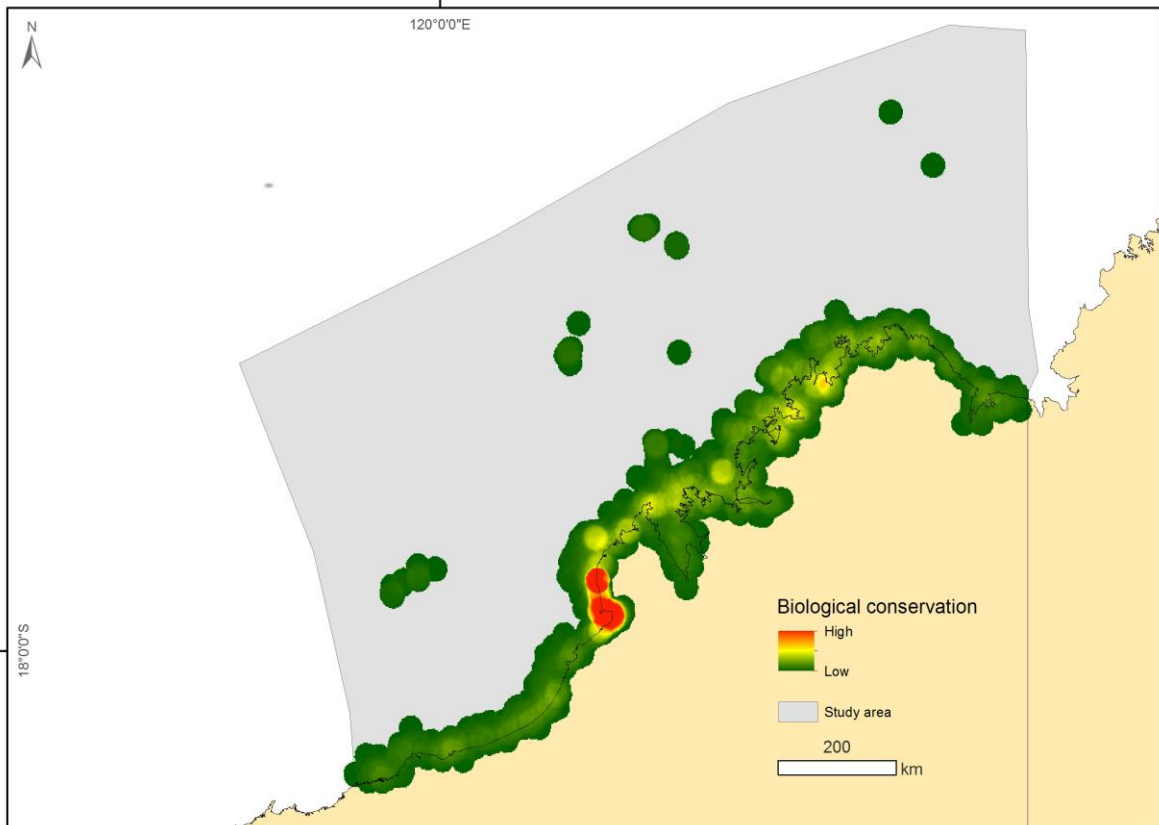


Figure 6. Non-resident mapping for biological/conservation value (N=169)

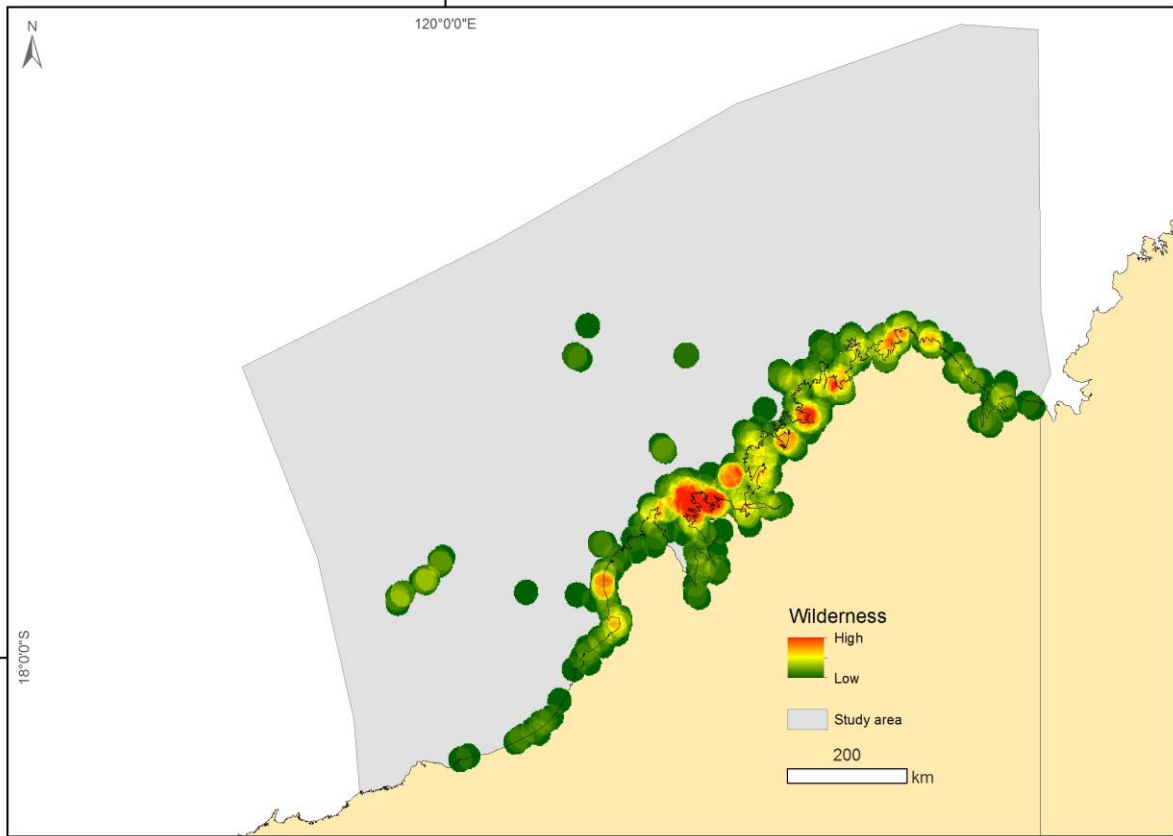


Figure 7. Resident mapping for wilderness/pristine value (N=65)

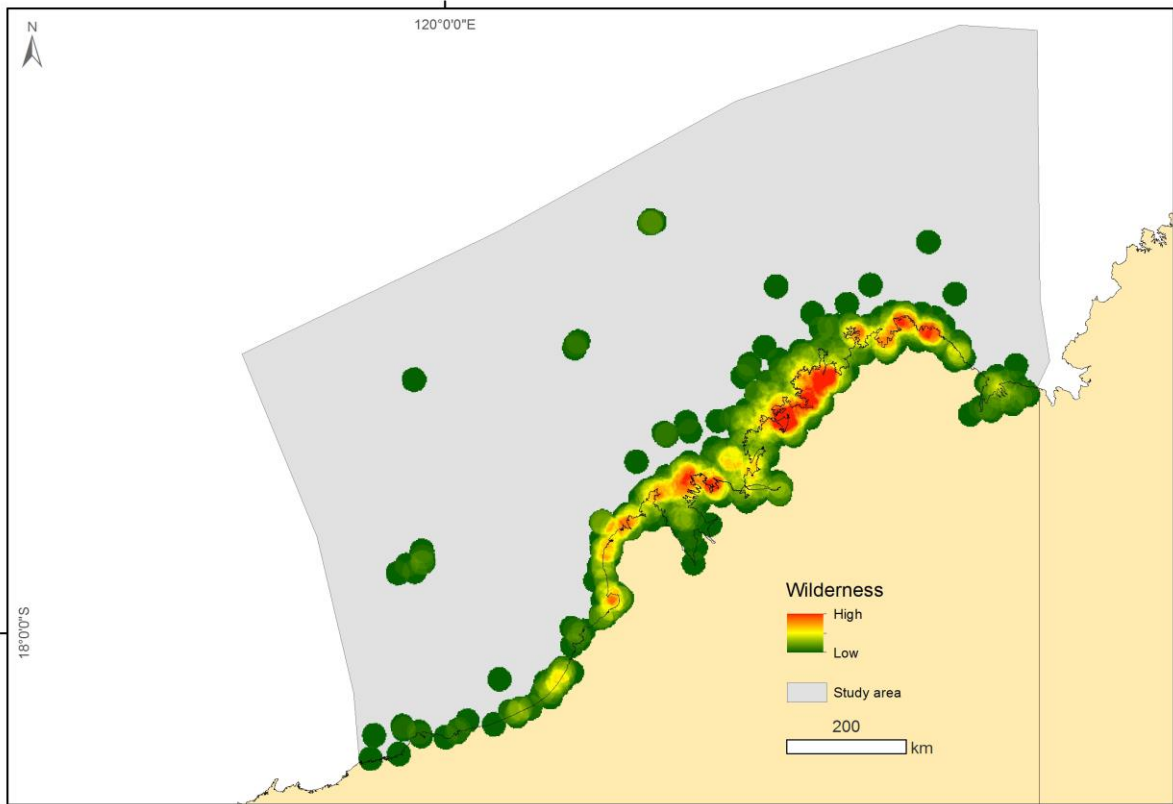


Figure 8. Non-resident mapping for wilderness/pristine value (N=169)

These comparative figures illustrate point density results for those values for which a statistically significant difference in mapping exists (Figures 1-8). For recreational (non-fishing) value, both residents and non-residents mapped recreational value across the study area. Both groups evidenced high density hotspots around Broome/Roebuck Bay and the northern Dampier Peninsula. Non-residents also displayed a hotspot around Derby, and had a much greater incidence of medium-density hotspots spread along the coastline, particularly to the north, in comparison to residents (Figures 1 & 2).

Mapping by residents for recreational fishing value provided a smaller number of hotspots than evidenced for non-residents. For residents, seven distinct hotspots were evident along the coast: Bidadanga/Port Smith, Roebuck Bay, Broome, northern Dampier Peninsula, Buccaneer Archipelago, and Derby/King Sound, with one in the northern Kimberley (Figure 3). Non-resident mapping in contrast displayed nine hotspots, with three located in the northern Kimberley (Figure 4). Figures 5 and 6 compare mapping for biological/conservation value. Residents mapped a greater number of hotspots (nine) than non-residents (two hotspots). Despite this, non-residents were statistically more likely to map biological/conservation values than residents. Resident hotspots were distributed along the coastline with a number located in central and northern coastline areas, while non-resident hotspots were located in the southern region around Broome and Roebuck Bay, and the southern Dampier Peninsula. Wilderness values were widespread along the coastline (Figures 7 & 8), with both resident and non-resident mapping displaying a number of hotspots, although these hotspots were more intense in the northern Kimberley for non-residents than residents. Again, non-residents were statistically more likely to map wilderness values than were residents.

Resident versus non-resident mapping: management preferences

Chi-squared analyses of significance were similarly used to analyse differences in the mapping of management preferences between Kimberley residents and non-residents (see Technical Report 2 for further details of statistical analyses). Table 4 highlights those management preferences for which a statistically significant difference in mapping propensity (likelihood of mapping a particular marker) was evident. Residents were more likely to map markers relating to adding recreational facilities, new port development as well as ‘other’ preferences. Non-residents did not display a propensity to map any given preference more than others.

Table 4. Management preferences with statistically significant differences in propensity to map (likelihood of mapping a particular marker). p-values associated with the Chi-squared analyses are indicated in brackets.

Stakeholder	Management preference
Resident	Add recreation facilities (0.012) New port development (0.000) Other (0.008)
Non-resident	

Point density maps for the three preference categories evidencing statistically significant differences in propensity to map – add recreation facilities, new port development and other – are given below.

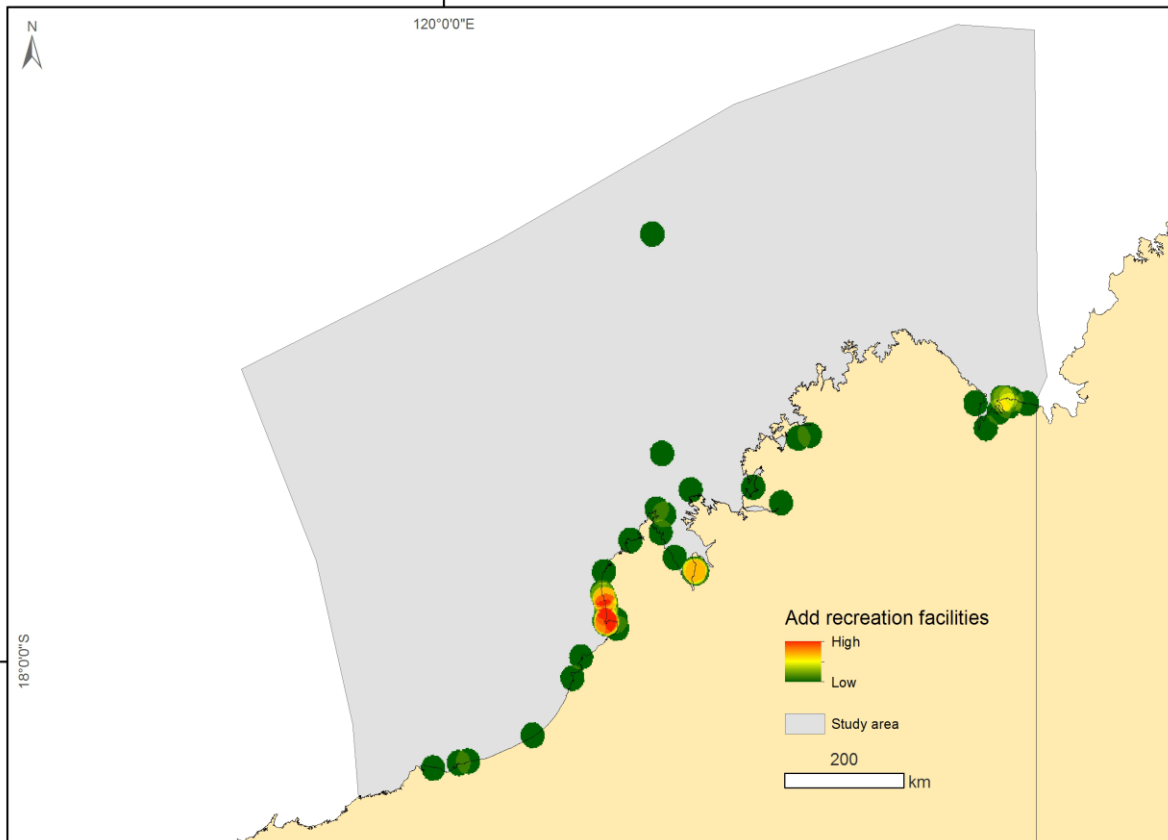


Figure 9. Resident mapping for 'add recreation facilities' preference (N=31)

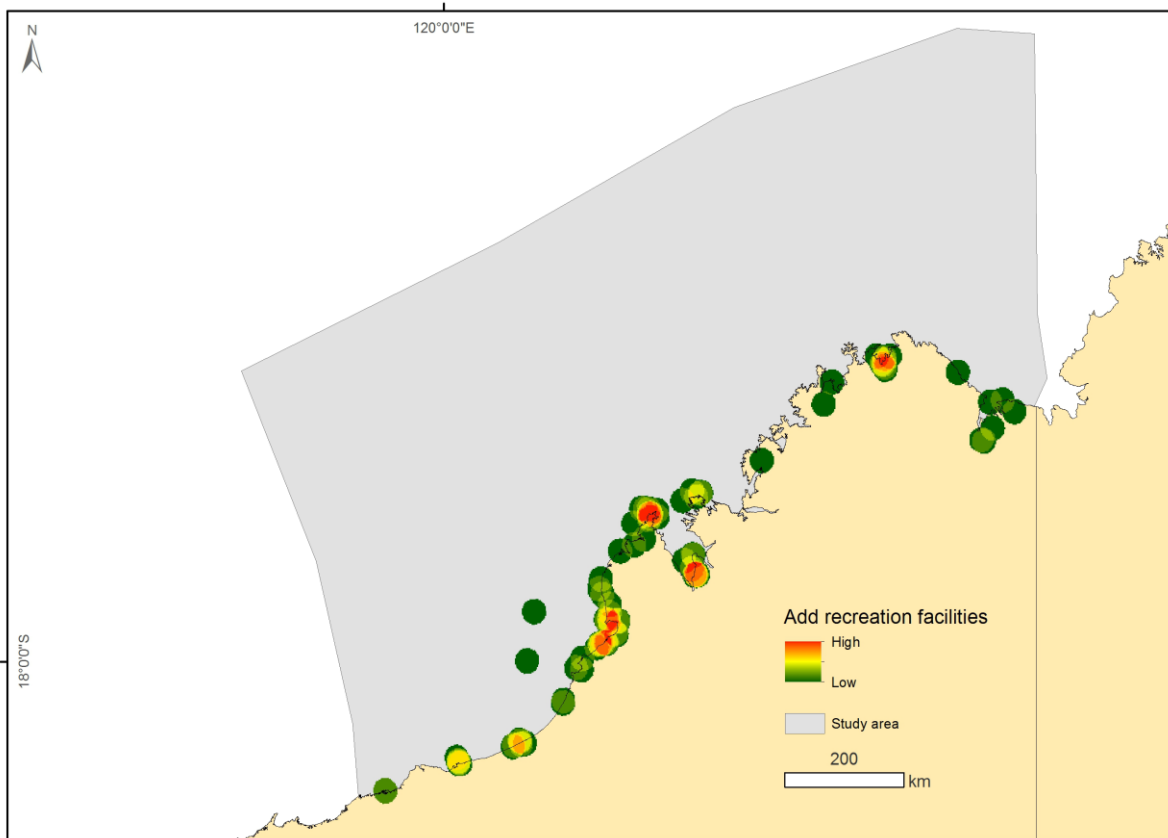


Figure 10. Non-resident mapping for 'add recreation facilities' preference (N=39)

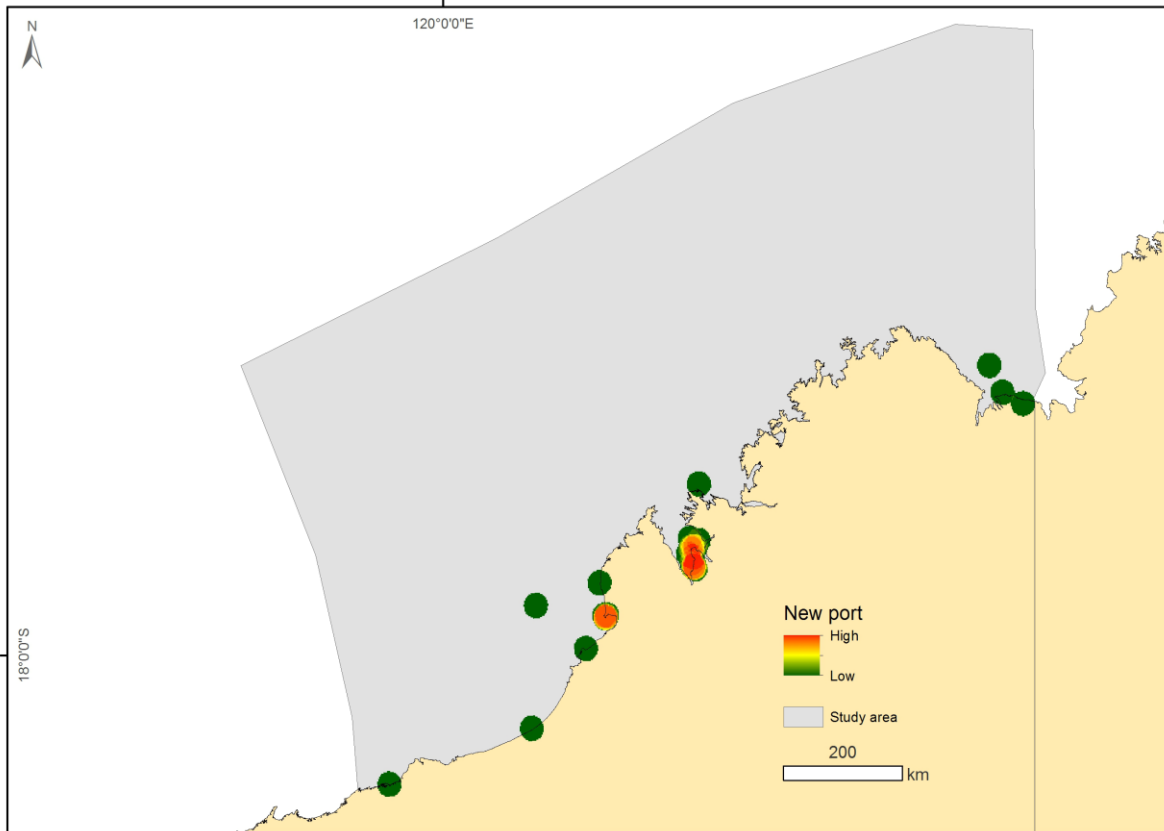


Figure 11. Resident mapping for 'new port development' preference (N=30)

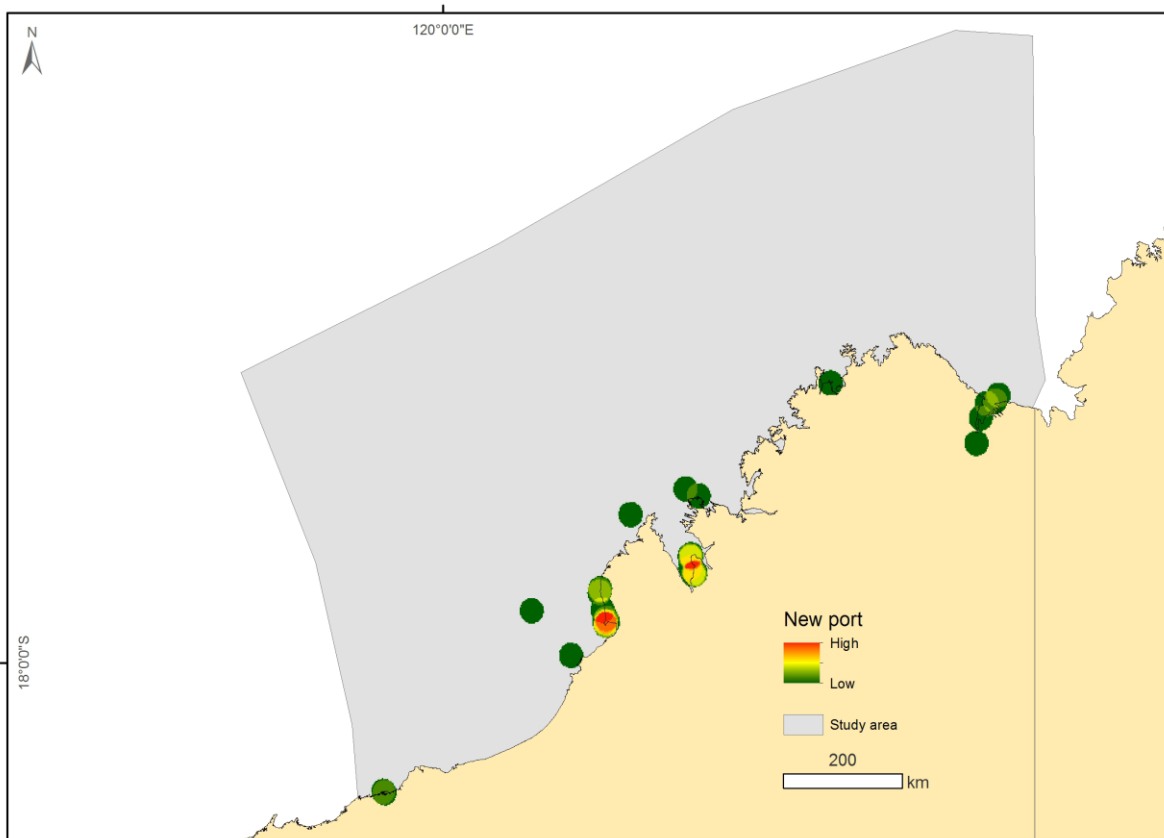


Figure 12. Non-resident mapping for 'new port development' preference (N=23)

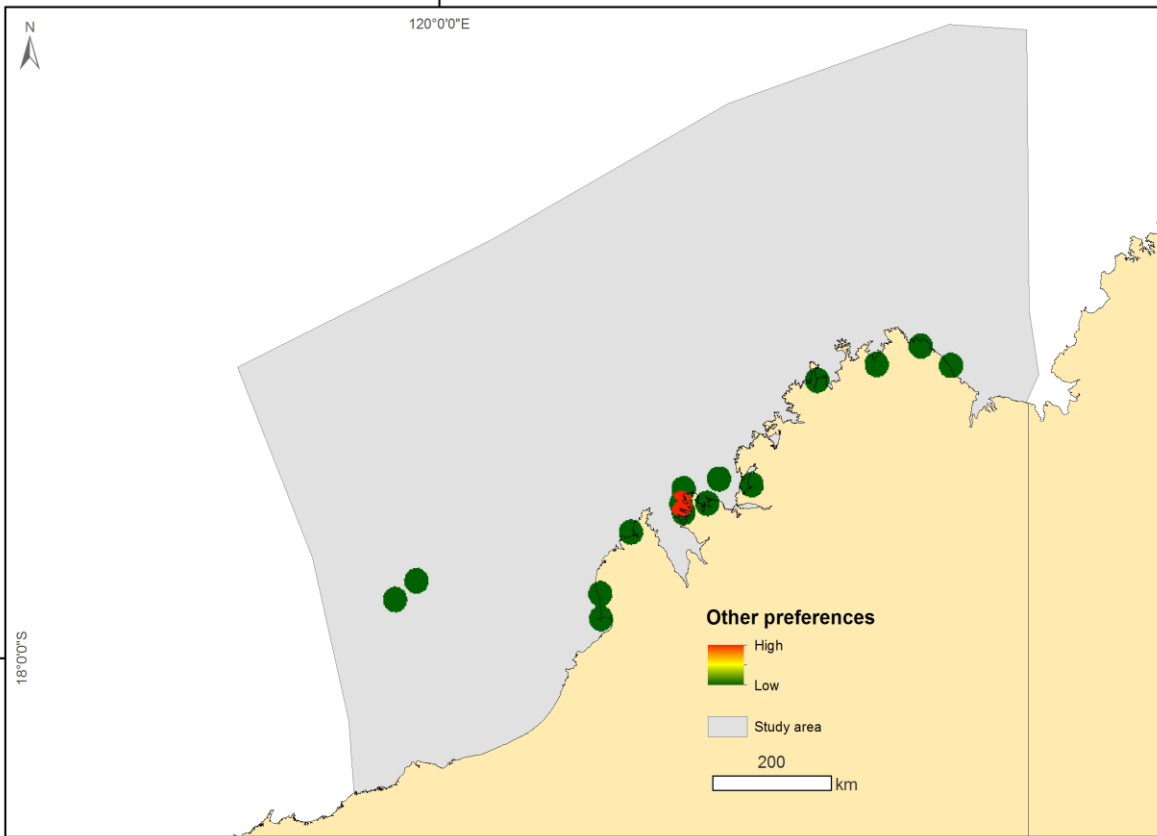


Figure 13. Resident mapping for 'other' preference (N=9)

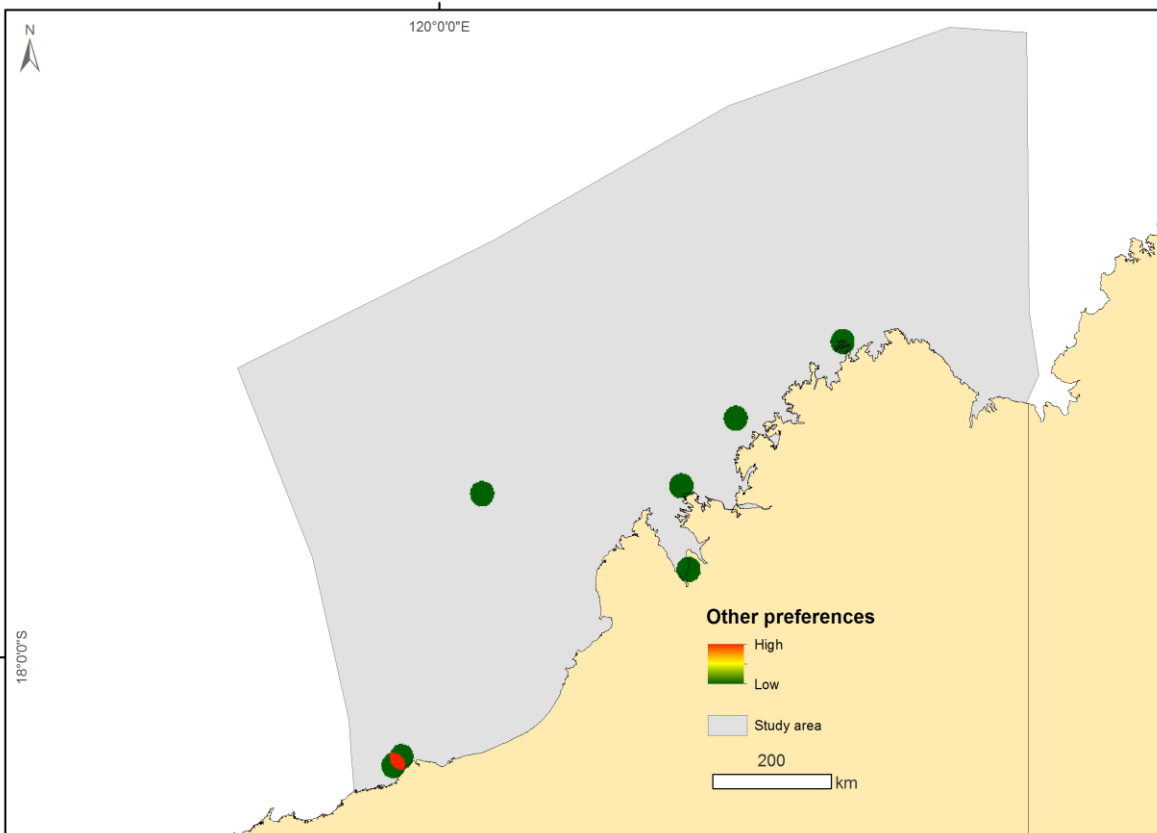


Figure 14. Non-resident mapping for 'other' preference (N=5)

Residents were more likely to map preferences relating to add recreation facilities, new port development and 'other' than were non-residents (Figures 9 – 14). Residents mapped three 'add recreation facilities' hotspots (Broome, southern Dampier Peninsula and Derby) while non-residents mapped six (Eighty Mile Beach, Barn Hill/Eco Beach, Roebuck Bay/Broome, northern Dampier Peninsula, Derby and Kalumburu) (Figures 9 & 10). Broome and the Derby/Point Torment region are hotspots for preferences by both residents and non-residents for new port development (Figures 11 & 12). 'Other' included preferences relating to facilitating access, greater research, supporting biodiversity and maintaining current management regimes. Both resident and non-resident mapping displayed one hotspot each, although their location differed with residents focusing on the Buccaneer Archipelago and non-residents on the Port Hedland area (Figures 13 & 14).

3.2 Comparing PPGIS mapping and choice experiment results

This report compares the values and preferences identified through the PPGIS mapping (Technical Report 2) with the preference structure revealed by the choice experiment (Technical Report 3). This comparison provides a synthesis of existing information as well as new, combined analyses. Both the PPGIS mapping and choice experiment components were informed by the values and management preferences identified through the interviews forming the backbone of the first phase of this research project (Table 5 below and Technical Report 1). The initial emergent value categories informed the choice of the values and management preferences available for mapping in the PPGIS survey as well as the selection of attributes used in the choice experiment. Table 6 provides a description for each attribute from the choice experiment, with further details in Technical Report 3.

Table 5. Corresponding values and preferences across the three social research projects.

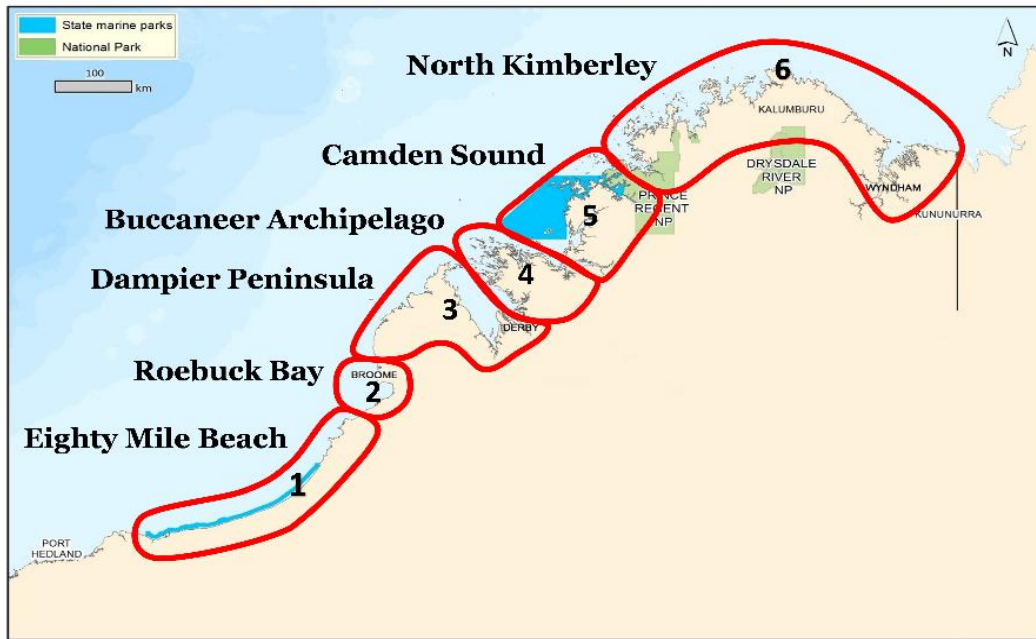
Values and preferences	Emergent values identified from interviews (% of interviews mentioned)		Management preferences identified from interviews		PPGIS Values	PPGIS Management Preferences	Choice Experiment Attributes
	TECHNICAL REPORT 1		TECHNICAL REPORT 1		TECHNICAL REPORT 2	TECHNICAL REPORT 2	TECHNICAL REPORT 3
Indirect use values	Biodiversity (80%)		Conservation/protection Wilderness protection		Biological/conservation	Increase conservation/ protection	Sanctuary areas
Non-use values	Bequest (7%) Existence (4%)				Intrinsic/existence		
Direct use, non-consumptive values	Physical landscape (77%) Therapeutic (62%) Social interaction and memories (56%) Recreation–other (62%) Learning and research (34%) Experiential (51%) Historical (19%) Spiritual (11%)				Scenic/aesthetic Wilderness/pristine areas Therapeutic/health Learning/education/research European heritage Spiritual		
	Aboriginal culture (63%)		Aboriginal futures (inc. self-management, ranger teams, living on country, tourism ventures)		Aboriginal culture/heritage	Increase Aboriginal management	Aboriginal rangers
Direct use, consumptive values	Recreation–camping (58%) Recreation–fishing (54%) Subsistence (44%)		Good fisheries management Improved visitor management systems		Recreation Fishing (recreational)	Add recreation facilities	Recreation facilities
	Economic Development	Commercial fishing, pearling and aquaculture (24%)		Fisheries management Industrial economic development	Economic (non-tourism)	Oil/gas development No oil/gas development New port development No new port development Improve/increase access Restrict/limit access Commercial fishing/aquaculture No commercial fishing/aquaculture	Coastal development
		Tourism (36%)		Low-key tourism development		Nature-based tourism	Add tourism services and development
					Special places	Other	

Table 6. Attributes used in Choice Experiment.

Attributes	Description	Attribute levels shown to respondents
Sanctuary area	Percentage of additional area of State waters managed as 'no-take' sanctuary area for biological conservation	0%, 15%, 30%, 40%
Recreation	Overall improvement to average recreation facilities levels: Low (NATURAL) - Difficult 4WD access track with no boating or camping facilities provided Medium (RECREATION) - Seasonal 2WD access with designated camping and parking areas, basic toilets, tables, basic visitor formation and signage. Boating facilities include small moorings or a small boat ramp High (HIGHLY MODIFIED) - Sealed road access with high level of camping and parking facilities, toilets, gas BBQ's, extensive visitor information. Boating facilities include large boat ramp or a jetty	Low, Medium, High
Aboriginal rangers	Number of additional Aboriginal rangers in the zone	0, 5, 10, 30
Coastal development	Small scale coastal development would occur in the zone that means you would see it every day if you were travelling through the zone	Yes (1), NO (0)
Cost	Annual household cost (\$)	\$10, \$50, \$75, \$100, \$150, \$200

3.2.1 Choice experiment zones

To enable the choice experiment to be spatially explicit, the Kimberley coastline was divided into six hypothetical management zones (Figure 15). These six zones were chosen in consultation with senior managers at the West Australian Department of Parks and Wildlife and other key stakeholders. The six 'choice' zones broadly reflect major features of the physical landscape, marine park areas and commonly understood regions of the Kimberley. Importantly, no current or proposed marine parks cross these zone boundaries. These zones are not used in management or planning, but were identified for this research project as a practical and logical way to divide the Kimberley into discrete regions for analytical purposes. The zones are applied in the choice experiment only and were not shown when respondents conducted the PPGIS mapping.



Map source: Geoscience Australia 2014, Department of Parks and Wildlife 2014

Figure 15. Map of the Kimberley coast study area showing the six hypothetical management zones used in the choice experiment.

In this report, the six zones that framed the choice experiment questions provide the basis for spatial comparisons between the PPGIS and choice experiment results. For this spatial comparison, point density maps are used to show areas where a greater relative number of markers were placed, showing the relative intensity of values and management preferences. Technical report 2 has more detail on this method. The following analysis relies on overlaying PPGIS point density maps with the choice experiment zones (*cf.* Figure 16).

Before presenting the combined results, an overview of the spatial trends across the entire study region is provided, based on analysis of the results from the two study methods. Following this, each of the four choice experiment attributes (Table 6: sanctuary area, recreation, Aboriginal rangers and coastal development) is compared with their corresponding PPGIS value and preferences. One of the attributes included in the choice experiment was a ‘personal cost to the respondent’, which is used to calculate respondents’ marginal willingness-to-pay for the choice attributes. Since this is not a specific characteristic of values or preferences for the Kimberley coast, there is no comparison for the cost attribute in the sections below.

3.2.2 Spatial trends across the study region

Two assumptions underpin the results discussed below. Firstly, we assume that the zone-specific constants used in the choice experiment model (see Technical Report 3, Section 3.4) give some indication of the spatial order of preference for management. Secondly we assume that, during the PPGIS mapping, respondents placed more markers in zones that held greater value for them, and placed more management preference markers according to the same rationale (*i.e.* the number of markers placed provides an indication of the extent of respondent’s values and preferences, such that a greater number of markers placed signified that respondents cared more about that zone).

The PPGIS and CE results show that the entire Kimberley coast is valued and/or associated with some form of management preference. Areas of higher value and preference density were evident in the PPGIS mapping, centred on the choice experiment zones of Roebuck Bay, Dampier Peninsula and Buccaneer Archipelago (Figures 16 and 17). The choice experiment results, however, revealed that people had, on average, an

increasing preference for management occurring in the northern zones compared to the southern zones^[1] (Figure 17).

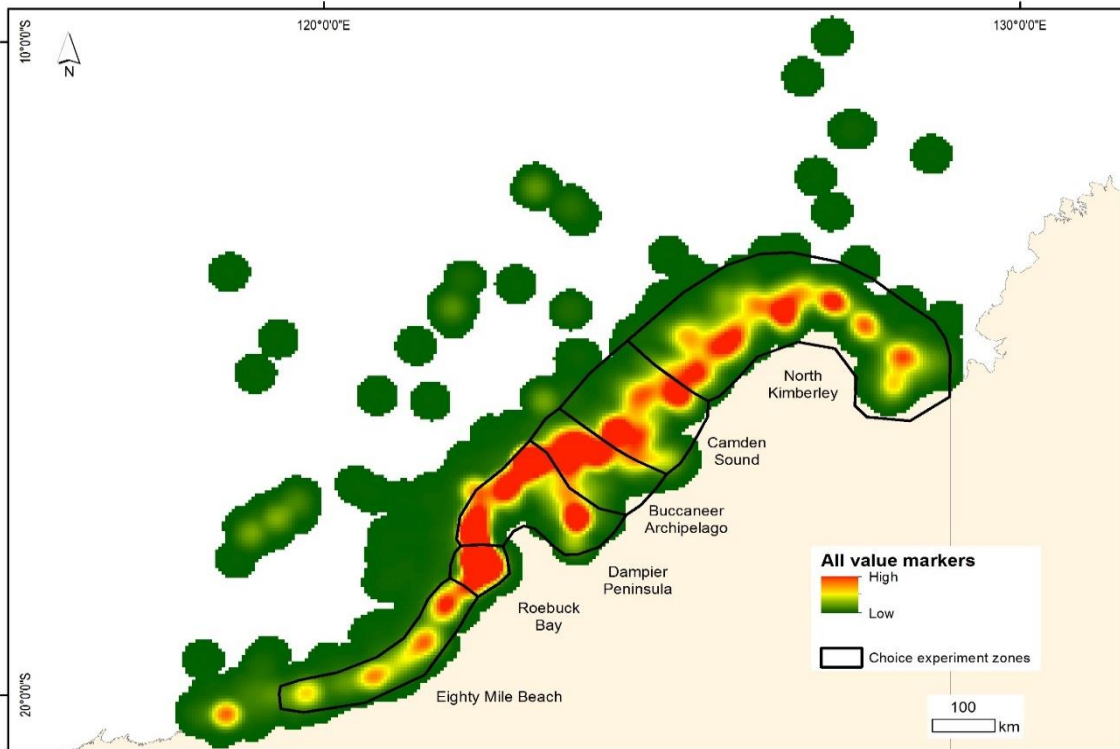


Figure 16. All PPGIS value markers mapped within the study area with choice experiment zones overlaid (n=13,756).

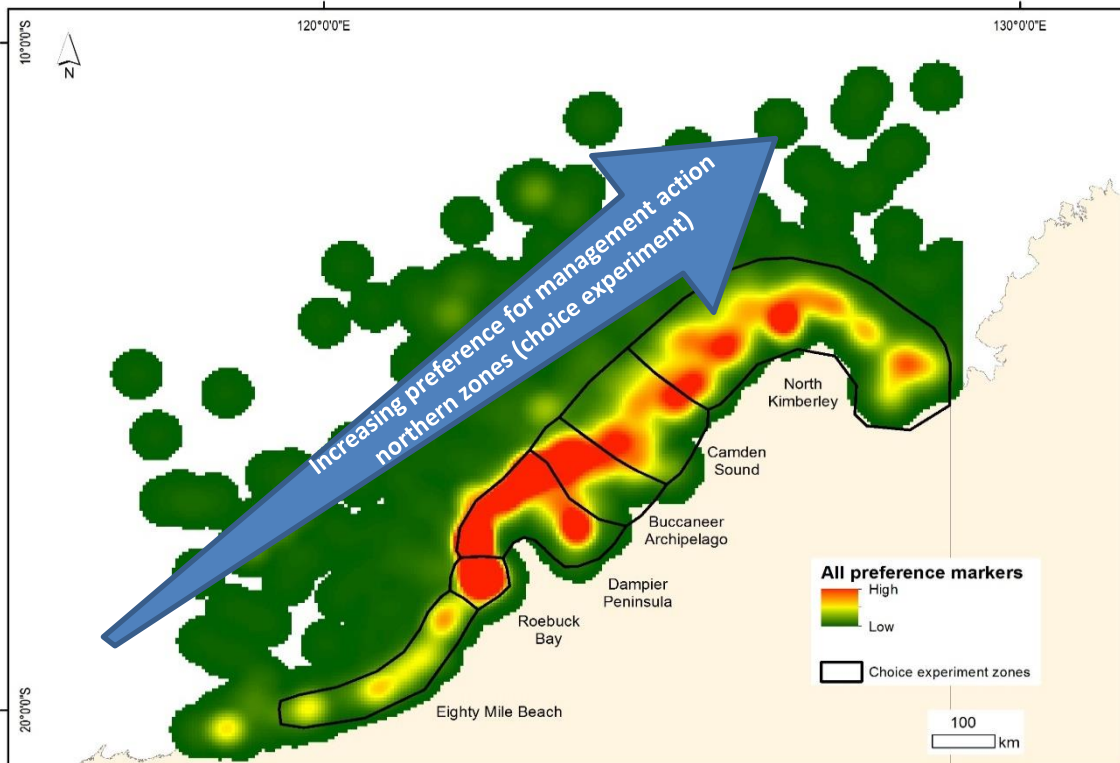


Figure 17. All PPGIS management preference markers mapped within the study area with choice experiment zones and indicative choice experiment results overlaid (n=5,376).

^[1] As indicated by the zone-specific constants in the logit models (see Spencer-Cotton et al. (2016) – Tables 20-23)

Two key observations arise from the combined analysis of the results from the two components. First are important geographic similarities in the results obtained from the PPGIS and choice experiment. That is, Eighty Mile Beach is revealed as a lesser focus of attention than other zones in both the PPGIS and choice experiment results. It has fewer values and preferences hotspots and a lower level of interest in CE management outcomes. This result may in large part be attributed to Eighty Mile being regarded by many people as ‘not really part of the Kimberley’ and therefore not afforded the values held in peoples’ minds and hearts regarding the Kimberley ‘proper’. Similar complementary results are evident for the North Kimberley zone, where the PPGIS shows this zone as highly valued as do the choice experiment results for this zone. These high levels of interest are expressed despite the North Kimberley being relatively remote.

Second, a geographic difference in the spatial trends across the study region is evident through comparing the PPGIS and choice experiment results, with this difference centred on Roebuck Bay and the Dampier Peninsula. Roebuck Bay was the most densely mapped zone and Dampier Peninsula the second most densely mapped (Figure 18). In contrast, the choice experiment indicated a greater intensity of preferences for management outcomes in the zones to the north: Buccaneer Archipelago, Camden Sound and North Kimberley. Although the North Kimberley zone had the highest percentage of markers placed in any zone in the PPGIS it also has at least twice the area of any other zone (Figures 18 and 19).

The difference in results from the two methods may be attributable to different underpinning assumptions, with the PPGIS ‘allowing’ intense mapping efforts in the places respondents are most familiar with (note the pattern between marker density and visitation rates for the zones in Figure 18 and 19), or that they value highly. The choice experiment results, on the other hand, are revealing intensity of values across the region as a whole, which may not be strictly linked to the number of places mapped. Both results are useful. Decision makers need to know where the most valued places are in a region. They also need the guidance provided by choice experiments regarding how to decide on the allocation of scarce management resources, and make sensible, societally-acceptable trade-offs between management outcomes across a large region such as the Kimberley coastline.

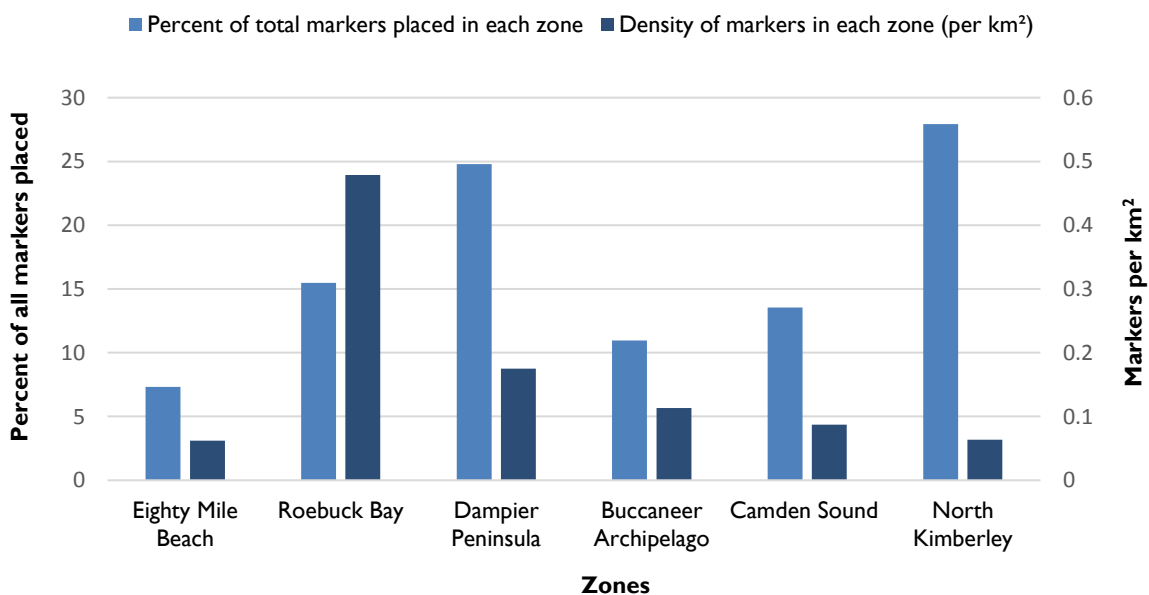


Figure 18. Percent of all (combined) value and preference markers mapped in each zone (left axis) and the density of markers in each zone (right axis) (n=18,443).

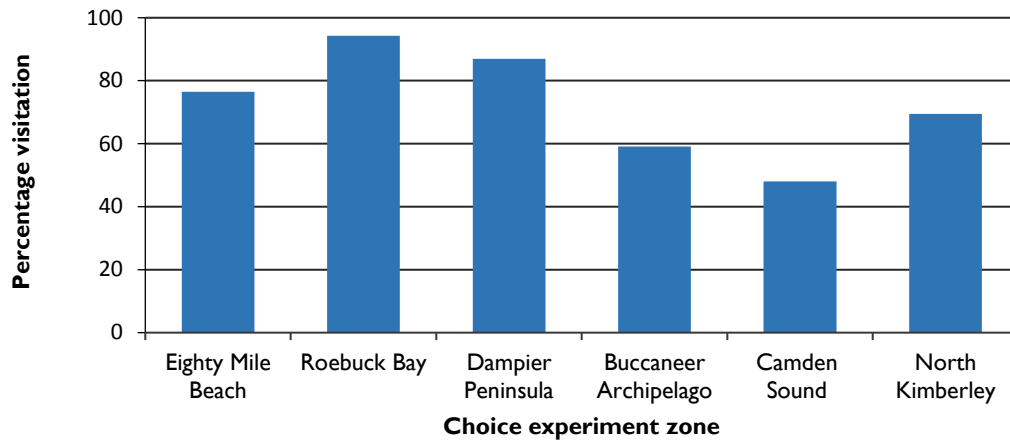


Figure 19. Percent of people that have visited each zone by land, sea or air, in their lifetime (n=320).

Management implications: Spatial trends across the study region

1. The PPGIS mapping effort did not necessarily equate with the overall spatial pattern for management preferences from the choice experiment. The management implication from this is that a link to a given place based on visitation or detailed knowledge is not a prerequisite to, or indicator of, a person’s likely interest or potential involvement in planning for that area. This understanding emphasises the need to broadly define and engage with a wide range of stakeholders (both residents and non-residents) for planning and management purposes.
2. Eighty Mile Beach appeared the least valued zone in terms of both number of PPGIS markers placed and preferences for management outcomes. However, the zone has a high level of visitation (Figure 19) and is more accessible than the northern zones of Buccaneer Archipelago, Camden Sound and North Kimberley. These two factors, together with the region’s rich Aboriginal culture and active Aboriginal ranger teams, suggest opportunities to invest in education and interpretation to build stakeholder awareness and appreciation of the zone’s biological and cultural assets. In this respect, Eighty Mile Beach could benefit from potential tourism or conservation product development based on the zone’s rich Aboriginal culture, and pearling and pastoral history. Properly designed and implemented, such offerings would assist in achieving greater stakeholder engagement and in building a support platform for ongoing conservation activities in the region. Local Traditional Owners, Aboriginal ranger teams, tourism operators and the Department of Parks and Wildlife are best placed to develop and implement these products.

3.3 Attribute-specific comparisons

The following section provides a series of comparisons between the results of the two methodologies, with comparison facilitated by overlaying PPGIS point density maps with the choice experiment zones (*cf.* Figure 15). The resulting figures provide a graphical illustration for general analytical purposes. The section is ordered according to the four choice experiment attributes used in the research: sanctuary zones, Aboriginal rangers, recreation, and coastal development. Each attribute is compared with their corresponding PPGIS value and/or preference (see Table 5). Information on ‘personal cost to the respondent’ was included in the choice experiment, with this information used to calculate respondents’ marginal willingness-to-pay for management relating to sanctuary zones, Aboriginal rangers, recreation, and coastal development. These willingness to pay data are included where relevant. Management implications relevant to each attribute/value and preference comparison are outlined within each subsection.

3.3.1 Value and preference markers

Prior to undertaking the comparison between PPGIS and choice experiment results, it is useful to provide an overview of the relative number of value and preference markers mapped by PPGIS respondents. Figure 20 depicts the count of value markers. Values relating to biological/conservation, scenic/aesthetic, recreational fishing, Aboriginal culture, wilderness, nature-based tourism and recreation were the most commonly mapped value types.

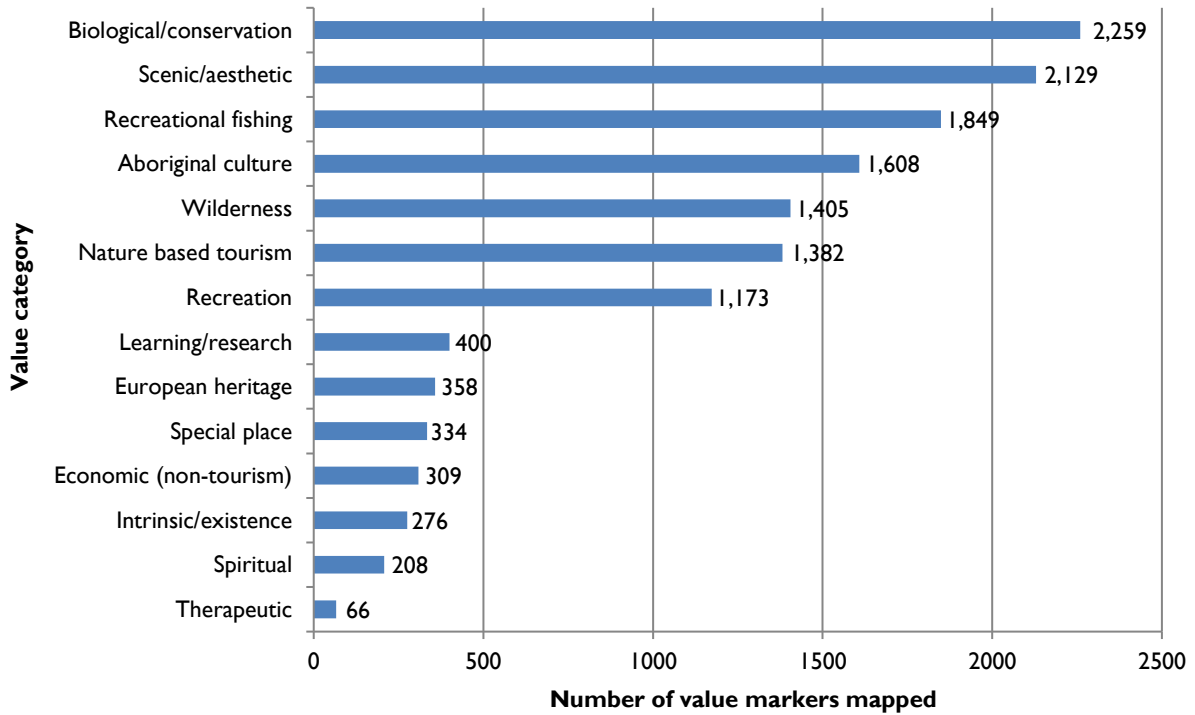


Figure 20. Count of value markers mapped in the PPGIS (n=13,756).

Figure 21 depicts the relative count of management preference markers placed by PPGIS respondents. ‘Pro-conservation’ preferences including increase conservation, no oil/gas development, no commercial fishing and increase Aboriginal management dominated. ‘Pro-development’ preferences were far less numerous. This grouping include preferences such as new port, oil/gas development, commercial fishing and add recreational facilities.

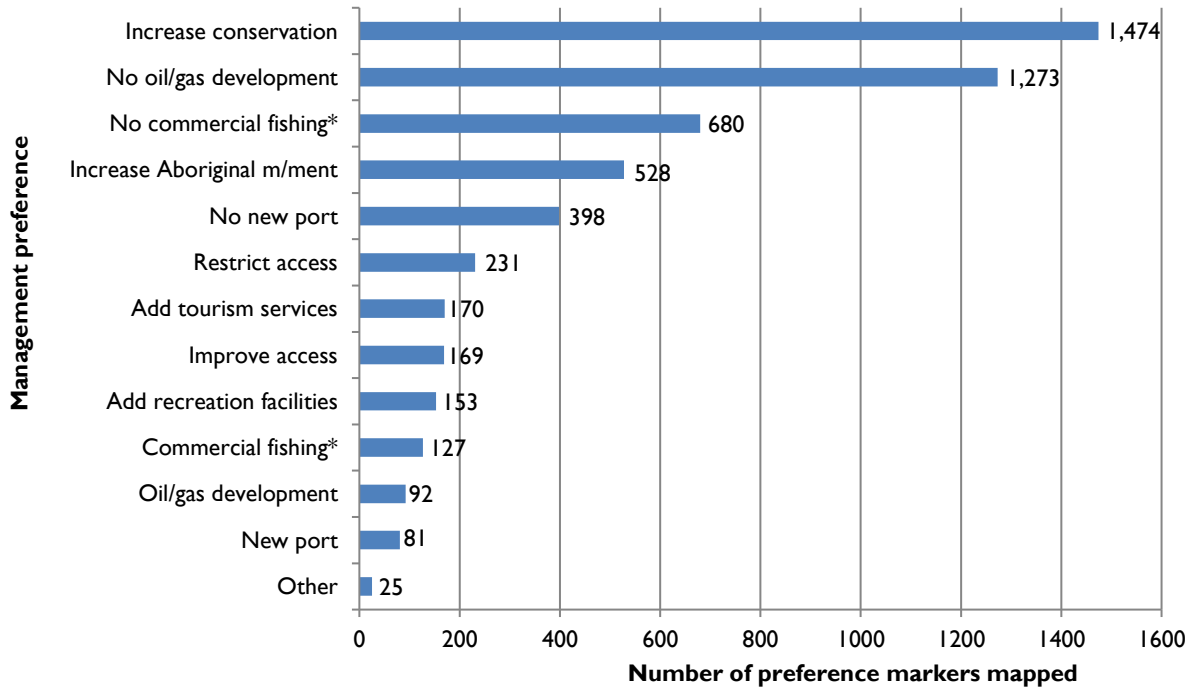


Figure 21. Count of management preferences mapped in the PPGIS (n=5,376).

* Includes aquaculture

3.3.2 Choice experiment attribute: Sanctuary zones

The first attribute explored relates to sanctuary zones. Choice experiment respondents were asked to consider the additional area of State waters they wished to be managed as a ‘no-take’ sanctuary area for the purposes of biological conservation (Table 6). This attribute corresponded to the PPGIS value ‘biological/conservation’ and the PPGIS management preference to ‘increase conservation/protection’ (cf. Table 5).

Choice experiment results revealed that respondents held a positive willingness to pay for increases in the area of sanctuary zones throughout the study region (Figure 23). There was no spatial differentiation in preferences between the zones. The corresponding PPGIS value and preference markers (‘biological/conservation’ and ‘increase conservation/protection’) were the most frequently mapped markers for their respective value and preference categories (Figures 20 & 21). Together, markers relating to ‘biological/conservation’ value and ‘increase conservation’ preferences account for over 20% of all markers mapped during the PPGIS study.

Overall, both choice experiment and PPGIS results reveal that respondents hold positive values for marine and coastal protection and conservation along the whole Kimberley Coast (Figures 22 & 23). Whereas the choice experiment results revealed no variation in preferences for sanctuary areas between the zones, PPGIS results indicate clear spatial clustering of values and preferences. Although the entire coastline is valued, Figure 8 highlights biological/conservation value hotspots centred on Roebuck Bay and to a lesser extent, Dampier Peninsula. Figure 9 similarly depicts ‘increase conservation’ hotspots within Roebuck Bay and Dampier Peninsula, with the latter zone evidencing two hotspots.

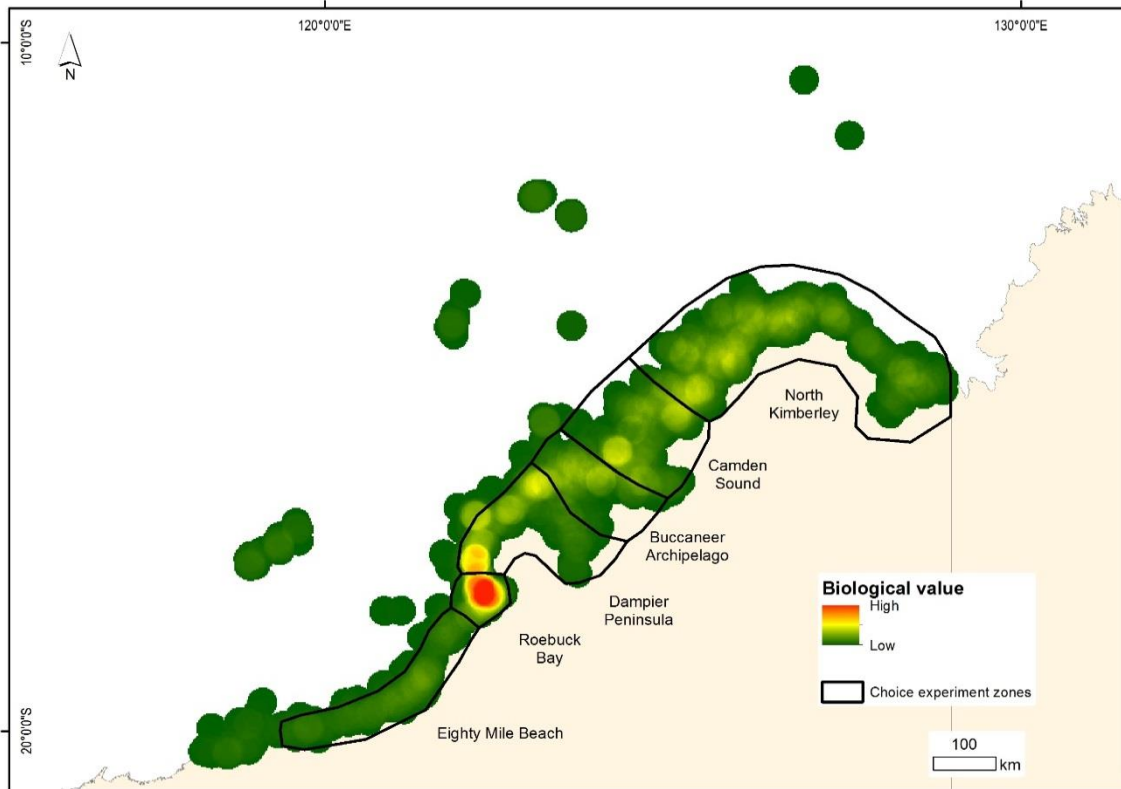


Figure 22. PPGIS point density map for biological/conservation values (n=2,259).

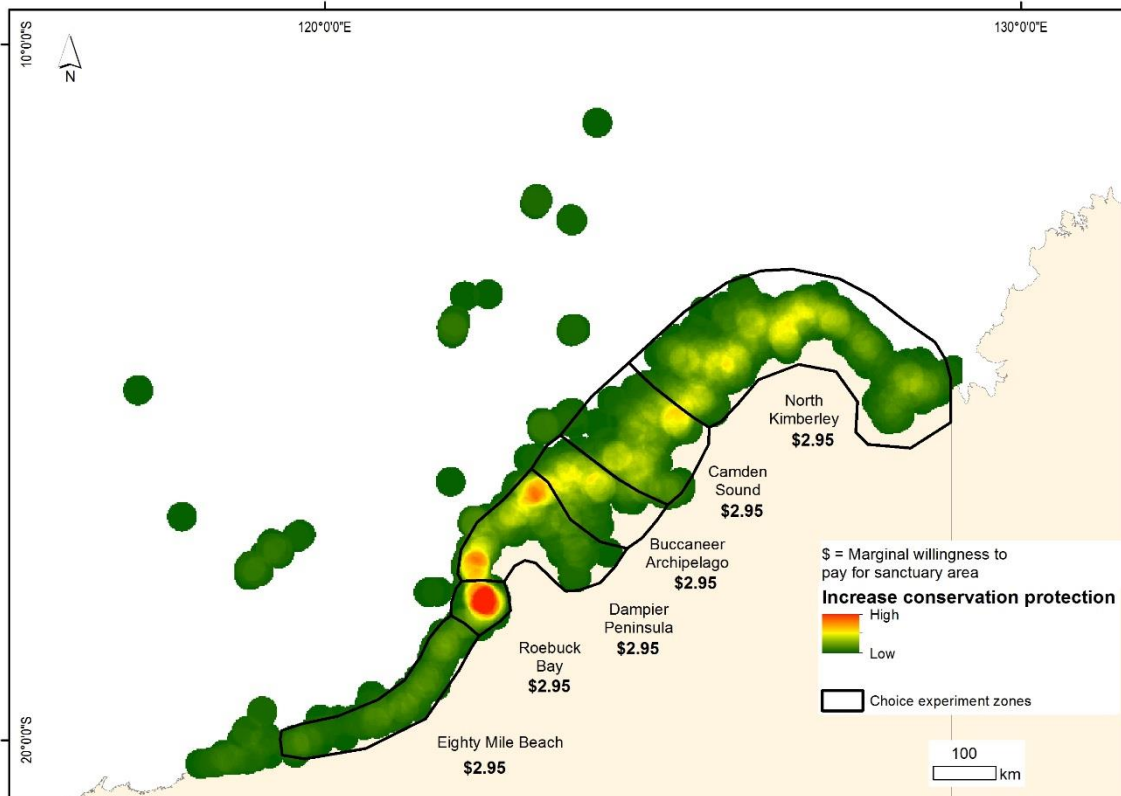


Figure 23. PPGIS point density map for 'Increase conservation/protection' management preference (n=1,474) and the marginal willingness to pay per year estimated from the choice experiment for a 1% point increase in the percentage of State waters in sanctuary area in that zone ($\$ \cdot \%^{-1} \cdot \text{yr}^{-1}$).

Management implications: Sanctuary zones

1. Choice experiment results indicate that sanctuary zones are valued equally across the study area (Figure 23). Thus, it is important for planners and managers to implement sanctuary zones within marine protected areas across the entire study region (it is possible to conduct future additional analysis on the differences in preferences according to stakeholder groups). Additionally, the choice experiment results showed a generally higher preference for management actions in general in the northern regions (Figure 17). This means that a policy package proposing sanctuary area in the North Kimberley might be higher valued than the same sanctuary area in the Roebuck Bay or Broome area, *all else being equal*. Importantly, these results recognise that more areas under a sanctuary designation is a preference for all zones.
2. The high conservation values evident for Roebuck Bay and Dampier Peninsula suggest future attention to the designation of some form of conservation protection. For the Dampier Peninsula, held largely under Native Title and not subject to Department of Parks and Wildlife management, this presents an opportunity for Traditional Owners to pursue formal conservation protection through the designation of an Indigenous Protected Area(s) over important land and sea country.

3.3.3 Choice experiment attribute: Recreation

Respondents in the choice experiment were given options for the development of recreation facilities to a low, medium or high level (*cf.* Table 6). Respondents were given a choice between staying at the current level of recreational facilities, or choose a new, higher level of facilities. Respondents were generally indifferent to improving recreation facilities from a low level to a medium level. However, respondents who nominated themselves as having good-excellent knowledge of the Kimberley coast were averse to this change, i.e., they had a negative willingness to pay for improving recreational facilities to a medium level. Notably, all respondents revealed a negative willingness to pay to improve recreation facilities to a high level in zones north of Roebuck Bay (Figure 25). That is, respondents did not want to see high levels of recreational development in the northern Kimberley coastal areas. Respondents were indifferent to high levels of recreational development in the Eighty Mile Beach and Roebuck Bay zones, with willingness to pay data not significantly different from a zero value (Figure 25).

Mapping of 'recreation' value from the PPGIS survey, while spread along the entire coastline, was concentrated in the Roebuck Bay zone, with a further hotspot evident in the Dampier Peninsula zone to the north (Figure 24). The PPGIS preference to 'add recreational facilities' received only a small number of markers (Figures 17 & 25).

Results from both the PPGIS and choice experiment methods illustrate that respondent's value recreation along the Kimberley coastline. However, these values for recreation do not necessarily translate into a preference for more, or improved, recreational facilities. This was particularly evident in the choice experiment where respondents actually displayed an aversion to higher levels of recreation facilities, particularly in the more northern zones. The Dampier Peninsula provides a particular challenge to interpret the data from the two research methods: the place-based management preference markers from the PPGIS show a place-driven interest in adding recreation facilities in this zone while the more regional perspective provided by the choice experiment suggesting an aversion to moving to high levels of facilities. These combined results could be interpreted as some preference to move from the current generally low level of facilities across the Peninsula to medium levels of recreational facilities at certain sites, but an aversion to moving to high levels of recreational facilities in the region.

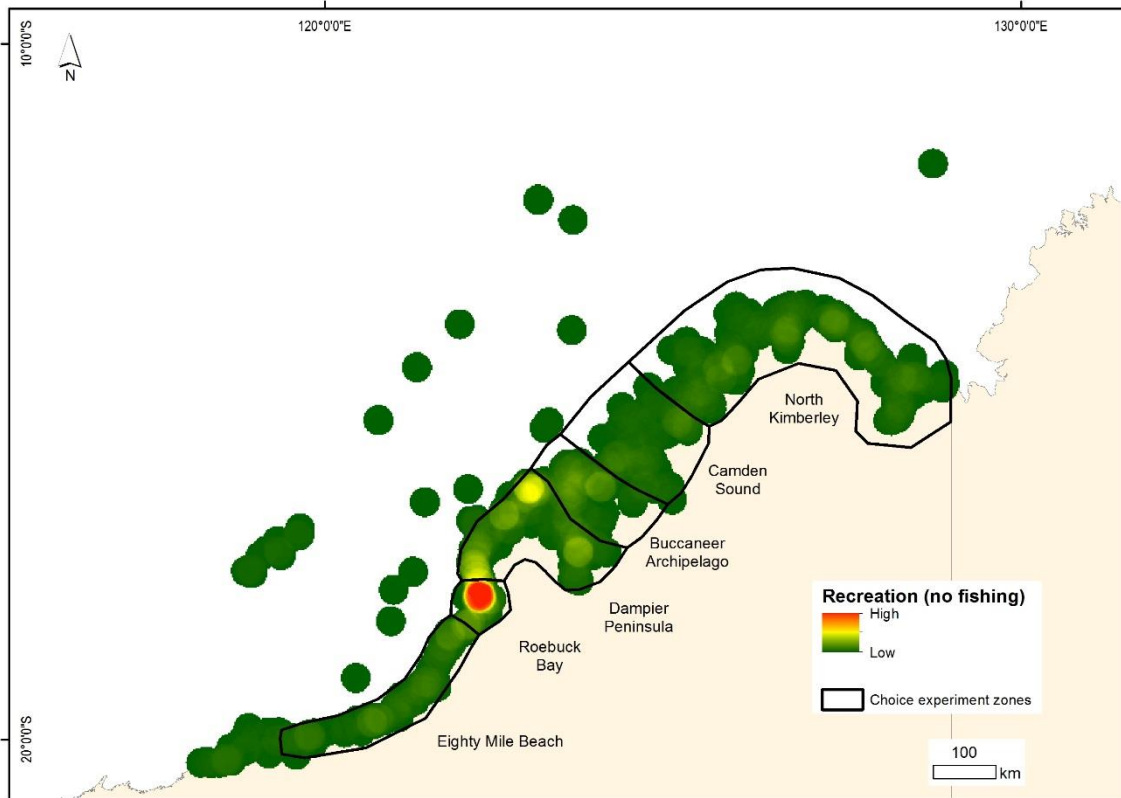


Figure 24. PPGIS point density map for recreation (non-fishing) values (n=1,173).

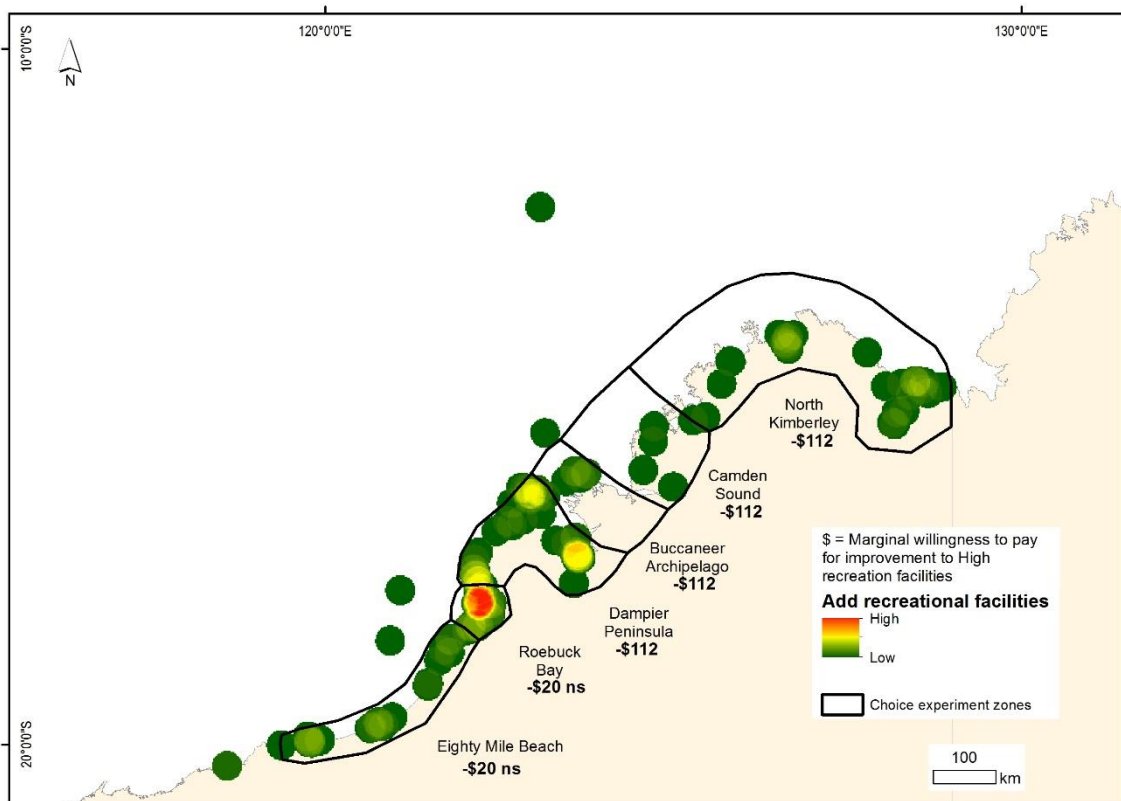


Figure 25. PPGIS point density map for 'Add recreation facilities' management preference (n=153) and the marginal annual willingness to pay estimated from the choice experiment for an improvement to High recreational facilities in that zone ($\$.yr^{-1}$) (ns= not significantly different from zero).

Management implications: Recreation

1. The PPGIS mapping shows that recreation is widely valued, however, an interest in adding facilities is limited to Roebuck Bay, and the northern and western Dampier Peninsula. This finding is generally supported by the choice experiment findings that suggest, on average, people are indifferent to recreation improvements to high levels in the southern zones and do not want such improvements to facilities in the northern zones. For planners and managers, this means careful consideration and discussion with stakeholders of the effects of any proposed developments on the experiences visitors and residents have and want at the sites of interest, and the effect of any proposed changes on these experiences.
2. The Dampier Peninsula zone has provided a challenging set of results with indications of enthusiasm for improved facilities (from the PPGIS) and a general aversion to increasing the level of recreational development to high. At the moment the Peninsula varies between low and medium facilities, so the concerns raised by the choice experiment are an issue for future policy makers and planners.

3.3.4 Choice experiment attribute: Aboriginal rangers

The third choice experiment attribute concerned Aboriginal rangers, defined as the number of additional Aboriginal rangers working on country that respondents wished to see in a given zone (*cf.* Table 6). This attribute corresponded to the value category 'Aboriginal culture and heritage' and management preference 'increase Aboriginal management' (*cf.* Table 5).

The choice experiment revealed a positive willingness to pay for increasing the number of Aboriginal rangers across the study area (Figure 27). There was no differentiation in the marginal willingness to pay for additional rangers between the six zones. PPGIS results depict almost the entire coastline as holding Aboriginal culture and heritage value and preferences for increased Aboriginal management (Figures 26 and 27). The PPGIS results add nuance to the choice experiment findings by indicating hotspots for Aboriginal culture and heritage value within the Dampier Peninsula zone as well as Roebuck Bay, and North Kimberley to a lesser extent. 'Increase Aboriginal management' management preference hotspots were similarly evident in these three zones.

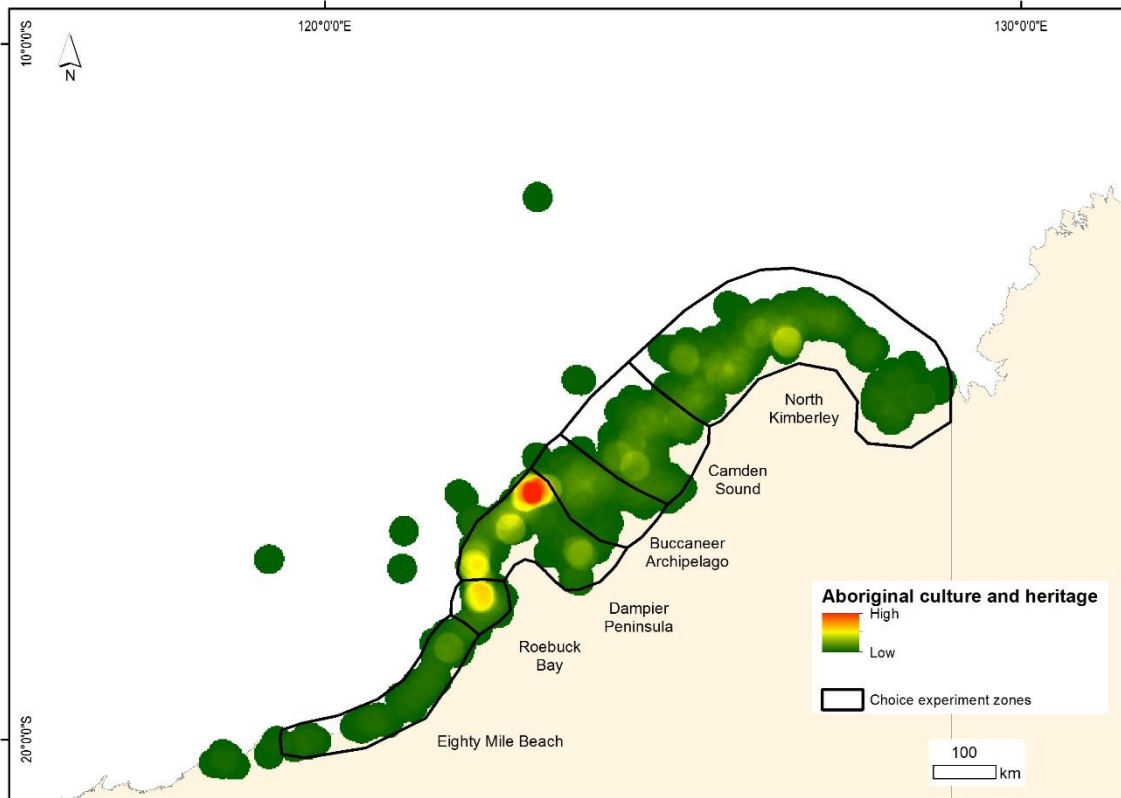


Figure 26. PPGIS point density map for Aboriginal culture and heritage values (n=1,608).

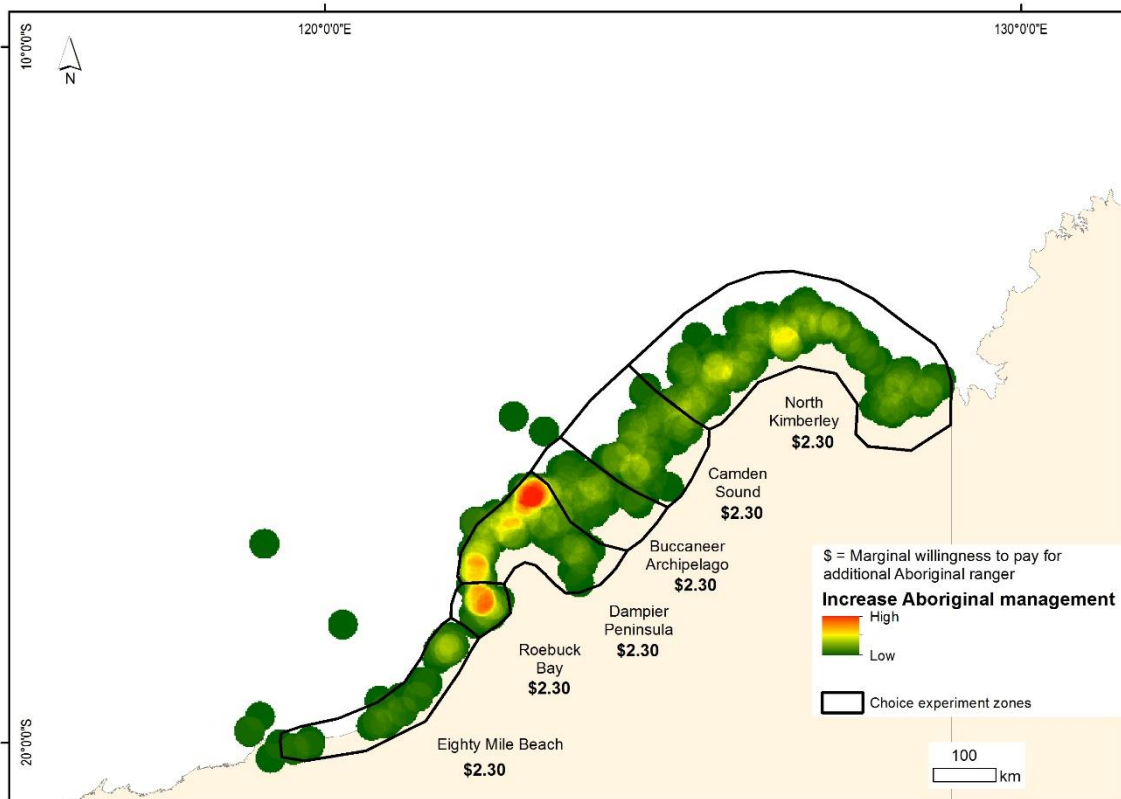


Figure 27. PPGIS point density map for 'Increase Aboriginal management' management preference (n=528) and the marginal annual willingness to pay estimated from the choice experiment for an increase in one Aboriginal ranger employed in that zone ($\$.ranger^{-1}.yr^{-1}$).

While the choice experiment did not reveal any specific spatial differentiation regarding the number of Aboriginal rangers, the concentration of PPGIS value and preference markers within the Dampier Peninsula zone warrants further attention. In this zone, Aboriginal culture and heritage was the most numerous mapped value, accounting for 18% of all value markers placed (Figure 28). In comparison, the preference to increase Aboriginal management accounted for 12% of all preference markers placed in the zone, behind the more frequently mapped preferences of ‘no oil/gas development’, ‘no new port development’ and ‘increase conservation/protection’ (Figure 29). It is evident that the Dampier Peninsula zone is important to respondents for its Aboriginal culture and heritage values. However, the management preference for more Aboriginal management seems to be crowded out by current ‘topical’ preferences. This may be a reflection of the current additional interest from the recent debate over oil and gas development along this coastline.

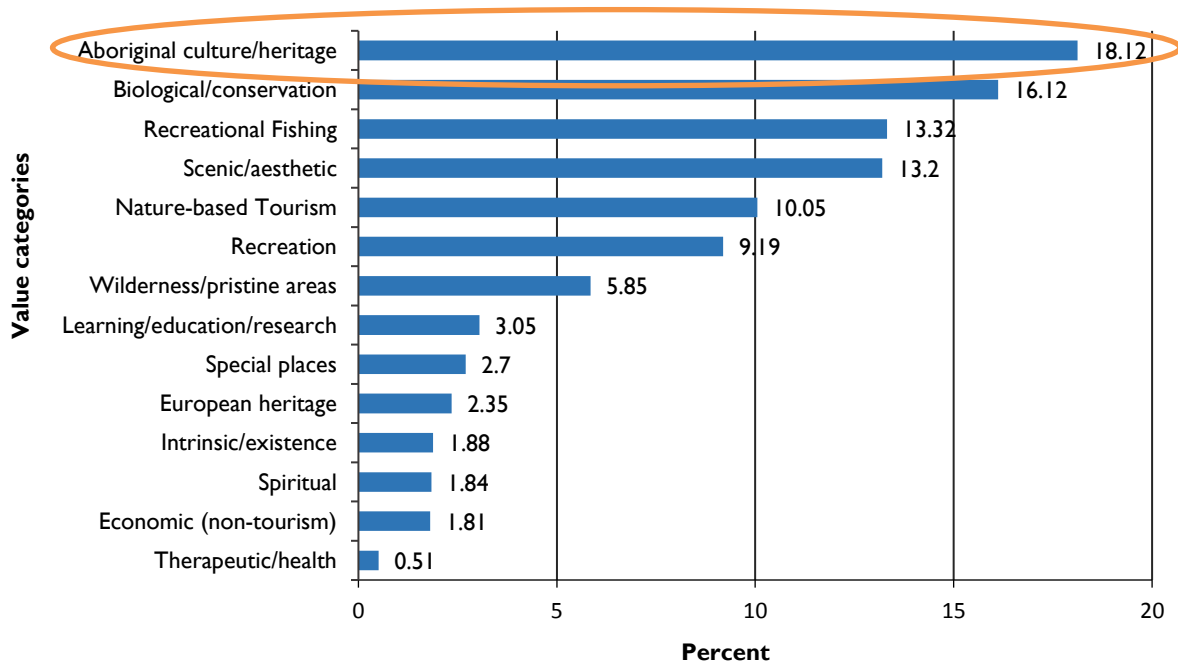


Figure 28. Distribution of PPGIS value markers placed in the Dampier Peninsula zone (n=3145).

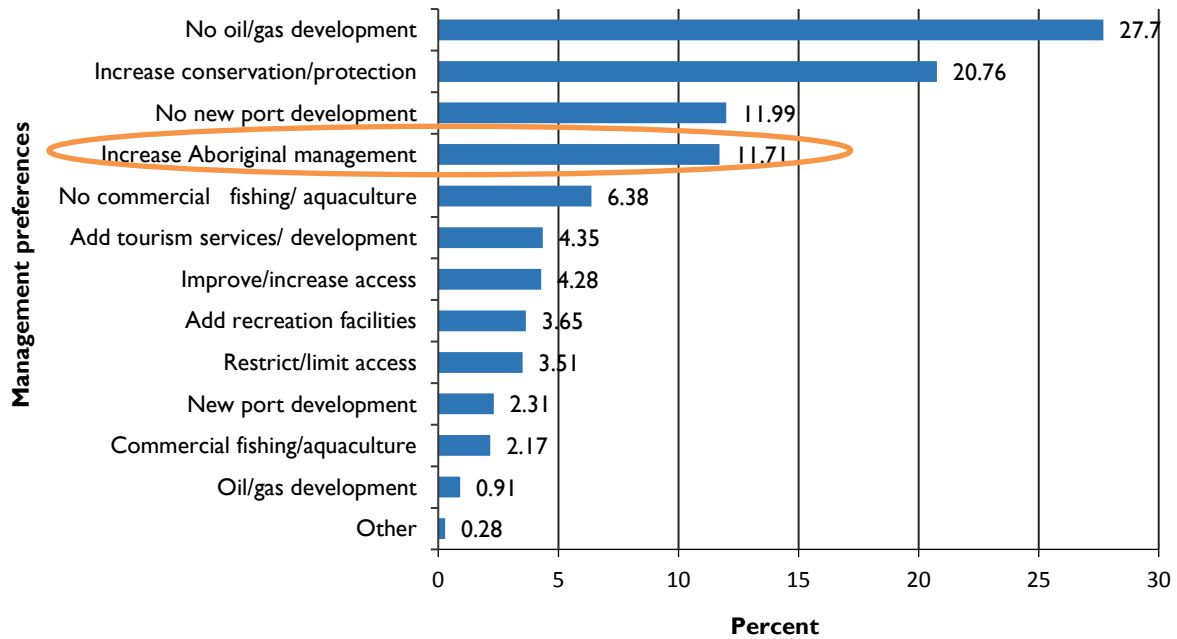


Figure 29. Distribution of PPGIS preferences markers placed in the Dampier Peninsula zone (n=1426).

Management implications: Aboriginal rangers

1. Aboriginal culture and heritage values are widespread across the study area and respondents are positively predisposed towards increasing Aboriginal management. This finding presents opportunities for a range of groups including the Department of Parks and Wildlife, Traditional Owners, Tourism WA and tourism operators to build upon and develop new conservation and tourism-related products that harness stakeholder interest in Aboriginal culture. With additional resourcing and training, Aboriginal ranger groups in particular present an ideal means of combining conservation, tourism and Aboriginal culture in a manner that will help to foster greater understanding of, and support for, cultural values and Aboriginal management of the coastline and marine environment.
2. The Dampier Peninsula has been a hotly contested area in recent years, with competing stakeholder interests polarized by proposed industrial development. The highlighting of Dampier Peninsula as a hotspot for Aboriginal culture and heritage re-emphasises the importance of involving Traditional Owners (and other Aboriginal people) in decision-making and management into the future.
3. The choice experiment showed that Aboriginal rangers were equally valued across all zones, suggesting the need for policy and management attention to this attribute along the entire Kimberley coastline. All zones are subject to both established and claimed Native Title interests over land and sea country, positioning Aboriginal management as pivotal to the immediate and long-term successful management of coastal and marine protected areas.

3.3.5 Choice experiment attribute: Coastal Development

Coastal development was the fourth choice experiment attribute, with respondents asked to consider the amount of visible small-scale coastal development they were willing to have occurring in a zone. Four PPGIS management preferences generally correspond to this particular choice attribute. Two of these may be classed as 'pro-development' preferences: 'oil/gas development' and 'new port development', while the remaining two represent 'pro-conservation' preferences: 'no new oil/gas development' and 'no new port development'. Roebuck Bay and Dampier Peninsula contain common hotspots for both 'pro-development' preferences

(Figures 30 & 31) and 'pro-conservation' preferences (Figures 32 & 33). This suggests that these zones are areas that may be characterised by potential conflict over proposed developments. It seems highly likely that recent controversial development proposals may have influenced the position of the PPGIS mapping hotspots. The latter 'pro-conservation' preferences were mapped more heavily in the PPGIS than were 'pro-development' markers (*cf.* Figure 21).

The fact pro-development markers were the least-mapped of all preference markers accords with the choice experiment results that showed respondents were averse to allowing some additional coastal development in all of the zones along the Kimberley coastline, and significantly more so with respect to coastal development in northern zones. Figure 32 shows the (negative) willingness to pay values for coastal development, with the associated map— no oil/gas development – chosen for illustrative purposes as no single PPGIS management preference category corresponded directly to the coastal development choice attribute.

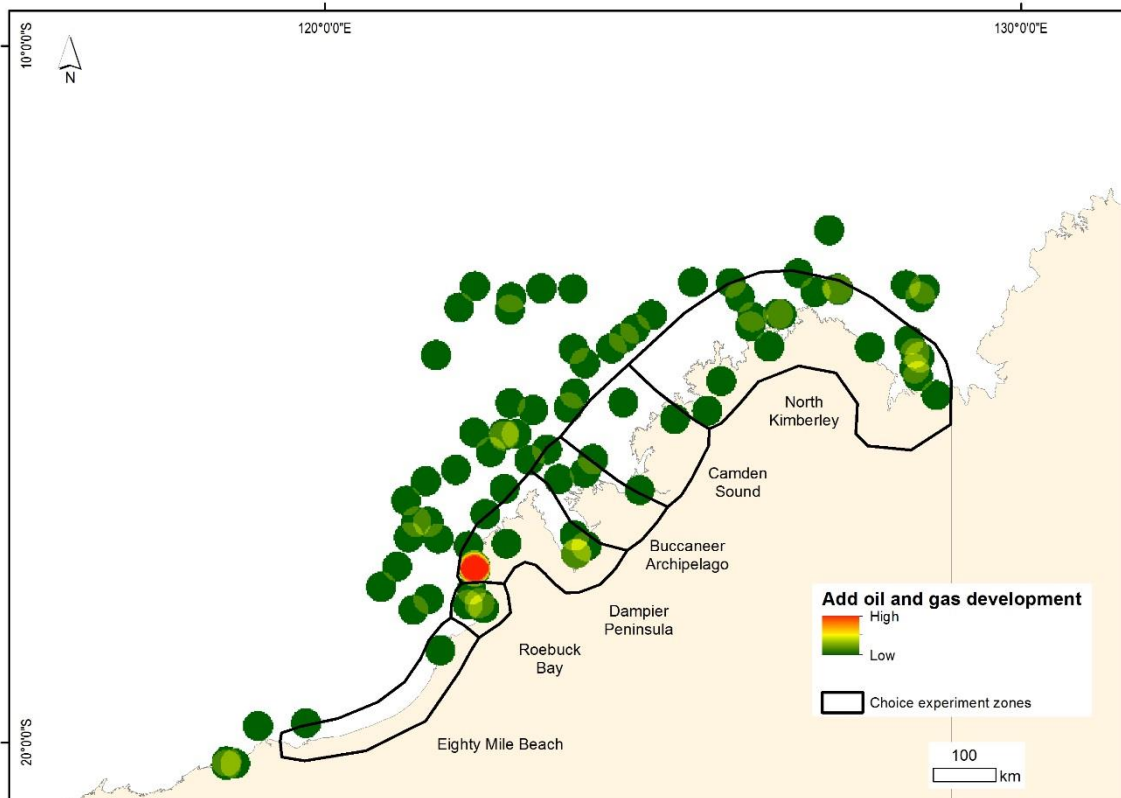


Figure 30. PPGIS point density map for 'Oil/gas development' management preference (n=127).

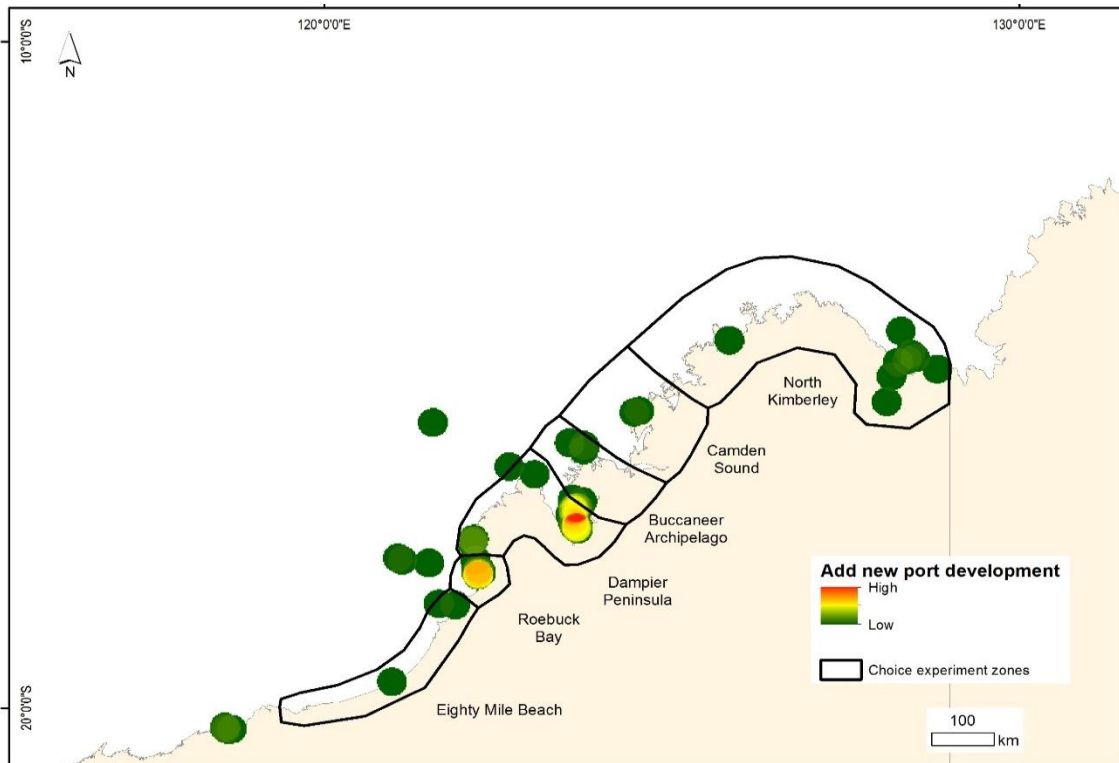


Figure 31. PPGIS point density map for 'New port development' management preference (n=92).

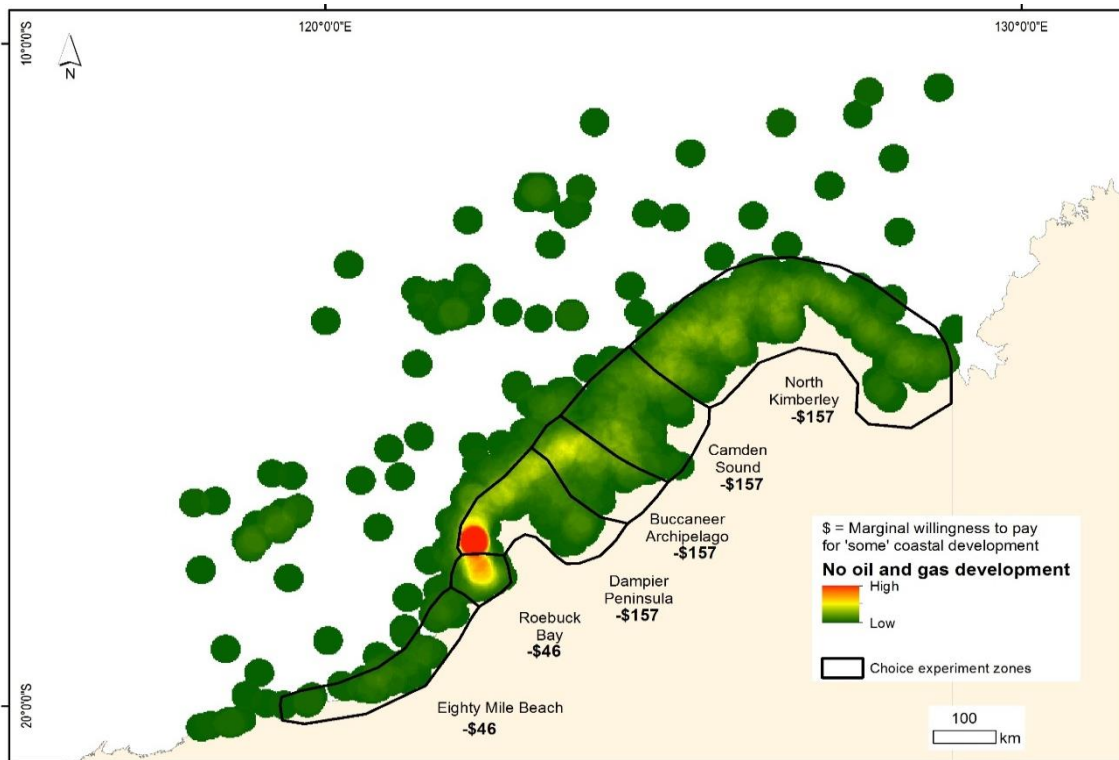


Figure 32. PPGIS point density map for 'No oil/gas development' management preference (n=1,273) and the marginal willingness to pay per year estimated from the choice experiment for allowing 'some' development to occur in that zone (expressed in $\$.yr^{-1}$, a negative willingness to pay indicates that respondents were, on average, averse to allowing 'some' development).

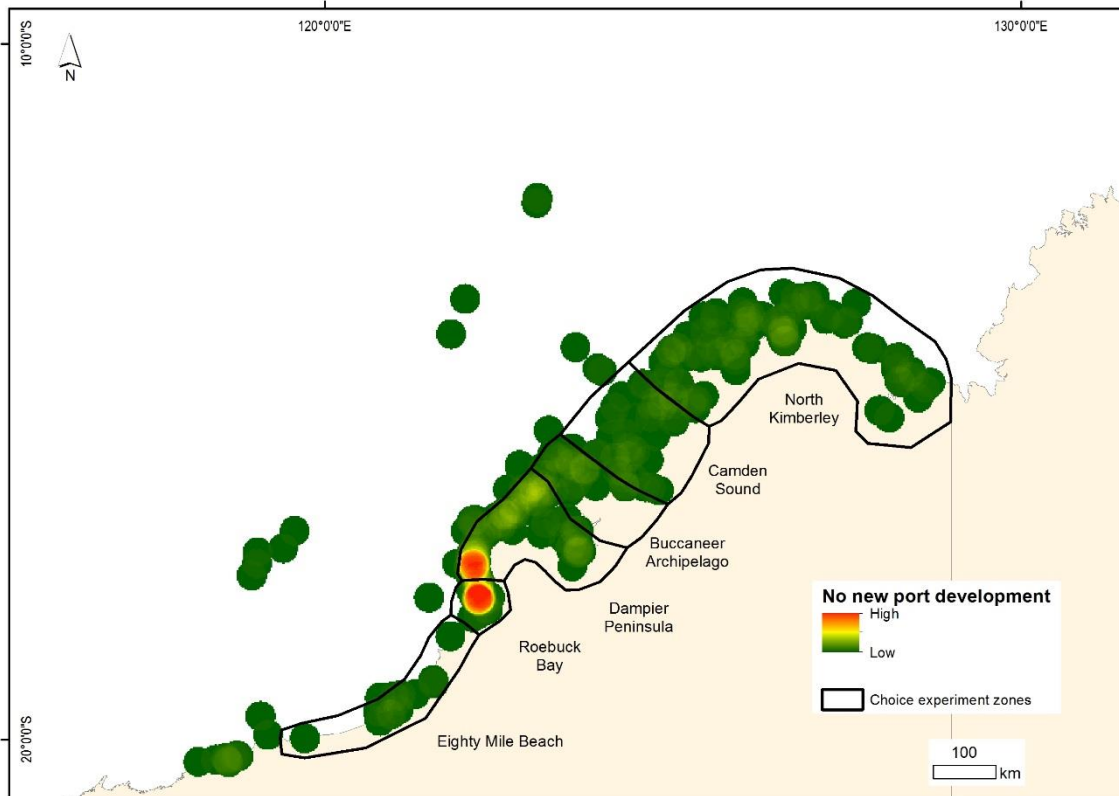


Figure 33. PPGIS point density map for 'No new port development' management preference (n=398).

Management implications: Coastal development

1. Concerns regarding coastal development are concentrated mainly within hotspots in the Roebuck Bay and Dampier Peninsula zones. These findings likely reflect recent development controversy in the Kimberley, with respondents making decisions based on the values held for those zones and perceived threats to those values. This suggests that responses to societal concerns within these contested zones must be developed on a case-by-case basis that is highly context-specific.

3.4 Joint management implications summary

The following implications are based on the integration of the PPGIS mapping and choice experiment modelling research results. As noted above, management implications from the individual research phases can be found in previous technical reports. The management implications in this final report are relevant to a broad range of end users including both those within the Department of Parks and Wildlife and external bodies. Within the Department of Parks and Wildlife, potential end users include both marine and terrestrial protected area planners, regional managers and operational managers, education officers and social scientists. Outside of Parks and Wildlife, this information will be of interest to Local Government Authorities, Traditional Owner groups and organisations, Regional Planning bodies, industry, tourism operators and bodies, and Government Departments including the Departments of Transport, Fisheries, Premier and Cabinet, and State Development, among others. The management implications from an integration of the PPGIS mapping and choice experiment modelling research results are:

1. The Kimberley coastline is valued for its use (e.g., recreation) and non-use (e.g. biological, bequest) values. Strong support exists for marine and coastal protection and conservation along the whole

coastline. Non-use values also include support for sanctuary areas as part of these conservation efforts. Of particular note is that non-use values, such as bequest and spiritual values, are held by residents and non-residents. Therefore, good planning must take both use and non-use values into account and emphasises the need to broadly define and engage with a wide range of stakeholders (both residents and non-residents) for planning and management purposes.

2. Dampier Peninsula and to a lesser extent, Roebuck Bay and the North Kimberley, are areas of particularly high value for Aboriginal culture, heritage and management. This positions these areas as high priorities for management attention to ensure that the broad suite of values associated with Aboriginal culture are adequately recognised and supported in both policy and planning.
3. While people value recreation, they may have low demand for improvement to or additional recreation facilities. For managers and planners this means careful consideration of the motivations behind proposals to increase recreational facilities in the region.
4. There is contestation over where development should take place. Roebuck Bay and the marine environment of Dampier Peninsula, as hotspots for both 'pro-development' and 'pro-conservation' preferences, are areas of potential development-related conflict.
5. Both PPGIS and choice experiment methods help planners and managers to understand the complex nature of human values that exist along the Kimberley coast. In particular, the two methods combined can provide rich detail on how particular places are valued and what management is preferred for these places into the future as well as a broad scale, regional overview of how decisions (trade-offs) regarding management outcomes are made.

4 Acknowledgements

The researchers gratefully acknowledge the contribution of research interviewees, online PPGIS and panel respondents and members of the Karajarri Traditional Lands Association.

5 Communication

5.1 Students supported

N/A

5.2 Journal publications

- Strickland-Munro, J., Kobryn, H., Brown, G., and Moore, S. (in press) Marine spatial planning for the future: Using Public Participation GIS (PPGIS) to inform the human dimension for large marine parks. *Marine Policy*.
- Brown, G, Strickland-Munro, J, Kobryn, H, Moore, SA (2016) Stakeholder analysis for marine conservation planning using Public Participation GIS. *Applied Geography* 67: 77-93. [doi:10.1016/j.apgeog.2015.12.004](https://doi.org/10.1016/j.apgeog.2015.12.004)
- Strickland-Munro J, Kobryn H, Moore, SA (in press) Valuing the wild, remote and beautiful: Using Public Participation GIS to inform tourism planning on the Kimberley Coast, Western Australia. *Special Issue of the International Journal of Sustainable Development and Planning* (March 2016)
- Pearce, J, Strickland-Munro, J, Moore, SA (in press) What contributes to awe-inspiring nature based tourism experiences? *Journal of Sustainable Tourism* (June 2016)

5.3 Proceedings/Technical Reports

- Strickland-Munro J, Kobryn H, Moore SA, Palmer D (2016a) Human values and aspirations for coastal waters of the Kimberley: Port Smith (Purnturpurntur) visitor survey. Technical Report 4. Kimberley Marine Research Program Node of the Western Australian Marine Science Institution, WAMSI, Perth, Western Australia. Available <http://researchrepository.murdoch.edu.au/30194/>
- Strickland-Munro J, Kobryn H, Moore SA, Brown G (2016b) Human values and aspirations for coastal waters of the Kimberley: Social values and management preferences using Public Participation GIS. Technical Report 2. Kimberley Marine Research Program Node of the Western Australian Marine Science Institution, WAMSI, Perth, Western Australia. Available <http://researchrepository.murdoch.edu.au/30129/>
- Spencer-Cotton A., Kragt M, Burton M (2016). Human values and aspirations for coastal waters of the Kimberley: Social values and management preferences using Choice Experiments. Technical Report 3. Kimberley Marine Science Program Node of the Western Australian Marine Science Institution. Available <http://www.wamsi.org.au/research-site/social-values>
- Strickland-Munro J, Moore SA, Kobryn H, Palmer D (2015) Values and aspirations for coastal waters of the Kimberley: social values and participatory mapping using interviews. Technical Report 1. Kimberley Marine Science Program Node of the Western Australian Marine Science Institution, WAMSI, Perth, Western Australia. Available <http://researchrepository.murdoch.edu.au/25482/>

5.4 Submitted manuscripts

- Brown, G, Strickland-Munro, J, Kobryn, H., Moore, SA (under review). Mixed methods participatory GIS: A review and evaluation of the validity of qualitative and quantitative mapping methods. *Applied Geography* (February 2016)
- Strickland-Munro J, Pearce J, Moore SA (under review). Review of social science research in marine and coastal environments with a particular emphasis on marine protected areas. *Ocean and Coastal Management* (March 2016)
- Moore, SA, Brown, G, Kobryn, H, Strickland-Munro, J (under review). Identifying conflict potential in a coastal and marine environment using participatory mapping. *Journal of Environmental Management* (April 2016)

5.5 Presentations

- Spencer-Cotton, A, Kragt, ME, Burton, M (2016) Implications of scale and scope for valuing management on the remote Kimberley coast, Western Australia. The 23rd Ulvon Conference on Environmental Economics, Ulvon, Sweden, 15-17 June 2016
- Strickland-Munro, J, Kobryn, H, Brown, G, Moore, SA (2016). Valuing the wild, remote and beautiful: Using Public Participation GIS to inform tourism planning on the Kimberley Coast, Western Australia. 7th International Conference on Sustainable Tourism, Valencia, 18-20 May 2016
- Strickland-Munro, J, Kobryn, H, Brown, G, Spencer-Cotton, A, Kragt, ME, Pearce J, Burton, M, Moore, S (2016). How do people value the Kimberley coast? Science on the Broome Coast Seminar Series, Broome, Western Australia, 6 April 2016
- Strickland-Munro, J, Kobryn, H, Brown, G, Spencer-Cotton, A, Kragt, ME, Pearce J, Burton, M, Moore, S (2016). How do people value the Kimberley coast? Department of Parks and Wildlife – West Kimberley region, Broome, Western Australia, 6 April 2016

- Strickland-Munro, J, Kobryn, H, Brown, G, Spencer-Cotton, A, Kragt, ME, Pearce J, Burton, M, Moore, S (2016). How do people value the Kimberley coast? Presentation to the Derby community, Derby Council Chambers, Western Australia, 5 April 2016
- Kragt, ME, Brown, G, Burton, M, Kobryn, H, Moore, SA, Spencer-Cotton, A, Strickland-Munro, J (2016) Estimating spatially explicit values for the Kimberley Coast. Invited presentation for South Australian branch of the Australian Agricultural and Resource Economics Society, University of Adelaide, Adelaide, 16 March 2016
- Kragt, ME, Spencer-Cotton, A, Burton, M (2016) Valuing remote wilderness – estimating spatially explicit values for the Kimberley coast. The 60th Australian Agricultural and Resource Economics (AARES) 2016 Annual Conference, 2-5 February 2016, Canberra ACT
- Spencer-Cotton, A, Kragt, ME, Burton, M (2016) Implications of geographical scope in valuing wilderness management in the Kimberley. The 60th Australian Agricultural and Resource Economics (AARES) 2016 Annual Conference, 2-5 February 2016, Canberra ACT
- Burton, M (2015) Spatially explicit discrete choice experiments: an application to coastal management in the Kimberley. Western Australia Seminar to the Environmental and Resource Economics Group, School of Social Sciences, University of Manchester, October 2015
- Moore, SA, Strickland-Munro, J, Kobryn, H, and Palmer, D (2015) Spatially explicit delineation of the social values of the Kimberley coastal and marine environment. WAMSI Research Conference, Perth, Western Australia, 30 March-1 April 2015
- Strickland-Munro, J, Moore, SA, Kobryn, H, Brown, G, Spencer-Cotton, A, Burton, M and Kragt, M (2015) Human values and aspirations for coastal waters of the Kimberley. Final Project Presentation. Department of Parks and Wildlife, Kensington, 15 December 2015
- Strickland-Munro, J, Moore, SA, Kobryn, H, and Palmer, D (2015) Mapping community values for the Kimberley coast. Water Corporation Environmental Masterclass, Leederville, Western Australia, 22 July 2015
- Strickland-Munro, J, Moore, SA, Kobryn, H, and Palmer, D (2015) “Whose values?” Mapping community values for the Kimberley coast. Chamber of Commerce and Industry Environment Committee, Perth, Western Australia, 26 May 2015
- Moore, S, Strickland-Munro, J, Kobryn, H, and Palmer, D (2014) “Whose values?” Mapping community values for the Kimberley coast. Parks for People Annual Parks Conference, KMSCS Kensington WA, 14-16 October 2014
- Pearce, J, Strickland-Munro, J and Moore, SA (2014) Why is the Kimberley coast so awe-some? International Tourism Studies Association Conference, WA Department of Parks and Wildlife, Kensington, WA, 26-28 November 2014
- Strickland-Munro, J, Kobryn, H, Moore, S, Palmer, D and Friedman, K (2014) Valuing the wild, remote and beautiful: Tourism on West Kimberley coast, Western Australia. International Tourism Studies Association Conference, WA Department of Parks and Wildlife, Kensington, WA, 26-28 November 2014
- Strickland-Munro, J, Moore, S, Kobryn, H, and Palmer, D (2014) Mapping and interpreting the social values of the Kimberley coast. Department of State Development, Adelaide Terrace, Perth, 6 August 2014
- Strickland-Munro J, Kobryn H, Palmer D, Moore SA (2014) Mapping and interpreting the social values of the Kimberley coast. WAMSI Seminar Series No. 1. Social Science Contributions to Marine Science. 18 June, CSIRO Floreat, WA

- Strickland-Munro J, Kobryn H, Palmer D, Moore SA (2014) Socio-cultural values of the Kimberley coast: Preliminary feedback. WA Department of Parks and Wildlife Head Office, Kensington, WA, 23 May 2014
- Strickland-Munro J, Kobryn H, Palmer D, Moore SA (2014) Socio-cultural values of the Kimberley coast: Preliminary feedback to Nyamba Buru Yaruwu, NBY offices, Broome, WA, 2 May 2014
- Strickland-Munro J, Kobryn H, Palmer D, Moore SA (2014) Socio-cultural values of the Kimberley coast: Preliminary feedback. WA Department of Parks and Wildlife West Kimberley District, District Office, Broome, WA, 2 May 2014
- Strickland-Munro J, Kobryn H, Palmer D, Moore SA (2014) Socio-cultural values of the Kimberley coast: Preliminary feedback. Broome community, Lotteries House, Broome, WA, 2 May 2014
- Strickland-Munro J, Kobryn H, Palmer D, Moore SA (2014) Socio-cultural values of the Kimberley coast: Preliminary feedback. Karajarri Rangers, Mangkuna, WA, 1 May 2014
- Strickland-Munro J, Moore SA (2014) Human values and aspirations for coastal waters of the western Kimberley. WAMSI, Floreat, WA, 15 January 2014
- Moore SA (2013) Human values and aspirations for coastal waters of the western Kimberley. Department of Premier and Cabinet, Perth, WA, 5 August 2014
- Moore SA, Strickland-Munro J, Palmer D, Rodger K, Kobryn H, Burton M, Kragt M, Smith A (2013) Human values and aspirations for coastal waters of the Kimberley. WAMSI North West Australia Symposium, WA Maritime Museum, Fremantle, 21 February 2013

5.6 Other communication achievements

- Anon. (2015) Have your say on future of coastline. Kimberley Echo. 16 April, Kununurra WA
- Anon. (2015) Kimberley Marine Science Program survey to quiz residents about favourite coastal spots. ABC Online. 13 April 2015, URL: <http://www.abc.net.au/news/2015-04-13/kimberley-residents-urged-to-nominate-favourite/6388850>
- Anon. (2015) What is the Kimberley worth? WAMSI Newsletter, April 2015, URL: <http://www.wamsi.org.au/news/what-kimberley-worth>
- Cordingley, G (2015) Views on coast surveyed. Yahoo! News. 26 April 2015, URL: <https://au.news.yahoo.com/thewest/a/27318755/views-on-coast-surveyed/>
- Cordingley, G (2015) Views on coast surveyed. Broome Advertiser. 23 April, Broome WA
- Strickland-Munro, J (2015) Values of the Kimberley coast. Goolari Radio. 14 April 2015, Perth WA
- Strickland-Munro, J (2015) Values of the Kimberley coast. ABC Local Radio Kimberley /Pilbara. 13 April, Perth WA
- Anon. (2014) Valuing the Kimberley: social science informs planning for marine parks. WAMSI Newsletter, October 2014, URL: http://www.wamsi.org.au/valuing-kimberley-social-science-informs-planning-marine-parks?utm_source=WAMSI+Bulletin&utm_campaign=57c2eb6ca4-October_WAMSI_Bulletin10_22_2014&utm_medium=email&utm_term=0_fc05a335bb-57c2eb6ca4-194371085
- Moore SA, Strickland-Munro J, Kobryn H, Palmer D (2014) Mapping social values of the Kimberley coast. Rangelands NRM newsletter. July, Broome, WA
- Moore SA, Strickland-Munro J (2013) Mapping social values of the Kimberley coast. Goolarri Radio. 10 September, Broome, WA

5.7 Knock-on opportunities created as a result of this project

- Career development: this project contributed to the postdoctoral development of J. Strickland-Munro, and to the research experience of A. Spencer-Cotton. The project has thus built capacity in Australia for social research in marine environments and these researchers possess the ability to provide an essential contribution to marine spatial planning.

5.8 Key methods for uptake

See Section 5.

6 Appendices

Appendix 1. Technical Report 1 (PDF provided separately). Also available from <http://researchrepository.murdoch.edu.au/25482/>.

Appendix 2. Technical Report 2 (PDF provided separately). Also available from <http://researchrepository.murdoch.edu.au/30129/>.

Appendix 3. Technical Report 3 (PDF provided separately). Also available from <http://www.wamsi.org.au/research-site/social-values>

Appendix 4. Technical Report 4 (PDF provided separately). Also available from <http://researchrepository.murdoch.edu.au/30194/>.